Current Horticulture **13**(1): 55–58, January–March 2025
DOI: 10.5958/2455-7560.2025.00009.9
Received: 03 December 2023; Accepted: 11 November 2024

Interaction effect of boron and zinc on growth, yield and quality of chilli (*Capsicum annuum*)

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Abstract

The study was carried out at School of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan), during 2022-23, in Factorial Randomized Block Design, comprising nine treatment combinations, *viz.* control (T_0), boron @ 0.2% (T_1), boron @ 0.4% (T_2), zinc @ 0.2% (T_3), zinc @ 0.4% (T_4), boron @ 0.2% + zinc @ 0.2% (T_5), boron @ 0.2% + zinc @ 0.4% (T_6), boron @ 0.4% + zinc @ 0.2% (T_7) and boron @ 0.4% + zinc @ 0.4% (T_8). The treatments were replicated three times. The effect of different concentrations of micronutrients on growth, yield and quality attributes were significantly influenced by different concentrations of boron and zinc under local agroclimatic conditions of Jaipur. The maximum (31.64 cm) and (49.98 cm) plant height at 45 and 60 DAT, respectively, 162.47 leaves per plant, 14.54 branches per plant, 16.67 flower clusters per plant, 50.10 fruits per plant, (2.66 cm) fruit girth, minimum (45.10 days) and (50.03 days) took for 50% flowering and first harvesting, respectively and longest (8.15 cm) fruit length, heaviest (11.79 g) fruit and maximum (468.73 g/plant and 18.03 t/ha) green chilli yield and (3.20 t/ha) dry red chilli yield and highest B: C ratio (3.25)were recorded under foliar spray of boron @ 0.2% + zinc @ 0.4% treatment. Hence, foliar application of boron @ 0.2% + zinc @ 0.4% performed significantly superior over control and remaining treatments to get highest green chilli production.

Key words: Boron, Zinc on growth, Yield, Quality, Growth, Parameters, Economics

Chilli (*Capsicum annuum* L.) is an important vegetable and spice crop in the family of Solanaceae. With diploid chromosome number, 2n=24.India is one of the largest producers, consumers and exporters of India chilli in the world (Anonymous, 2021). India ranks first in area and second in production. It contributes 4.26 million ha area and 34.5 million tonnes production in the world (FAO, 2018). In Rajasthan chilli is cultivated in 13,812 ha area with 13,649 tonnes. The important chilli-producing districts are Jodhpur, Alwar, Jaipur, Bhilwara, Tonk, Swai Madhopu and Udaipur. Boron plays an important role in cell wall synthesis and membrane stability (Iwai *et al.,* 2006). It improves flowering and fruit setting, fruit formation and fruit quality (Rawaa *et al.,* 2014). Translocation of sugar, starches, nitrogen, phosphorus synthesis of amino acids and proteins are also influenced by boron (Rawaa *et al.*, 2014). Zinc is also most important micronutrient (Mousavi, 2011). The information on impact of micronutrients on chilli is scanty. Keeping in view, study was undertaken to find out best combination of micronutrients with optimum concentration for quality chilli production.

MATERIALS AND METHODS

The study was carried out at Suresh Gyan Vihar University, Jaipur (Rajasthan) to see the effect of different boron and zinc on chilli during 2022-23. The experiment was laid out in FactorialRandomized Block Design which comprises nine treatment combinations, *viz.* control (T_0), boron @ 0.2% (T_1), boron @ 0.4% (T_2), zinc @ 0.2% (T_3), zinc @ 0.4% (T_4), boron @ 0.2% + zinc @ 0.2% (T_5), boron @ 0.2% + zinc @ 0.4% (T_6), boron @ 0.4% + zinc @ 0.2% (T_7) and boron @ 0.4% + zinc @ 0.4%@ 0.4% (T_8) replicated three times. The observations were measured on five randomly selected and tagged plants in each plot and their mean value was calculated. Significance of difference in treatment effect was tested through 'F' test at 5 per cent level of significance and CD (critical difference) was calculated, wherever results were found significant.

RESULTS AND DISCUSSION

Growth parameters

The maximum (26.55 cm), (44.89 cm) and (70.89 cm) plant height was recorded under foliar spray of boron @ 0.2% treatment at 45, 60 and 75 DAT, respectively. It might be due to boron application and it plays an important role in activation of cell division and cell elongation. The boron strengthens the number of metabolic activities for building plant organs that consequently increased the plant height (Marschner, 1995). Maximum (17.94 cm), (36.27 cm) and (62.27 cm) plant height was recorded under foliar spray of zinc @ 0.4% treatment at 45, 60 and 75 DAT, respectively. This attribute might be due to active synthesis of tryptophane; a precursor of auxin, besides the

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synergistic effect of zinc which may serve as asource of energy for the synthesis of auxin. It could be attributedas one of the key factor for the growth of plant (Raghav and Singh, 2004).

The maximum interaction effect (31.64 cm) and (49.98 cm) plant height were recorded under foliar spray of boron @ 0.2% + zinc @ 0.4% treatment at 45 and 60 DAT. At 75 DAT, maximum (75.98 cm) plant height was recorded under foliar spray of boron @ 0.2% + zinc @ 0.4% treatment followed by (73.00 cm), (70.20 cm) and (69.05 cm) plant height under boron @ 0.2% + zinc @ 0.2%, boron @ 0.4% + zinc @ 0.2% and boron @ 0.4% + zinc @ 0.4% but all treatments performed at par with boron @ 0.2% + zinc @ 0.4% treatment and had significant effect over control. It might be due to synergistic effect of boron and zinc on vegetative characters. The produced auxin promotes the apical dominance that ultimately enhanced the plant height.

The maximum (162.47) leaves/plant was observed under foliar sprayed plants with boric acid @ 0.6% (T_3), whereas maximum (14.54) branches/plant was observed under boron @ 0.2% + zinc @ 0.4% and it showed significant effect. The maximum (16.67) flower clusters/plant was observed on same treatment. The increase of leaves and branches/plant might be due to enhancing of metabolic reaction for building of plant organs by exogenous application of boron that increased cell wall plasticity and cell wall elongation (Yugandhar *et al.*, 2014 and Somkuwar *et al.*, 2023). The plant height augmented with foliar application of boron. It might be due to production of more branches and more available space and photosynthates. These results are in agreement with those of Sugania and Kumuthini (2015) and Bohra and Nautiyal (2019).

The minimum (38.85) and (45.10) days took for 50% flowering and first harvesting, respectively under foliar spray of boron @ 0.4% (T_2) treatment, whereas maximum (38.51 days) took for 50% flowering and (46.03 days) took for first picking under foliar spray of boron @ 0.2% + zinc @ 0.4%, followed by (51.70 days) under foliar spray of boron @ 0.2% + zinc @ 0.2% treatment. These results are in line of Elankavi *et al.* (2009) who also observed that exogenous application of boron significantly reduced number of days to 50% flowering and first picking. It might be due to application of boron which increased fruit set and advanced flowering (Khatri *et al.*, 2022 and Vyas *et al.*, 2024). The results are in conformation with those of Gopal and Sarangtham (2021) and Khan *et al.* (2023).

Reproductive structures

Fruit setting increased dramatically with spraying of low concentration of micronutrients in chilli (Nawaz *et al.*, 2008). The maximum flower clusters/plant (16.67), fruits/plant (48.10), minimum days (38.51) took for 50% flowering and days (46.03) took for first picking under foliar spray of boron @ 0.2% + zinc @ 0.4% treatment, whereas minimum flower clusters/plant (11.38) and fruits/plant (29.67) under control (Table 1). It might be due to foliar feeding of micronutrients that strengthen the photosynthetic activity. The accumulation of carbohydrates favors the flower retention in fruit vegetables.

The foliar spray of micronutrients was most effective in reducing premature fruit drop. It might be due to absorption of boron that promoted the production of more photosynthates required for more number of fruits (Vyas *et al.*, 2016). Similar results were also reported by Gopal and Sarangtham (2021) and Meriño-Gergichevich *et al.* (2021).

Yield-attributing parameters

The application of boric acid and zinc sulphate spray significantly increase in length, breadth, weight and volume. It may be due to boron improved fruit weight and and fruit size may be due to its role in increasing cell elongation and cell division (Eman *et al.*, 2007). The maximum fruit length (8.15 cm) was observed in foliar spray of boron @ 0.2% + zinc @ 0.4% treatment followed by (7.41 cm) under boron @ 0.2% + zinc @ 0.2% treatment (Table 1). These results are in close conformity with those of Singh *et al.* (2019). The increase in fruit length and fruit diameter might be due to accumulation of photosynthates which were synthesized in leaves and translocated towards fruits. The increased fruit size due to accumulation of photosynthates was probably due to more and growth (Singh *et al.*, 2019 and Vyas *et al.*, 2024).

The application of boric acid had significant effect on fruit length, girth and diameter. The maximum fruit girth (2.66 cm) was observed in foliar spray of boron @ 0.2% + zinc @ 0.4% treatment, followed by (2.47 cm) under foliar spray of boron @ 0.2% + zinc @ 0.2% treatment, whereas minimum fruit girth (1.20 cm) was recorded in control (Table 1). It might be due to boron that promoted photosynthesis rate and cell divisions that increased fruit diameter. Boron and zinc encouraged tryptophan formation which helped in the biosynthesis of proteins and auxins (Khan *et al.*, 2023 and Nehra and Malik, 2024).

The highest fruit weight (11.79 g) was recorded in foliar spray of boron @ 0.2% + zinc @ 0.4% treatment, whereas the lowest fruit weight (6.51 g) was recorded under the control (T_0). These results are in line of Khan *et al.* (2023) and Somkuwar *et al.* (2023).

Table 1: Effect of plant growth regulators on yield and yield-attributing characters

Treatment	Number of flowers /plant	Number of days to first picking	Number of fruits / plant	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Green chilli yield			Dry chilli yield (tonnes/ ha)	B:C ratio
							(g/ plant)	(kg/ plot)	(tonnes/ ha)		
Control	11.38	71.16	29.67	4.81	1.20	6.62	191.70	4.60	7.10	1.25	1.04
Boron											
Boron @ 0.2%	13.30	57.61	39.10	6.39	2.15	8.68	322.85	7.75	11.96	2.12	2.18
Boron @ 0.4%	12.63	59.83	38.50	5.86	2.03	8.12	318.49	7.64	11.80	2.08	1.87
S.Em+	0.30	1.55	0.59	0.20	0.11	0.12	12.48	0.30	0.46	0.08	
C.D. (p=0.05)	0.90	4.68	1.79	0.60	0.32	0.36	37.73	0.91	1.40	0.23	
Zinc											
Zinc @ 0.2%	11.79	61.50	35.50	5.37	1.71	7.47	253.01	6.06	9.38	1.67	1.83
Zinc @ 0.4%	11.91	60.70	37.17	6.01	2.18	8.08	290.76	6.98	10.79	1.91	1.87
S.Em+	0.30	1.55	0.59	0.20	0.11	0.12	12.48	0.30	0.46	0.08	
C.D. (p=0.05)	0.90	N.S.	1.79	0.60	0.32	0.36	37.73	0.91	1.40	0.23	
Interaction between boron and zinc											
Boron @ 0.2% + Zinc @ 0.2%	16.67	51.70	43.50	7.41	2.47	10.84	417.27	10.01	15.45	2.74	2.95
Boron @ 0.2% + Zinc @ 0.4%	14.71	46.03	48.10	8.15	2.66	11.79	486.73	11.68	18.03	3.20	3.25
Boron @ 0.4% + Zinc @ 0.2%	14.53	54.20	41.90	7.17	2.42	9.91	369.22	8.86	13.67	2.42	2.57
Boron @ 0.4% + Zinc @ 0.4%	14.39	57.50	39.50	6.47	2.39	8.72	324.60	7.79	12.02	2.14	2.51
S.Em+	0.52	2.68	1.03	0.35	0.18	0.21	21.35	0.52	0.80	0.13	
C.D. (p=0.05)	1.56	8.10	3.10	1.04	0.55	0.62	65.35	1.57	2.42	0.39	

Yield parameters

The highest fruit yield (468.73 g) was observed under foliar spray of boron @ 0.2% + zinc @ 0.4% treatment. Similar trend was also reported on green chilli yield and highest green chilli fruits (11.68 kg/plot) were produced in boron @ 0.2% + zinc @ 0.4% treatment (Table 1). The highest green chilli yield (18.03 tonnes/ha) was obtained in foliar spray of boron @ 0.2% + zinc @ 0.4% treatment. Hence, boron @ 0.2% + zinc @ 0.4% treatment performed significantly superior over foliar spray of different concentrations of boron, zinc individually and their interaction treatments on green chilli yield (Table 1). Similarly, interaction of boron and zinc had significant effect on dry red chilli yield. The highest dry red chilli yield (3.20 t/ha) was recorded in foliar spray of boron @ 0.2% + zinc @ 0.4% treatment, whereas lowest dry red chilli yield (1.25 t/ha) was recorded under water sprayed plants in control (Table 1). Foliar application of B and Zn increased the yield of chilli significantly as it enhanced the vegetative growth, retention of flowers and fruits (Nehra and Malik, 2024). These results are in close conformity with the findings of Khan *et al.* (2023) and Vyas *et al.* (2024).

Economics

The highest B: C ratio (3.25) was recorded in boron @ 0.2% + zinc @ 0.4% treatment, followed by (2.95) in boron @ 0.2% + zinc @ 0.2% and (2.57) B: C ratio in boron @0.4% + zinc @ 0.2% as compared to lowest B: C ratio (1.04) in control (Table 1). It might be due to increasing fruit set, fruit retention, number of fruits/plant and minimized fruit drop percentage in foliar application of boron that ultimately increased the yield. These results are in close conformity with those of Gopal and Sarangtham (2021) and Khan *et al.* (2023).

CONCLUSION

Thus, it may be concluded that boron @ 0.2% + zinc @ 0.4% was found the best treatment followed by boron @ 0.2% + zinc @ 0.4% treatment.

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