Biological Forum – An International Journal **15(9): 614-618(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment of Effect of various Micronutrients and their Optimum Dose for Growth and Yield Parameters of Broccoli (*Brassica oleracea var italica* L.) under Polyhouse Condition

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(Received: 30 June 2023; Revised: 02 August 2023; Accepted: 30 August 2023; Published: 15 September 2023)
(Published by Research Trend)

ABSTRACT: Agriculture, IGKV, Raipur (C.G)" to find out the possible effect of foliar application of micronutrients with different concentration levels on growth and yield of broccoli. Three replications of the experiment were set up using a completely randomized design (CRD). It was consisted of ten treatments including T_0: Control (without spray of micronutrients), T_1: Cu @ 0.20%, T_2: Cu @ 0.40%, T_3: Cu @ 0.60%, T_4: Bo @ 0.20%, T_5: Bo @ 0.40%, T_6: Bo @ 0.60%, T_7: Zn @ 0.20%, T_8: Zn @ 0.40% and T_9: Zn @ 0.60%,". Three foliar applications were performed at 15, 30 and 45 days after transplanting. The experiment's findings revealed a considerable difference between different treatment combinations. Treatments T9 -zinc sulphate @ 0.60% found highly effective for growth parameters as it showed greatest plant height (66.81cm), no. of leaves (26.47), stalk length (18.22 cm), root length (16.06 cm) while T5- boric acid @ 0.40% was found superior to days to first curd induction, 50% maturity and harvest of curd. Foliar application of micronutrients has become a farm management practices which increases the overall characters of various crops. The aim of this experiment was to evaluate the effect of foliar application of individual nutrients on growth and yield of broccoli. It may be concluded that foliar application of zinc sulphate @ 0.60% showed a positive response and gives highest effect for growth parameters and boric acid @ 0.40% resulted in increased yield attributing parameters. Therefore, foliar micronutrient the absorption may be a potential strategy to maximize broccoli growth and output.

Keywords: Broccoli, foliar application, Micronutrient, growth and yield.

INTRODUCTION

Among the key vegetables used for cole crops is broccoli (*Brassica oleracea* var. *Italica* L.). Brocco, which means "arm" or "branch" in Italian, and the Latin word brachium are the source of the word broccoli. It provides plants with a lot of nutrients. When harvested for fresh consumption, broccoli, a dicotyledonous biennial plant that belongs to the family Brassicaceae (2n=18), is considered as an annual (Yamayuchi, 1983). In India, it is grown as an underappreciated vegetable. Beta-carotene levels in broccoli are 14 times more concentrated than in grown cabbage (Decoteau, 2000). It has a high vitamin C content, which lowers the risk of cardiovascular disease (Du *et al*., 2012). Despite being a food crop that is largely restricted to a small area, particularly close to major cities, broccoli is underutilized in India. Furthermore, it has significant amounts of minerals like iron, calcium, salt, phosphorus, and potash. It provides substantial amounts of nutrients such as vitamin A (9000 mg/100 g), vitamin B1 (0.05 mg/100 g), vitamin B2 (0.12 mg/100g), vitamin C (137 mg/100 g), total carbohydrates (5.5 %), fat (0.2 %), water (89.9 %) and calories (36/100 g) (Thamburaj and Singh 2001).

According to reports, more than 90 percent of agricultural soils around the world are deficient in one or more vital elements needed to produce healthy plants. Applying foliar or soil fertilizers or amendments might compensate up for this lack of soil nutrients. Foliar application is one of the more straightforward and efficient ways to provide plants with the nutrients they require in sufficient amounts, enhance the nutritional condition of plants, and increase crop output and quality (Smolen, 2012).

The most critical micronutrients are boron and zinc, which are vital to cell division, nitrogen and glucose metabolism, and interactions with water in plant growth (Brady, 1990). Boron is important in glucose translocation, cell wall construction, and RNA synthesis, and it regulates these processes (Narayanamma *et al.,* 2007). Boron use dramatically

boosts cauliflower yield, quality, yield, and curd weight (Kumar *et al*., 2002). In early plants, interveinal chlorosis, leading to in stunted shoot growth and internode shortening, as well as mottled leaves and small leaves, is an indicator of zinc deficiency since zinc also significantly influences plant growth and stimulates enzymes (Liang *et al.,* 2006). Therefore, a field experiment was carried out to investigate the manner in which micronutrients affected the growth and productivity of broccoli.

MATERIALS AND METHODS

The study was carried out during the rabi of 2020–21 at the Centre of Excellence on Protected Cultivation and Precision Farming, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was performed in a "Completely Randomized design" with three replications comprising of ten treatments. Green Magic (F1 hybrid) seeds of broccoli were sown in the pro trays and monitored regularly by keeping them in nursery. A 15-20 cm raised nursery bed of sized (3.0 m × 1.0 m) was prepared in the month of October 2020. The seedlings became ready for transplanting within 4-5 weeks after sowing. FYM 25 tones/ha was added in the experimental field. Fertilizer in the form of Urea, DAP and MOP were used as the source of nitrogen, phosphorous and potassium (NPK) was applied @ 100, 80 and 80 kg/ha respectively. Mulching was done to check the population of weed density and to conserve the soil moisture. When the dewdrops had evaporated in the morning (about 9.30 a.m.), spraying had been carried out. After transplanting broccoli crops, the appropriate micronutrient concentrations were prepared, and the first, second, and final sprayings were carried out at 15, 30, and 45 days.

Table 1: Treatment details.

Treatment	Treatment details
T0	Control (Water spray)
T1	Copper Sulphate (Cu) @ 0.20 %
T2	Copper Sulphate (Cu) @ 0.40 %
T3	Copper Sulphate (Cu) @ 0.60 %
T4	Boric Acid (B) @ 0.20 %
T5	Boric Acid (B) @ 0.40 %
T6	Boric Acid (B) @ 0.60 %
T7	Zinc Sulphate (Zn) @ 0.20%
T8	Zinc Sulphate (Zn) @ 0.40%
T9	Zinc Sulphate (Zn) @ 0.60%

RESULT AND DISCUSSION

A. Micronutrients influence on growth characteristics

The information in Table 2 suggested that foliar micronutrient administration had a substantial impact on the vegetative growth parameters. Effect of foliar spraying of the micro-nutrients which given significant variance with respect to plant height, number of leaves per plant, length of stalk and root length was recorded at 60 days after transplanting (DAT). The greatest plant height was recorded 66.81 cm under the T9 {Zinc sulphate ($ZnSO_4$) 0.60%} followed by T8 {Zinc sulphate ($ZnSO_4$) @ 0.40%} is 65.38 cm and the minimum plant height 50.42 cm were observed under the T0 (control). The increase in vegetative growth might be related to zinc's involvement in the synthesis of chlorophyll; it also affects cell division, the meristematic activity of plant tissues, cell expansion, and the development of cell walls through active tryptophan synthesis. Zinc is also responsible for encouraging plant growth through cell elongation and cell division. These outcomes were carefully documented by Meena (2004); Lal *et al.* (2015) in broccoli).

The highest number of leaves 26.47 was noted in treatment T9 {Zinc Sulphate ($ZnSO_4$) @ 0.60 %} followed by T8 {Zinc sulphate ($ZnSO_4$) @ 0.40%} is 25.83 while minimum number of leaves is 19.06 under the treatment T0 (Control) at 60 DAT. The availability of the necessary quantity of vital plant nutrients controlling the plant's metabolic process, including sugar metabolism and protein synthesis, may have caused the plant to produce more leaves. The same outcomes are also reported by Chaudhari *et al*. (2017) in cauliflower; Lal *et al.* (2015); Zhi *et al*. (2005) in broccoli.

At 60 DAT, the maximum stalk length 18.22 cm was reported under the T9 {Zinc sulphate ($ZnSO_4$) 0.60%} followed by T8 {Zinc sulphate ($ZnSO_4$) @ 0.40%}is 17.54 cm and the lowest stalk length 13.63 cm were observed under the T0 (Control). Various treatments of the micronutrients significant affect the growth of stalk length. The length of the stalk is substantially longer after all micronutrient treatments compared to the control. The application of the various micronutrients may have sped up the plant's metabolic processes, which could have increased the plant's height and stalk length. Zinc is a precursor to IAA and triggers the synthesis of tryptophan. It is also responsible for boosting plant growth. This is in accordance with findings of Singh *et al*. (2018) in broccoli; Ahmed *et al.* (2011); Agarwal and Ahmed (2007) in cauliflower.

The longest root length was noticed in the foliar spray was 16.06cm under the treatment T9 {Zinc sulphate ($ZnSO_4$) @ 0.60%} followed by T8 {Zinc sulphate ($ZnSO_4$) @ 0.40%} is 14.42cm and the minimum value of root length was observed 10.5 cm under T0 (Control). Zinc is required for development and growth. It also plays a role in cell division, which stimulates root elongation and shoot growth. It is possible that zinc sulphate's direct impact on plant enzymatic control is the factor that causes the increase in root length that has been linked to it. This result is in close agreement with Kumar (2009); Sharma (2012) in broccoli and Chaudhari *et al.* (2017) in cauliflower.

B. Effect of micronutrients on yield parameters

The data obtained on various yield attributing parameters of broccoli viz. curd yield plant^{-1} (g), curd yield plot^{-1} (kg), curd yield (q ha^{-1}) and curd diameter (cm) were presented in Table 2. The data indicated that maximum curd yield plant^{-1} (g) was observed 326.46g under the treatment T5 {Boric acid (H_3BO_3) @ 0.40%} followed by T4{Boric acid (H_3BO_3) @ 0.20%} is

318.52g and the minimum yield of curd yield 192.70g was reported in the T0 (control). The increment in the yield of curd might be due to physiological role of micronutrients. Furthermore, boron has a catalytic function in the oxidation and reduction processes and is essential for the metabolism of sugar, which may have contributed to the increased curd weight. The latest findings agree with earlier studies of Slosar *et al.* (2017) in broccoli and Chaudhari *et al.* (2017) in cauliflower.

Table 2: Micronutrient influence on broccoli dimensions of growth var. Green Magic

Notations	Treatments	Plant height	No. of leaves	Stalk length	Root length
T0	Control (Water spray)	50.42	19.06	13.63	10.5
T1	Copper Sulphate (Cu) @ 0.20 %	59.61	20.15	14.08	11.51
T2	Copper Sulphate (Cu) @ 0.40 %	61.44	23.03	14.88	12.43
T3	Copper Sulphate (Cu) @ 0.60 %	60.15	21.46	14.12	11.34
T4	Boric Acid (B) @ 0.20 %	61.07	22.46	15.32	13.18
T5	Boric Acid (B) @ 0.40 %	63.39	24.15	16.86	13.52
T6	Boric Acid (B) @ 0.60 %	60.33	21.87	15.24	12.54
T7	Zinc Sulphate (Zn) @ 0.20%	62.35	23.48	15.57	14.18
T8	Zinc Sulphate (Zn) @ 0.40%	65.38	25.83	17.54	14.42
T9	Zinc Sulphate (Zn) @ 0.60%	66.81	26.47	18.22	16.06
	SE(m)	0.68	0.47	0.21	0.13
	C.D (p = 0.05)	2.03	1.40	0.62	0.40

Table 3: Response of micronutrients on yield attributing parameters of broccoli var. Green Magic.

Notations	Treatments	Curd yield plant^{-1} (g)	Curd yield plot^{-1}(Kg)	Curd yield (q ha^{-1})	Curd diameter (cm)
T0	Control (Water spray)	192.70	2.88	72.16	12.49
T1	Copper Sulphate (Cu) @ 0.20 %	245.01	3.67	91.75	15.23
T2	Copper Sulphate (Cu) @ 0.40 %	252.76	4.45	111.24	15.48
T3	Copper Sulphate (Cu) @ 0.60 %	232.71	3.48	87.03	14.82
T4	Boric Acid (B) @ 0.20 %	318.52	6.10	153.38	17.37
T5	Boric Acid (B) @ 0.40 %	326.46	6.29	157.24	17.57
T6	Boric Acid (B) @ 0.60 %	286.31	5.21	130.23	16.13
T7	Zinc Sulphate (Zn) @ 0.20%	262.82	4.60	115.16	15.84
T8	Zinc Sulphate (Zn) @ 0.40%	273.87	5.17	128.56	16.08
T9	Zinc Sulphate (Zn) @ 0.60%	305.16	6.04	151.02	16.87
	SE(m)	3.83	0.25	3.26	0.43
	C.D (p = 0.05)	11.31	0.73	9.61	1.28

Significant differences in yield (kg plot^{-1}) were observed with the application of micronutrient. The maximum yield 6.29kg was reported in the treatment T5{Boric acid (H_3BO_3) @ 0.40%} followed by T4 {Boric acid (H_3BO_3) @ 0.20%} is 6.10kg and T9 {Zinc sulphate ($ZnSO_4$) @ 0.60%} is 6.04kg. The minimum yield 2.88 kg was obtained in the T0 (control). Similar results reported by Adhikary *et al.* (2004); Bairwa *et al.* (2020) in cauliflower and Sharma (2002) in broccoli.

The curd yield plot^{-1} in various treatments were recorded and change it into yield q ha^{-1}. And the results showed significant variations among other treatments, it is presented in the Table. The greatest yield 157.24 q ha^{-1} was reported with the treatment T5 {Boric acid (H_3BO_3) @ 0.40%} followed by T4 {Boric acid (H_3BO_3) @ 0.20%} is 153.38 q ha^{-1} and T9 {Zinc sulphate ($ZnSO_4$) @ 0.60%} is 151.02 q ha^{-1} and T0 (Control) obtained minimum yield 76qha^{-1} was recorded. The increase in output might be attributed to

the application of several micronutrients in the needed amounts in deficient conditions, which resulted in significant uptake of major nutrients and vigorous plant development, resulting in improved yield and quality. Present result is in agreement with the findings of Pizetta *et al*. (2005); Ain *et al*. (2016); Shivran *et al.* (2017) in broccoli.

Among the treatments there was significant differences were observed with respect to curd diameter. The maximum curd diameter observed 17.57 cm under the treatment T5 {Boric acid (H_3BO_3) @ 0.40%} followed by T4 {Boric acid (H_3BO_3) @ 0.20%} is 17.37 cm and T9 {Zinc sulphate ($ZnSO_4$) @ 0.60%} is 16.87 cm and the minimum curd diameter 12.49cm was observed under the treatment T0 (Control).Through enhancing physiological processes such as photosynthesis, which is when food is created by plants, assimilates are transported from leaves to curd, and their storage in curd for which boron was a contributing factor micronutrient enhance the curd width and curd weight. Singh *et al.* (2017); Chowdhury and Sikder (2019) also demonstrated the better efficiency of boron towards better yield in broccoli plants.

CONCLUSIONS

The current experimental findings suggest that sprays of different micronutrients (Cu, B, Zn) give effective response in growth, yield and quality in broccoli. The finding revealed that T9- zinc sulphate @ 0.60% was found better for increasing vegetative parameters whereas T5- Boric acid @ 0.40% were found better performance in yield parameters.

FUTURE SCOPE

A thorough investigation is required, as well as the application of several other micronutrients including Mo, Fe, and Mn at varied concentrations to evaluate their impact on growth, yield, and quality in broccoli. The same experiment can be performed for one or more seasons in order to arrive at any firm recommendations.

Acknowledgement. The Department of Horticulture provided all the necessary resources and moral support for the authors to carry out the entire research program and produce its important conclusions. The Department of Soil Science has the incredible privilege of giving authors all the information, equipment, and moral support they need.

Conflict of Interest. None.

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How to cite this article: Alka Minz, Susmitha Kottapu, Nisha Jangre, Deepshikha and Karuna Sahu (2023). Assessment of Effect of various Micronutrients and their Optimum Dose for Growth and Yield Parameters of Broccoli (*Brassica oleracea var italica* L.) under Polyhouse Condition. *Biological Forum – An International Journal*, *15*(9): 614-618.