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Influence of Sulphur and Zinc Levels on Growth and Yield of (ZAID) Sunflower (*Helianthus annus* L.)

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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

Background: The field experiment was carried out during *Zaid* 2022 at 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 7.1), low in organic carbon (0.36 %), available N (171 kg/ha), available P (15.2 kg/ha) and available K (233 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: Sulphur 15 kg/ha + Zinc 0.2%, T_2: Sulphur 15 kg/ha + Zinc 0.3%, T_3: Sulphur 15 kg/ha + Zinc 0.4%, T_4: Sulphur 25 kg/ha + Zinc 0.2%, T_5: Sulphur 25 kg/ha + Zinc 0.3%, T_6: Sulphur 25 kg/ha + Zinc 0.4%, T_7: Sulphur 35 kg/ha + Zinc 0.2%, T_8: Sulphur 35 kg/ha + Zinc 0.3%, T_9: Sulphur 35 kg/ha + Zinc 0.4%, T_{10}: Control are used. The results

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showed that application of Sulphur 35 kg/ha + Zinc 0.4% recorded significantly higher plant height (111.00 cm), Number of leaves/plant (12.00), Stem Diameter (5.80 cm), Plant dry weight (55.99 g/plant), Seeds/capitulum (216.66), unfilled Seeds/capitulum (35.00), Test weight (62.57 g), Seed yield (1935.60 kg/ha), stalk yield (4942.4 kg/ha), Harvest index (56.07 %), gross returns (Rs.1,16,136.00/ha), net return (Rs.82,486.00/ha) and benefit cost ratio (2.45).

Keywords: Sulphur; zinc; sunflower; growth; yield attributes.

1. INTRODUCTION

"Helianthus is a genus comprising about 70 species of annual and perennial flowering plants in the daisy family Asteraceae commonly known as sunflowers" [1]. "Except for three South American species, the species of *Helianthus* are native to North America and Central America. The best-known species is the common sunflower (*Helianthus annuus*), whose round flower heads in combination with the ligules look like the Sun. This and other species, notably Jerusalem artichoke (*H. tuberosus*), are cultivated in temperate regions and some tropical regions, as food crops for humans, cattle, and poultry, and as ornamental plants. The species *H. annuus* typically grows during the summer and into early fall, with the peak growth season being mid- summer" (Natural Resources Conservation Service, 2019).

"Several perennial *Helianthus* species are grown in gardens, but have a tendency to spread rapidly and can become aggressive. On the other hand, the whorled sunflower, *Helianthus verticillatus*, was listed as an endangered species in 2014 when the U.S. Fish and Wildlife Service issued a final rule protecting it under the Endangered Species Act. The primary threats are industrial forestry and pine plantations in Alabama, Georgia, and Tennessee. They grow to 1.8 metres (6 feet) and are primarily found in woodlands, adjacent to creeks and moist, prairie-like areas" [2].

"Zinc is required in various metabolic processes as catalysts. Zinc also increases the content of protein, calorific value, amino acid and fat in oilseed crop Balanced fertilization helps to improve the quality of the produce. Zinc entered into the constituents of enzyme system that regulate initial metabolic reactions in the plants body. Zinc catalyses the process of oxidation in plant cells and is vital for the transformation of carbohydrates. It regulates the consumption of sugars and increases the source of energy for the production of chlorophyll. Zinc also aids in the formation of auxin and synthesis of protein" [3].

Bio-fertilizers are known to play a variety of important functions in soil fertility, crop productivity, and agricultural production since they are environmentally friendly, but they cannot, at any cost, replace chemical fertilizers, which are required for maximum crop yields. They supplement chemical fertilizers in addressing crops' integrated nutritional demand. Bio-fertilizers promote mineral and water intake, root development, vegetative growth, and nitrogen fixation. Bio-fertilizers provide an economically appealing and environmentally sound way of lowering external inputs while enhancing crop quality and quantity. They contain microorganisms capable of mobilizing nutritional components from unavailable to available forms via various biological processes.

2. MATERIALS AND METHODS

The experiment was conducted to know the effect of different doses of bio-fertilizers and foliar application of zinc on growth and yield attributes of Sunflower variety SRISHTI 5272 was carried out at Crop Research Farm of Sam Higginbottom University, Prayagraj, Uttar Pradesh during 2022. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171 kg/ha), available P (15.2 kg/ha) and available K (233 kg/ha). The experiment was laid out in a RBD consisting of Ten treatments including Control with 3 replications, with the treatment combinations T_1: Sulphur 15kg/ha + Zinc 0.2%, T_2: Sulphur 15kg/ha + Zinc 0.3%, T_3: Sulphur 15kg/ha + Zinc 0.4%, T_4: Sulphur 25kg/ha + Zinc 0.2%, T_5: Sulphur 25kg/ha + Zinc 0.3%, T_6: Sulphur 25kg/ha + Zinc 0.4%, T_7: Sulphur 35kg/ha + Zinc 0.2%, T_8: Sulphur 35kg/ha + Zinc 0.3%, T_9: Sulphur 35kg/ha + Zinc 0.4%, T_{10}: Control are used.

3. RESULTS

At harvest, there was significant difference among the treatments. However, highest plant height (111.00 cm) was recorded with the application of Sulphur 35kg/ha + Zinc 0.4% followed y treatment with Sulphur 35kg/ha + Zinc 0.3% (110.5 cm) and Sulphur 35kg/ha + Zinc 0.2% (109.5 cm) and Sulphur 25kg/ha + Zinc 0.4% (108.00 cm) whereas comparatively lesser plant height was recorded with the treatment Sulphur 15kg/ha + Zinc 0.2% (96.0 cm) and Control (88.6 cm). The highest stem diameter (5.80) was recorded with the application of Sulphur 35kg/ha + Zinc 0.4% while significantly lower stem diameter was recorded with the treatment viz., Sulphur 15kg/ha + Zinc 0.2% (4.40 cm) and Control (4.10 cm). Treatment with Sulphur 35kg/ha + Zinc 0.3% (5.80 cm) and Sulphur 35kg/ha +Zinc 0.2% (5.65 cm) were statistically at par with treatment Sulphur 35kg/ha + Zinc 0.4%.

The treatments differed significantly from one another. However, the application of Sulphur 35kg/ha + Zinc 0.4% resulted in the maximum plant dry weight (55.99 gm). In contrast, the treatment Sulphur 15 kg/ha + Zinc 0.2% (51.52 gm) and Control both reported the lowest plant dry weight (47.14 gm). Treatments viz., Sulphur 35 kg/ha + Zinc 0.3% (55.93 gm) and Sulphur 35 kg/ha + Zinc 0.2% (55.68 gm) were statistically equivalent to treatment Sulphur 35kg/ha + Zinc 0.4%.

Significantly maximum seeds per capitulum (216.00) was recorded with the treatment of application of Sulphur 35kg/ha +Zinc 0.4% over all the treatments. However, the treatments Sulphur 35kg/ha +Zinc 0.3% (213.26) and Sulphur 35kg/ha +Zinc 0.2% (209.68) which was found to be statistically at par with Sulphur 35kg/ha +Zinc 0.4%.

Significantly Maximum unfilled seeds per capitulum (37.00) was recorded with the treatment of application of Sulphur 15kg/ha + Zinc 0.2% over all the treatments. However, the treatments Sulphur 15kg/ha +Zinc 0.3% (36.59) and Sulphur 15kg/ha +Zinc 0.4% (36.58) which was found to be statistically at par with Sulphur 15kg/ha + Zinc 0.2%. Significantly Maximum Test weight (62.57 gm) was recorded with the treatment of application of Sulphur 35kg/ha + Zinc 0.4% over all the treatments. However, the treatments Sulphur 35kg/ha + Zinc 0.3% (62.31 gm) and Sulphur 35kg/ha + Zinc 0.2% (59.61 gm) which was found to be statistically at par with Sulphur 35kg/ha + Zinc 0.4%.

4. DISCUSSION

Significant increase in number of silique/spike is due to increase in the availability of Nitrogen through biofertilizer inoculation by which more spikelets are produced due to increased rates of spikelets production, similar result was recorded by Hadiyal et al. [4].

Zinc plays a crucial role in a myriad of physiological and metabolic processes such as the synthesis of tryptophane and used to produce growth harmones (auxins) such as IAA. Similar findings was reported by Swaroop and Debbarma [5].

“The greater photosynthesis production of metabolites and enzymatic activities due to the vermicompost application might have influenced into increased and extensive root system and the greater production of metabolites and their translocation to various sinks especially the productive structures (Silique and seeds) could have helped to increase into the number of Silique per plant besides increasing the overall growth. The inoculation of bacterial preparation accelerates plant growth provide biologically fixed nitrogen to the inoculated plant and also stimulate plant growth by excreting plant growth promoting substances like auxins, kinetins, vitamins and gibberellins” [6]. “The increase in seed and stover yields might be due to increased growth and yield attributes. This might be due to adequate and steadily supply of all nutrients to plants at all stages of crop growth. This corroborates the earlier report of” [7] and [8]. Sulphur increases the amount of oil seeds while also improving crop quality, color, and uniformity. Sulphur application promotes photosynthetic activity and protein synthesis. According to Sarkar and Mallick [9], Sulphur has a positive effect on yield attributes due to proper photosynthate partitioning from source to sink. Sulphur addition boosted leaf chlorophyll content and resulted in a substantial positive connection between chlorophyll content in leaf and crop output. This was reported by Kumar et al. [10] reported that “higher yield and oil content with increased application of sulphur enzyme synthesis as it is a constituent of sulphur containing amino acids namely methonine, cysteine, and cystine”.

Table 1. Effect of sulphur and zinc levels on growth of sunflower

Treatments	Plant Height	Stem Diameter	Dry weight	Seeds/capitulum	Unfilled seeds/capitulum	Test weight
T_1	83.0	4.40	51.52	205.52	37.00	55.00
T_2	88.2	4.40	52.49	206.61	36.59	56.19
T_3	89.3	4.70	52.87	206.87	36.58	56.35
T_4	90.0	4.90	53.52	207.52	36.42	57.48
T_5	91.0	5.20	53.55	207.55	36.17	59.14
T_6	95.0	5.40	54.74	208.74	36.00	59.37
T_7	96.5	5.60	55.68	209.68	35.49	59.61
T_8	97.0	5.65	55.93	213.26	35.21	62.31
T_9	98.0	5.80	55.99	216.66	35.00	62.57
T_{10} (Control)	75.6	4.10	47.14	201.14	37.00	51.32
F – Test	S	S	S	S	S	S
Se M(±)	1.34	0.07	0.65	2.55	0.56	1.06
CD (p=0.05)	3.98	0.20	1.94	7.59	1.67	3.16

5. CONCLUSION

It is concluded that application of Sulphur 35kg/ha + Zinc 0.4% was recorded significantly higher plant height (111.0 cm), seed yield (1935.60 kg/ha), and benefit cost ratio (2.45) as compared to other treatments. Since, the finding based on the research done in one season, it has to test verified.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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