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EFFECT OF FOLIAR APPLICATION OF B AND Zn ON THE GROWTH AND YIELD OF CAULIFLOWER (*Brassica oleracea*)

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ABSTRACT

In order to investigate the foliar application of B and Zn on the growth and yield of cauliflower, a field experiment was conducted at Students' Research Farm, Department of Agriculture, Amritsar, during the *rabi* season of 2021-2022. The experiment was laid out in a randomized block design and replicated three times. The research design comprised seven treatments of micronutrients (0.25% and 0.5% of B and Zn) spray individually and in their combinations. Among the different treatments zinc sulphate 0.25% and borax 0.25% along with recommended dose of NPK 120:60:60 kg ha^{-1} (T_6) gave the maximum plant height (cm), number of leaves plant^{-1}, leaf length (cm), curd diameter (cm), curd weight (g), dry matter accumulation (q ha^{-1}) and curd yield (q ha^{-1}), while alone recommended dose of NPK @120:60:60 kg ha^{-1} (T_1) was recorded minimum values of growth parameters and curd yield.

(Key words: Cauliflower, foliar application, RDF, boron, zinc sulphate)

INTRODUCTION

Vegetables play a vital role in Indian agriculture by providing food, nutrition, economic security, and, most importantly, higher returns unit^{-1} area and time. Furthermore, vegetables have shorter maturity cycles, a high value, and provide more income, leading to improved livelihoods of farmers. After China, India is the world's second-largest producer of vegetables. The main vegetable-growing states in India are West Bengal, Uttar Pradesh, and Madhya Pradesh. (Kumar *et al*., 2022). Cauliflower (*Brassica oleracea*) is an important Cole crop that belongs to the Brassicaceae or Cruciferous family that originated in the Mediterranean region and has chromosomes no 2n=18. Curd is the edible part of cauliflower. Cauliflower is a heavy feeder crop that responds well to nutrients (Pawar and Barkule, 2017). Zinc has been the micronutrient needed by crops for proper growth and development.

Unfortunately, in India, about 50% of soils are deficient in zinc inducing Zn deficiency in humans and animals due to a reduction in the concentration of zinc in edible plant parts. According to recent research, one-third of the world's population is at risk of zinc malnutrition. Zinc is an essential component of enzymes, RNA, electron carriers, and other biological processes necessary for metabolism in plants and animals. (Yashona *et al*., 2018). Zinc plays a vital role in synthesizing chlorophyll, protein and regulates water absorption (Naveena *et al*., 2021). After zinc and sulphur, boron emerged as the third most deficient nutrient in Indian soils and the latest figures show 23.2% deficiency level. (Shukla and Behera, 2017). Recent research revealed that one-third of the world's population is at risk of zinc malnutrition. Boron is involved in sugar transfer, carbohydrate metabolism, RNA metabolism, as well as indole acetic acid and ascorbate phenol metabolism (Pandey *et al*., 2020). Boron is closely related to the functions that calcium performs in the plant. It has also been suggested that boron is necessary for the lignin polymerization process. Since, there is an association between flavonoids content and lignin production (Yadav *et al*., 2019)

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2021-2022 at Students' Research Farm, Khalsa College, Amritsar, Punjab, India to assess the effect of foliar application of B and Zn on the growth and yield of cauliflower. The experiment was laid out in randomized block design with three replications. Research design comprised of seven treatments *viz*., T_1: RDF, T_2: RDF+Borax @ 0.25%, T_3: RDF+Borax @ 0.5%, T_4: RDF+$ZnSO_4$ @ 0.25%, T_5: RDF+$ZnSO_4$ @ 0.5%, T_6: RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25% and T_7: RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%. The soil of the experimental plot was sandy loam in texture. During the growing season of the crop, the maximum temperature varied from 16.5°C to 33.7°C and the minimum temperature ranged from 3.1°C to 25.0°C. The relative humidity varied from 16.52 to 79.03% during the period of the crop season. The Pant Shubhra cultivar of cauliflower was used in the experiment. The recommended dose of N, P and K fertilizer (120 kg N +60 kg P_2O_5 + 60 kg K_2O ha^{-1}) was applied as urea,

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diammonium phosphate and muriate of potash, respectively. The sources of Zn and B were zinc sulphate and borax, respectively. The observations on vegetative growth characters were taken at harvest with respect to plant height, number of leaves, leaf length, curd diameter, curd weight, dry matter accumulation and curd yield. In order to represent the plot, five plants of cauliflower from each net plot were selected randomly for various biometric observations on growth and yield. The selected five plants were labelled and all biometric observations were recorded properly on them. Curd yield was recorded on a plot basis. Data on different parameters were analysed statistically as suggested by Panse and Sukhatme (1995).

RESULTS AND DISCUSSION

Effect on growth and yield attributes

The data pertaining to various growth attributes studied *viz*., plant height, number of leaves, leaf length, curd diameter, curd weight, dry matter accumulation and curd yield at harvest as influenced by various treatments are presented in Table 1.

Plant height (cm)

The plant height indicates the vigor, strength and adaptability of the crop. It is an important physiological parameter related to the growth and development of crops. It is an important measure to determine growth. The tallest plants were recorded by the application of RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25% (T_6) at harvest. However, treatments T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) and T_5 (RDF+$ZnSO_4$ @ 0.5%) were found to be at par with each other. The shortest plants of cauliflower were recorded in the plot receiving only RDF. Zinc helps in the production of auxin which regulates the growth hormone and enhanced plant growth resulting in an increase in plant height. Boron plays an important role in various physiological processes of plants such as cell elongation, cell maturation, meristematic tissue development, sugar transportation, IAA formation, germination and protein synthesis which in turn leads to an increase in plant height. A similar kind of increment in the plant height of chickpeas was also reported by Raut *et al.* (2019) with the foliar application of $ZnSO_4$ applied at the magnitude of 0.5 %. Sitapara *et al.* (2019) reported that foliar spray of boron at 0.20 % concentration produced the highest values of plant height in cauliflower.

Number of leaves plant^{-1}

The number of leaves is an important index of plant growth and development. Although the number of leaves is controlled genetically it may be markedly modified by agronomic manipulations. The data revealed that a number of leaves plant $^{-1}$ was affected due to the foliar application of zinc and boron. A significant maximum number of leaves plant^{-1} was noticed with the application of RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25% (T_6). Further, it was observed that treatment T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) was at par with treatment T_5 (RDF+$ZnSO_4$ @ 0.5%). This might be the result of the availability of the required quantity of essential plant nutrients at various growth stages leading to hastening the metabolic processes of plant and sugar metabolism, translocation of solutes and protein synthesis that might have resulted in the production of a greater number of leaves. These results are in accordance with Agnihotri *et al*. (2020), who reported adequate supply of 0.5% Zn + 0.2% B produced more leaves. Kumar and Khare (2015) also noticed the maximum number of leaves with the application of 0.25% B in cabbage.

Leaf length (cm)

The result revealed that the leaf length was significantly influenced by boron and zinc (Table 1). The maximum length of the leaf was found with the foliar application of zinc sulphate 0.25% and borax 0.25% along with recommended dose of NPK 120:60:60 kg ha^{-1} (T_6). However, treatments T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%)) and T_5 (RDF+$ZnSO_4$ @ 0.5%) were found at par with each other. The increase in leaf length might be due to the fact that zinc affects cell division, photosynthesis, synthesis of tryptophan and proteins and the activities of many enzymes. The particular function of boron, which resulted in the precipitation of excess cation, buffer action, and maintenance of conducting tissues, ultimately helped in the absorption of nitrogen. Singh *et al*. (2022) studied the effect of zinc and boron foliar application on the growth and yield of okra and observed that application of 50 ppm Zn increased the growth parameters of okra. Tyagi *et al*. (2018) reported that foliar application of borax applied at magnitude of 0.3% produced the highest values of leaf length in cauliflower.

Curd diameter (cm)

It is evident from the data shown in Table 1 that curd diameter was recorded maximum with the application of RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25% (T_6). However, treatment T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) was found to be at par with treatment T_5 (RDF+$ZnSO_4$ @ 0.5%). The combined application of micronutrients increases the curd diameter due to the enhanced physiological activities like photosynthesis during which food is synthesized by the plant, translocation of assimilates from leaves to curd and their storage in curd. These results are similar to the findings of Yadav *et al*. (2014), who reported adequate supply of 40 ppm Zn resulted in an increase in curd diameter. Thakur *et al*. (2019) also reported an increase in curd diameter with the foliar application of B @ 0.05 %.

Curd weight (g)

The data revealed that curd weight was affected due to the foliar application of zinc and boron. A significant maximum curd weight was noticed with RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25%. However, treatment T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) was found at par with treatment T_5 (RDF+$ZnSO_4$ @ 0.5%). The better efficacy of the combined application of boron and zinc might be due to the beneficial role played by both micronutrients. The increase in curd weight is attributed to their role in enhancing the

Table 1. Effect of foliar application of B and Zn on the growth and yield of cauliflower

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Leaf length (cm)	Curd diameter (cm)	Curd weight (g)	Dry matter accumulation (q ha^{-1})	Curd yield (q ha^{-1})
T_1- RDF	37.04	15.26	25.32	9.43	0.47	27.99	259.25
T_2- RDF+Borax@0.25%	41.43	19.40	26.91	11.36	0.58	31.18	280.37
T_3- RDF+Borax@0.5%	40.15	17.25	25.93	10.85	0.53	28.82	269.24
T_4- RDF+$ZnSO_4$@0.25%	39.22	18.63	26.24	11.01	0.56	31.03	277.54
T_5- RDF+$ZnSO_4$@0.5%‘	43.38	21.28	27.62	12.92	0.64	32.40	293.61
T_{6-}RDF+$ZnSO_4$@0.25%+Borax@0.25%	46.65	23.32	28.45	14.55	0.79	35.87	312.48
T_7- RDF+$ZnSO_4$@0.5%+Borax@0.5%	44.54	21.40	27.88	13.16	0.66	33.36	300.73
SE(m) ±	0.69	0.62	0.11	0.45	0.01	0.74	3.21
CD (P = 0.05)	2.07	1.86	0.33	1.35	0.03	2.22	9.63

translocation of carbohydrates from the sight of synthesis to the storage tissue in the curd in cauliflower. However, micronutrients activate physiological processes by stimulating the metabolism and enhancing the growth of the plant. These results are in accordance with Sourabh *et al*. (2019), who reported an adequate supply of 0.5% Zn + 0.2% B increased curd weight.

Dry matter accumulation (q ha^{-1})

Dry matter accumulation is an important growth parameter that expresses the metabolic efficiency of plants. It is the accumulation of the synthesis during the stimulated growth period and is considered an important prerequisite for higher yields. Significantly maximum accumulation of dry matter was noticed in treatment T_6 (RDF+$ZnSO_4$ @ 0.25%+Borax @ 0.25%). However, treatments T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) and T_5 (RDF+$ZnSO_4$ @ 0.5%) were found to be at par with each other. The beneficial role of zinc on dry matter production might be attributed to the synthesis of tryptophan in plants, a precursor for growth regulator indole acetic acid (IAA) which played a significant role in cell division and cell elongation, thereby enhancing the growth and nutrient uptake with the consequent increase in vegetative growth and finally promotes dry matter production. The improvement in dry-matter yield can be attributed to the role of B in stabilizing certain constituents of the cell wall and plasma membrane, enhancement of cell division, tissue differentiation and metabolism of nucleic acids, carbohydrates, proteins, auxins and phenols. Padbhushan and Kumar (2015) revealed that foliar application of 0.1% borax to green gram showed favourable results in dry matter yield.

Curd yield (q ha^{-1})

The data revealed that curd yield was affected due to the foliar application of zinc and boron. Significantly maximum yield was found with the foliar application of zinc sulphate 0.25% and borax 0.25% along with recommended dose of NPK 120:60:60 kg ha^{-1} (T_6). Further, it was observed that treatment T_7 (RDF+$ZnSO_4$ @ 0.5%+Borax @ 0.5%) was at par with treatment T_5 (RDF+$ZnSO_4$ @ 0.5%). This might be because zinc and boron take place in many physiological processes of plants such as chlorophyll formation, stomatal regulation, and starch utilization which enhance the yield of cauliflower. Karad *et al.* (2022) studied the effect of foliar application of micronutrients on the yield of chickpeas and observed that application of Zn @ 0.50 % increased the yield. Sourabh *et al.* (2019) also noticed the maximum head yield with the application of 0.20% B in broccoli.

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