International Journal of Environment and Climate Change

Volume 13, Issue 8, Page 722-727, 2023; Article no.IJECC.101002
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Boron and Zinc on Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L.) F1 Hybrid

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i82003

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101002

Original Research Article

Received: 01/04/2023
Accepted: 02/06/2023
Published: 03/06/2023

ABSTRACT

The field experiment was conducted during *Rabi* season in the year 2021-2022 at post graduate Horticulture Experimental farm, Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, to study the foliar application of different micro-nutrient treatments on Okra cv. Sahnaaj. The experiment was laid out in Randomized Block Design (RBD) with 9 treatments and 3 replications. Okra plants were treated with (boron and zinc) subjected to growth, yield and quality parameters and showed better results in combination treatment T_7 [0.3% Boron + (RDF 100:40:100)] the treatment whereas minimum was observed in T_0 (control).

Keywords: Okra; foliar application; boron; zinc; micronutrients.

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1. INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as lady's finger, belongs to the family Malvaceae. Okra popularly known as Bhendi' is an important warm season vegetable, widely cultivated for its tender, green fruits. It is widely adopted and popular vegetable in Indian kitchens and can be grown in summer and rainy seasons throughout India. India is the highest producer in the world and exported there by helping in earning foreign exchange. Okra is an important vegetable grown for its tender fruits which are used as a vegetable in various ways. It is also grown during early winter season of mid cool temperature. Okra is specially valued for its tender and delicious fruits. However, to a limited extent, it finds its use in dehydrated or frozen form. It has been reported to have an average nutritive value. In India, it ranks first in its consumption but its original home is Ethiopia and Sudan, the Northeastern African countries. It is one of the oldest cultivated crops and presently grown in many countries and is widely distributed from Asia to Africa, Southern Europe and America.

It is mainly cultivated for its tender green fruits that are available in the most of market. It is a good source of several vitamins, minerals and is useful to fight against various diseases [1,2]. The green tender pods of okra (per 100 g edible portions) contains 89.6 percent of moisture, 1.9 g protein, 88 IU of vitamin A, 0.07 mg thiamine, 0.1 mg riboflavin, 13 mg vitamin C, 0.7 g minerals (103 mg potassium, 6.9 mg sodium, 56 mg phosphorus, 66 mg calcium, 1.5 mg iron, 30 mg sulphur and other nutrients.

In India, okra is cultivated throughout the country for its immature tender pods (fruits), occupying an area over 511 hectares with production of 6219 tons [3]. In Rajasthan, it is grown over an area of 3.40 thousand hectares with an annual production to the tune of 10.50 thousand metric tons and productivity of 3090 kg/ha [3]. It is a warm season vegetable crop and required a long warm growing season. In India, it is grown in summer months and during the rainy season. It requires summer temperature 18-35°C. Seed germination best between 25-30°C and fails below 20°C. Bhendi can grow well in all kinds of soil but sandy loam and clay loam soils are best. It is tropical to subtropical is sensitive to frost, low temperature, water logging and drought condition.

2. MATERIALS AND METHODS

The area of Prayagraj district comes under subtropical belt in the southeast of Utter Pradesh, which experience extremely hot summer and fairly cold winter.

The experiment was conducted in Randomized Block Design with 9 treatment replicated thrice. The treatments were T_0 Control, T_1 0.1% Boron, T_2 0.1% Zinc, T_3 0.3% boron, T_4 0.3% Zinc, T_5 0.1% boron + (NPK 100:40:100), T_6 0.1% Zinc+ (NPK 100:40:100), T_7 0.3% Boron+ (NPK 100:40:100), T_8 0.3% Zinc + (NPK 100:40:100).

3. RESULTS AND DISCUSSION

3.1 Plant Height

At 30 DAS the maximum plant height was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 29.81 cm followed by 28.44 cm with T_8 (0.3% Zinc + RDF 100:40:100) and minimum plant height 20.14 was recorded in T_0 control. At 60 DAS the maximum plant height was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 56.22 cm followed by 53.13 cm with T8 (0.3% Zinc + RDF 100:40:100) and minimum plant height 36.5 was recorded in T_0 control.

At 90 DAS the maximum plant height was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 84.46 cm followed by 81.83 cm with T_8 (0.3% Zinc +RDF 100:40:100) and minimum plant height 62.90 was recorded in T_0 control. This is simultaneously reported by Singh et al. [4] and Aref [5].

3.2 Number of Branches/Plants

The maximum number of branches per plant was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 7.33 cm followed by 7.13 cm with T_8 (0.3% Zinc + RDF 100:40:100) and minimum number of branches 4.46 was recorded in T_0 control. This is simultaneously reported by Singh et al. [4] and Aref [5].

3.3 Leaf Area

The maximum leaf area was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 114.17 cm followed by 111.21 cm with T_8 (0.3% Zinc + RDF 100:40:100) and minimum leaf area 97.08 was recorded in T_0 control. This is simultaneously reported by Nawaz et al. [6].

3.4 Leaf area Index

The maximum leaf area index was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 1.27 followed by 1.1 with T_8 (0.3% Zinc + RDF 100:40:100) and minimum number of leaves 0.25 was recorded in T_0 control. This is simultaneously reported by Singh et al. [4]

3.5 Days to Flowering

The minimum number of days was recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) 40.67 followed by 42.66 with T_8 (0.3% Zinc + RDF 100:40:100) and maximum number of days 49.33 was recorded in T_0 control. This is simultaneously reported by Rahman et al., [7].

3.6 Days to First Fruiting

The minimum number of days was recorded in the treatment T_7 (0.3% Boron RDF 100:40:100) 47.66 followed by 49 with T_8 (0.3% Zinc +RDF 100:40:100) and maximum number of days 57 was recorded in T_0 control. This is simultaneously reported by Rahman et al. [7] and Kadam [8].

3.7 Number of Fruits per Plant

The maximum number of fruits per plants was 27.53 recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) followed by 25.73 with T_8 (0.3% Zinc + RDF 100:40:100) and minimum number of fruits per plants 17.66 was recorded in T0 control. This is simultaneously reported by Jena et al., [9]

3.8 Fruit Length

The maximum fruit length was 17.62 cm recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) followed by 17.41 cm with T_8 (0.3% Zinc +RDF 100:40:100) and minimum fruit length 9.66 was recorded in T_0 control. This is simultaneously reported by Kadam et al. [8].

3.9 Average Fruit Weight

The maximum fruit weight was 18.08 recorded in the treatment T_7 (0.3%Boron + RDF 100:40:100) followed by 17.55 with T_8 (0.3% Zinc + RDF 100:40:100) and minimum fruit weight 13.19 was recorded in T_0 control. This is simultaneously reported by Singh et al. [4] and Aref [5].

3.10 Fruit Yield per Plant

The maximum fruit yield per plant was 232.01g recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) followed by 215.68g with T_8 (0.3% Zinc + RDF 100:40:100) and minimum fruit yield per plant 77.08g was recorded in T_0 control. This is simultaneously reported by Pujari et al. [10].

3.11 Fruit Yield per Plot

The maximum fruit yield per plot was 5.48kg recorded in the treatment T_7 (0.3% Boron +RDF 100:40:100) followed by 4.98kg with T8 (0.3% Zinc + RDF 100:40:100) and minimum fruit yield per plot 1.38 kg was recorded in T0 control. This is simultaneously reported by Kadam et al., [8] and Rahman et al. [7].

3.12 Fruit Yield per Hectare

The maximum fruit yield per hectare was 18.7t recorded in the treatment T_7 (0.3% Boron +RDF 100:40:100) followed by 15.73 t with T_8 (0.3% Zinc + RDF 100:40:100) and minimum fruit yield per hectare 3.56 t was recorded in T0 control. This is simultaneously reported by Singh et al. [4] and Aref [5].

3.13 TSS

The maximum TSS was 3.36 recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) followed by 3.13 with T_8 (0.3% Zinc + RDF 100:40:100) and minimum TSS 1.63 was recorded in T_0 control. This is simultaneously reported by Jena et al. [9].

3.14 Ascorbic Acid

The maximum Ascorbic Acid was 16.91 recorded in the treatment T_7 (0.3% Boron + RDF 100:40:100) followed by 16.27 with T_8 (0.3% Zinc + RDF 100:40:100) and minimum Ascorbic acid 14.9 was recorded in T_0 control. This is simultaneously reported by Kumar et al. [11] and Saha et al. [12].

3.15 B:C Ratio

The maximum benefit cost ratio (3.28) was recorded under treatment T_7 (0.3% boron + RDF (100:40:100) and minimum benefit cost (1.11) was recorded under treatment control.

Table 1. Effect of boron and zinc plant height, No. of leaves, no. of branches, leaf area, leaf area index (LAI), days to first flowering and days to first fruiting

Symbol	Treatment combinations	Plant Height			Number of leaves	No. of Branch	Leaf area	LAI	Days to 1st flowering	Days to 1st fruiting
		30 Days	60 Days	90 Days						
T_0	Control	20.14	36.5	62.90	14.00	4.46	97.08	0.25	49.33	57.00
T_1	0.1% Boon	23.06	39.66	69.67	16.66	5.20	101.86	0.32	46.33	54.33
T_2	0.1% Zinc	22.50	38.72	65.55	15.33	5.00	99.46	0.31	47.66	55.33
T_3	0.3% boron	24.10	44.26	74.14	18.66	5.66	105.65	0.46	44.00	51.33
T_4	0.3% Zinc	23.8	42.66	71.93	17.33	5.53	103.12	0.33	46.00	52.66
T_5	0.1% boron + (NPK 100:40:100)	25.67	50.89	79.77	20.33	6.67	108.94	0.82	43.0	49.33
T_6	0.1% Zinc+ (NPK 100:40:100)	26.67	46.92	76.07	19.33	6.53	109.12	0.68	43.66	49.66
T_7	0.3% Boron+ (NPK 100:40:100)	29.81	56.22	84.46	22.33	7.33	114.17	1.2	40.67	47.66
T_8	0.3% Zinc + (NPK 100:40:100)	28.44	53.13	81.83	21.33	7.13	111.21	1.1	42.66	49.00
	F 'test'	S	S	S	S	S	S	S	S	S
	S.E. (d) (±)	1.31	0.65	0.29	1.12	0.15	1.46	0.05	1.02	0.87
	C.D. (5%)	2.78	1.38	0.61	2.38	0.44	3.09	0.10	2.16	1.85
	C.V.	6.45	1.75	0.48	7.47	3.06	1.69	9.72	2.78	2.07

Table 2. Effect of boron and zinc plant height, no. of leaves, no. of branches, leaf area, leaf area index (LAI), days to first flowering and days to first fruiting

Symbol	Treatment combinations	Number of fruits per plant	Fruit Length (cm)	Av. Fruit weight (g)	Fruit yield per plant	Fruit Yield per Plot	Yield/ha	TSS	Vit- C	B:C
T_0	Control	17.66	9.66	13.19	77.08	1.38	3.56	1.63	14.9	1.11
T_1	0.1% Boon	20.06	13.13	15.71	130.10	**2.99**	**5.49**	**2.59**	**15.17**	**1.64**
T_2	0.1% Zinc	18.66	11.17	14.57	102.81	2.53	4.66	2.10	15.14	1.36
T_3	0.3% boron	21.26	14.82	17.35	163.29	3.67	10.12	2.88	15.37	2.97
T_4	0.3% Zinc	19.46	14.68	17.09	136.24	3.23	7.82	2.80	15.25	2.21
T_5	0.1% boron + (NPK 100:40:100)	24.86	16.82	17.97	169.56	4.28	13.47	3.05	16.21	2.99
T_6	0.1% Zinc+ (NPK 100:40:100)	21.73	15.48	17.5	149.15	4.03	12.68	3.01	15.58	2.98
T_7	0.3% Boron+ (NPK 100:40:100)	27.53	17.62	18.08	232.01	5.48	18.7	3.36	16.91	3.28
T_8	0.3% Zinc + (NPK 100:40:100)	25.73	17.41	17.55	215.68	4.98	15.73	3.13	16.27	3.02
	F 'test'	S	S	S	S	S	S	S	S	
	S.E. (d) (±)	0.52	0.84	0.72	4.72	0.40	0.66	0.28	0.23	
	C.D. (5%)	1.10	1.17	1.53	10.00	0.86	1.41	0.59	0.50	
	C.V.	2.91	7.12	5.34	3.80	13.64	7.93	12.43	1.83	

4. CONCLUSION

It is concluded from the investigation of treatment T_7 (0.3% Boron (NPK 100:40:100)) was found superior followed by T_8 (0.3% Zinc (NPK 100:40:100)) for growth, yield and quality parameters. In this investigation the treatment T_7 (0.3% Boron (NPK 100:40:100)) is the best treatment for growth, quality, yield and economic returns 169921.00 Rs/ha and benefit- cost ratio (3.28) for cultivation of Okra, as such to validate the present findings more such trails need to be carried out in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101002