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Research Article

Multi-response of foliar applied Zinc and Boron on growth parameters of Okra crop (*Abelmoschus esculentus. L*)

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Abstract | The current research study was conducted at experimental field of Department of Agronomy, Sindh Agriculture University sub-campus Umarkot, Sindh Pakistan, during Kharif season 2022. The research experiment was accomplished in a Randomized Complete Block Design (RCBD) with six treatments and three replications. Treatments include T_1: Water Spray (Control), T_2: 0.2% $ZnSO_4$, T_3: 0.2% Boric acid, T_4: 0.6% $ZnSO_4$ + 0.4% Boric acid, T^5: 0.8% $ZnSO_4$ + 0.6% Boric acid, T_6: 10% ZnSO4 + 0.8% Boric acid. The results indicated that among different treatments, the highest plant height (151.33cm), highest numbers of nodes per plant (39.00), highest number of fruits per plant (34.66), highest number of leaves per plant (43.66), highest number of seeds per pod (39.00), highest weight of pod (g) (18.33), were recorded with treatment T_6= 10% ZnSo4 + 0.8% Boric acid. The minimum results for all parameters were observed in T_1: Water spray (Control), whereas plant height was observed (112.66 cm), Number of Leaves (25.66), Number of Nodes (31.00), Numbers of fruits (26.66), Number of Seeds Per Pods (19.67), Weight of per pods (g) (3.32) respectively. It is determined that T_6: 10% ZnSO4 + Boric acid in combination may be helpful for okra cultivation in the field level to improve the overall production of respective crops.

Keywords | Okra, Growth, Development, Zinc and Boron
Keyfindings | Treatment 6 show the positive influence of all parameters.

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1. Introduction

Okra *(Abelmoschus esculentus L.)* is one of the popular and important vegetable grown in various areas of Pakistan. It belongs to *Malvaceae* family and grown tropical and sub-tropical regions in the world (Ahmed N, Abid M & Rashid A *et al.*, 2003). Okra is an annual herbaceous and warm season crop, and tall growing and an erect hardy crop. It is a self-pollinated crop, but sometimes 20% cross pollination occurs through the natural insects. Okra pods are harvested when they reached the maximum size but still tender (may be 60 -180 days from sowing) around 5-10 days after opening of flowers depending on the cultivar grown (Adetuyil *et al*., 2008).

The immature pods of okra crops consumed as vegetables, can be used in salads, soups and stews, fresh or dried, fried or boiled (Gopalan C, Sastri SB & Balasu BS *et al*., 2007). Okra mature pods are considered high nutritious and providing some human supplementary including Vitamins C, A, B complex, calcium, potassium, iron and other essential minerals (Gadade, S. B., Shinde, V. S., Deosarkar, D. B., & Shinde, S. S. 2017). The okra seeds are high nutrition and contain proteins 22.30%-37.02%, oil 2.65%-23.99% and carbohydrate 29.44%-44.03% (Ali, H. M., Ali, H., Liaquat, H., Maqsood, H. T. B., & Nadir, M. A. *et al.*, 2015). Okra contains some amount of fiber which is suitable for the manufacturing of papers and cardboard (Aloni *et al.*, 1990). Okra seeds have a special value for its high nutritious and delicious fruits and has been reported to have an average nutritive value (ANV) of 3.21 which has been higher then tomato, eggplant, and most of the cucurbits (Grubben *et al.,* 1997). The intensive Agriculture farming practices and chemical fertilizers usage which are deteriorated the soil fertility and increase the soil pH results show the available nutrients are unavailable to crop and affected the crops growth and development stages (Ahamdi and Souri, 2019; Hatamian *et a*l., 2020).

Foliar application is useful practice which conflicts minerals and particular micronutrient deficiencies (Aslani, M., & Souri, M. K. *et al.,* 2018). Farmers and Researchers use essential micronutrients such as Zinc and Borax. Inappropriately, farmers's community acquired less attention of importance micronutrients due to poor extension program and fertilizers management's investigation authorities. There are many scientists reported that micro nutrients play important role in improvement of growth and yield parameters of vegetable crops (Anant *et al*., 2010; Rizwan *et al*., 2015; Gorana *et al*., 2017; Habibur *et al*., 2020; Taheri *et al*., 2020).

In detail, Zn and B are known as important micronutrients for specific crop on various growth stages such as germination and developments, as well as for soil Productivity (Karim, M. R., & Rahman, M. A. *et al* 2015). Okra crop shoots and buds show the Zinc deficient plants contain very low auxin causing dwarfism and growth reduction. Moreover, Zinc deficiency stunted plants and lengthened the duration of growth. Zinc and B play important role in chlorophyll formation, cell division, meristematic activity of tissue expansion of cell and formation of cell wall (Souri *et al*., 2017; Souri and Hatamin.,*et al* 2019. Boron is trace element which are required for the translocation of food materials, and proper development and differentiation of plant tissue (Mohan *et al*., 2008). Boron is necessary for cell and cell wall formation, development of fruits, seed, helps in pollen formation, pollination and flowering of plants (Tohidloo and Souri, 2009; Khalaj *et al*., 2016). Boron is also involved in metabolism and transport of carbohydrate, nucleic acid synthesis and root absorption in plant parts. Boron increase the stability of plant cell and is involved in the reproductive phase of plants (Katyal and Randhawa, 1983; Pandav *et al*., 2016). Boron dose not easily move around the plant and consequently, its deficiency occur in first young plant tissues, developing shoots, buds, root tips and results may cause sterility, poor fruit set, immature fruit size and poor quality which consequently lower the overall yield. Leaves may have a dense coppery texture, occasionally curled and become stiff with blackened appearance. Crop growth rate is also stops at the growing points. Boric acid deficiency also cause cracking and distorted growth in fruits (Bubarai *et al*., 2017). The excessive amount of boron causes toxicity which may results in considerable lose in yield of many plants (Brown PH, Bellaloui N, *et al*., 2002). Therefore, proper management of these nutrients in crop is crucial for good yield and productivity. The present study was directed with the main objective to evaluate the performance of okra crop on the foliar spray of Zinc and Boric acid.

2. Materials and Methods

Present research experiment on Okra crop **(***Abelmoschus esculentus***)** was conducted at the experimental field of Department of Agronomy, Sindh Agriculture University, Sub-campus Umerkot, and Pakistan during the Kharif season in 2022. The experiment was layout in Randomized Completely Block Design with three

replication and six treatment including; T_1 = Water Spray (Control), T2 = 0.2 % $ZnSO_4$, T_3 = 0.2 % Boric acid, T_4 = ZnSO4 + 0.4% Boric acid, T_5 = 0.8 % $ZnSO_4$ + 0.6% Boric acid, T_6 = 10 % $ZnSO_4$ + 0.8% Boric acid. The parameters that were studied include Plant Height (cm), Number of leaves per plant, Number of nodes per plant, Number of Fruits per Plant, Number of seeds per Pods, Weight of pod per plant (g).

The site of experimental field was selected according to suitable soil for Okra crop cultivation, and was properly prepared with tillage implements. Recommended doses of Farm yard manure were incorporated in soil. The bed size was 12 x 8 feet. The bed to bed distance was properly maintained at 2.5 whereas, plant to plant distance was 35 to 34 cm respectively. Seeds were treated with fungicide, and drilling method was used for seed sowing. The irrigation was applied two times in a week, and all cultural practices were done after the 40 DAS (Days after Sowing). For recording of data, five plants were selected from each line. For statistical analysis of the data, the statistical software STATISTIX (Version 8.1) was used.

Results and Discussion

Plant Height (cm).

The Plant height is crucial part of crops to maintaining their growth and as well as theirs yields. Current study experiment found significant results that indicate zinc and boron effects on the crop. Significantly the highest plant height (151.33 cm) was recorded with T_6 10% ZnSO4 +0.8% Boric acid followed by (143.66 cm) was T_5 0.8% $ZnSO_4$ + 0.6% Boric acid. Whereas, the lowest plant height was measured (112.66 cm) with T_0 control water spray plots (Table 1, Figure 1). Similarly, study was directed by (Davis *et al.,* 2003) in tomato crop plant height, the maximum plant height from (122.0 cm) to (137.0) of crop to evaluate the impact of zinc and boron on growth and development stages, which indicated that the zinc and boron positively impact the zinc support on auxin production and in association with boron helps on cell wall development and cell differentiation of plants height (Basavarajeswari *et al*., 2008).

Numbers of Fruits

The number of fruits in plant is important factor to increase the yield of okra. In Present study experimentation trial evaluated the effect of zinc and boric acid on the number of fruits per plant. Significantly highest number of fruits per plant (34.66) was observed with T_6=10% $ZnSO_4$ + 0.8% Boric acid followed by (29.00) was T_5 0.8 % $ZnSO_4$ + (0.6%) Boric acid fruits was recorded. While the lowest number of fruits per plant (26.66) was observed in control plots (Table 2, Figure 2). Similarly, study was conducted in Okra crop to evaluate the effect of zinc and boron on growth and development stages which indicated that the zinc and boron significantly influence the number of fruits per plant with maximum number of fruits per plant (33.6) of crop (Yadav *et al.,* 2001). These previous study results support the present study. This comparable results was reported by combined application of zinc and boron increased the number of fruits maximum (33.6) and minimum (29.4) fruits per plant.

Number of Leaves Plant $^{-1}$

The leaves utmost portion of crops to regulate the growth and development through the photosynthesis process and maintaining the stomata regulation. The foliar application of zinc and boron shown a positive difference in the number of leaves on different growth stages of okra crop. During research trail was evaluated the zinc and boron effects on crops leaves. Significantly, the maximum number of leaves (43.66) was recorded with T_6 10 % $ZnSO_4$ + 0.8% Boric acid followed by (42.00) was T_5 0.8 % $ZnSO_4$ + 0.6% Boric acid result showing in (Table 1, Figure 1). Whereas, the lowest numbers of leaves was recorded (25.66) from T_0 Control water spray

plots. Similarly, study was conducted (Singh, H. M. & Tiwari, J. K. (2013) in Okra crop to evaluate the effect of zinc and boron on growth and development stages which specified that the zinc and boron significantly influence the numbers on leaves per plant with maximum number of leaves (33.6) of crop. This equivalent results was suggested by combined application of zinc and boron increased the number of leaves maximum (33.6) and minimum (29.4) fruits per plant

Number of Seeds per Pod

The numbers of seeds per pods were counted by manual in present study. Seeds is key element to increase the crop yield and as well as seed production. The study was evaluated the impact of zinc and boron on seeds in per pods. The significant results were obtained for single fruits of okra pod seeds as influenced by different zinc and boron applications. Positively, the highest numbers of single pods seed (39.00) were recorded with T_6= 10% $ZnSO_4$ + 0.8% Boric acid, followed by minimum (36.00) T_5: 0.8% $ZnSO_4$ + 0.6% Boric acid, whereas, lowest numbers of single fruit pods seeds were recorded (19.67) through (T_0) control water spray replication plot (Table 2, Figure 2). Similar result was reported by Patel *et al*., (2015), Kumar *et al*., (2017), Patel *et al.,* (2016) and Makdoomi *et al*., (2018), indicate that zinc and boron shown the less influence on okra crop seeds. And also suggested the number of seeds per fruit and 100 seed weight were not much contributed to the increasing crop yield. In this regard this study was showed that consumers gave less preference of more seeds vegetables.

Weight of per pod (g)

Maximum and minimum weight of fruits which are directly proportional to crops yield. The study was evaluated the impact of zinc and boron in different concentrations on the okra crop. Significantly highest weight of pods recorded (18.33g) was T_6 10% $ZnSO_4$ + 0.8% boric acid followed by minimum (13.33 g) was T_5 0.8% $ZnSO_4$ + 0.6% boric acid. Whereas the lowest weight of pod obtained 13.32g from the T_0 control water spray plots (Table 2, Figure 2). The similarly results suggested by (*Shukha et al.*, 2011) in tomato crop that directed the maximum weight of per pod was found (30.4 g), though minimum weight of pods (19.8). The positive expansions of plant parts with zinc and boron application in different concentration on growth and developments phases of tomato crop. Improves fruit growth by synthesizing tryptophan and auxin on okra crop through the use of zinc and boron application in changed concentrations.

Numbers of Nodes per Vine.

The number of nodes is important factors to increase the stems per plant during their growth stages. The recent study was conducted and evaluated the significant numbers of nodes per plant during experiential period. The significant highest numbers of nodes per plant was (43.66) were recorded T_6 10 % $ZnSO_4$ + 0.8% Boric acid followed by minimum numbers of nodes were recorded (37.67) T_5 0.8 % $ZnSO_4$ + Boric acid (0.6%) whereas, lowest numbers of nodes per plant were recorded (25.66) in control plots (Table 1). The similar results also reported by (Pilbeam and Kirkby 1983), it was also found that B application on plant can increase the vegetative growth of okra. Since B is related to the development of cell wall, root, and shoot growth of plant. Combine application B and Zn might be effective to cell division into plants growth.

Table 1: Mutual effect of Zinc and Boric acid different growth stages of Okra

Treatments	Plant Height (cm)	Leaves Plant $^{-1}$	Nodes Plant $^{-1}$
T_1: (Control)	112.66	25.66	31.00
T_2: $ZnSO_4$- 0.2 %	128.66	25.33	35.66
T_3: Borax – 0.2%	121.33	45.00	33.66
T_4: $ZnSO_4$ (0.6 %) + Borax (0.4%)	130.33	34.33	31.33
T_5: ZnSO4 (0.8%) Boric acid (0.6%)	143.66	42.00	37.67
T_6: $ZnSO_4$ (10 %) + Boric acid (0.8%)	151.33*	43.66*	39.00*
SE(d)	0.88	1.9	2.8

Table 2: Mutual effect of Zinc and Boric acid different growth stages of Okra

Treatments	Fruits Plant^{-1}	Seeds Per Pods	Weight per pods (g)
T_1: Control	26.66	19.67	13.32
T_2: $ZnSO_4$- 0.2 %	32.33	31.00	16.33
T_3: Borax – (0.2%	27.00	35.00	17.33
T_4: $ZnSO_4$ 0.6 % + Borax (0.4%)	33.00	33.33	14.66
T_5: $ZnSO_4$ (0.8%) + Boric acid (0.6)	29.00	36.00	13.33
T_6: $ZnSO_4$ (10 %) + Boric acid (0.8%)	34.66*	39.00*	18.33*
SE(d)	2.2	2.0	2.5

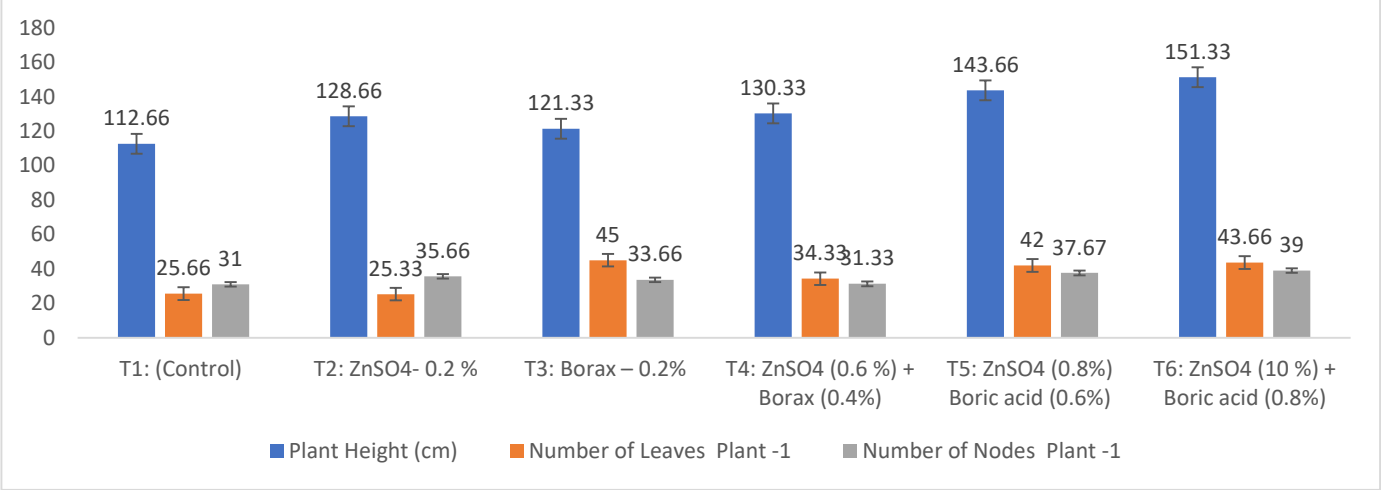

Figure 1: Results showing the Plant Height, Leaves per plant and Number of Nodes per plant

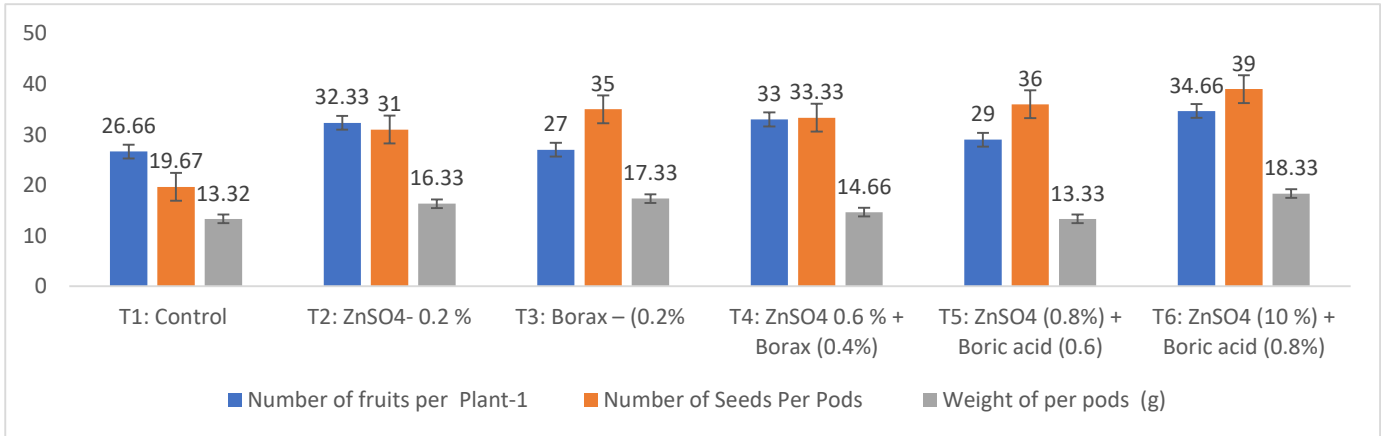

Figure 2: Results showing the Number of fruits per plant, Seeds per pods and Weight per pods

Conclusion.

The research study investigations it may concluded that selected combination of zinc and boron show the better performance in okra growth and growth parameters. It may be T_6: $ZnSO_4$ (10 %) + Boric acid (0.8%) show the positive influence of all parameters.

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