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Effect of Different Micronutrients on Economics of Broccoli (*Brassica oleracea* var. Italica) cv. Green Magic under Polyhouse Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was conducted to study of "Impact of foliar spray of micronutrients on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica*) under polyhouse condition" during the Rabi 2020-21 season under Department of Vegetable Science at the "Center of Excellence on Protected Cultivation and Precision Farming", IGKV, Raipur (C.G.). The experiment consisting of 10 treatments viz., copper sulphate @ 0.20%, copper sulphate @ 0.40%, copper sulphate @ 0.60%, boric acid @ 0.20%, boric acid @ 0.40%, boric acid @ 0.60%, zinc sulphate @ 0.20%, zinc sulphate @ 0.40% and zinc sulphate @ 0.60%. Experiment was carried out with completely

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randomized design with ten treatments and three replications. Economic study showed that highest cost of cultivation (180,735 Rs/ha) with T3-copper sulphate @ 0.60% while maximum gross income (471,720 Rs/ha), net income (292,325 Rs/ha) and B:C ratio (2.62) was observed with T5- boric acid @ 0.40%.

Keywords: Micronutrients; broccoli; yield; economics.

1. INTRODUCTION

The word broccoli comes from the Italian plural of “broccoli”, which means "the flowering crest of a cabbage", and is the diminutive form of “brocco”, meaning "small nail" or "sprout". Broccoli (*Brassica oleracea L.* var. *italica*) is one of the most nutritious vegetables amongst the cole crops grown for its tender heads. It belongs to the family Brassicaceae and originated from the Mediterranean region [1]. Consumption of broccoli has been steadily increased due to its health promoting properties and conscious of human towards health. Broccoli has 14 times more beta-carotene than cultivated cabbage [2]. As it rich in vitamin C, thus reduces the risk of cardiovascular disease (Du *et al.,* 2012). It also contains appreciable amount of minerals like phosphorus, potash, calcium, sodium and iron. Its medicinal properties are steadily gaining more importance in the world. Broccoli's health advantages are attributed in part to secondary plant chemicals having antioxidant properties [3]. Broccoli is also high in glucosinolates, which are the precursors to the chemoprotective isothiocyanate, a compound linked to cancer prevention [4].

India is the world's second largest producer of vegetables, after China with an annual production of approximately 162.187 (million tonnes) from 92.05 (million hectare) of land. India ranks second in terms of area and production of cauliflower and broccoli. In 2019, global production of broccoli (combined for production reports with cauliflowers) was 27 million tonnes, where as China and India together contribute for 73% of the world total. In India (2019) the production of broccoli was 9.1 million tonnes. Major broccoli producing growing states of India are West Bengal, Bihar, Odisha, Madhya Pradesh, Haryana, Gujarat and Jharkhand (FAO, 2019). However, this production does not meet the requirement of 300g of vegetables per capita per day. As a result, India's vegetable production must be greatly increased.

Morphologically, it resembles to cauliflower although the plant produces heads rather than curds, with green buds and thick fleshy flowering stalks. It has a large, generally green flower head arranged in a tree-like pattern on branches that grow from a thick, edible stem. Broccoli is dicotyledonous biennial herbaceous for seed production and considered as annual when harvested for fresh consumption. The temperature of 20^0C to 25^0C is optimum for its growth while 15^0C to 20^0C for its heading stage.

Horticultural crops suffer widely in zinc deficiency followed by boron, manganese, copper, iron and molybdenum deficiencies. The most appropriate method to overcome such deficiencies in crops is foliar spray of nutrients such as boron, copper, and zinc for growth and metabolism [5]. Zinc also dramatically regulates the plant growth and activates enzymes, so it's essential for plants as well, interveinal chlorosis, which causes stunted shoot growth and internode shortening, as well as mottled leaf and little leaf, is an indication of zinc deficiency in early plants [6]. Boron is important in glucose translocation, cell wall construction, and RNA synthesis, and it regulates these processes [7]. Copper is a component of enzymes and serves as a catalyst for respiration. Copper is found in large amounts in enzyme proteins, which control the rate of a number of biochemical reactions in plants.

2. MATERIALS AND METHODS

The present research entitled was carried out during the Rabi season 2020-21 at Center of Excellence on Protected Cultivation and Precision farming under polyhouse condition, College of Agriculture, IGKV, Raipur (C.G.). Green magic is one of the good varieties of broccoli, it is in the mid-early maturity class with wider adaptability. Therefore, in present investigation green magic cultivar was selected. The experiment consisting of 10 treatments viz., copper sulphate @ 0.20%, copper sulphate @ 0.40%, copper sulphate @ 0.60%, boric acid @ 0.20%, boric acid @ 0.40%, boric acid @ 0.60%, zinc sulphate @ 0.20%, zinc sulphate @ 0.40% and zinc sulphate @ 0.60%. Experiment was carried out with completely randomized design with ten treatments and three replications. As per schedule of treatments the required quality of micronutrients were dissolved in appropriate quantity of water and applied by foliar spraying. Micronutrient solution. (%) = g of substance

dissolve in liter of water. Fresh solution was prepared just prior to spraying. For making 1 litre of 0.20%, 0.40% and 0.60% concentration of each micronutrient, 2g, 4g and 6g amount of each micronutrient was taken and weighed and carefully dissolved in 1litre of water. Solutions of various concentrations were uniformly spread to the plant to wet both the surfaces of leaves. Spraying of micro-nutrients was done with the help of knap sack sprayer or hand sprayer.

2.1 Economics of Cultivation

2.1.1 Cost of cultivation (Rs ha^{-1})

The cost of the inputs that was prevailing at the time of their use was considered to work out the cost of cultivation which was given in rupees per hectare.

2.1.2 Gross income (Rs)

The income was calculated based on the prevailing market price for the broccoli.

2.1.3 Net income (Rs)

The net income per hectare was calculated on the basis of gross income and cost of cultivation per hectare as follows.

Net income = Gross income – Cost of cultivation.

2.2 Benefit of Cost Ratio

The benefit to cost ratio was worked out by using the following formula;

$$\text{Benefit cost ratio} = \frac{\text{Gross income (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

3. RESULTS AND DISCUSSION

3.1 Cost of Cultivation

The total cost of each treatment was separated into two parts: general costs and treatment-specific costs. Costs of field preparation, seed, sowing expenses, weeding and insecticide spraying, irrigation, harvesting, and general expenses are all common charges. The cost of cultivation of Rs.178635 was common for all the treatments (Table 3) but the cost of different treatments of micronutrients varied from treatments to treatments. The highest total cost of cultivation (Rs180735/ha) was incurred under T3 {copper sulphate @ 0.60%} against the total cost of Rs 178635/ha involved in control (T0).

3.1.1 Gross income

Data embodied in Table 4 revealed that the maximum gross income of Rs 471720/ha was obtained with the Boric acid @ 0.40% (T5- Boric acid (H3BO3) @ 0.40%) followed by in order resulting are T4 (Rs 460140), T9 (Rs 453060), T6 (Rs 390690), T8 (Rs 385680), T7 (Rs 345480), T2 (Rs 333720) and T1 (Rs 275250) against T0- control (Rs 216480).

3.1.2 Net income

The net income obtained by foliar application of ten micro-nutrients treatments to broccoli crop was ranging from Rs 37845 to Rs 292325 per hectare, maximum net return of Rs 292325/ha was obtained with treatment (T5 -Boric acid (H_3BO_3) @ 0.40%) followed by T4 (Rs 281123), T9 (Rs 273375), T6 (Rs 210885), T8 (Rs 206363), T7 (Rs 166505), T2 (Rs 153720), T1 (Rs 95934) and T3 (Rs 80355) respectively against T0 (Rs 37845). Similarly result found by Singh [8] reported that in cauliflower borax applies at 5 kg/ha as soil application + 0.25% as foliar spraying at 45 DAT and 60 DAT, the net profit (51,203rupees/ha) and benefit cost ratio (4.20).

3.2 Benefit: Cost Ratio

The B:C ratio for foliar application of ten micro-nutrients treatments was ranging from 1.21 to 2.62 while maximum benefit: cost ratio obtained with T5 (2.62) followed by T4 (2.57), T9 (2.52), T6 (2.17), T8 (2.15), T7 (1.93), T2 (1.85), T1 (1.53) and T3 (1.44) respectively against T0 (1.21). These finding are also closely to Tudu *et al.* [9] reported that in broccoli the combined micronutrients gave the results revealed invariably better performance of combined foliar spray of 0.2% borax with 0.5% ZnSO4 (1.37 lakh ha^{-1}, 0.63 lakh ha^{-1} and 1.85), closely followed by foliar application of 0.5% ZnSO4 (1.35lakh ha^{-1}, 0.62 lakh ha^{-1} and 1.84) for gross income, net income and B:C ratio, respectively. Singh (2003) and Lal et al. [10] reported that in cauliflower borax applies at 5 kg/ha as soil application + 0.25% as foliar spraying at 45 DAT and 60 DAT, the net profit (51,203rupees/ha) and benefit cost ratio (4.20) [11].

Table 1. Physico-chemical characters of soils

Particulars	Sand (%)	Silt (%)	Clay (%)	Textural class	Soil pH	Organic carbon (%)	Available N (kg ha-1)	Available P (kg ha-1)	Available K (kg ha-1)	Zinc (mg/kg)	Copper (mg/kg)	Boron (mg/kg)
Value (0-30cm depth)	55.54	18.35	24.10	Clay Loam(dorsa)	7.6	0.47	227.78	19.00	494.10	0.51	0.9	2.0

Table 2.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%

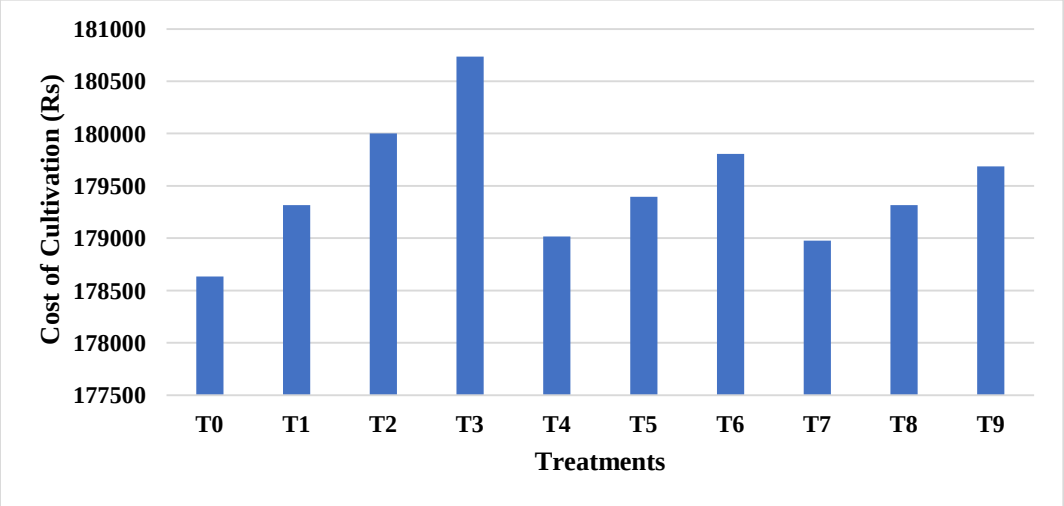

Fig. 1. Cost of cultivation (Rs) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition

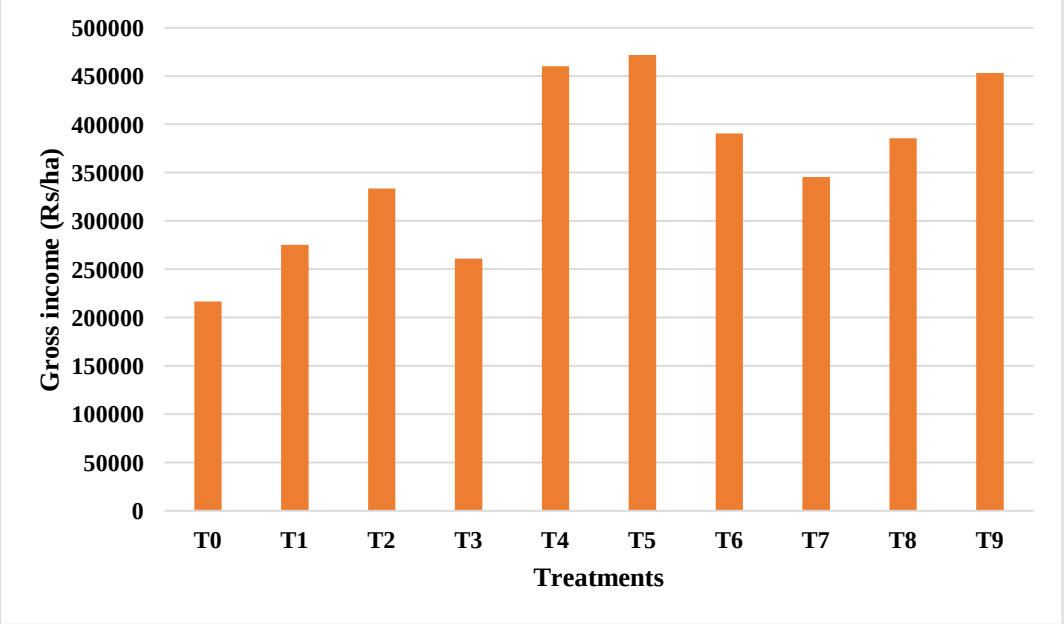

Fig. 2. Gross income (Rs/ha) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition

Table 3. Cost of cultivation of broccoli crop (fixed cost for all treatment) per hectare

S. No.	Material/work	Expenditure (in Rs)
1.	Seed cost (300/ha.)	10,000
2.	Land preparation	
	(a) Ploughing, Tractor rent and leveling @ 800/hr for 3hr	2,400
	(b) Furrow/bed preparation	20,000
	(c) FYM-21 tones/ha @ 600/t	12,600
	(d) Fertilizers	24,000
	(e) Cost of mulching material	20,000
	(f) Labours cost for mulch installation	30,000
	(g) Drip irrigation installation (Depreciation cost)	4,000
3.	Transplanting	
	(a) Transplanting cost (15 labour at 287/day)	4,500
	(b) Drenching of micronutrients (10 labours @ 287/day)	2,870
4.	Intercultural operation	
	(a) Insect/pests and disease control (cost of insecticides, fungicides, labour for spraying)	15,000
5.	Harvesting	
	(a) Crop harvesting (80 labour @ 287/ days)	22,960
	(b) Selling (15 labour @ 287/ days)	4,305
6.	Overhead expenses (polyhouse depreciation cost)	6,000
	Total	1,78,635

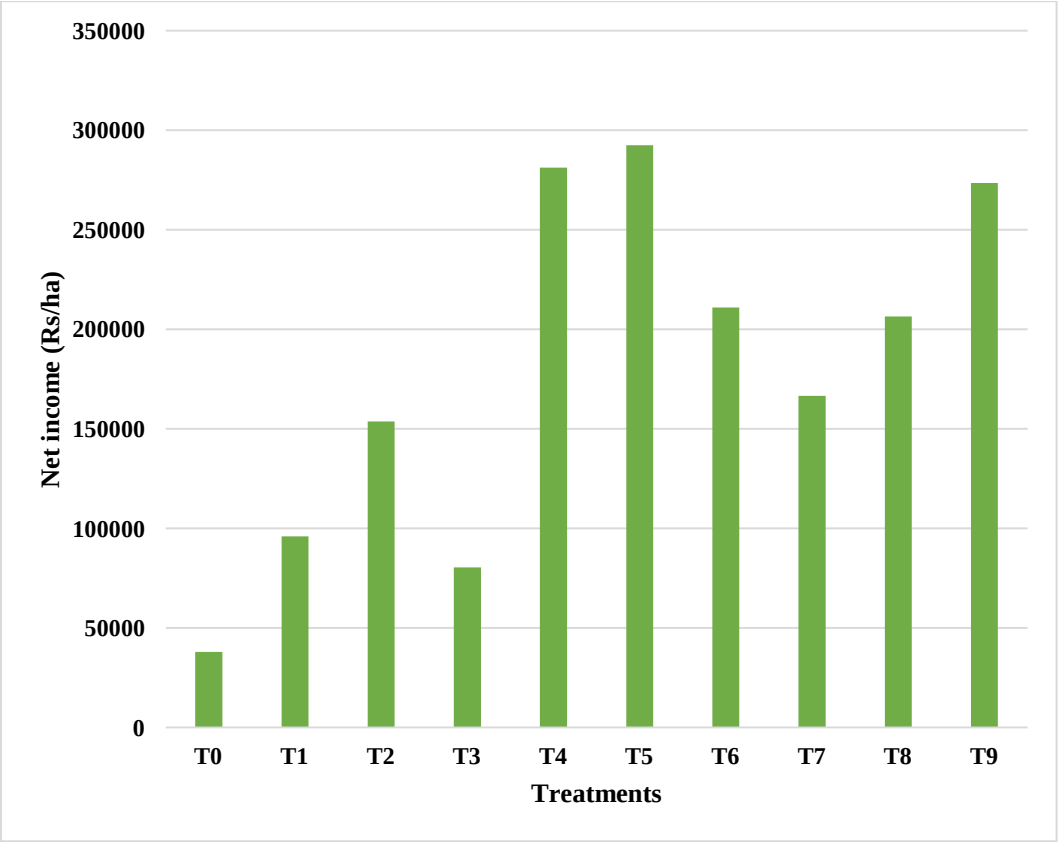

Fig. 3. Net income (Rs) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition

Table 4. Economics of different treatment combination

Treatment	Yield Q ha^{-1}	Treatment's cost (Rs/ha)	Common cost (Rs/ha)	Total cost of Cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
T0	74.66	0	178,635	178,635	216,480	37,845	1.21
T1	136.00	681	178,635	179,316	275,250	95,934	1.53
T2	104.08	1,365	178,635	180,000	333,720	153,720	1.85
T3	150.83	2,100	178,635	180,735	261,090	80,355	1.44
T4	178.58	380	178,635	179,017	460,140	281,123	2.57
T5	187.83	760	178,635	179,395	471,720	292,325	2.62
T6	142.83	1,170	178,635	179,805	390,690	210,885	2.17
T7	127.66	340	178,635	178,975	345,480	166,505	1.93
T8	108.83	682	178,635	179,317	385,680	206,363	2.15
T9	94.50	1,050	178,635	179,685	453,060	273,375	2.52

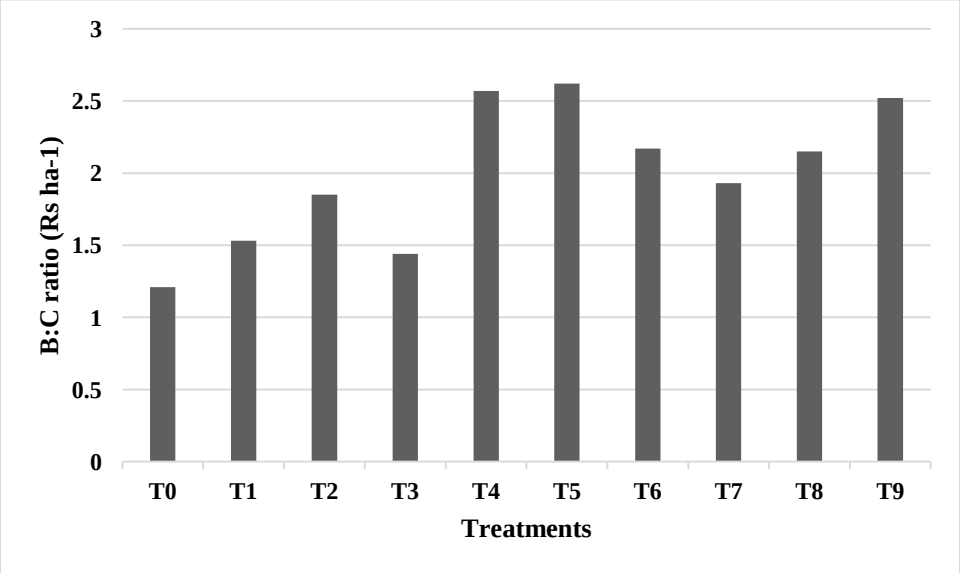

Fig. 4. B:C ratio (Rs/ha) s affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition

4. CONCLUSION

It can be concluded from the results that application of T5 (Boric Acid @ 0.40 %) was best among all other treatments. The total cost of cultivation was found to be highest (180,735 Rs/ha) with T3-copper sulphate @ 0.60% and lowest in control (T0) (178,635 Rs/ha). The highest gross income (471,720 Rs/ha), net income (292,325 Rs/ha) and B:C ratio (2.62) was observed with T5- boric acid @ 0.40%. Thus, Broccoli cultivation with Boric acid @ 0.40% was found to be best treatment in gross income, net income and B:C ratio but Broccoli cultivation with copper sulphate @ 0.60% was found to be the best treatment as it is evident for total cost of cultivation.

5. FUTURE SCOPE

Regarding the future scope, it is concluded that, to identify the best micronutrients for different agroclimatic zones of Chhattisgarh, more detailed studies will be needed, and also applications of some other micronutrients (such as Mo, Fe, Mn) at different concentrations, to evaluate their effectiveness in growth, yield and quality in broccoli crops.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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