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EFFECT OF APPLICATION OF MICRONUTRIENTS ON YIELD ATTRIBUTES AND ECONOMICS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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ABSTRACT

A field trial was conducted during the pre-*rabi*, 2024 at Experimental Farm, Agronomy section, ATS, Latur, M.H., to evaluate the effect of soil and foliar application of micronutrients on growth and yield of sunflower (*Helianthus annnus* L.). The experimental field was laid out in a Randomized Block Design (RBD) with eight treatments replicated three times. The treatments were T_1- Control, T_2- 100 % RDF (90:45:45 kg NPK kg/ha), T_3- RDF + soil application of $ZnSO_4$ @ 25 Kg/ha, T_4- RDF + soil application of Borax @ 5 Kg/ha, T_5- RDF + foliar application of 0.5% $ZnSO_4$ at head formation, T_6- RDF + foliar application of 0.2% Borax at head formation, T_7- RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha and T_8- RDF + foliar application of 0.5% $ZnSO_4$ + 0.2% Borax at head formation. Highest yield attributes *viz.* number of filled seeds plant^{-1} (888), seed yield plant^{-1} (48.10 g), seed yield (1975 kg ha^{-1}), stalk yield (3434 kg ha^{-1}), biological yield (5409 kg ha^{-1}) and harvest index (36.51 %) were recorded by the application of treatment RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha (T_7). The highest GMR (140036 ¹ /ha), NMR (88817 ¹ / ha) and B:C (2.73) ratio was obtained with application of treatment RDF + soil application of $ZnSO_4$ @ 25 Kg/ ha + Borax @ 5 Kg/ha (T_7).

Key words : Sunflower, Zinc, Boron, Foliar application, Yield, Economics.

Introduction

Sunflower, also known as 'Surajmukhi, is a familiar plant in India. It has been used as an ornamental plant for quite a sometime. It belongs to *Compositae* family and is a day-neutral, short duration, drought, and salinity tolerant oilseed crop. With roughly 20% protein and 40–50% vegetable oil, sunflower seeds are incredibly nutrient rich and have a high calorific value. The oil is believed to be of high quality due to its non-cholesterol properties and has been recommended for the patient having heart problem. Oil is also utilized in the production of soaps and cosmetics. The oil cake has 40-44% high-quality protein. It is great for poultry and animal rations. It can also be used to make infant food. Seeds can be consumed raw or roasted. It contains 60 to 73% linoleic acid, with adequate amount of calcium, iron and vitamins like A, B, E and K (Rajendra *et al.*, 2013).

Globally India ranks 14th in sunflower production (0.2%), Russia being 1st with 32% of global production. (FAS, USDA, 2024). In Maharashtra sunflower is grown over an area of 0.0061 M ha with 0.0024 M t of production and 386 kg/ha of yield during 2023-24. (DOD, 2024).

One of the main agronomic elements influencing sunflower oil and achene productivity is nutrient management. Particularly in the production of sunflowers, farmers have historically overused N, P, and K fertilizers but neglected the use of micronutrients. Poor seed setting and a large percentage of chaffy seeds in the capitulum's center are two major causes of sunflowers' low output.

Due to their impact on growth and yield components, micronutrients have been found to be crucial in raising the seed setting percentage in sunflowers. Boron promotes pollen tube germination, resulting in enhanced fertilization and seed set in sunflowers (Johri and Vasil, 1961). Therefore, applying micronutrients can boost seed production. The most common issue causing significant losses in crop yield seems to be micronutrient deficiencies. The use of micronutrients has a significant impact on seed setting percentage, as well as growth and production. (Kumbhar *et al*., 2017). Micronutrient application has a positive influence on sunflower growth, including plant height, leaf number, and dry matter production per plant (Siddiqui *et al*., 2009). The most common micronutrient deficiency in a wide range of soils is of zinc. (Graham *et al.,* 1992 and Cakmak *et al.,* 1996). Plants grown in zinc-deficient soils are more vulnerable to environmental stress, which in turn promote the development of deficiencies and result in stunted growth. Because it has been noted that applying zinc greatly improves sunflower production and quality, the zinc deficiency should be taken into consideration (Murthy *et al*., 1999). Boron deficiency has also been identified in India alongside zinc. In certain areas of India, lack of boron is becoming a major obstacle to sustainable agricultural productivity. Applying sufficient and balanced amounts of zinc and boron to oilseed crops is necessary (Rex Immanuel *et al*., 2019b and 2019c).

Since 1950, foliar fertilizer application has been a popular practice among farmers. Foliar feeding is application of nutrients directly to the aerial parts which are absorbed by stomata or epidermis. Foliar fertilizer application is both effective and economical. The goal is not to replace soil fertilizers, but to deliver plant nutrients during their critical growth stages. When nutrient deficiencies cannot be rectified through soil application, foliar fertilization can be a good alternative. In recent studies it is found that micronutrients like Zn, Fe, B and Mn can be used for foliar spraying to enhance crop yield. The application of nutrients by foliar fertilization boosts yield and improves crop product quality. Nutrient foliar feeding boosts nutrient uptake or may even improve root absorption.

Materials and Methods

The experiment was conducted during pre-*rabi* season, 2024-2025 at Agriculture Technology School, Latur which is situated on an elevation of 631 m above the mean sea level, between 17°52' N to 18°50' N and 76°18' E to 79°12' E comes under semi-arid region of Maharashtra state. The soil of experimental plot was clayey in texture with chemical composition such as low in available nitrogen (242.61 kg ha^{-1}), medium in available phosphorous (18.56 kg ha^{-1}) and very high in available potassium (396.72 kg ha^{-1}). The soil was slightly alkaline in reaction and having pH 7.64. low in available zinc (0.54 ppm) and boron (0.14 ppm). The present experiment was laid out in Randomized Complete Block Design with three replications. The allotment of treatments to various plots in each replication was done by randomization. T_1- Control, T_2- 100 % RDF (90:45:45 kg NPK kg/ha), T_3- RDF + soil application of $ZnSO_4$ @ 25 Kg/ha, T_4- RDF + soil application of Borax @ 5 Kg/ha, T_5- RDF + foliar application of 0.5% $ZnSO_4$ at head formation, T_6- RDF + foliar application of 0.2% Borax at head formation, T_7- RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha and T_8- RDF + foliar application of 0.5% $ZnSO_4$ + 0.2% Borax at head formation. Sowing was done by dibbling with seed rate of 5-6 kg/ha. Sunflower hybrid LSFH-171 was sown with recommended fertilizer dose of 90:45:45 kg/ha. Gross plot was of size 5.4 m x 4.5 m and net plot of 4.2 m x 3.9 m. Soil application of half dose of nitrogen and full dose of phosphorous, potassium, zinc and boron was applied through urea, SSP, MOP, zinc sulphate (36%) and borax (20%) respectively at the time of sowing and remaining half dose of nitrogen (urea) was applied at 30 days after sowing. Foliar spray of $ZnSO_4$ @ 0.5 % and boron @ 0.2% was done at 45 days after sowing. Standard package of practices was followed as per VNMKV guidelines. At harvest, the head diameters of the five representative samples were measured and reported in cm. After counting all of the seeds, the mean values $head^{-1}$ was calculated and noted. After separating and counting the filled and chaffy seeds, the mean values were converted to the number of filled seeds per head. From each treatment plot's sunflower heads, one hundred full seeds were chosen at random and their weight was noted in grams (g). After being collected, threshed and sun-dried. The sunflower heads from each treatment plot were weighed, and the seed output was reported in kilograms per hectare. Each treatment plot's stalks were collected, and the stalk yield was measured in kilograms per hectare once they had completely dried in the sun. The current market price served as the basis for calculating the benefit cost ratio (B: C ratio). Data obtained on various variables were analysed by "Analysis of variance method" (Panse and Sukhatme, 1967).

Results and Discussion

Yield attributes

The data pertaining to yield attributes recorded at physiological maturity stage of the crop are presented in

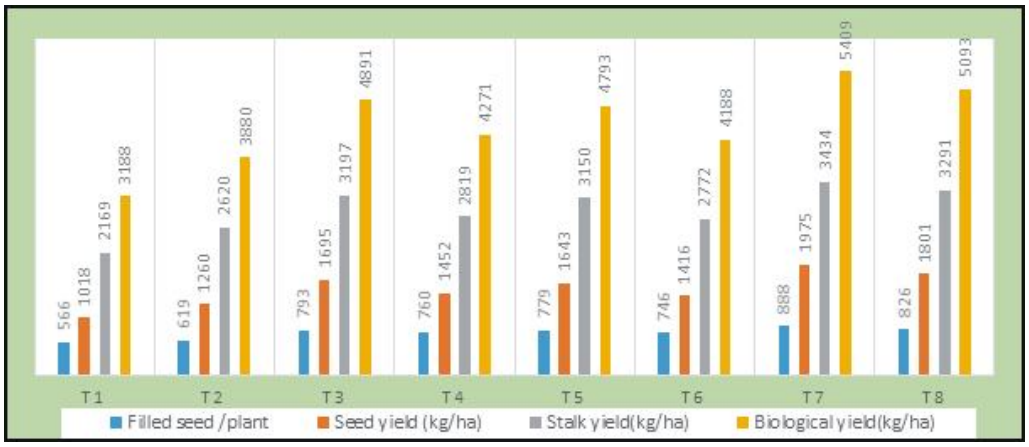

Fig. 1 : Mean number of filled seed plant^{-1}, seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}), biological yield (kg ha^{-1}), and harvest index (%) of sunflower crop as affected by application of different treatments.

Table 1 : Mean yield attributes of sunflower as affected by various treatments.

Treatment	Filled Seed Plant^{-1}	Seed Yield Plant^{-1} (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
T_1 - Control (no fertilizer)	566	27.23	1018	2169	3188	31.95
T_2 - 100 % RDF (90:45:45 NPK kg/ha)	619	32.03	1260	2620	3880	32.48
T_3 - RDF + soil application of $ZnSO_4$ @ 25 Kg/ha	793	41.99	1695	3197	4891	34.64
T_4 - RDF + soil application of Borax @ 5 Kg/ha	760	40.03	1452	2819	4271	34.00
T_5 - RDF + foliar application of 0.5% $ZnSO_4$ at head formation	779	41.30	1643	3150	4793	34.27
T_6 - RDF + foliar application of 0.2% Borax at head formation	746	35.57	1416	2772	4188	33.81
T_7 - RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha	888	48.10	1975	3434	5409	36.51
T_8 - RDF + foliar application of 0.5% $ZnSO_4$ + 0.2% Borax at head formation	826	45.77	1801	3291	5093	35.37
SE ±	31	2.05	89.74	152.78	179.85	-
CD @ 5%	94	6.15	269.01	457.98	539.13	-
General mean	**747**	**38.87**	**1532**	**2932**	**4464**	**34.13**

GMR- Gross Monetary Returns; **NMR-** Net Monetary Returns; **COC-** Cost of Cultivation; **B:C** – Benefit: Cost ratio

Table 1. The highest number of filled seeds plant^{-1} (888), seed yield plant^{-1} (48.10 g), seed yield (1975 kg ha^{-1}), stalk yield (3434 kg ha^{-1}), biological yield (5409 kg ha^{-1}) and harvest index (36.51%) recorded with application of treatment RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha (T_7) and which was followed by the application of RDF + foliar application of 0.5% $ZnSO_4$ + 0.2% Borax at head formation (T_8) and was found to be significantly superior over rest of treatments. The treatment control (T_1) recorded lowest values of yield and yield attribute. Boron aids in the transport of sugars and carbohydrates from source (leaves) to sink (developing seeds). While, zinc enhances chlorophyll synthesis, improving photosynthesis and energy supply for seed filling. Zinc and boron synergistically improve reproductive success, nutrient flow, and metabolic functions, leading to a significant increase in the number of filled seeds per plant in sunflower. These findings were in agreement with the conclusions of Hakale (2014), Immanuel *et al.* (2020), Lotha *et al.* (2021) and Kundu

Table 2 : Mean seed yield and economics of sunflower as affected by different treatments.

Treatment	Economics				
	Seed yield (kg/ha)	GMR	COC	NMR	B:C ratio
T_1 – Control (no fertilizer)	1018	73331	39881	33450	1.84
T_2 - 100 % RDF (90:45:45 NPK kg/ha)	1260	90729	48519	42210	1.87
T_3 - RDF + soil application of $ZnSO_4$ @ 25 Kg/ha	1695	122006	50519	71487	2.42
T_4 - RDF + soil application of Borax @ 5 Kg/ha	1452	104563	49219	55344	2.12
T_5 - RDF + foliar application of 0.5% $ZnSO_4$ at head formation	1643	118271	48719	69552	2.43
T_6 - RDF + foliar application of 0.2% Borax at head formation	1416	101925	48659	53266	2.09
T_7 - RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha	1975	142172	51219	90953	2.78
T_8 - RDF + foliar application of 0.5% $ZnSO_4$ + 0.2% Borax at head formation	1801	129705	48859	80846	2.65
SE ±	92.06	6628.36	-	6628.36	-
CD @ 5%	275.97	19869.69	-	19869.69	-
General mean	**1530**	**110191**	**48199**	**61991**	**2.27**

et al. (2023).

Economics

Data related to economics of sunflower as affected by various treatments is shown in Table 2. The highest gross monetary return (140036 ` /ha), net monetary return (88817 ` /ha) and B:C ratio (2.73) were recorded with application of treatment RDF + soil application of $ZnSO_4$ @ 25 Kg/ha + Borax @ 5 Kg/ha **(T_7)** which was found significantly superior over rest of treatments expect for treatment T_8. The treatment control **(T_1)** recorded lowest value as shown in Table 2. The administration of micronutrients, specifically zinc and boron, successfully addressed the deficiencies and balanced the other nutrients and resources available, which eventually improved the economic yield by achieving a greater B:C ratio. These results were similar to the conclusions drawn by Immanuel *et al.* (2020).

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