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Effect of micronutrients on growth and yield of sunflower (*Helianthus annus* L.) Variety DRSH-1

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Abstract
A field experiment was carried out during the *Zaid* season of 2021 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.). Foliar application of different micronutrients (zinc, iron and boron) either single or with combinations were applied. The experiment was laid out in Randomized Block Design with eight treatments replicated thrice. The application of treatment NPK + B @ (0.3%) + Zn @ (0.5%) was found significantly higher in Plant height (223.53 cm), dry weight (59.67 g/plant) and crop growth rate (14.14 g/m2/plant), as compared to other treatments. Maximum number of seed yield (1036.67 kg/ha), stover yield (28.91 t/ha) and test weight (37.33 g) were found significantly higher with the application of treatment NPK + B @ (0.3%) + Zn @ (0.5%). Maximum Gross return (1,03,933 ₹/ha), Net return (80,736.35 ₹/ha) and B: C ratio (3.48) were recorded in treatment with application of treatment NPK + B @ (0.3%) + Zn @ (0.5%). From the findings of present study, it is concluded that application of Treatment No. 7: NPK + B @ (0.3%) + Zn @ (0.5%) as compared to other treatments among all other treatments has given the best results for growth and yield of sunflower. Therefore, application of NPK + B @ (0.3%) + Zn @ (0.5%) will improve growth and yield of sunflower as a result of which the growers will be economically benefited.

Keywords: Sunflower, micronutrients, zinc, boron

Introduction
Sunflower (*Helianthus annus*) is grown as an oilseed crop worldwide in temperate and subtropical climates in 72 countries. Among oilseeds, sunflower generally ranks fifth behind soybean, rapeseed, cottonseed, and peanut, with an average annual world production of 32–44 million tonnes. Sunflower is an important oilseed crop in India popularly known as "Surajmukhi." It belongs to the family Compositeae. Sunflower crop was introduced to India during 1969 as a supplement to introduce oilseed crops to bridge the gap of recurring edible oil shortage in the country (Shankergoud *et al.,* 2006). Karnataka ranks first both in area (0.462 Mha) and production (1.052 Mt) of sunflower in the country (Kumar *et al*., 2010) [10].

Sunflower is an important oil seed crop of the world and it ranks third in production next to groundnut and soybean. In India oil seeds crop occupy an area of 32.4 million hectares with 28.2 million tonnes of production registering a productivity levels of 1041 kg ha-1. About 14 million persons are engaged in production and another one million in processing of oil seeds (Sonnad *et al.,* 2011). It is one of the fastest growing oilseed crops in India and is cultivated over an area of about 5.2 lakh hectares with a production of 3.35 lakh tones and a productivity of 643 kg per hectare.

Sunflower seed is highly nutritious containing about 20% protein and 40 to 50% vegetable oil associated with a very high calorific value. The oil is considered to be of high quality due to its non- cholesterol properties and has been recommended for the patient having heart problem. It contains 60to 73% linoleic acid, with sufficient amount of calcium, iron and vitamins like A, B, E and K (Rajendra *et al*., 2013).

The lower yield of sunflower is mainly due to lack of high yielding varieties, its cultivation on marginal lands with inadequate nutrients, non- adoption of proper crop rotation and weed management practices. Hence, there is an urgent need to work out a suitable Agro-production technology to explore potentiality of sunflower to meet the increasing demand of hybrid seed. The commercial yield in sunflower is the product of interaction between three important components *viz.*, seed, nutrients and climatic conditions.

In this interaction seed plays a decisive role and it is therefore, necessary to use seeds of high quality and genetic purity. Organic agricultural practices aim to enhance biodiversity, biological cycles and soil biological activity so as to achieve optimal natural systems that are socially, ecologically and economically sustainable (Samman *et al*., 2008).

Application of micronutrients plays a major role in increasing seed setting percentage and influence growth and yield (Kumbhar *et al.,* 2017) [11]. There are positive effects of micronutrient application on the growth of sunflower, in terms of plant height, number of leaves and dry matter production per plant (Siddiqui *et al*., 2009) [22]. The commercial cultivation of sunflower started in India during 1972-73 with a few imported varieties from USSR and Canada. Now, the crop has been well accepted by the farming community because of its desirable attributes such as short duration, photo period insensitivity, adaptability to wide range of soil and climatic conditions, drought tolerance, lower seed rate, higher seed multiplication ratio and high quality of edible oil. Now, India has emerged as second major sunflower producing country in Asia after China (Han *et al.,* 2007**).**

The heads consist of many individual flowers which mature into seeds on a receptacle base (Seghatoleslami *et al*., 2012). To ameliorate seed filling problems and for increasing seed yield and quality in sunflower, several approaches including application of micro nutrients have been suggested. Area under this crop is gradually decreasing due to its inherent problems like improper seed filling, low seed yield per hectare and non-availability of quality seed for seed production. Therefore, there is a need to circumvent these problems by using modern techniques like adequate mother plant nutrition, application of micro nutrients like boron, sulphur and zinc in combination with major nutrients to mitigate the problem of poor setting and seed yield. Boron, as a foliar spray was found to increase thousand seed weight and seed oil content (Kastori and Grujie, 1992).

Zinc has emerged as an indispensable nutrient for plant growth. It is involved in the bio- synthesis of plant hormone, Indole Acetic Acid (IAA) and is a component of variety of enzymes. It plays an important role in nucleic acid and protein synthesis and helps in utilization of phosphorous and nitrogen as well as seed formation and development. Soil application of zinc at the rate of four kg per ha at the time of sowing increased the leaf area index, crop growth rate, net assimilation rate and seed yield in sunflower (Sarkar *et al*., 1998).

Though the sunflower crop has the yield potential of around 2.3 to 2.5 tonnes per hectare under favourable conditions, mean productivity level in India is only 0.6 tonnes per hectare. One of the main reasons for low productivity of sunflower is poor seed setting and high per cent of chaffy seeds in the center 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. Hence, seed yield can be increased by the application of micronutrients. Among micronutrients, boron is known to play an important role in seed setting and yield of sunflower. Boron can influence photosynthesis and respiration and activate a number of enzymatic systems of protein and nucleic acid metabolism in plants (Kibalenko, 1972). It also stimulates germination of pollen tubes which results in better fertilization and higher seed set in sunflower (Johri and Vasil, 1961).

Materials and Methods

The experiment entitled "Effect of micronutrients on growth and yield of Sunflower (*Helianthus annus* L.) Variety DRSH-1" was carried at Crop Research Farm, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 2021. All the facilities necessary for cultivation, including labour were made available in the department. The experiment was laid out in a Randomized Block Design with ten treatments and three replications *viz.* T1 -Control, T2- NPK + B @ (0.3%), T3- NPK + Fe @ (0.5%), T4- NPK + Zn @ (0.5%), T5- NPK + B @ (0.3%) + Fe @ (0.5%), T6- NPK + Fe @ (0.5%) + Zn @ (0.5%, T7- NPK + B @ (0.3%) + Zn @ (0.5%), T8- NPK + B @ (0.3%) + Fe @ (0.5%) + Zn @ (0.5%),

Applied during the research work on Sunflower. The foliar application was done at 30 and 50 DAS (Days after sowing). Five healthy plants were randomly selected from each plant at full maturity stage to record the various developmental parameters of the plants.

The method employed during the course of investigation and materials utilized have greater significance in the research program. The details of materials used and technique employed in carrying out the investigation described under the following heads.

Results and Discussion

The results obtained from present investigation have been summarized as below:

1). Growth Parameters

1. **Plant height (cm):** The perusal of the data in (table 1) revealed the significant effect of foliar application of micronutrients in singular and combined dose on plant height (cm) of sunflower at 80 DAS. Maximum value for plant height (223.53 cm) was observed with T7 NPK + B @ (0.3%) + Zn @ (0.5%). It was reported by Farokhi *et al.* (2014) that the beneficial effect of zinc on plant height may be due to its essential for synthesis of proteins and auxins in plants and it activates many enzymes such as proteinase and peptidases
2. **Dry Matter Accumulation (g):** The perusal of the data in (table 1) revealed the significant effect of foliar application of micronutrients in singular and combined dose on dry matter accumulation (g) of sunflower at 80 DAS. Maximum value for dry matter accumulation (59.67 g) was observed with T7 NPK + B @ (0.3%) + Zn @ (0.5%). Micronutrients like zinc and boron are involved in nitrogen fixation and translocation into parts, which might have led to higher dry matter production Elayaraja *et al.* (2014). Dry matter production is a function of leaf area and its activity. Sarmah *et al.* (1992) opined that increased leaf area per plant would contribute to higher dry matter production and seed yield. Similar results were reported by Kastori and Gurjie (1992); Renukadevi *et al*. (2003); Chowdhary *et al.* (2010)
3. **Crop Growth Rate (g/m2/day):** The perusal of the data in (table 1) revealed the significant effect of foliar application of micronutrients in singular and combined dose on crop growth rate (g/m2/day) of sunflower at 80 DAS. Maximum value for crop growth rate (14.14 g/m2/day) was observed with T7 NPK + B @ (0.3%) + Zn @ (0.5%). The increase in chlorophyll content and higher photosynthesis may promote the increase in CGR due to better accumulation of dry matter.

2). Yield Attributes

The perusal of the data in (table 2) revealed the significant effect of foliar application of micronutrients in singular and combined dose on yield parameters of sunflower, *viz.* test weight (g), head diameter (cm), head weight (g), Seed yield (kg/ha) and Stover yield (t/ha) and harvest yield (%) of sunflower. The application of T7 NPK + B @ (0.3%) + Zn @ (0.5%) resulted in significantly highest test weight (37.33 g)**,** head diameter (11.07 cm)**,** head weight (39.13 g)**,** seed yield (1036.67 kg/ha), stover yield (28.91 t/ha) and harvest Index (6.87%).

Zinc and boron play a very important role in quantitative and qualitative development of plants which results in higher seed weight. Baloch *et al*. (2015), application of zinc promotes reproduction and development of seed Sepehr *et al.* (2002). Sunflowers are sensitive to boron deficiency in soils and the yield of sunflower drastically reduced when there is poor supply of boron Schuster and Stephenson (1940). With the efficient amount of boron supplied we can assume that it helps in the progression of the plant's biological features and yield. Farokhi *et al.* (2014) reported that consumption of FeSO4, ZnSO4 and boron either single or combined had optimistic effect on plant height and head diameter. Similar findings were also reported by Chowdhary *et al.* (2010); Malla Reddy *et al.* (2011); Hadi F *et al*. (2014); Sudarsan and Ramaswamy (1993)

3). Economics

Maximum benefit cost ratio (3.48) was recorded in T7 NPK + B @ (0.3%) + Zn @ (0.5%).

Table 1: Effect of micronutrients on growth parameters of sunflower at 80 DAS

S. No	Treatments	Plant Height (cm)	Dry Matter Accumulation (g)	Crop Growth Rate (g/m2/day)	Relative Growth Rate (g/g/day)
1	Control (80:40:40) Kg/ha	187.37	35.27	7.55	0.01
2	NPK + B (0.3%)	185	42.63	8.5	0.02
3	NPK + Fe (0.5%)	191.07	45.53	8.83	0.02
4	NPK + Zn (0.5%)	213.9	50	12.76	0.02
5	NPK + B (0.3%) + Fe (0.5%)	191.67	43.8	10.62	0.02
6	NPK + Fe (0.5%) + Zn (0.5%)	194.33	38.33	9.29	0.02
7	NPK + B (0.3%) + Zn (0.5%)	223.53	59.67	14.14	0.02
8	NPK + B (0.3%) + Fe (0.5%) + Zn (0.5%)	191.07	45.1	7.95	0.01
	F-test	S	S	S	NS
	S.Ed (+)	10.72	6.06	1.99	-
	CD at 5%	23.00	12.99	4.26	-

Table 2: Effect of micronutrients on yield attributes of sunflower

S. No	Treatments	Test Weight (g)	Head Diameter (cm)	Head Weight (g)	Seed Yield (Kg/ha)	Stover Yield (t/ha)	Harvest Index (%)	Benefit Cost Ratio (B:C)
1	Control (80:40:40) Kg/ha	30.33	8.93	19.73	546.67	20.36	2.38	1.38
2	NPK + B (0.3%)	32.33	9	20.2	706.67	17.73	2.96	2.05
3	NPK + Fe (0.5%)	33.33	9.4	23.8	833.33	19.15	4.71	2.55
4	NPK + Zn (0.5%)	35	10.23	30.03	1003.33	25.47	4.75	3.35
5	NPK + B (0.3%) + Fe (0.5%)	30.33	9.73	25	650	25.28	2.40	1.74
6	NPK + Fe (0.5%) + Zn (0.5%)	33.67	9.47	26.47	690	16.79	3.65	1.93
7	NPK + B (0.3%) + Zn (0.5%)	37.33	11.07	39.13	1036.67	28.91	6.87	3.48
8	NPK + B (0.3%) + Fe (0.5%) + Zn (0.5%)	33.33	8.4	21.8	793.33	19.46	4.84	2.34
	F-test	S	S	S	S	S	S	
	S.Ed (+)	1.51	0.49	4.17	105.89	3.51	1.23	
	CD at 5%	3.25	1.05	8.95	227.12	7.54	2.64	

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Conflict of Interest

As a Corresponding Author, I, Nzan Lotha, confirm that none of the others have any conflicts of interest associated with this publication.

Conclusion

From the present investigation it is concluded that for obtaining higher yield in Sunflower during Zaid season, T7 NPK + B @ (0.3%) + Zn @ (0.5%) recorded the yield and was found more productive with maximum net returns and B:C ratio of 3.84.

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