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Effect of Zinc and Boron Foliar Application on Growth, Biomass Production and Yields of Spring-summer Okra

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ABSTRACT
Micronutrient study (Zn and B) in okra was carried out at Vegetable Farm of P.G. College, Ghazipur, Uttar Pradesh. Treatment comprised of two foliar spray of Zn (50 and 100 ppm) and Boron (25 and 50 ppm) solely or in their combinations. Thus, a total of 9 treatments including control (water spray) were replicated thrice. Micronutrient sprays were done twice at 30 and 45 days after sowing.The highest values for plant height (66.50cm),total drymatter production (51.30 g), root area (234.34 cm^2) and root length density (1486.87 cm/cm^3),fruits/plant (24.33), fruit yield (38.22 g/ plant or 102.56 q/ha) were recorded for combination spray of Zn(50ppm) + B(25ppm). This treatment registered 23.18% higher fruit yield over control.

KEYWORDS
Micronutrient, Okra, Zinc, Boron, Biomass, Yield

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INTRODUCTION

Okra is a major vegetable crop of India grown during kharif (June-September) and spring-summer (March-May) seasons. It has a prominent position among the vegetable due to its wide adaptability, year-round cultivation, export potential and high nutritive as well as medicinal values. In India, okra is grown on 509-thousand-hectare area with production of about 6095 thousand tones (Anonymous, 2018). Application of fertilizers is one of the most importance agronomical practices, as improvement in growth, yield and quality of any crop is linked with physiological activities of the plant for which the micronutrients are equally important. Micronutrient such as zinc, boron and to a limited extent iron, manganese, copper and molybdenum have also been reported to be deficient in most of the Indian soils. Deficiency of micronutrient during the last three decades has grown in both, magnitude and extent. This is because of indiscriminate and increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity. This has become a major constraint to production and productivity of most of the crop including vegetables.

Plant requires micronutrients in small quality but are essential for obtaining higher crop yield and quality produce, which may be achieved by judicious use of nutritional and mineral elements.Foliar spray of micronutrient is an important method to maintain or enhance plant nutritional status in short time.Zinc is important for the formation and activity of chlorophyll and in the functioning of several enzymes and growth hormones like auxin, whereas boron is required for cell division and development in the growth regions of the plant, besides, boron also affects sugar transport, pollination and seed development. There are several reports that indicate enhancement in growth and yields of vegetables with foliar application of micronutrients ((Anant *et al*, 2010; Rizwan *et al*, 2015; Gorana *et al*, 2017; Habibur *et al*, 2020; Taheri *et al*, 2020). The present study was carried out with objective of effect of foliar spray of B and Zn on vegetative growth, biomass production and yields of okra.

MATERIALS AND METHODS

The present investigation was carried out Agricultural Farm of Department of Horticulture, P.G. College, Ghazipur (25°19′ and 25°54′ north latitude and 83°4′ and 83°58′ east longitude) during the spring-summer season of 2021. The pH of soil was 7.4, organic carbon 0.51%, available N- 202.5 kg/ha, P -27.0 kg/ha and K- 240.0 kg/ha.Two concentrations of zinc (50 and 100 ppm) and two concentrations of boron (25 and 50 ppm) were sprayed solely or in their combinations. A control (water spray) was also included for comparison with micronutrients. Thus, a total of 9 treatments were used with three replications in RBD fashion. Seeds of Kashi Chaman variety of okra (tolerant to YVMV) were sown in wide raised bed (80 cm wide) on both side at row to row spacing of 60 cm and plant to plant spacing 30 cm. At the time of bed preparation 20 tons of FYM, 60 kg N, 60 kg P_2O_5 and 60 kg K_2O applied in soil per hectare area basis. Rest 60 kg N was supplied in two split doses i.e. 30 and 50 days after sowing. Two hand weedings and hoeings were carried out at 30 and 45 days after sowing. Irrigation was given in furrows at every 5-7 days to maintain soil moisture near to field capacity. Micronutrients were sprayed twice, 30 and 45 days after sowing. Fruits picking was started 50 days of sowing, and a total of 5 pickings were made. In each treatment three

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plants were tagged for recording all growth, yields, biomass production and root parameters.Root parameters such as root length density, root volume, root area, etc. were recorded with Root Scanner Win Rhizo- LA2400 (Regent Instruments Inc., Canada). Well washed intact roots were scanned, and above parameters were analyzed automatically using Win-Rhizo software with root scanner. CCI(Chlorophyll content index) was recorded at 50 days after sowing with help of CCM 200 (Opti-Sciences Inc., Hudson, USA). Insecticide and fungicides were sprayed to crop for management of pests and diseases as and when required.

RESULTS AND DISCUSSION

Plant growth and biomass production

In present study, it has been observed that foliar spray of micronutrients (Zn and B) significantly affected most of the growth parameters in okra. Application of Zn and B significantly enhanced the plant height.The highest plant height of 65.83 cm and 66.50 cm were recorded by the application of Zn at 50 ppm and combined spray of Zn (50 ppm)and B (50ppm), respectively (Table 1). Similarly, maximum CCI values were noticed in leaves sprayed with Zn 50ppm+ B 50ppm (54.50) followed by Zn 50 ppm and Zn 50ppm + B 25ppm. Similar results were also reported by Suraj *et al* (2019); Taheri *et al* (2020),and they reported that higher plant height and plant canopy in cucumber was obtained by the spray of $ZnSO_4$ (0.75%) and Borax (0.5%). Higher crop growth with foliar application of Zn and B mixture might be due to higher chlorophyll and LAI which leads to more biomass production. Increased vegetative growths also might be due to activation of different physiological activities such as, stomatal regulation, chlorophyll formation, enzyme activation and biochemical processes which resulted in increased dry matter production ((Khan *et al*, 2010; Marschner, 2012; Tariq *et al*, 2014). In present study, most of the growth parameters were also improved with two foliar sprays of Zn at 50 ppm. This may be due to fact that zinc affects cell division, photosynthesis, synthesis of tryptophan and proteins, and the activities of many enzymes (Li et al, 2016). Increased chlorophyll production with Zn application might also be due to increase in length and width of leaves (Samreen *et al*, 2013), as Zn is actively involved in cell division (Zhu *et al*, 2015). Micronutrients significantly affected the biomass production and their distribution among various plant parts. Maximum total dry matter (TDM) was observed under Zn 50 ppm+B 50 ppm (51.3 g/plant) followed by Zn 50 (45.35 g). These two treatments noticed an increase of 49.7% and 32.3% TDM over control (34.27 g/plant). As far as per cent distribution of dry matter in different plant parts were concerned, it was 26.3% in leaves and 35.67% in fruits under Zn 50 ppm+B 50 ppm, whereas the corresponding values under Zn 50 ppm were 25.7% in leaves and 38.25% in fruits (Figure 1). Shova *et al* (2020) reported that low to moderate applications of B and Zn nearly doubled biomass accumulation and plant nutrient uptake, and increased the economic yields of cauliflower and tomato between 8 and > 100%. Zinc and boron influence the enzyme activity, plant resistance, carbohydrates assimilation and primary macro elements utilization by the plant, that have a significant effect on plant growth and yield ((Daneshtalab and Moballeghi, 2020).

Table 1: Effect of Zinc and Boron spray on plant growth and yield parameters of okra

Micronutrient treatments	Plant height (cm)	CCI [1]	TDM (g/ plant) [2]	Fruits (No./ plant)	Fruit length (cm)	Fruit yield/plant (g)	Fruit yield (q/ ha)
Zn 50	65.83	52.68	45.35	21.67	16.27	402.67	95.68
Zn 100	63.67	50.91	35.62	19.33	14.70	322.17	75.58
B 25	60.17	48.84	31.00	16.67	14.91	303.83	69.47
B 50	60.83	48.73	33.54	15.67	13.58	234.17	61.73
Zn 50 + B 25	63.67	49.86	42.50	20.33	15.34	352.23	81.58
Zn 50 + B 50	66.50	54.50	51.30	24.33	16.88	438.33	102.56
Zn 100 + B 25	63.00	52.54	39.77	18.33	14.44	341.60	79.21
Zn 100 + B 50	61.83	51.23	32.00	16.33	14.35	357.00	81.27
Control (Water spray)	61.17	49.02	34.27	18.00	14.75	349.83	83.26
SEm±	1.32	0.95	2.29	0.67	0.50	13.86	3.65
$CD_{0.05}$	3.95	2.84	6.73	2.01	1.49	41.56	10.93

[1]Chlorophyll content index; [2]Total dry matter production

Yield parameters

Fruit yield is an important parameter, which is affected by number of fruits /plants, fruit weight and size.In present study, micronutrient spray significantly improved most of the yield traits in okra. Maximum number of fruits per plant was recorded with combined spray of Zn 50ppm+ B 50ppm (24.33). Besides, application of Zn 50ppm and combination of Zn 50ppm + B 25ppm also enhanced the number of fruits significantly, however these two treatments were at par to each other (Table 1). The maximum fruit length of 16.27cm and 16.88cm were recorded, respectively in Zn 50 ppm and Zn 50 ppm +B 50 ppm. As far as fruit yield concerned, maximum fruit yield of 438.22 g/ plant or 102.56 q/ha was noticed with application of Zn 50 ppm + B 50ppm followed by Zn 50 ppm (402.67 g/plant or 95.68 q/ha). These two treatments registered 23.18% and 14.91% higher fruit yield than control. In corroborate to our findings, Ss and Tiwari (1993) in onion, Naruka *et al* (2000) Satpute *et al* (2013) Habibur *et al* (2020) in okra, Anant *et al* (2010) in cowpea and French bean, Rizwan *et al* (2015) in tomato and Mahmoud *et al* (2019)

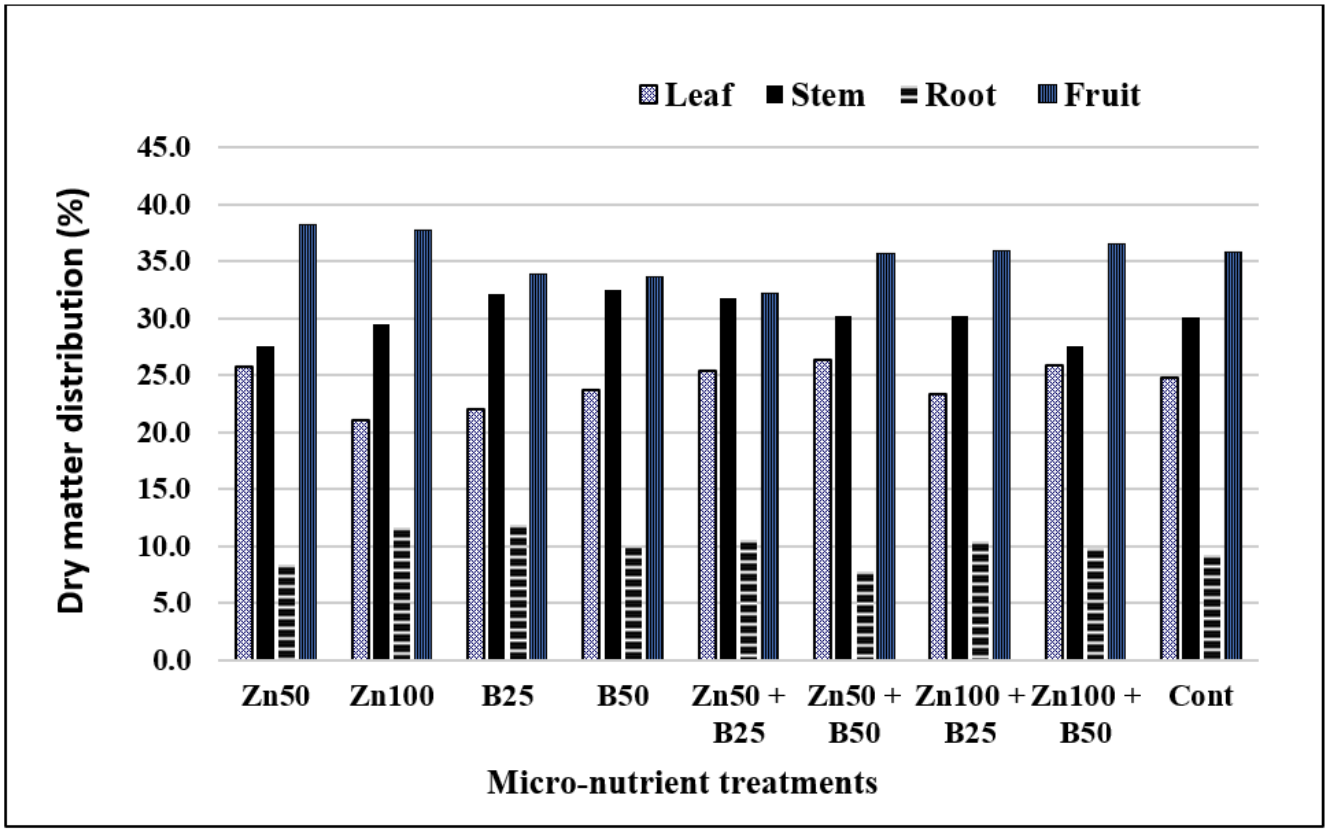

Fig. 1: Effect of micronutrient spray on per cent dry matter partitioning indifferent plant parts

in broccoli were also observed enhancement in yield parameters with spray of zinc and boron. Daneshtalab and Moballeghi (2020) reported that foliar application of micronutrients significantly increased the availability of primary and secondary macro-nutrients, beside some micronutrients (Zn, Fe, Cu, Mn, B), enzyme activities, plant resistance and carbohydrates assimilation that might have ultimately affect the yield and quality traits in okra. The improvement in yield traits of okra is might be due to fact that Zn is important for the formation and activity of chlorophyll and in the functioning of several enzymes and growth hormones like auxin, whereas B application enhanced the pollen tube germination and fruit setting, besides involved in metabolism, root growth and synthesis of proteins and carbohydrates (Moeinian *et al*, 2011).

Root parameters

It is evident fromTable 2 that foliar spray of micronutrients (Zn & B) significantly improved the root development in okra. Root parameters such as root area, volume, density and diameter were recorded with root scanner indicates that the maximum surface area (234.34 cm^2) and root length density (1486.87 cm/ cm^3) were recorded with application of Zn 50 ppm + B 50 ppm, however, statistically at par value wasalso recorded with Zn 50ppm (233.88 cm^2 and 1470 cm/cm^3).

Table 2: Effect of Zinc and Boron spray on root parameters of okra

Micronutrient treatments	Root surface area (cm^2)	Root volume (cm^3)	Root diameter (mm)	Total root length (cm)	Root length density (cm/ cm^3)
Zn 50	233.88	2.96	0.506	34.07	1470.00
Zn 100	147.52	2.25	0.510	28.93	889.13
B 25	134.05	1.96	0.507	30.17	721.33
B 50	131.20	2.45	0.601	30.50	562.45
Zn 50 + B 25	178.86	2.68	0.599	30.93	950.13
Zn 50 + B 50	234.34	2.94	0.501	28.43	1486.87
Zn 100 + B 25	207.88	2.54	0.612	29.00	1081.20
Zn 100 + B 50	178.55	2.05	0.620	29.70	856.14
Control (Water spray)	167.37	2.52	0.601	26.40	885.46
SEm±	4.08	0.17	0.023	1.46	31.63
$CD_{0.05}$	12.03	0.52	0.070	NS	93.33

CONCLUSION

On the basis of the experimental findings, it was concluded that combined foliar application of zinc and boron significantly influenced the growth and yield parameters in spring-summer okra. It was reported that two foliar sprays of Zn at 50ppm +B 25 ppm significantly enhanced most of the plant growth and yield parameters.This treatment combination registered 23.18% more fruit yields than the control. Thus, from present studyit was concluded that two foliar sprays of Zn 50ppm + B 25ppm may be practiced to enhance the productivity of okra.

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