Effect of foliar application of micronutrients on growth and yield of Sesame (*Sesamum indicum*)

ABSTRACT

The field experiment was carried out during *kharif season* of 2022, at crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh. The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.82%), available N (291.24 kg/ha), available P (32.85 kg/ha) and available K (264.78 kg/ha). The treatments included three sources (Zinc), (Boron), (Iron) levels and one control plot, respectively. Randomized block design comprising of 9 treatments with different combination of zinc, boron along with iron which are replicated thrice and T_9 is control. The experimental results revealed that application of Zinc 100 ppm + Boron 100 ppm + iron 100 ppm recorded maximum plant height (114.80 cm), Plant dry weight (16.29 g/plant), number of capsules per plant (43.77), Seeds/capsules (69.73), Seed yield (1.10 t/ha), Stover yield (2.45 t/ha)

Key words- Sesamum, Zinc, Boron, Iron, Growth, Seed yield, stover yield

INTRODUCTION

Sesame (*Sesamum indicum L.)* family *Pedaliaceae*, chromosome number 2n = 26, commonly known as Til, Ellu, Beniseed, Simsim in India. It is one of the most important edible oilseeds cultivated in India since ancient times. Due to its superior quality, sesame is known as the "queen of oilseeds". Sesame is a drought-tolerant plant in semi-arid regions. It's called a survival plant and can grow where most plants fail. Sesame seeds generally have an oil content of 46 - 52 percent and a protein content of 18 - 20 percent. “Sesame products are used not only for culinary purposes, but also for various industrial, technical and pharmaceutical applications” (Anilakumar 2010). “India is the world leader with the largest area, production and export of sesame. Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Orissa, Tamil Naidu, West Bengal and Karnataka are the major sesame producing states in the country. Indian soils are reported to be 48% and 12% deficient in zinc and iron, respectively. The positive impact of micronutrients is due to the activation of various enzymes and efficient utilization of the supplied nutrients, which can lead to increased yield components” (Tiwari et al., 1996 and Shanker et al., 1996 and Shanker et al., 1999). Foliar fertilization is an option when nutritional deficiencies cannot be addressed by adding nutrients to the soil (Sarkar et al., 2007).

Zinc (Zn) is one of the essential trace elements known to play an important role as the metal component of enzymes or as a functional, structural, or regulatory cofactor for various enzymes (Gupta et al. 2006). Murthy (2008) found that Zn can be applied to improve yield and quality.

“Boron is involved in pollen germination. Its deficiency and toxicity cause lower chlorophyll content and rate of photosynthesis and may induce cell wall synthesis influencing. The Pharma Innovation Journal http://www.thepharmajournal.com the activity of the plasma lemma and can disturb the maintenance of meristem in the plants. Higher level of boron reduced seed yield and oil content” **(Bolanos et al., 2004**). “It has been reported that boron is required for pollen germination and pollen tube growth. Boron is unique among essential mineral micronutrients in that it is the only element normally present in soil solutions as a non-ionized molecule in the pH range suitable for plant growth. It is one of the essential micronutrients required for normal growth of most crops”. (Shiny et. Al., 2021)

Iron plays an important role in chlorophyll synthesis and also helps in the absorption of other nutrients. As a building block of chlorophyll, it regulates respiration, photosynthesis, and the breakdown of nitrates and sulfates. Iron also plays an important role in cell wall synthesis and anion uptake, pollen viability, and carbohydrate and lipid metabolism. Iron is essential for many biochemical and physiological processes in plants. Ten days after planting, iron deficiency occurs in young leaves that turn yellow with the exception of midribs and veins. Plant growth is still stunted, with weak stems limiting eventual growth and subsequently stunting growth altogether.

MATERIALS AND METHODS

A field experiment was conducted during Kharif season 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and sciences. Prayagraj (UP), India**.** The soil test plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.82%), available N (291.24 kg/ha), available P (32.85 kg/ha) and available K (264.78 kg/ha). The treatments were as follows: Zinc 75ppm + Boron 75ppm + iron 75ppm (T1), Zinc 100ppm + Boron 75ppm + iron 75ppm (T2), Zinc 75ppm + Boron 100ppm + iron 75ppm (T3), Zinc 75ppm + Boron 75ppm + iron 100ppm (T4), Zinc 100ppm + Boron 100ppm + iron 75ppm (T5), Zinc 100ppm + Boron 75ppm + iron 100ppm (T6), Zinc 75ppm + Boron 100ppm + iron 100ppm (T7), Zinc 100ppm + Boron 100ppm + iron 100ppm (T8) and control (T9). The experiment was set up in a randomized block design with 3 replicates of 9 treatments. Several plant growth parameters were recorded during the period from germination to harvest (80 DAS). These parameters are recorded growth parameters, plant height and plant dry weight. Yield parameters such as number of capsules/plants, number of seeds/capsules, seed yield (t/ha), stover yield (t/ha).

RESULTS AND DISSCUSIONS

Growth Parameters

Plant height

At harvest, there was a significant difference among the treatments. However maximum plant height of 114.80 cm was recorded with treatment Zinc 100ppm + Boron 100ppm/ha + iron 100ppm/ha. However, Zinc 100ppm + Boron 100ppm + iron 75ppm and Zinc 100ppm + Boron 75ppm + iron 100ppm (110.90 and 113.10 cm respectively) recorded statistically at par with Zinc 100ppm + Boron 100ppm + iron 100ppm.

The observed improvement in plant height by zinc could lead to increased plant growth through IAA biosynthesis, cell division and cell expansion. Similar results were also reported by Murthy et al. (2011) in Sesame. Boron plays an important role in various enzymatic and other biochemical reactions. Similar results were reported by Gitte et al., (2005). This iron application resulted in increased chlorophyll content and a more significant effect of photosynthesis on plant height. Similar results were also reported by Balachander et al. (2003) reported.

Plant Dry matter

At harvest highest plant dry weight was found in treatment Zinc 100ppm+ Boron 100ppm + iron 100ppm (16.29 g). However, treatment Zinc 100ppm + Boron 75ppm + iron 100ppm (16.08) was found to be statistically at par with treatment Zinc 100ppm + Boron 100ppm+ iron 100ppm.

Zinc and iron tend to increase synthesis of enzymes such as auxin biosynthesis, indole-3-acetic acid production and protein synthesis, which have helped promote vegetative growth Gawande *et al.* (2022). Boron application generally affects cell division, and nitrogen uptake from the soil may improve plant growth as reflected in plant dry weight. "The results were consistent with Mamatha et al (2022).

Yield Attributes:

Number of Capsules/plant

Treatment Zinc 100ppm+ Boron 100ppm+ iron 100ppm resulted in significantly highest number of capsules/plant (43.77). The lowest values in control (31.23).

It was found that increasing the number of capsules/plants by higher application of boron increased growth of cell wall structures pollen tube synthesis, improved pollen germination and increased pollen fecundity. Both foliar applications recorded significantly higher capsule numbers. This was mainly due to the synergistic interaction of iron and zinc and the application of micronutrients alone. Ravi et al. (2008), increased dry matter production may be due to improved nutrient intake, particularly iron and zinc and

NPs, which favorably influence carbohydrate metabolism and ensure good sustained availability of nutrients. increased the conversion of photosynthetic activity in the growing part of the plant.

Number of Seeds/capsule

Significant effect was observed by the statistical analysis of number of seeds/capsule. Treatment Zinc 100ppm + Boron 100ppm + iron 100ppm recorded significant and highest number of seeds/capsule (69.73). However, Zinc 100 ppm. Zinc is required for the synthesis of carbohydrates and therefore plays an important role in photosynthesis and cell elongation. These results have also been confirmed by Singaravel et al. (2001) in Sesame. Iron is directly or indirectly involved in chlorophyll production, and iron deficiency irreversibly damages chlorophyll synthesis. In foliar application of peanuts, iron availability is unaffected by soil pH and works in concert to ensure higher yield characteristics of peanuts (Yadav and Meena, 2009). The enhancing effect of seeds per capsule was attributed to the beneficial effects of boron application to crops on nutrient metabolism, biological activity, and growth parameters, which affected higher enzymatic activity, which resulted in higher Capsules/plants and seeds/capsules promoted. Similar results were reported by Yadav et al. (2016).

Seed yield and stover yield

A significantly higher seed yield showed increasing trend with the foliar application of micronutrients in sesame. The treatment Zinc 100 ppm + Boron 100 ppm + iron 100 ppm obtained higher seed yield(1.10 t/ha) and stover yield (2.45 t/ha)

As a result, increased seed and straw yields may be due to increased yield attributes (number of capsules per plant and number of seeds per capsule).

The increase in yield components is likely due to more available water increasing nutrient availability. This improves the absorption of nitrogen and other macro- and micro-elements, improving dry matter content production and transport from source to sink. Seed yield advantage through foliar application of supplemented micronutrients enhances nutrient efficiency according to crop needs. Several researchers have highlighted improved nutrient utilization efficiency with foliar fertilizer application in Niger and other similar crops under different agroclimatic conditions (Fakeerappa Arabhanvi et al., 2015, Hedage, 2012, Galvi et al., 2012).

CONCLUSION

It was concluded that applying of Zinc 100 ppm + Boron 100 ppm + iron 100 (T8) ppm recorded a significantly higher seed yield (1.10 t/ha) compared to the other treatments. Results are based on studies conducted in one season, so further testing may be required to confirm results

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Table 1. Effect of foliar application of micronutrients on growth parameters of sesame

Treatment	Treatments	Plant height (cm)	Dry weight (g plant^{-1})
T_1	Zinc 75ppm/ha + Boron 75ppm/ha + iron 75ppm/ha	103.85	14.08
T_2	Zinc 100 ppm/ha + Boron 75ppm/ha + iron 75ppm/ha	107.95	14.91
T_3	Zinc 75ppm/ha + Boron 100ppm/ha + iron 75ppm/ha	105.65	14.45
T_4	Zinc 75ppm/ha + Boron 75ppm/ha + iron 100ppm/ha	106.65	14.71
T_5	Zinc 100 ppm/ha + Boron 100 ppm/ha + iron 75 ppm/ha	110.90	15.41
T_6	Zinc 100 ppm/ha + Boron 75ppm/ha + iron 100 ppm/ha	113.10	16.08
T_7	Zinc 75 ppm/ha + Boron 100 ppm/ha + iron 100 ppm/ha	108.35	15.15
T_8	Zinc 100 ppm/ha + Boron 100 ppm/ha + iron 100 ppm/ha	114.80	16.29
T_9	Control	103.35	13.95
	SEm (±)	1.67	0.07
	CD (P 0.05)	5.00	0.22

Table 2. Effect of foliar application of micronutrients on yield and yield attributing characters of sesame

TREATMENT	Treatments	No. of capsules/plant	No. of seeds/ capsule	Grain Yield (t ha^{-1})	Stover Yield (t ha^{-1})
T_1	Zinc 75ppm + Boron 75ppm + iron 75ppm	35.17	58.33	0.96	2.35
T_2	Zinc 100 ppm + Boron 75ppm + iron 75ppm	38.43	62.00	1.02	2.38
T_3	Zinc 75ppm + Boron 100ppm + iron 75ppm	36.50	59.67	0.99	2.36
T_4	Zinc 75ppm + Boron 75ppm + iron 100ppm	37.20	60.73	1.01	2.38
T_5	Zinc 100 ppm + Boron 100 ppm + iron 75 ppm	41.60	65.53	1.07	2.41
T_6	Zinc 100 ppm + Boron 75ppm + iron 100 ppm	42.00	67.47	1.09	2.42
T_7	Zinc 75 ppm + Boron 100 ppm+ iron 100 ppm	41.27	64.67	1.04	2.40
T_8	Zinc 100 ppm + Boron 100 ppm + iron 100 ppm	43.77	69.73	1.10	2.45
T_9	Control	31.23	56.00	0.92	2.33
	SEm (±)	0.86	0.87	0.01	0.01
	CD (P 0.05)	2.57	2.61	0.03	0.04