Effect of different micronutrients on economics of broccoli (*Brassica oleracea* var. *italica*) cv. Green Magic under polyhouse condition

ABSTRACT: A field experiment was conducted to study of "Impact of foliar spray of micronutrients on growth, yield and quality of broccoli (*Brassica oleraceae* var. *italica*) under polyhouse condition" was conducted during Rabi season 2020-21 under department of Vegetable Science at "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 randomized design with ten treatments and three replications. Economic study of broccoli showed that highest cost of cultivation (Rs 180735 ha^{-1}) with T3-copper sulphate @ 0.60% while maximum gross income (Rs 471720 ha^{-1}), net income (Rs 292325 ha^{-1}) and B:C ratio (2.62) was observed with T5- boric acid @ 0.40%.

Keywords: Micronutrients, broccoli, yield, economics.

INTRODUCTION: The word broccoli comes from the Italian plural of broccolo, 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 (Thamburaj and Singh, 2001). 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 (Sharma, 2000). 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 (Jones *et al.,* 2006). Broccoli is also high in glucosinolates, which are the precursors to the chemoprotective isothiocyanate, a compound linked to cancer prevention (Aires *et al*., 2006).

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 (Kaya and Higgs, 2002). 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 (Liang *et al.*, 2006). Boron is important in glucose translocation, cell wall construction, and RNA synthesis, and it regulates these processes (Narayanamma *et al*., 2007). 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.

MATERIAL AND METHODS: The details of materials used, experimental procedure followed and techniques adopted during the course of investigation have been described in this chapter. The present research entitled "Impact of foliar spray of micronutrients on growth, yield and quality of broccoli (*Brassica oleraceae var. italica*) under polyhouse condition" was carried out during the year 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.

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%

Economics of Cultivation

Studies on the economics of the treatment application are critical because they are of key importance to farmer in terms of monetary returns and profitability from crop suggestion and the farmer's adaption of any package of activities is depends on the treatment's economic feasibility. As a result, in order to determine the correct treatment, it is important to calculate the economics of various therapies used in the experiment.

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

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

Gross income (Rs)

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

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.

Benefit of Cost ratio

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

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

RESULTS AND DISCUSSION:

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 1) 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).

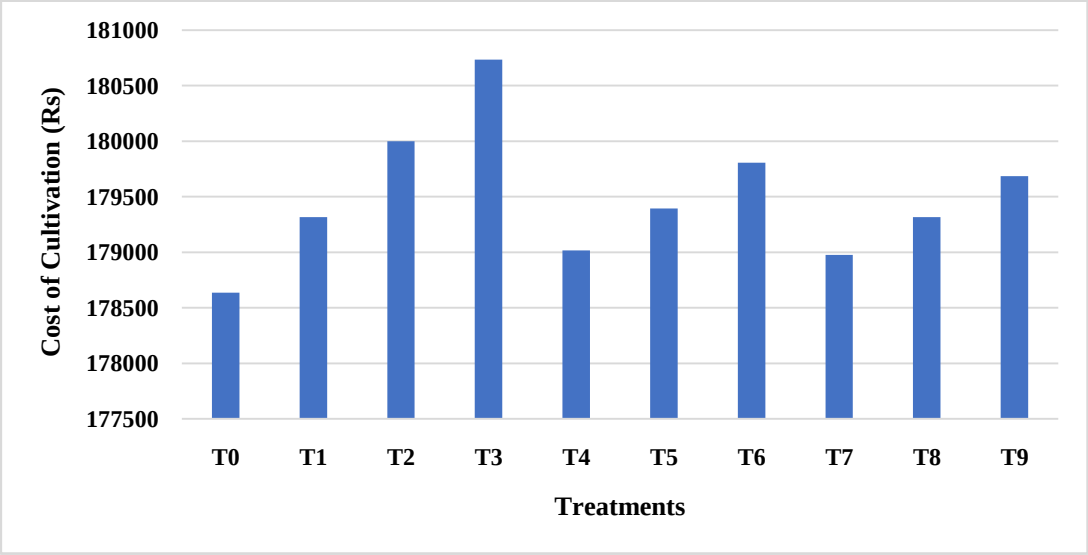

Fig.1. Cost of cultivation (Rs) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition.

Gross income: Data embodied in Table 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).

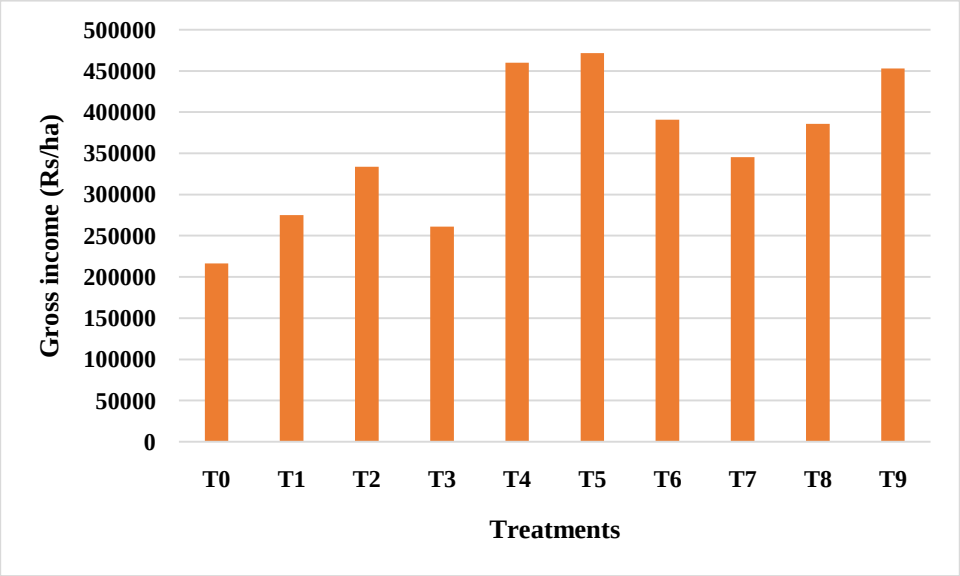

Fig.2. Gross income (Rs/ha) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition.

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 (2003) 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).

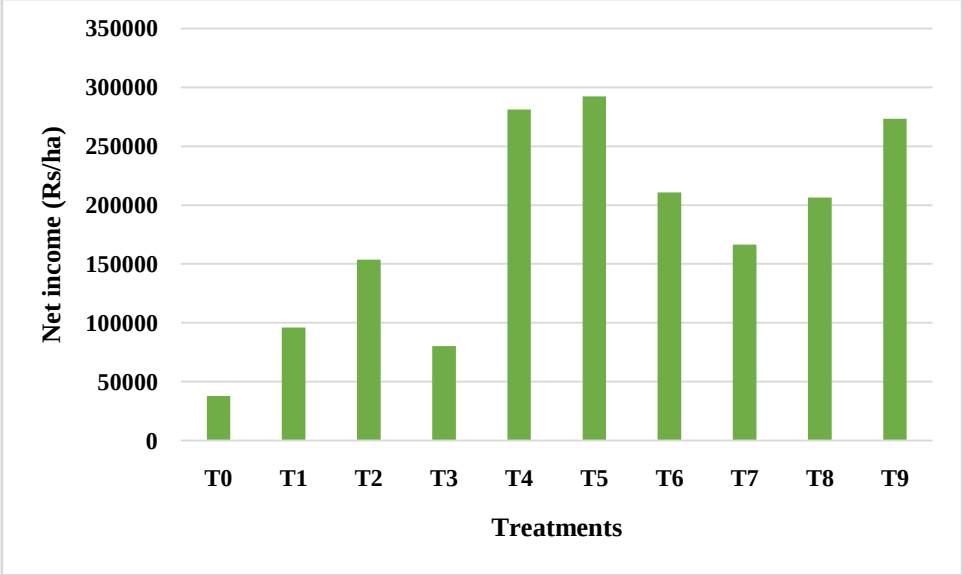

Fig.3. Net income (Rs) as affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition.

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*. (2020) 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.

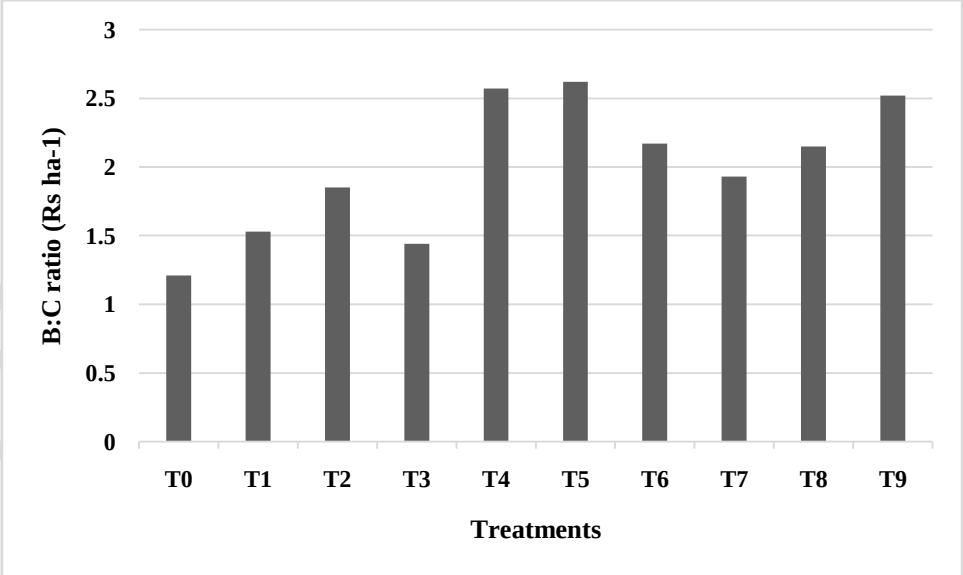

Fig.4. B:C ratio (Rs/ha) s affected by the foliar spray of micronutrients on broccoli cv. Green Magic under polyhouse condition.

Table 2: Cost of cultivation of broccoli crop (fixed cost for all treatment) per hectare

S. No.	Material/work	Expenditure
1.	Seed cost (37,500 plants/ha.)	10000

2.	Land preparation	
	(a) Ploughing, Tractor rent and leveling @ 800/hr for 3hr	2400
	(b) Furrow/bed preparation	20000
	(c) FYM-21 tones/hectare @ 600/t	12600
	(d) Fertilizers	24000
	(e) Cost of mulching material	20000
	(f) Labours cost	30000
	(g) Drip irrigation installation (Depreciation cost)	4000
3.	Transplanting	
	(a) Transplanting cost (15 labors at 287/day)	4500
	(b) Drenching of micronutrients (10labours @ 287/day)	2870
4.	Intercultural operation	
	(a) Insect/pests and disease control (cost of insecticides, fungicides, labour for spraying)	15000
5.	Harvesting	
	(a) Crop harvesting (80 labours @ 287 per days)	22,960
	(b) Selling (15 labours @ 287 per days)	4305
6.	Overhead expenses (polyhouse depreciation cost)	6000
	Total	1,78,635

Table 3: 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	178635	178635	216480	37845	1.21
T1	136.00	681	178635	179316	275250	95934	1.53
T2	104.08	1365	178635	180000	333720	153720	1.85
T3	150.83	2100	178635	180735	261090	80355	1.44
T4	178.58	380	178635	179017	460140	281123	2.57
T5	187.83	760	178635	179395	471720	292325	2.62
T6	142.83	1170	178635	179805	390690	210885	2.17
T7	127.66	340	178635	178975	345480	166505	1.93
T8	108.83	682	178635	179317	385680	206363	2.15
T9	94.50	1050	178635	179685	453060	273375	2.52

CONCLUSION: The micronutrients Cu, B and Zn were applied with different doses in which the application of micronutrients was found economically best treatment T5 (Boric Acid @ 0.40 %) with the benefit: cost ratio of (2.62:1 follow 2.57:1), net income (Rs292325/ha) and gross income (Rs 471720/ha), respectively T0 (control).

FUTURE SCOPE: To identify the best micronutrients for different agro-climatic zones of Chhattisgarh, detailed study is needed and also application of some other micronutrients like Mo, Fe, Mn at different concentration to assess its effectiveness on growth, yield and quality in broccoli.

REFERENCES:

Anonymous. 2019. FAOSTAT Production Databases. Available online at: http://www.faostat.fao.org.

Aires, A., Rosa, E. and Carvallo, R. 2006. Effect of nitrogen and sulphur fertilization on glucosinolates in the leaves and roots of broccoli sprouts (*Brassica oleracea* var. *italica*). *Journal of the Science of Food and Agriculture*, 86(10):1512 – 1516.

Du J, Cullen JJ, Buettner GR. 2012. Ascrbic acid; chemistry, biology and the treatment of cancer. *Biochim Byophy Acta*, 1826:443-457.

Jones, R.B., Faragher, J.D. and Winkler, S. 2006. A review of the influence of postharvest treatments on quality and glucosinolate content in broccoli (*Brassica oleracea* var. *italica* L.). Postharvest Biological Technology, 41:18.

Kaya, C. and D.E.B. Higgs, 2002. Response of tomato (*Lycopersicon esculentum* L.) cultivars to foliar application of zinc when grown in sand culture at low zinc. *Scientia Horticulture*, 93: 53–64.

Liang, H., Yuan, Q.P. and Xiao, Q. 2006. Effects of metal ions on myrosinase activity and the formation of sulforaphane in broccoli seed. *Journal of Molecular Catalysis B-Enzymatic*, 43: 19–22.

Narayanamma, M., Chiranjeevi, C. H. and Ahmed, S. R. 2007. Effect of foliar application of micronutrients on growth, yield and nutrient content of cabbage (*Brassica oleracea* var. *capitata)* in Andra Pradesh. *Journal of Pharmacognosy and Phytochemistry*, 34(2): 213-214.

Singh, D. N. 2003. Effect of boron on growth and yield of cauliflower in lateritic soil of Western Orissa. *Indian Journal of Horticulture*, 60(3): 283-286.

Tudu, R., Tripathy, P., Sahu, G.S., Dash, S.K., Nayak, R.K., Sahu, P., Rojalin, M., Tripathy, B. and Nayak, N.J. (2020). Influence of lime and micronutrients on head quality and economics of Broccoli (*Brassica oleraceae var. italica*) var. Palam Samridhi. *International Journal of Chemical Studies*, 8(5): 272- 275.

Thamburaj S, Singh N. Textbook of Vegetables, Tubercrops and Spices. ICAR. New Dehli, 2001, 469.