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RESEARCH ARTICLE

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Effect of Foliar Application of Zinc on the Growth and Yield of Sesame (*Sesamum indicum* L.)

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Abstract

The experiment was conducted during Rabi, 2023 to study the effect of foliar application of zinc on the growth and yield of sesame (*Sesamum indicum* L.) at Students' Experimental Farm, Department of Agronomy, Faculty of Crop production, Sindh Agriculture University, Tandojam in triplicate following randomized complete block design (RCBD). The treatments included; T_1 = Control (No zinc), T_2 = 1.5% @ vegetative stage, T_3 = 2.0% @ flowering stage and T_4 = 2.0% @ pod formation. The results of the study indicated that the sesame treated with 2.0% @ pod formation (T_4) resulted maximum 58.51 m^{-2} plant population, 168.00 cm plant height, 12.00 number of branches plant^{-1}, 156.00 capsules plant^{-1}, 49.42 seeds capsule^{-1}, 46.00 g seed index and 847.05 kg ha^{-1} seed yield. The 2.0% @ flowering stage (T_3) resulted 59.00 m^{-2} plant population, 144.62 cm plant height, 11.48 number of branches plant^{-1}, 122.85 capsules plant^{-1}, 43.58 seeds capsule^{-1}, 41.91 g seed index and 720.85 kg ha^{-1} seed yield. Similarly, the sesame treated with 1.5% @ vegetative stage (T_2) resulted 56.66 m^{-2} plant population, 121.42 cm plant height, 10.31 number of branches plant^{-1}, 87.25 capsules plant^{-1}, 37.39 seeds capsule^{-1}, 37.82 g seed index and 595.64 kg ha^{-1} seed yield. However, control (No zinc) resulted minimum 56.73 m^{-2} plant population, 97.50 cm plant height, 9.14 number of branches plant^{-1}, 51.69 capsules plant^{-1}, 31.38 seeds capsule^{-1}, 33.73 g seed index and 470.14 kg ha^{-1} seed yield. After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing zinc levels and the sesame fertilized with Zn @ 5 kg ha^{-1} resulted in highest grain yield (836.32 kg ha^{-1}), followed by Zn @ 4 kg ha^{-1} (830.47 kg ha^{-1}) and Zn @ 3 kg ha^{-1} (824.68 kg ha^{-1}).

KEYWORDS
Sesame, Zinc, Foliar applications, Growth, Yield.

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1 | INTRODUCTION

Sesame (*Sesamum indicum* L.) is among the world's oldest cultivated plants, as well as the country's most significant ancient oilseeds crop. It is a member of the Pedaliaceae family. The crop is grown in tropical and subtropical areas worldwide (Tripathy et al., 2019). The production of low-yielding dehiscent cultivars having poor harvest index values, high yield loss during threshing, and a shortage of agricultural inputs such as better varieties, fertilizers and other agro-chemicals were all blamed for the low yield (Tripathy et al., 2019). Organic sesame is another rapidly developing market, with a 50% yearly growth rate. 'Organic by default' or 'a form of non-certified organic agriculture' are terms used to characterize this approach. As a result, one of the most effective techniques for farmers in the tropics to increase sesame production is to produce high-yielding cultivars that can thrive in a variety of agro-ecozones (Soumen et al., 2019) highlighted that modifying cultural practices to fit the crop with the existing environment can improve sesame yield and quality.

Oilseeds are crops in which energy is stored mainly in the form of oil and are a very important component of semi-tropical and tropical agriculture, providing easily available and highly nutritious human and animal food (Wei et al., 2016). Among the important oilseed crops widely grown in the world such as rapeseed, peanut, soybean, sunflower, sesame provides one of the highest and richest edible oils (Pathak et al., 2015). Despite its importance, sesame is considered as an orphan crop because it has received very little support from science, industry, and policy makers. Consequently, it lags the other major oilseed crops as concerns genetic improvement (Dossa et al., 2017). Cultivated sesame still has some wild characters including seed shattering, indeterminate growth habit and asynchronous capsule ripening leading to a very weak seed yield (300-400 kg ha^{-1}) Islam et al. (2016).

Sesame is known for its tolerance to adverse environmental conditions and its ability to thrive in diverse agroclimatic zones. The growth and yield of sesame are influenced by various factors, including nutrient availability in the soil. Zinc (Zn) is one such essential micronutrient that plays a significant role in plant growth and development. Zinc is a vital component in various enzymatic and metabolic processes, including photosynthesis, hormone regulation, and DNA synthesis, making it crucial for overall plant health. A deficiency of zinc in the soil can result in reduced plant growth and poor crop yield. To address this issue, researchers have conducted numerous studies to investigate the impact of zinc on sesame growth and yield (Abubakar et al., 2015; Shafiq et al., 2016). The zinc (Zn) content of soils, according to rather extensive surveys, is generally in the range of 10-300 ppm. Certainly Zn, because of its concentration, can be considered as a trace element in soil. It occurs most frequently in the lithosphere as the mineral Zn (sphalerite). Zn appears to be scattered throughout the mineral fraction of soils. Since it is a trace element, it is usually surrounded, by many other solid phases. Zn can also be held, by exchange sites, and adsorbed to solid surfaces. Crops differ in their sensitivity to zinc deficiency. Zn deficiencies are frequently found on soils, with restricted root zones (Diwevedi et al., 2020). The movement of Zn to plant roots is dependent on the intensity factors (concentration) and on the capacity factors (ability to replenish). Increasing the pH decreases the solubility of zinc in soils, and thereby reduces the concentration, the concentration gradient, and, hence, the uptake and availability of Zn to plants.

Zinc plays an important role in auxin formation and in other enzyme systems. Presently, Zn is recognized as an essential component in several dehydrogenases, proteinases, and peptidases. It is one of the most important micronutrients in plants. It has an important role in enzyme combination, translocation procedure, nucleic acid structure, and protein synthesis and auxin metabolism. Zinc (Zn) is important micronutrients in sesame production. Reduced growth hormone production in Zn deficient plants causes shortening of internodes and short leaves resulting in malformation of fruit with little or no yield (Eifediyi et al., 2021). The versatility of sesame makes it a crucial commodity in global agriculture. However, the growth and yield of sesame are influenced by a multitude of factors, one of which is the availability of essential micronutrients in the soil (Jahan et al., 2019). Among these micronutrients, zinc (Zn) stands out as a critical element that plays a pivotal role in plant growth, development, and overall productivity. Zinc is an essential micronutrient for plants, and it participates in a range of fundamental physiological processes. It is a cofactor for numerous enzymes involved in photosynthesis, DNA synthesis, and hormone regulation. Inadequate zinc levels in the soil can lead to growth limitations, reduced seed production, and ultimately lower crop yields. Recognizing the significance of zinc in optimizing sesame production, researchers have conducted numerous studies to investigate its impact on sesame growth and yield (Yadav et al., 2020; Eifediyi et al., 2021).

The amount of trace elements in soil is sometimes so small and barely detectable, but without them plants fail to thrive. Zinc (Zn) is one of the essential trace elements, known to have an important role either as a metal component of enzymes or as a functional, structural, or regulatory cofactor of many enzymes. Zn deficiency causes leaf discoloration called chlorosis, which causes the tissue between the veins to turn yellow while the veins remain green. The extent of variation in seed phytic acid and Zn observed when sesame plants are grown in nutrient cultures with widely varying levels of P and Zn. Jahan et al. (2019) indicated Zn application raise yield components. They also noted that Zn increase oil seed yield and stated that application of Zn can be implemented for higher yield and quality. The increase in plant protein is related with increasing soil-Zn concentrations.

2 MATERIALS AND METHODS

The field experiment was conducted at Student's Experimental Farm, Department of Agronomy, Sindh Agriculture University, Tandojam during Kharif, 2023. The details of the experiment are as under:

2.1. Experimental design

The Experiment was designed in Randomized complete block design (RCBD), replicating thrice. The net plot size of experiment was 5m x 4m = (20 m^2).

2.2. Treatments

The treatments include various concentrations of zinc such as; T_1 = Control (No zinc), T_2 = 1.5% @ vegetative stage, T_3 = 2.0% @ flowering stage, and T_4 = 2.0% @ pod formation.

2.3. Observations recorded

Following parameters including Plant population (m^2), Plant height (cm), Number of branches plant^{-1}, Capsules plant^{-1}, Seeds capsule^{-1}, Seed index (1000-seeds weight, g), and Seed yield (kg ha^{-1}) were recorded to determine the growth and yield of sesame as affected by foliar applications of zinc.

2.4. Procedure for recording Observations

Plant population (m^2)

Plant population was recorded after germination of the crop by using meter square frame in each plot and averaged in centimeters.

2.5. Plant height (cm)

Plant height (cm) was recorded at maturity of the crop by using measurement tap from bottom to tip of the randomly selected plants in each plot and average was work out in centimeters. Similarly, numbers of branches per plant were counted and average was work out. Total number of capsules per plant were counted and average was work out. Total number of seeds per capsule were counted and average was work out.

2.6. Seed index (1000-seeds weight, g)

One thousand seeds from each plot was counted and weighted using electrical weight balance.

2.7. Seed yield (kg ha^{-1})

At maturity, the crop in each plot was harvested, threshed. The plot^{-1} seed yield was converted to seed yield kg ha^{-1} by using following formula:

$$\frac{\text{Seed yield plot}^{-1}\text{ (kg)}}{\text{Plot size (m}^2\text{)}} \times 10000$$

2.8. Statistical analysis

The collected data was subject to statistical analysis using Computer Software Statistix ver. 8.1 (Statistix, 2006). The LSD test was applied to compare treatments superiority, where necessary.

3 RESULTS

The experiment conducted during Rabi 2022-23 to study the effect of foliar application of zinc on the growth and yield of sesame (*Sesamum indicum* L.) at Students' Experimental Farm, Department of Agronomy, Faculty of Crop production, Sindh Agriculture University, Tandojam in a three replicated randomized complete block design (RCBD). The treatments included; T_1 = Control (No zinc), T_2 = 1.5% @ vegetative stage, T_3 = 2.0% @ flowering stage and T_4 = 2.0% @ pod formation. The observations were recorded on plant population (m^{-2}), plant height (cm), number of branches plant^{-1}, capsules plant^{-1}, seeds capsule^{-1}, seed index (1000-seeds weight, g) and seed yield (kg ha^{-1}).

3.1. Plant population (m^2)

The results that were recorded for plant population (m^{-2}) of sesame as affected by different foliar application of zinc are presented in Table 1. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on plant population (m^{-2}). The maximum plant population (58.51 m^{-2}) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average plant population 59.00 m^{-2}, respectively. Significant decreases in plant population were observed in treatments that included 1.5% @ vegetative stage (T_2) 56.66 m^{-2}. Finally, the minimum plant population 56.73 m^{-2} was observed in control (no zinc) (T_1).

Table 1: Plant population (m^2) of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	56.73±0.04 d
T_2 = 1.5% @ vegetative stage	56.66±0.04 c
T_3 = 2.0% @ flowering stage	59.00±0.03 a
T_4 = 2.0% @ pod formation	58.51±0.03 b
S.E.±	0.0179
LSD 0.05	7.3203
P-value	0.2064

3.2. Plant height (cm)

The varietal influence or response of plant to management factors is primarily reflected by the plant height. The results that were recorded for plant height (cm) of sesame as affected by different foliar application of zinc are presented in Table 2. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on plant height (cm). The maximum plant height (168.00 cm) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average plant height 144.62 cm, respectively. Significant decreases in plant height were observed in treatments that included 1.5% @ vegetative stage (T_2) 121.42 cm. Finally, the minimum plant height 97.50 cm was observed in control (no zinc) (T_1).

Table 2: Plant height (cm) of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	97.50±2.23 d
T_2 = 1.5% @ vegetative stage	121.42±3.15 c
T_3 = 2.0% @ flowering stage	144.62±4.14 b
T_4 = 2.0% @ pod formation	168.00±3.60 a
S.E.±	0.6845
LSD 0.05	1.6749
P-value	0.0000

3.3. Number of branches per plant

The results that were recorded for the number of branches $plant^{-1}$ of sesame as affected by different foliar application of zinc are presented in Table 3. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on number of branches $plant^{-1}$. The maximum number of branches $plant^{-1}$ (12.00) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average number of branches $plant^{-1}$ 11.48, respectively. Significant decreases in number of branches $plant^{-1}$ were observed in treatments that included 1.5% @ vegetative stage (T_2) 10.31. Finally, the minimum number of branches $plant^{-1}$ 9.14 was observed in control (no zinc) (T_1).

Table 3: Number of branches $plant^{-1}$ of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	9.14±0.02 d
T_2 = 1.5% @ vegetative stage	10.31±0.04 c
T_3 = 2.0% @ flowering stage	11.48±0.04 b
T_4 = 2.0% @ pod formation	12.00±0.04 a
S.E.±	0.0264
LSD 0.05	0.0645
P-value	0.0000

3.4. Capsules per plant

The results were recorded that the capsules plant^{-1} of sesame as affected by different foliar application of zinc are presented in Table 4. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on capsules plant^{-1}. The maximum capsules plant^{-1} (156.00) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average capsules plant^{-1} 122.85, respectively. Significant decreases in capsules plant^{-1} were observed in treatments that included 1.5% @ vegetative stage (T_2) 87.25. Finally, the minimum capsules plant^{-1} 51.69 was observed in control (no zinc) (T_1).

Table 4: Capsules plant^{-1} of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	51.69±3.45 d
T_2 = 1.5% @ vegetative stage	87.25±3.10 c
T_3 = 2.0% @ flowering stage	122.85±2.48 b
T_4 = 2.0% @ pod formation	156.00±2.94 a
S.E.±	2.2421
LSD 0.05	5.4861
P-value	0.0000

3.5. Seeds per capsule

The results were recorded that the seeds capsule^{-1} of sesame as affected by different foliar application of zinc are presented in Table 5. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on seeds capsule^{-1}. The maximum seeds capsule^{-1} (49.42) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average seeds capsule^{-1} 43.58, respectively. Significant decreases in seeds capsule^{-1} were observed in treatments that included 1.5% @ vegetative stage (T_2) 37.39. Finally, the minimum seeds capsule^{-1} 31.38 was observed in control (no zinc) (T_1).

Table 5: Seeds capsule^{-1} of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	31.38±3.06 d
T_2 = 1.5% @ vegetative stage	37.39±3.04 c
T_3 = 2.0% @ flowering stage	43.58±2.75 b
T_4 = 2.0% @ pod formation	49.42±2.03 a
S.E.±	0.4015
LSD 0.05	0.9823
P-value	0.0000

3.6. Seed index (1000-seed weight in grams)

The seed index is a trait of great economic importance in sesame that measures the grain quality at random from a seed lot. However, seed index may vary between sesame varieties because some varieties may produce bolder grains but may be weaker in other traits. The results that were recorded for seed index (g) of sesame as affected by different foliar application of zinc are presented in Table 6. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on seed index (g). The maximum seed index (46.00 g) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average seed index 41.91 g, respectively. Significant decreases in seed index were observed in treatments that included 1.5% @ vegetative stage (T_2) 37.82 g. Finally, the minimum seed index 33.73 g was observed in control (no zinc) (T_1).

Table 6: Seed index (1000-seed weight, g) of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	33.73±1.82 d
T_2 = 1.5% @ vegetative stage	37.82±1.86 c
T_3 = 2.0% @ flowering stage	41.91±1.91 b
T_4 = 2.0% @ pod formation	46.00±1.94 a
S.E.±	0.1392
LSD 0.05	0.3405
P-value	0.0000

3.7. Seed yield (kg ha^{-1})

The seed yield (kg ha^{-1}) is a dependent character that depends on its different components. Apart from the varietal influence on seed yield (kg ha^{-1}), this trait may also be influenced by the soil status for various nutrient elements. The results that were recorded for seed yield (kg ha^{-1}) of sesame as affected by different foliar application of zinc are presented in Table 7. The analysis of variance showed that there was significant ($P<0.05$) impact of various foliar application of zinc on seed yield (kg ha^{-1}). The maximum seed yield (847.05 kg ha^{-1}) was achieved with the treatment involving 2.0% @ pod formation (T_4). Following this, the treatment of 2.0% @ flowering stage (T_3) resulted in average seed yield 720.85 kg ha^{-1}, respectively. Significant decreases in seed yield were observed in treatments that included 1.5% @ vegetative stage (T_2) 595.64 kg ha^{-1}. Finally, the minimum seed yield 470.14 kg ha^{-1} was observed in control (no zinc) (T_1).

Table 7: Seed yield (kg ha^{-1}) of sesame crop as influenced by different foliar application of zinc

Treatments	MEAN±SE
T_1 = Control (No zinc)	470.14±4.36 d
T_2 = 1.5% @ vegetative stage	595.64±4.46 c
T_3 = 2.0% @ flowering stage	720.85±4.55 b
T_4 = 2.0% @ pod formation	847.05±5.68 a
S.E.±	0.6799
LSD 0.05	1.6638
P-value	0.0000

4 | DISCUSSION

The foliar application of zinc has emerged as a promising agronomic strategy to enhance the growth and yield of various crops, including sesame (*Sesamum indicum* L.). Zinc, an essential micronutrient, plays a pivotal role in numerous physiological processes crucial for plant development. Sesame, valued for its oil-rich seeds and adaptability to diverse agro-climatic conditions, may benefit significantly from optimized zinc nutrition. As a trace element, zinc participates in enzymatic activities, hormonal regulation, and overall metabolic functions, influencing plant growth and reproductive outcomes. This study delves into the effects of foliar application of zinc on a specific variety of sesame, aiming to unravel the intricate relationship between zinc supplementation, plant physiology, and ultimately, sesame yield. By exploring the impact of zinc at the foliar level, this research contributes valuable insights that can inform sustainable agricultural practices and potentially optimize sesame production for the benefit of farmers and the broader agricultural community.

The present study showed that the sesame treated with 2.0% @ pod formation (T_4) resulted maximum 58.51 m^{-2} plant population, 168.00 cm plant height, 12.00 branches plant^{-1}, 156.00 capsules plant^{-1}, 49.42 seeds capsule^{-1}, 46.00 g seed index and 847.05 kg ha^{-1} seed yield. The 2.0% @ flowering stage (T_3) resulted 59.00 m^{-2} plant population, 144.62 cm plant height, 11.48 branches plant^{-1}, 122.85 capsules plant^{-1}, 43.58 seeds capsule^{-1}, 41.91 g seed index and 720.85 kg ha^{-1} seed yield. Similarly, the sesame treated with 1.5% @ vegetative stage (T_2) resulted 56.66 m^{-2} plant population, 121.42 cm plant height, 10.31 branches plant^{-1}, 87.25 capsules plant^{-1}, 37.39 seeds capsule^{-1}, 37.82 g seed index and 595.64 kg ha^{-1} seed yield. However, control (No zinc) resulted minimum 56.73 m^{-2} plant population, 97.50 cm plant height, 9.14 branches plant^{-1}, 51.69 capsules plant^{-1}, 31.38 seeds capsule^{-1}, 33.73 g seed index and 470.14 kg ha^{-1} seed yield. After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing zinc levels and the sesame fertilized with Zn @ 5 kg ha^{-1} resulted in highest grain yield (836.32 kg ha^{-1}), followed by Zn @ 4 kg ha^{-1} (830.47 kg ha^{-1}) and Zn @ 3 kg ha^{-1} (824.68 kg ha^{-1}). The results are further compared with the study of Maheshwari et al. (2018) observed improvement in plant height due to zinc might be due to biosynthesis of IAA growth hormones, cell enlargement, cell division and multiplication which ultimately led to better plant height of sesame and boosted plant growth. Sulphur through gypsum might have promoted the uptake and translocation of food assimilates from source to sink effectively, resulting in higher yield attributes vi, no of capsules plant, weight of capsules plant leading to higher seed yield. The increase in yield might be attributed to easy availability of sulphate (SO) sulphur present in gypsum compared to sulphide form in elemental sulphur, which essentially requires its ostidation to be converted in to SOS prior to its absorption by the plants. Zinc plays as an activator of several enzymes in plants and it is directly involved in the biosynthesis of growth substances such as auxin thereby producing more plant cells and enhanced dry matter" (Christopher et al., 2019). The increase in yield attributes and yield due to the application of Zn might be due to fact that Zn influences on the water economy and crop growth through its effect on water uptake, root growth, maintenance of turgor, transpiration and stomatal behavior, overcomes the adverse effect of water stress and improving the drought tolerance.

Similar results were also reported by Paraye et al. (2017), Deosarkar et al. (2016) in soybean. Similarly, the study of Maheshwari et al. (2018) discovered that the application of Zinc at 100 ppm, Boron at 100 ppm, and iron at 100 ppm led to a significantly higher number of capsules per plant (43.77). In contrast, the control group exhibited the lowest values (31.23). The study revealed that augmenting the concentration of boron resulted in increased growth of cell wall structures, enhanced pollen tube synthesis, improved pollen germination, and elevated pollen fecundity, ultimately contributing to a higher number of capsules per plant. Notably, both foliar applications demonstrated significantly greater capsule numbers. The observed effect was attributed to the synergistic interaction of iron and zinc, as well as the application of micronutrients in isolation. According to Ravi et al. (2017), the increased production of dry matter may be attributed to improved nutrient intake, particularly of iron and zinc, and nanoparticles (NPs), which positively influence carbohydrate metabolism, ensuring sustained nutrient availability and promoting the conversion of photosynthetic activity in the growing part of the plant. Similarly, the study of Dehnavi et al. (2017) revealed that the statistical analysis of the number of seeds per capsule revealed a significant impact. The treatment involving Zinc at 100 ppm, Boron at 100 ppm, and iron at 100 ppm exhibited a noteworthy and highest number of seeds per capsule (69.73). In contrast, the application of Zinc at 100 ppm alone did not show a similar effect. Zinc is crucial for carbohydrate synthesis, playing a vital role in photosynthesis and cell elongation (Eifediyi et al., 2021). El-Sherif (2016) reported that the augmentation in the number of seeds per capsule was attributed to the positive effects of zinc application on crops, influencing nutrient metabolism, biological activity, and growth parameters. This impact, in turn, led to higher enzymatic activity, resulting in increased capsules per plant and seeds per capsule (Hasani et al., 2018). Patil et al. (2020) reported that the rise in yield components is likely attributed to increased water availability, which, in turn, enhances nutrient accessibility. This improvement facilitates the absorption of nitrogen and other macro- and micro-elements, ultimately boosting the production of dry matter content and its efficient transport from source to sink. The advantage in seed yield achieved through foliar application of supplemented micronutrients contributes to enhanced nutrient efficiency aligned with the specific needs of the crop (Singaravel et al., 2019). The positive impact of foliar fertilizer application on nutrient utilization efficiency in crops such as Niger and similar varieties under diverse agroclimatic conditions (Islam et al., 2019; Elayaraja & Sathiyamurthi, 2020).

5 | Conclusions

After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing zinc levels and the sesame fertilized with Zn @ 5 kg ha^{-1} resulted in highest grain yield (836.32 kg ha^{-1}), followed by Zn @ 4 kg ha^{-1} (830.47 kg ha^{-1}) and Zn @ 3 kg ha^{-1} (824.68 kg ha^{-1}).

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Generative AI Statement: The authors declare that this manuscript has been written without the use of generative artificial intelligence tools.

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