

Effect of foliar spray of micronutrients on yield and **benefit-cost** ratio of cauliflower (*Brassica oleracea* var. *botrytis* L.) under polyhouse

ABSTRACT

The present investigation entitled “Effect of foliar spray of micronutrients on yield and benefit cost ratio of cauliflower (*Brassica oleracea* var. *botrytis* L.) under polyhouse” was conducted during the *Kharif* season 2023 at the Center of Excellence on Protected Cultivation and Precision Farming, IGKV, Raipur, (C.G.). The experiment was laid in randomized block design (RBD) with three replications consisting of twelve treatments. The treatments included viz. T₀: Control, T₁: FeSO₄ (0.5%), T₂: ZnSO₄ (0.5%), T₃: Borax (0.2%), T₄: Ammonium Molybdate (0.03%), T₅: FeSO₄ (0.5%) + ZnSO₄ (0.5%), T₆: FeSO₄ (0.5%) + Borax (0.2%), T₇: FeSO₄ (0.5%) + Ammonium Molybdate (0.03%), T₈: ZnSO₄ (0.5%) + Borax (0.2%), T₉: ZnSO₄ (0.5%) + Ammonium Molybdate (0.03%), T₁₀: Borax (0.2%) + Ammonium Molybdate (0.03%) and T₁₁: FeSO₄ (0.5%) + ZnSO₄ (0.5%) + Borax (0.2%) + Ammonium Molybdate (0.03%). Foliar spray of micronutrients was done at 30 and 45 DAT of cauliflower. The results revealed that foliar application of treatment T₁₁ recorded significantly maximum yield parameters such as curd diameter (13.22 cm), curd depth (9.26 cm), curd size index (122.66cm²), total biomass production per plant (599.73 g), marketable curd weight (315.51 g), net curd weight (208.55g), yield per plot (6.94 kg plot⁻¹) and yield per hectare (231.37 qha⁻¹). In economics, T₁₁ incurred maximum total cost of cultivation (Rs. 263739.00 ha⁻¹), gross income (Rs. 809800.44 ha⁻¹), net income (Rs. 546061.44 ha⁻¹) and maximum benefit : cost ratio 3.07. Whereas in contrast, the minimum value for the above parameters were recorded under T₁ (control).

Key words: Cauliflower, micronutrients, foliar spray, yield, economics, benefit: cost ratio

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INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.), is an important Cole crop widely grown in tropics, subtropics and temperate regions of the world, which belongs to the family Brassicaceae and genus Brassica, has a chromosome number of $2n=18$. Eastern Mediterranean region is its center of origin. The group 'Cole crop' is said to be derived from the wild cabbage, "Cole warts" (*Brassica oleracea* var. *sylvestris*). It is ~~fast-growing annual and herbaceous vegetable crop which has thick and small stems~~ fast-growing annual herbaceous vegetable crop with thick and small stems. Its main growing point develops into a short shoot system whose apices make up the convex surface of the curd, so the curd is a prefloral fleshy apical meristem that is used for making vegetables, curry, soup, and pickles (Dixit *et al.*, 2020). Cauliflower is a thermo-sensitive crop. It can grow at an average temperature of 5-8°C to 25-28°C. During vegetative growth, some varieties may withstand temperature as low as -10°C and as high as 40°C for a few days. The optimum temperature for the growth of young plants is around 23°C and 17-20°C in later stages. (Singh, 2004).

India is the second largest producer of cauliflower in the world. Area of cauliflower in India is 473 thousand ha. with a production of 92.83 lakh tonne and productivity 19.70 tonnes/ha. Cauliflower accounts for 5.06% of vegetable production ~~of in~~ the country. The important cauliflower growing states are West Bengal, Madhya Pradesh, Bihar, Gujrat, Haryana, Orissa and Chhattisgarh. Chhattisgarh is the 7th highest producer of cauliflower in the India. In Chhattisgarh cauliflower is grown in 24.07 thousand ha area with production of 482.48 thousand tonnes and productivity is 20.04 tonnes/ha. ~~Mainly cauliflower growing districts are Kondagaon, Raipur, Durg, Surguja, Balod, Surajpur, Bemetara~~ The main cauliflower-growing districts are Kondagaon, Raipur, Durg, Surguja, Balod, Surajpur, Bemetara, and Korba. (Anon., 2022)

Micronutrients play an important role in the growth and development of plants. Though these are required in small amounts ~~but are equally indispensable for the normal growth of the plant, they are~~ equally indispensable for the normal growth of the plant. However, in deficient conditions, they lead to the occurrence of some physiological disorders and ultimately affect the yield and quality of the cauliflower. Micronutrients improve ~~the chemical composition of curd and the general condition of the plant~~ curd's chemical composition and the plant's general condition. It increases macronutrient uptake, production, and quality through enhances photosynthetic activity and increases metabolite content of leaves. They also reduce the incidence of diseases, pests, and disorders and improve the post-harvest quality of the crop produced. (Ranjan *et al.*, 2020). Objectives of this research

MATERIAL AND METHODS

The experiment was conducted at the Center of Excellence on Protected Cultivation and Precision Farming, IGKV, Raipur, (C.G.) during *Kharif* season 2023. The experiment was laid out in randomized block design (RBD) with three replications consisting of twelve treatments. The cauliflower seedlings ~~are were~~ transplanted at the spacing of 45x 30(RxP) cm. ~~Size~~ The size of each plot was taken 3 m² ~~which occupied 22 plants~~. The soil type of the experimental field was clay loam. During field preparation 10 tonnes/ha FYM and 10 quintal/ha vermicompost were added and water-soluble

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fertilizers such as 12:61:0, 0:52:34, 13:0:45, 19:19:19, and 00:00:50 were fertigated with [the](#) recommended dose of NPK (125:80:60 kg/ha). Foliar application of each treatment was done at 30 and 45 DAT. Common cultural practices were done for cauliflower production such as irrigation, drenching, fertigation, weeding etc. For [the](#) preparation of solution of micronutrients, the required amounts of micronutrients were completely dissolved in the desired amount of water. Micronutrient solutions of different concentrations were carefully applied to both surfaces of the plant. ~~The spraying of micronutrients was done by~~ [Micronutrients were sprayed](#) using a garden pump pressure sprayer, which was thoroughly cleaned before use to avoid contamination. Five randomly selected plants were tagged in each plot and used for recording observations of growth, yield and quality parameters.

RESULT AND DISCUSSIONS

Yield parameters

The result of various yield parameters viz: curd diameter, curd depth, curd size index, total biomass production per plant, marketable curd weight, net curd weight, yield per plot and yield per hectare as influenced by foliar spray of micronutrients on cauliflower are presented in table 1 and table 2. The effect of foliar spray of micronutrients exhibited significant differences with respect to all yield parameters. Results revealed that the foliar application of treatment T₁₁ recorded [a](#) maximum curd diameter (13.22 cm) which was at par with T₆ (12.22 cm), T₇ (12.20 cm), T₈ (12.37 cm), T₉ (12.26 cm) and T₁₀ (12.53 cm) while the minimum curd diameter (11.30 cm) was recorded in treatment T₀ (Control). Treatment T₁₁ recorded [a](#) maximum curd depth (9.26 cm), which was at par with T₇ (8.58 cm), T₈ (8.67 cm), T₉ (8.60 cm) and T₁₀ (8.82 cm), while the minimum curd depth (7.98 cm) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded [a](#) maximum curd size index (122.42 cm²) which was at par with T₇ (104.68 cm²), T₈ (107.25 cm²), T₉ (105.44 cm²) and T₁₀ (110.52 cm²), while the minimum curd size (90.39 cm²) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded maximum total biomass production per plant (599.73 g), which was at par with T₆ (553.80 g), T₇ (550.73 g), T₈ (563.73 g), T₉ (559.73 g) and T₁₀ (580.60 g) whereas the minimum total biomass production per plant (517.60 g) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded maximum marketable curd weight (315.51 g), which was at par with T₆ (294.63 g), T₇ (293.93 g), T₈ (305.60 g), T₉ (302.93 g) and T₁₀ (309.35 g) whereas the minimum marketable curd weight (280.93 g) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded maximum net curd weight (208.55 g) which was at par with T₆ (189.44 g), T₇ (188.78 g), T₈ (193.78 g), T₉ (191.34 g) and T₁₀ (194.67 g) whereas the minimum net curd weight (176.83 g) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded maximum yield per plot (6.94 kg), which was at par with T₆ (6.48 kg), T₇ (6.47 kg), T₈ (6.72 kg), T₉ (6.66 kg) and T₁₀ (6.81 kg) whereas the minimum yield per plot (6.18 kg) was observed under the treatment T₀ (Control). Treatment T₁₁ recorded maximum yield per hectare (231.37 qha⁻¹) which was at par with T₆ (216.06 qha⁻¹), T₇ (215.55 qha⁻¹), T₈ (224.11 qha⁻¹), T₉ (222.15 qha⁻¹) and T₁₀ (226.86 qha⁻¹) whereas the minimum yield per hectare (206.02 qha⁻¹) was observed under the treatment T₀ (Control).

Combine micronutrients enhance the curd diameter, curd depth and curd size index due to the promote physiological activities like photosynthesis, translocation of assimilates from leaves to curd

and storage of assimilates in curd for which boron and zinc may be responsible factor as reported by Lashkari *et al.* (2007). Iron play major role in formation of chlorophyll which is the major component of photosynthesis. molybdenum involves in various enzymes that regulates the nitrogen metabolism in plants. Similar results have been reported by Kotur (1998), Mori *et al.* (2020), Punam *et al.* (2020), Kumar *et al.* (2023) and Moklikar *et al.* (2018).

The contribution of foliar application of different micronutrient mixture to increase in total biomass production per plant, marketable curd weight, net curd weight, yield per plot and yield per hectare is might be due to availability of essential micro-nutrients at the required growth stages, which increases the rate and efficiency of metabolic activities resulting in high assimilation of proteins and carbohydrates which translocated to curd and helped in enhancing the biomass and yield of cauliflower. Iron is essential for chlorophyll synthesis, which is crucial for photosynthesis, zinc acts as a catalyst for the synthesis of enzyme tryptophan synthetase that involved in the biosynthesis of auxin, which regulates the growth and development of cauliflower, boron is crucial for cell wall formation and transport of sugars, molybdenum acts as a cofactor for the enzyme (nitrate reductase) involved in nitrogen metabolism. Similar results have been reported by Moklikar *et al.* (2018), Bairwa *et al.* (2023), Chaudhari *et al.* (2017), Ali *et al.* (2019) and Kumar *et al.* (2021).

Benefit Benefit-cost ratio

The effect of foliar spray of micronutrients on the economics of cauliflower are presented in table Table 2. The highest total cost of cultivation (Rs. 263739.00 ha⁻¹) was incurred under the treatment T₁₁, followed by (Rs. 262734.00 ha⁻¹) in treatment T₉ and the lowest total cost of cultivation Rs. 258324.00 ha⁻¹ incurred in treatment T₀ (control). The highest gross income of Rs. 809800.44 ha⁻¹ was obtained under the treatment T₁₁, followed by (Rs. 794002.61 ha⁻¹) in treatment T₁₀ and the lowest gross income Rs. 721062.22 ha⁻¹ was obtained in treatment T₀ (control). The highest gross income of Rs. 809800.44 ha⁻¹ was obtained under the treatment T₁₁, followed by (Rs. 794002.61 ha⁻¹) in treatment T₁₀ and the lowest gross income Rs. 721062.22 ha⁻¹ was obtained in treatment T₀ (control). The maximum net income of Rs. 546061.44 ha⁻¹ was obtained under the treatment T₁₁, followed by (Rs. 531658.61 ha⁻¹) in the treatment T₁₀ and the lowest net income Rs. 462738.22 ha⁻¹ was obtained in treatment T₀ (control). The highest benefit: cost ratio of 3.07 was obtained under the treatment T₁₁, followed by 3.03 in treatment T₁₀ and the lowest benefit: cost ratio of 2.79 was obtained in treatment T₀ (control). Similar results were reported by Moklikar *et al.* (2018) and Punam *et al.* (2020).

CONCLUSION

Based on the results obtained from the present investigation it can be concluded that a foliar application of treatment T₁₁: FeSO₄(0.5%) + ZnSO₄ (0.5%) + Borax (0.2%) + Ammonium Molybdate (0.03%) at 30 and 45 days after transplanting significantly enhanced the yield parameters and also recorded highest B:C ratio with net income of Rs. 546061.44 ha⁻¹. Hence the treatment T₁₁ can be considered as the most effective and beneficial for cauliflower production compare to all other treatment and it, the treatment T₁₁ can be considered the most effective and beneficial for cauliflower

| [production compared to all other treatments and](#) can be recommended for production practices to the farmers.

UNDER PEER REVIEW

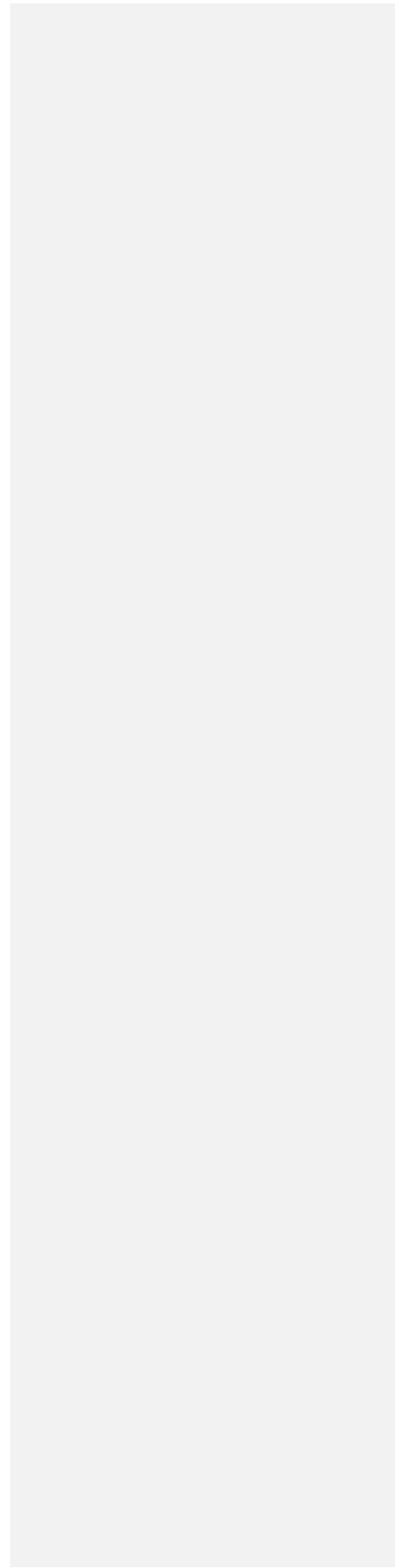


Table 1: Effect of foliar spray of micronutrients on curd diameter (cm), curd depth (cm), curd size index (cm²), total biomass production per plant (g), marketable curd weight (g) and net curd weight (g)

Tr. No.	Treatments details	Curd diameter (cm)	Curd depth (cm)	Curd size index (cm ²)	Total biomass production per plant (g)	Marketable curd weight (g)	Net curd weight (g)
T ₀	Control	11.30	7.98	90.39	517.60	280.93	176.83
T ₁	FeSO ₄ (0.5%)	11.71	8.18	95.84	513.27	281.33	179.62

Comment [MRI4]: Tables should be self-explanatory; therefore, spell out terms even if they have been introduced in the text. Terms may be abbreviated within the table and defined in a footnote; all abbreviated terms may be defined in the same footnote. Also explain any use of boldface in a footnote

UNDER PEER REVIEW

T₂	ZnSO ₄ (0.5%)	11.72	8.21	96.21	521.93	281.54	180.36
T₃	Borax (0.2%)	11.80	8.25	97.31	526.80	284.25	186.22
T₄	Ammonium Molybdate (0.03%)	11.80	8.22	97.06	525.73	283.07	185.96
T₅	FeSO ₄ (0.5%) + ZnSO ₄ (0.5%)	12.16	8.28	100.71	542.80	287.53	188.44
T₆	FeSO ₄ (0.5%) + Borax (0.2%)	12.22	8.40	102.65	553.80	294.63	189.44
T₇	FeSO ₄ (0.5%) + Ammonium Molybdate (0.03%)	12.20	8.58	104.68	550.73	293.93	188.78
T₈	ZnSO ₄ (0.5%) + Borax (0.2%)	12.37	8.67	107.25	563.73	305.60	193.78
T₉	ZnSO ₄ (0.5%) + Ammonium Molybdate (0.03%)	12.26	8.60	105.44	559.73	302.93	191.34
T₁₀	Borax (0.2%) + Ammonium Molybdate (0.03%)	12.53	8.82	110.52	580.60	309.35	194.67
T₁₁	FeSO ₄ (0.5%) + ZnSO ₄ (0.5%) + Borax (0.2%) + Ammonium Molybdate (0.03%)	13.22	9.26	122.42	599.73	315.51	208.55
	SE (m)	0.35	0.24	4.68	16.99	8.67	5.51
	C.D. (5% level)	1.03	0.72	18.31	49.83	25.45	20.05
	C.V.	5.05	5.05	7.95	5.38	5.12	5.06

Table 2: Effect of foliar spray of micronutrients on yield per plot (kg plot⁻¹), yield per hectare (qha⁻¹), cost of micronutrients (Rs. ha⁻¹), total cost of cultivation (Rs.ha⁻¹), gross income (Rs. ha⁻¹), net income (Rs. ha⁻¹) and B:C ratio

Tr. No.	Treatments details	Yield per plot (kg plot ⁻¹)	Yield per hectare (qha ⁻¹)	Cost of micronutrients (Rs. ha ⁻¹)	Total cost of cultivation (Rs.ha ⁻¹)	Gross income (Rs.ha ⁻¹)	Net income (Rs.ha ⁻¹)	B:C ratio
T ₀	Control	6.18	206.02	0.00	258324.00	721062.22	462738.22	2.79
T ₁	FeSO ₄ (0.5%)	6.19	206.31	495.00	258819.00	722088.89	463269.89	2.79
T ₂	ZnSO ₄ (0.5%)	6.19	206.46	900.00	259224.00	722619.33	463395.33	2.79
T ₃	Borax (0.2%)	6.25	208.45	510.00	258834.00	729578.42	470744.42	2.82
T ₄	Ammonium Molybdate (0.03%)	6.23	207.58	3510.00	261834.00	726537.78	464703.78	2.77
T ₅	FeSO ₄ (0.5%) + ZnSO ₄ (0.5%)	6.33	210.86	1395.00	259719.00	738002.22	478283.22	2.84
T ₆	FeSO ₄ (0.5%) + Borax (0.2%)	6.48	216.06	1005.00	259329.00	756217.00	496888.00	2.92
T ₇	FeSO ₄ (0.5%) + Ammonium Molybdate (0.03%)	6.47	215.55	4005.00	262329.00	754428.89	492099.89	2.88
T ₈	ZnSO ₄ (0.5%) + Borax (0.2%)	6.72	224.11	1410.00	259734.00	784373.33	524639.33	3.02
T ₉	ZnSO ₄ (0.5%) + Ammonium Molybdate (0.03%)	6.66	222.15	4410.00	262734.00	777528.89	514794.89	2.96
T ₁₀	Borax (0.2%) + Ammonium Molybdate (0.03%)	6.81	226.86	4020.00	262344.00	794002.61	531658.61	3.03
T ₁₁	FeSO ₄ (0.5%) + ZnSO ₄ (0.5%) + Borax (0.2%) + Ammonium Molybdate (0.03%)	6.94	231.37	5415.00	263739.00	809800.44	546061.44	3.07
	SE (m)	0.19	6.36					
	C.D. (5% level)	0.56	18.66					
	C.V.	5.12	5.12					

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Comment [MRI5]: Revise carefully

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