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 twelve treatments. The treatments included *viz.* T_0: Control, T_1: $FeSO_4$ (0.5%), T_2: $ZnSO_4$ (0.5%), T_3: Borax (0.2%), T_4: Ammonium Molybdate (0.03%), T_5: $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%), T_6: $FeSO_4$ (0.5%) + Borax (0.2%), T_7: $FeSO_4$ (0.5%) + Ammonium Molybdate (0.03%), T_8: $ZnSO_4$ (0.5%) + Borax (0.2%), T_9: $ZnSO_4$ (0.5%) + Ammonium Molybdate (0.03%), T_{10}: Borax (0.2%) + Ammonium Molybdate (0.03%) and T_{11}: $FeSO_4$ (0.5%) + $ZnSO_4$ (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 T_{11} recorded significantlymaximum yield parameter such ascurd diameter (13.22 cm), curd depth (9.26 cm), curd size index (122.66cm^2),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 T_{11} 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 the minimum value for above parameters were recorded under T_1 (control).

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

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 stem. 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 production of 92.83 lakh tonne and productivity 19.70 tonnes/ha. Cauliflower accounts for 5.06% of vegetable production of 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 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, 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. 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).

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 twelve treatments. The cauliflower seedlings are transplanted at the spacing of 45x 30(R×P) cm. Size of each plot was taken 3 m^2 which occupied 22 plants. The soil type of experimental field was clay loam. During field preparation 10 tonnes/ha FYM and 10 quintal/ha vermicompost were added and water-soluble fertilizers such as 12:61:0, 0:52:34, 13:0:45, 19:19:19, and 00:00:50 were fertigated with 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 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 using a garden pump pressure sprayer, which was thoroughly cleaned before use to avoid contamination.Five randomly selected plant 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 table1and table 2. The effect of foliar spray of micronutrients exhibited significant difference with respect to all yield parameters. Results revealed that the foliar application of treatment T_{11} recorded maximum curd diameter (13.22 cm) which was at par with T_6 (12.22 cm), T_7 (12.20 cm), T_8 (12.37 cm), T_9 (12.26 cm) and T_{10} (12.53 cm) while the minimum curd diameter (11.30 cm) was recorded in treatment T_0 (Control). Treatment T_{11} recorded maximum curd depth (9.26 cm) which was at par with T_7 (8.58 cm), T_8 (8.67 cm), T_9 (8.60 cm)and T_{10} (8.82 cm) while the minimum curd depth (7.98 cm) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum curd size index (122.42cm^2) which was at par with T_7 (104.68 cm^2), T_8 (107.25 cm^2), T_9 (105.44 cm^2) and T_{10} (110.52 cm^2) while the minimum curd size (90.39 cm^2) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum total biomass production per plant (599.73 g) which was at par with T_6 (553.80 g**)**, T_7 (550.73 g), T_8 (563.73 g), T_9 (559.73 g)and T_{10} (580.60 g) whereas the minimum total biomass production per plant (517.60 g) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum marketable curd weight (315.51 g) which was at par with T_6 (294.63 g**)**, T_7 (293.93 g), T_8 (305.60 g), T_9 (302.93 g)and T_{10} (309.35 g) whereas the minimum marketable curd weight (280.93 g) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum net curd weight (208.55 g) which was at par with T_6 (189.44 g**)**, T_7 (188.78 g), T_8 (193.78 g), T_9 (191.34 g)and T_{10} (194.67 g) whereas the minimum net curd weight (176.83 g) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum yield per plot (6.94 kg) which was at par with T_6 (6.48 kg**)**, T_7 (6.47 kg), T_8 (6.72 kg), T_9 (6.66 kg)and T_{10} (6.81 kg) whereas the minimum yield per plot (6.18 kg) was observed under the treatment T_0 (Control). Treatment T_{11} recorded maximum yield per hectare (231.37 qha^{-1}) which was at par with T_6 (216.06 qha^{-1}**)**, T_7 (215.55 qha^{-1}), T_8 (224.11 qha^{-1}), T_9 (222.15 qha^{-1})and T_{10} (226.86 qha^{-1}) whereas the minimum yield per hectare (206.02 qha^{-1}) was observed under the treatment T_0 (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 act as catalyst for synthesis of enzyme tryptophane synthetase that involved in biosynthesis of auxin which regulate growth and development of cauliflower, boron is crucial for cell wall formation and transport of sugars, molybdenum act as cofactor for 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 cost ratio

The effect of foliar spray of micronutrients on economics of cauliflower are presented in table 2. The highest total cost of cultivation (Rs. 263739.00 ha^{-1}) was incurred under the treatment T_{11} followed by (Rs. 262734.00 ha^{-1}) in treatment $T_9$and the lowest total cost of cultivation Rs. 258324.00 ha^{-1} incurred in treatment T_0 (control).The highest gross income of Rs. 809800.44 ha^{-1} was obtained under the treatment T_{11} followed by (Rs. 794002.61 ha^{-1}) in treatment $T_{10}$and the lowest gross income Rs. 721062.22 ha^{-1} was obtained in treatmentT_0 (control).The highest gross income of Rs. 809800.44 ha^{-1} was obtained under the treatment T_{11} followed by (Rs. 794002.61 ha^{-1}) in treatment $T_{10}$and the lowest gross income Rs. 721062.22 ha^{-1} was obtained in treatmentT_0 (control).The maximum net income of Rs. 546061.44 ha^{-1} was obtained under the treatmentT_{11} followed by (Rs. 531658.61 ha^{-1}) in the treatment $T_{10}$and the lowest net income Rs. 462738.22ha^{-1} was obtained in treatmentT_0 (control).The highest benefit: cost ratio 3.07 obtained under the treatment T_{11} followed by 3.03 intreatmentT_{10} and the lowest benefit: cost ratio 2.79 was obtained intreatment T_0 (control). Similar results were reported by Moklikar *et al*. (2018) and Punam *et al*. (2020).

CONCLUSION

Based on the results obtained from present investigation it can be concluded that a foliar application of treatment T_{11}: FeSO4(0.5%) + $ZnSO_4$ (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 T_{11} can be considered as the most effective and beneficial for cauliflower production compare to all other treatmentand it can be recommended for production practices to the farmers.

Table 1: Effect of foliar spray of micronutrients on curd diameter (cm), curd depth (cm), curd size index (cm^2), 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

T_2	$ZnSO_4$ (0.5%)	11.72	8.21	96.21	521.93	281.54	180.36
T_3	Borax (0.2%)	11.80	8.25	97.31	526.80	284.25	186.22
T_4	Ammonium Molybdate (0.03%)	11.80	8.22	97.06	525.73	283.07	185.96
T_5	$FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	12.16	8.28	100.71	542.80	287.53	188.44
T_6	$FeSO_4$ (0.5%) + Borax (0.2%)	12.22	8.40	102.65	553.80	294.63	189.44
T_7	$FeSO_4$ (0.5%) + Ammonium Molybdate (0.03%)	12.20	8.58	104.68	550.73	293.93	188.78
T_8	$ZnSO_4$ (0.5%) + Borax (0.2%)	12.37	8.67	107.25	563.73	305.60	193.78
T_9	$ZnSO_4$ (0.5%) + Ammonium Molybdate (0.03%)	12.26	8.60	105.44	559.73	302.93	191.34
T_{10}	Borax (0.2%) + Ammonium Molybdate (0.03%)	12.53	8.82	110.52	580.60	309.35	194.67
T_{11}	$FeSO_4$ (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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