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RESEARCH ARTICLE

EFFECT OF MICRONUTRIENT FORMULATION ON GROWTH, YIELD AND ECONOMICS OF CAULIFLOWER (*BRASSICA OLERACEA* VAR. BOTRYTIS L.)

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Abstract: The present study was conducted to assessment of vegetable micronutrient formulation (Vegetable Special) in cauliflower. Trial was conducted during the Rabi season 2023-24 on 10 fields of nearly in the same cropping season and parity selected from village-22 NTR, Block- Nohar, District- Hanumangarh, Rajasthan. The trial performed under two groups' viz. T_1: farmers practice (No use of Vegetable Special) and T_2: 3 sprays of Vegetable Special (5 gram per liter water at 25, 50 & 75 Days After Transplanting). Data indicated that foliar application of Vegetable Special recorded significantly maximum plant height at 30 and 60 DAT (14.97 and 29.86 cm), number of leaves at 30 and 60 DAT (10.48 and 15.93), stalk length (22.63 cm), curd diameter (11.8 cm), curd weight (607.1 g) and 17.37 per cent higher yield (163.5 q/ha) over the farmers practice treatment (139.3 q/ha). Net return and B: C ratio (Rs 228800 & 3.32), respectively under T_2 treatment were also maximum followed by T_1 treatment (Rs 182900 & 2.91), respectively.

Keywords: Cauliflower, Micronutrients formulation, Foliar spray, Economics, Yield

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 a fast-growing annual herbaceous vegetable crop with thick and small stems. The curd is a prefloral fleshy apical meristem that is used to make vegetables, curry, soup, and pickles. Its main growth point develops into a short stalk system, the apices of which make up the curd's convex surface (Dixit *et al*., 2020). Cole crops are rich in antioxidants, and glucosinolates and having anti-inflammatory properties. These vegetables are excellent source of fiber, aiding in food passage, digestion, healing stomach ulcers and cardio-vascular health. High-quality protein (2.6 g), moisture (90.8 g), fat (0.4 g), carbohydrates (4.0 g), calcium (33.0 mg), phosphorus (57.0 mg), iron (1.5 mg), carotene (30.0 mg), thiamine (0.04 mg), riboflavin (0.1 mg), vitamin C (56.0 mg), and energy (30 kcal) are all present in the 100 g edible portion of cauliflower. According to Thamburaj and Singh (2001), India is the world's biggest producer of cauliflower.

Micronutrients are vital components needed in trace amounts by plants for healthy growth, development, and reproduction. The word "micronutrient" refers to the amount of these components in plant nutrition rather than their importance. Iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), molybdenum (Mo), boron (B), and chloride (Cl) are a few of the main elements that are categorized as micronutrients. Aftab and Hakeem 2020 reported that micronutrients play pivotal roles in maintaining the overall health and vitality of plants. They are involved in various physiological and biochemical processes, each contributing uniquely to plant health and productivity. Micronutrients deficiency can cause many physiological disorders to the plants (Kundu and Chamroy 2020).

Understanding these roles is crucial for crop nutrition and for ensuring the production of vegetable crops. These trace elements, which are often present in small amounts, are indispensable for activating and assisting enzymes that drive vital metabolic reactions (Gomes *et al*. 2020). Micronutrients enhance the overall health of the plant and the curd's chemical makeup. By improving photosynthetic activity and raising the metabolite content of leaves, it improves the intake, production, and quality of macronutrients. They also reduce the incidence of diseases, pests, and disorders and improve the post-harvest quality of the curd. (Ranjan *et al*., 2020).

The application of boron, one of the micronutrients, improved plant height, leaf number, leaf length and width, plant spread, primary head weight, and head output per plant and per hectare (Moniruzzaman *et*

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al., 2018). On the other hand, due to boron deficiency water-soaked areas appear on the stem and head surface, gradually the stem becomes hollow and curd turns brown. Again, the molybdenum deficiency appears on young plant with chlorosis of leaf margins and gradually the whole leaf turns white. They also become cupped and wither, eventually. The leaf dies and the growing point also collapses (Ningawale *et al*. 2016). Zn also plays a crucial part in the metabolism of plant nucleic acids since it is an essential component of several biomolecules, including lipids, proteins, and auxins (Mengel *et al*., 2001). Iron is an essential nutrient that plays a critical role in life-sustaining processes. Iron functions as a cofactor for enzymes engaged in a wide range of oxidation-reduction activities because of its capacity to gain and lose electrons (i.e., photosynthesis, respiration, hormone synthesis, DNA synthesis, etc.). Because of this role, iron is a necessary nutrient; iron chlorosis, which results from a lack of it, severely impairs normal plant growth. The identification of the trans-acting factors responsible for the pathways will contribute greatly to an understanding of the regulatory mechanisms, and these factors will also prove beneficial to plants under iron-deficient conditions (Rout, G R (2015). Insufficiency of manganese (Mn) in cole crops is as similar as magnesium deficiency but yellowing is occurred over the whole plant. While veins remain green, the interveinal area turns from pale green to mottled-yellow. The soil may exhibit manganese toxicity at a pH of less than 5.5 and manganese deficiency with a pH of greater than 7.0, however the symptoms would be almost same in both situations. A micronutrient that is only required in minimal levels, copper (Cu) plays a crucial role in photosynthesis, nitrogen uptake, protein synthesis, and water management, among other important plant functions. Sufficient copper is essential to produce lignin, which impacts the plant's overall strength, and is also necessary for healthy seed formation. Reported the effect of foliar spray of growth hormones on nodulation, growth, and productivity in *Pisum sativum* (Tomar and Singh 2005). The objective of this research was to study the effect of foliar spray of micronutrient formulation on the yield and economics of cauliflower.

MATERIALS AND METHODS

The present study was conducted under on-farm trial laid out during Rabi, 2023-24 in Village-22 NTR, Block- Nohar, District- Hanumangarh, Rajasthan to evaluate the assessment of vegetable micronutrient formulation (Vegetable Special) in cauliflower. The trial performance under two groups' viz. T_1: farmers Practice (No use of Vegetable Special) and T_2: 3 sprays of Vegetable Special (5 gram per liter water at 25, 50 & 75 DAT). The recommended dose of NPK used for cauliflower crop was 120:60:60 kg per ha. Phosphorus in the form of Di Ammonium Phosphate and potassium in form of Murat of Potash (full dose) was applied at the time of transplanting and nitrogen in form of urea was applied in three equal splits, *viz*. at basal, 20 and 40 days after transplanting. The seedlings were raised in raised bed and one month old seedlings were transplanted into the main field at 60 x 45 cm row and plant distance. All cultural operations like weeding, fertilizer application, irrigation, earthing up and spraying of pesticides were done as per the recommendations of this region. For preparation of micro-nutrients solution, the desired amounts of micro-nutrients dissolved thoroughly in fix amount of water. Solutions of micro-nutrients were spread carefully to wet both the surfaces of the plant. Uniform spray of solution to all the plants was done at the time of 25, 50 & 75 days after the transplanting of cauliflower crops. Avoided the inclusion of micronutrient to the soil this precaution was taken. The knap sack sprayer was used to spray the micronutrients, and it was carefully cleaned before use to prevent contamination. The crop was harvested at physiological maturity and observations were recorded on five randomly selected competitive plants per replication at harvesting. Curd diameter was measured from widest part of the head. Total curd yield is calculated by formula: -

Total curd yield (q ha^{-1}) = Total curd yield (kg/plot) x 10,000/Net area of plot (m^2) x 100

Table 1. Mean monthly weather parameter during the period of crop growing season

Month	Rainfall (mm)	Temperature °C		Relative Humidity (%)	
		Maximum	Minimum	Maximum	Minimum
October, 2023	2	34.8	19.1	78.7	24.1
November, 2023	1.5	27.9	13.3	93.0	33.1
December, 2023	0	24.8	8.0	99.1	29.4
January, 2024	0	12.88	6.6	58.55	78.03
February, 2024	6	22.51	8.1	94.21	38.64

Experimental data was statistically analyzed by the standard technique of analysis of variance (ANOVA) and least significance difference test was applied to separate different treatment means (Panse and Sukhatme 1967)

RESULTS AND DISCUSSION

Effect of micronutrient formulation on growth parameters: The results of the study (Fig 1) showed that different micronutrients significantly influence the plant height, number of leaves and stalk length of cauliflower. Data indicated that among the treatments, treatment T_2: 3 sprays of Vegetable Special (5 gram per liter water at 25, 50 & 75 DAT) resulted in maximum plant height at 30 and 60 DAT (14.97 and 29.86 cm), number of leaves at 30 and 60 DAT (10.48 and 15.93) and stalk length (22.63 cm) over to farmers practice treatment plant height at 30 and 60 DAT (13.39 and 27.82 cm), number of leaves at 30 and 60 DAT (9.23 and 14.47) and stalk length (20.1 cm). The possible reasons because of the unique role of boron are connected to the potential cause of the observed improvement in a plant's growth features. This process supports the absorption of nitrogen by including the precipitation of excess cations, buffer action, and conducting tissue maintenance. On the other hand, molybdenum stimulates elements that improve the plant's development and metabolism, hence initiating physiological processes (Kumar *et al*. 2024). Rathore *et al*. (2025) reported that integrating balanced micronutrient management through foliar application for optimizing productivity, particularly in soils deficient in essential elements like zinc and iron. These results concur with earlier studies on cauliflower by Bairwa *et al*. (2024).

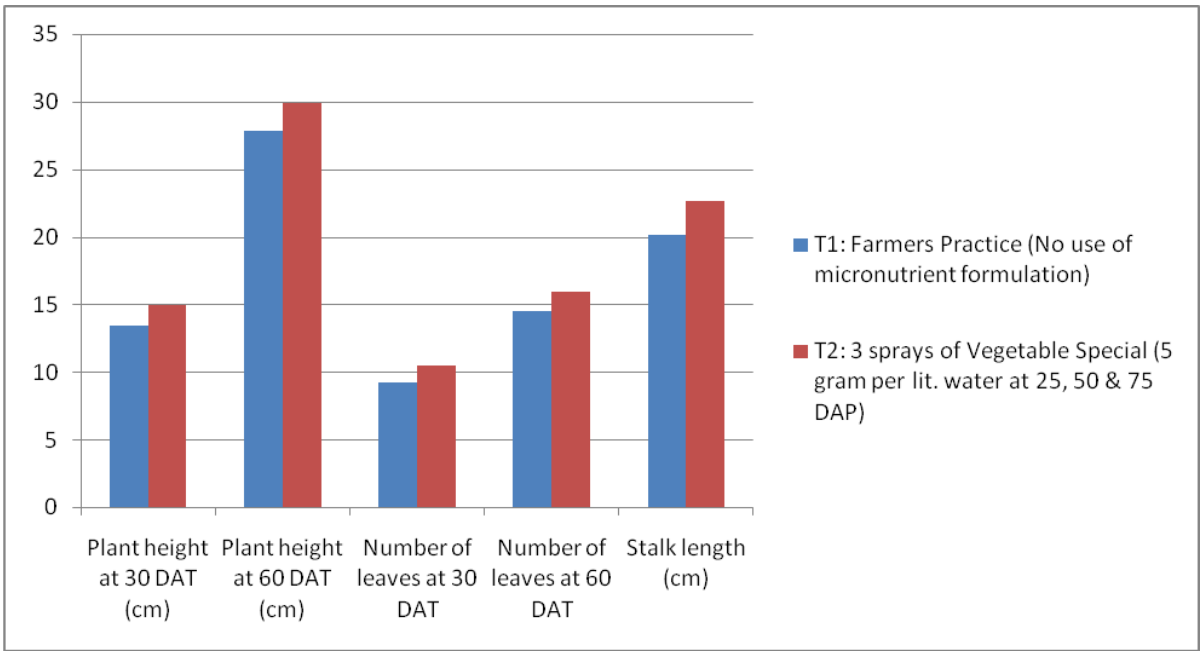

Fig 1 Effect of micronutrient formulation on growth parameters of cauliflower.

Effect of micronutrient formulation on yield parameters, yield and economics: The results of the study (Table 2) showed that different micronutrients significantly influence the yield of cauliflower is presented in Table 2. Data indicated that among the treatments, treatment T2: 3 sprays of Vegetable Special (5 gram per liter water at 25, 50 & 75 DAT) resulted in maximum curd diameter (11.8 cm), curd weight (607.1 g) and curd yield (163.5 q/ha) over to farmers practice treatment curd diameter (9.3 cm), curd weight (548.6 g) and curd yield (139.3 q/ha). Net return and B:C ratio (Rs 228800 & 3.32), respectively under T_2 treatment were also maximum followed by T_1 treatment (Rs 182900 & 2.91), respectively. A balanced supply of vital micronutrients that are required for plant growth and development may have caused the application of various micronutrients to speed up the rate of metabolic processes in the plant system, which may have increased the plant's growth parameters. Punam *et al*. (2020) reported that iron, zinc, boron, and molybdenum are very important for growth and development of cauliflower, Iron is component of ferredoxin, an electron transport protein and is associated with chloroplast, it helps in photosynthesis which resulted in better vegetative growth. Sani *et al*. (2018) reported that molybdenum is constituent of several enzymes, including nitrogenase and nitrate reductase both of which participate in nitrogen metabolism. Boron is involved in sugar translocation and involved in cell division and hence helps in root elongation and it is associated with several physiological processes such as calcium metabolism (Singh *et al*. 2022). Zinc is vital for carbohydrate, chlorophyll, DNA synthesis and formation of cell wall by active synthesis of aromatic amino acid *i.e.*, tryptophan, which is precursor of IAA and it is responsible to stimulated plant growth by cell elongation and cell division (Kumar *et al*. 2024). Copper and manganese are essential for antioxidant

enzyme reactions (Ghorbani *et al*., 2019). These micronutrients also promote the production of hormones, such as zinc's auxins, which affect root branching and cell elongation, and molybdenum's abscisic acid, which is essential for the stress response. These findings are in agreement with the results reported by Singh *et al*. (2025) and Kumar *et al*. (2023).

Table 2. Effect of micronutrient formulation on curd diameter, curd weight, curd yield and economics of cauliflower.

Treatments	Curd diameter (cm)	Curd weight (g)	Yield (q/ha)	Net Return (Rs/ha)	B:C Ratio
T_1: Farmers Practice (No use of micronutrient formulation)	9.3	548.6	139.3	182900	2.91
T_2: 3 sprays of Vegetable Special (5 gram per lit. water at 25, 50 & 75 DAP)	11.8	607.1	163.5	228800	3.32
SEM	0.28	6.54	2.71	5131.78	0.05
CD at 5%	5.02	117.53	48.62	92214.36	0.82

CONCLUSION

Based on the results obtained from present investigation it can be concluded that a foliar application of micronutrient formulation (Vegetable Special) at 25, 50 and 75 days after transplanting significantly enhanced the plant height, number of leaves, stalk length, curd diameter, curd weight and curd yield. Hence it can be concluded that 3 spray of Vegetable Special (5 gram per liter water at 25, 50 & 75 DAT) can be considered the most effective and beneficial for cauliflower production and it can be recommended for production practices to the farmers.

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