International Journal of Plant & Soil Science

Volume 36, Issue 12, Page 254-261, 2024; Article no.IJPSS.128024
ISSN: 2320-7035

Effect of Boron and Zinc on Growth and Yield of Cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Snowball K-1

Atul Dhakad [a], Sutanu Maji [a*], Razauddin [a], Tendul Chouhan [a], Dilkush Meena [a], Neha [a] and Sarjesh Kumar Meena [a]

[a] *Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2024/v36i125199

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/128024

Original Research Article

Received: 08/10/2024
Accepted: 10/12/2024
Published: 14/12/2024

ABSTRACT

Cauliflower (*Brassica oleracea* var. *botrytis* L.), one of the most popular vegetables in the cole group, is widely cultivated for its high yield, which is dependent on having adequate macronutrients. Deficits in the essential minerals boron and zinc are common in cauliflower crops. Hence the study was conducted to evaluate the experiment was laid out in three replications and nine treatments. The plot size was 1.8 m x 1.8 m and planting was done with spacing 45 cm x 45 cm. The treatments comprised the use of micronutrients Boron (0.2% and 0.4%), Zinc (0.3% and 0.5%) and

---

**Corresponding author: E-mail: majisutanu@gmail.com;*

Cite as: *Dhakad, Atul, Sutanu Maji, Razauddin, Tendul Chouhan, Dilkush Meena, Neha, and Sarjesh Kumar Meena. 2024. "Effect of Boron and Zinc on Growth and Yield of Cauliflower (Brassica Oleracea Var. Botrytis L.) Cv. Pusa Snowball K-1". International Journal of Plant & Soil Science 36 (12):254-61. https://doi.org/10.9734/ijpss/2024/v36i125199.*

their combinations. The B and Zn were applied to plants at 30 and 45 Days after transplanting (DAT). Observations pertained to growth parameters were recorded at various stages (30 DAT to 45 DAT, 45 DAT to 60 DAT and 30 DAT to 60 DAT). Among the foliar applications of B and Zn (T_9) *i.e.* Boron @ 0.4% + Zinc @ 0.5% was found to be significantly superior for plant height, number of leaves, length of leaf, width of leaf and plant spread but application of Boron @ 0.4% + Zinc @ 0.3% (T_8) and Boron @ 0.2% + Zinc @ 0.5% (T_7) were statistically *at par* in case of plant height. T_9 (Boron @ 0.4% + Zinc @ 0.5%) also showed early curd initiation and harvesting, improved curd diameter, fresh weight as well as curd yield. Thus, foliar application of Boron @ 0.4% + Zinc @ 0.5% at 30 and 45 days after planting may be beneficial for good marketable cauliflower production with superior curd size and high yield.

Keywords: Cauliflower; curd yield; curd size; growth; zinc; boron.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L., 2n=2x=18) is one of the important vegetable crops belonging to the family Brassicaceae or Cruciferae. The family Cruciferae is distinguished by having 6 stamens, of which 2 are short and 4 long and a unique type of pod called siliqua (Thambhuraj, 2018). Cauliflower is a "pre-floral fleshy apical meristem," and before it is exposed, it may be covered by inner leaves. The Latin words "Caulis" and" Floris," which signify stem and flower, respectively are the source of the term "cauliflower". The curd is the edible portion and marketable part of this plant. India harvests and consumes the majority of the cauliflower. At the moment, cauliflower is grown in practically all of the Indian states, though primarily in West Bengal, Uttar Pradesh, Bihar, and Karnataka. India is the world's second-largest producer of vegetables after China, with an approximate production of 204.84 million metric tonnes of vegetables, India produces food over an area of 11.34 million hectares of land area in the year 2021-22 (Anonymous, 2022).

Boron (B) and zinc (Zn) nutrients are crucial for proper crop growth and development, the crop responds well to both macronutrients (Nitrogen, Phosphorus, Potassium) and micronutrients (Boron, Molybdenum and Zinc, among others). Micronutrients are important in small amounts and serve a critical function in the plant lifecycle. Boron, Zinc and Molybdenum play a more important role than the other micronutrients (Boron, Molybdenum, Iron, Copper, Chlorine, Zinc and Manganese) due to their availability; the movement of nutrients depends on the soil's pH More micronutrients, particularly Boron, Zinc and Molybdenum, are mandatory in cauliflower. Because it is involved in cell division and promotes root and shoots growth, the mineral borate is essential for the growth and development of cauliflower. It has connections to a wide range of physiological activities, including protein synthesis, auxin production, calcium metabolism and translocation of solutes.

Boron is essential for cell division, cell wall elongation and pollen generation, all of which have an impact on the development of seeds and fruit sets (Sharma et al., 1999). It has also been shown to boost the vegetative growth of Cole crops (Singh, 2003). According to Yang et al. (2000), its application in the soil increased the broccoli crop's yield and quality. In green gram, boron promotes the expansion of the pollen tube, the establishment of the pollen grain, the viability of the pollen and the development of the seed (Praveena et al., 2018). Boron application considerably improved curd weight and curd diameter of cauliflower (Kumar and Chaudhary, 2002). However, increasing Boron doses harmed cauliflower plant height (Pandey et al., 2020). Boron plays a crucial role in maximizing curd size, production and superiority of cauliflower (Kumar et al., 2002).

Like boron, another important plant nutrient Zinc increases curd diameter and curd weight as a result of improved physiological processes including photosynthesis, during which food is created in large quantities by plants moving nutrients from leaves to curd and storing them there (Lashkari et al., 2008). An increase in plant height and stalk length is a liable sign of plant growth. This increase in vegetative growth may be attributable to Zinc's role in chlorophyll activation, which also affected cell division, the meristematic activity of plant tissues, cell expansion and cell wall formation by active synthesis of the aromatic amino acid tryptophan, a precursor to IAA and a stimulator of plant growth by cell elongation and cell division (Choudhary and Mukherjee, 1999; Kanujia et al., 2006). Zinc is an activator of enzymes involved in protein synthesis and has direct conclusion on the enzymatic regulation in plants. Keeping these in mind the present experiment was conducted to see the efficiency of boron and zinc on growth and yield of cauliflower cv. Pusa Snowball K-1 grown in subtropical slightly alkaline soil at Lucknow.

2. MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm-1, Department of Horticulture, Babasaheb Bhimrao Ambedkar University Lucknow (Uttar Pradesh) during 2022-2023 (*Rabi season*). The experimental site was situated at $26^0$50'N latitude and 80^0 52' E longitude and an altitude of 111 meters above mean sea level (MSL). This area is located in Uttar Pradesh in the fifth agricultural climate zone (ICAR). Lucknow has a dry subtropical climate with an average rainfall of 750 to 1100 mm and relative humidity of 60 to 90 % depending on the weather and climatic factors.

The seeds of the cauliflower variety "Pusa Snowball K-1" (*Brassica oleracea* var. *botrytis* L.) were obtained from the Indian Agricultural Research Institute, New Delhi. Raised beds of 1.8 x 1.8 x 0.15 m3 (L x B x H) size were prepared. The upper layer of 5 cm of each bed was mixed with an equal quantity of well-rotten FYM and sieved soil. Seeds of "Pusa Snowball K-1" were sown during October 2022. Watering was done regularly by rose can. Raised beds were kept clean by weeding regularly. The seedlings were kept healthy by taking two sprays of pesticides as and when required. Recommended doses of nitrogen, phosphorus and potassium (160:80:120 kg ha^{-1}) through urea, SSP and MOP, respectively were applied as basal doses during the experimental period. Nitrogen was applied 50% as basal and remaining at 40 DAT. In the present investigation, micronutrients viz. Boron and Zinc were tried involving nine treatment combinations such as T_1 (Control), T_2 (Boron @ 0.2%), T_3 (Boron @ 0.4%), T_4 (Zinc@ 0.3%), T_5 (Zinc@ 0.5%), T_6 (Boron @ 0.2% + Zinc@ 0.3%), T_7 (Boron @ 0.2% + Zinc@ 0.5%), T_8 (Boron @ 0.4% + Zinc@ 0.3%), and T_9 (Boron @ 0.4% + Zinc@ 0.5%). Boron was applied as Borax and Zinc was applied as Zinc sulphate. The experiment was laid out in Randomized Block Design with three replications. The observations were recorded on vegetative growth, curd yield and yield attributing characters. The collected data was analyzed by statistical method suggested by Panse and Sukhatme (1985).

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth Characters

Marked variations in increase of plant height were recorded due to foliar application of B and Zn at all the growth stages during crop season (Table 1). The maximum increase (13.51cm and 80.61%) in plant height was recorded from 30 DAT to 45 DAT under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by 12.96 cm & 78.21% increase under treatment T_8 (Boron @ 0.4% + Zinc @ 0.3%) and minimum increase in plant height (7.71cm & 49.36%) was observed under treatment T_1 (Control). Similarly, an increase in plant height from 45 DAT to 60 DAT was also found at maximum (10.87cm and 35.91%) under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by (10.04 cm and 35.19 %) increase under treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%). It was seen that total increase of plant height from 30 DAT to 60 DAT (24.38 cm & 145.47%) was observed as maximum and it was noted in treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by T_8 (Boron @ 0.4% + Zinc@ 0.3%).

Different foliar applications of Boron and Zinc significantly influenced the number of leaves of cauliflower. For 30 DAT to 45 DAT the maximum increase in several leaves $plant^{-1}$ (5.88 and 85.71%) was recorded under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by 5.25 and 82.81 % increase under treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%). Correspondingly, the highest increase number of leaves $plant^{-1}$ (6.93 and 54.40%) was observed during 45 to 60 DAT under treatment T_9 (Boron @ 0.4%+ Zinc@ 0.5%) Although, the minimum increased number of leaves $plant^{-1}$ (2.34 & 28.82%) was seen under control treatment (T_1), it was found that treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) had the highest total increase in number of leaves per plant (12.81 and 186.73%) from 30 DAT to 60 DAT, followed by treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%) with a total increase of (11.22 and 176.97%) (Table 2).

During the crop season, foliar applications of B and Zn similarly influenced leaf length at all growth stages (Table 2). The leaf length increased was a maximum (of 10.82cm and 77.67%) between 30 DAT and 45 DAT under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%)

subsequently, (9.19cm & 65.50%) T_8 (Boron @ 0.4% + Zinc@ 0.3%). Likewise, the maximum improved leaf length of (10.92cm and 44.12%) was recorded at 45 DAT to 60 DAT in treatment T_9 (Boron @ 0.4%+ Zinc@ 0.5%) afterward (9.41 cm and 40.53%) and it had the maximum overall increase in the length of leaves, expanding by (21.74 cm and 156.07%) between 30 DAT to 60 DAT.

A similar tendency was observed in change of leaf width showing maximum increased leaf width of 6.08 cm & 95.75% was noted under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by 5.30 cm and 88.48% increase under treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%) from 30 DAT to 45 DAT (Table 3). Similar trend was also observed at 45 DAT to 60 DAT, showing maximum increase (8.11cm & 65.25%) under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) followed by T_8 (Boron@0.4%+Zinc@ 0.3%) which continued at total increase from 30 to 60 DAT followed by treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%), with (12.37 cm and 118.03%). Similar to leaf characters, plant canopy spreading was found maximum under T_9 at different stages of growth (30 to 45 DAT, 45 to 60 DAT and total increase from 30 to 60 DAT), followed by treatment T_8 (Boron @ 0.4%+ Zinc@ 0.3%). The control treatment (T_1) exhibited the smallest rise between 30 DAT to 60 DAT, determining (18.31 cm and 106.14%).

Application of Boron @ 0.4% + Zinc @ 0.5% (T_9) was found to be significantly superior for plant height, number of leaves, length of leaf, width of leaf and plant spread but application of Boron @0.4% + Zinc@0.3% (T_8) and Boron @ 0.2% + Zinc @ 0.5% (T_7) applied on width of leaf and plant height are statistically at par that means no difference in plant height. Meena et al. (2019) also had a similar effect on the vegetative growth of cabbage by the application of boric acid @ 0.2%. Singh et al. (2017) recommended the use of borax @ 20 kg ha^{-1} as a soil application produced cauliflower with the highest plant height (60.95 cm), leaf length (51.8 cm), leaf width (20.24 cm) and total plant weight (1.93 kg). Similar, results were found by Kamal et al. (2013) that four basal dosages of boron in the form of borax (0, 5, 10 and 15 kg ha^{-1}) and Zinc in the form of Zinc (0, 10, 20 and 30 kg ha^{-1}) showed the highest effect on vegetative growth. Kant et al. (2013) also stated that combined application of borax (0, 5, 10 and 15 kg/ha) and Zinc (0, 10, 20 and 30 kg/ha) on cauliflower var. Himani got maximum vegetative growth of a plant.

3.2 Yield and Yield Attributes

The mean data about the effect of various treatments on days to first curd initiation was presented in Table 4. Minimum days of first curd initiation are the desirable characteristics for cauliflower. The minimum days to first curd initiation (56.23 DAT) was observed with application of Boron @ 0.4% + Zinc@0.5% (T_9). It was followed by treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%) with days taken to first curd initiation 57.73 DAT.

Application of Boron @ 0.4% + Zinc @ 0.5% (T_9) caused early harvesting of marketable curds (74.13 days). The minimum days taken from day to first curd initiation to days to first curd marketable harvesting (17.90 days) was recorded under T_9 (Boron @ 0.4% + Zinc sulfate @ 0.5) followed by 18.13 days in $T_{8.}$

There was a significant effect of Boron and Zinc on cauliflower curd diameter. The treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%) reported the largest curd diameter (13.87 cm) followed by T_8 (Boron @ 0.4% + Zinc@ 0.3%) (13.25cm).

The maximum number of florets was counted (15.66) in treatment T_8 (Boron @ 0.4% + Zinc@ 0.3%) followed by 14.45 florets under treatment T_9 (Boron @ 0.4% + Zinc@ 0.5%).

The average fresh weight of curd was determined in each treatment and the data so obtained were subjected to statistical computation. The mean data revealed that maximum fresh weight of curd viz 289.47g, 284.66 g was observed at harvest with an application of Boron @ 0.4% + Zinc@ 0.5% (T_9) and Boron @ 0.4% + Zinc@ 0.3% (T_8), respectively. The maximum increase in curd weight led to an increase in curd yield and curd yield (per plot and ha) was estimated higher under foliar application of Boron @ 0.4% + Zinc@ 0.5% (T_9) (14.63kg/plot and 142.96 q/ha) followed by T_8 (Boron @ 0.4% + Zinc @ 0.3%) and T 7 (Boron @ 0.2% + Zinc@ 0.5%).

Table 1. Effect of boron and zinc on plant height of cauliflower

Treatment	Increase in cm (30-45 DAT)	Increase in % (30-45 DAT)	Increase in cm (45-60 DAT)	Increase in % (45-60 DAT)	Total Increase in cm (30-60 DAT)	Total Increase in % (30-60 DAT)
T_1- Control	7.71	49.36	6.10	26.15	13.81	88.41
T_2- Boron @ 0.2%	8.35	50.24	6.70	26.83	15.05	90.55
T_3- Boron @ 0.4%	9.12	56.40	7.47	29.54	16.59	102.60
T_4- Zinc@ 0.3%	8.76	53.38	7.29	28.96	16.05	97.81
T_5- Zinc@0.5%	9.87	57.69	8.20	30.39	18.07	105.61
T_6- Boron @ 0.2% + Zinc @ 0.3%	11.89	75.88	8.42	30.55	20.31	129.61
T_7- Boron @ 0.2% + Zinc @ 0.5%	12.22	75.34	9.19	32.31	21.41	132.00
T_8- Boron @ 0.4% + Zinc@ 0.3%	12.96	78.21	10.04	35.19	22.00	132.77
T_9- Boron @ 0.4% + Zinc@ 0.5%	13.51	80.61	10.87	35.91	24.38	145.47
SEm (±)	**0.088**	**0.745**	**0.094**	**0.449**	**0.295**	**1.403**
C.D. (p=0.05)	**0.266**	**2.253**	**0.284**	**1.358**	**0.891**	**4.242**

Table 2. Effect of foliar application of boron and zinc on increase of number of leaves per plant [1] and length of leaf.

	Increase in number of leaves per plant						Increase in length of leaf					
Treatment	**Increase in no. (30-45 DAT)**	**Increase in % (30-45 DAT)**	**Increase in no. (45-60 DAT)**	**Increase in % (45-60 DAT)**	**Total Increase in no. (30-60 DAT)**	**Total Increase in % (30-60 DAT)**	**Increase in cm (30-45 DAT)**	**Increase in % (30-45 DAT)**	**Increase in cm (45-60 DAT)**	**Increase in % (45-60 DAT)**	**Total Increase in cm (30-60 DAT)**	**Total Increase in % (30-60 DAT)**
T_1- Control	2.38	41.46	2.34	28.82	4.72	82.23	4.63	34.25	5.41	29.81	10.04	74.26
T_2- Boron @ 0.2%	2.53	43.32	2.87	34.29	5.4	92.47	5.14	35.82	6.03	30.94	11.17	77.84
T_3-Boron@ 0.4%	2.96	46.54	3.51	37.66	6.47	101.73	5.74	40.62	6.38	32.11	12.12	85.77
T_4-Zinc@0.3%	3.2	47.98	3.56	36.07	6.76	101.35	5.59	38.31	6.31	31.27	11.9	81.56
T_5- Zinc@0.5%	3.55	51.15	4.16	39.66	7.71	111.10	6.75	47.01	7.12	33.73	13.87	96.59
T_6- Boron @ 0.2% + Zinc @ 0.3%	4.1	57.26	4.68	41.56	8.78	122.63	7.6	54.79	8.1	37.73	15.7	113.19
T_7- Boron @ 0.2% + Zinc @ 0.5%	4.78	72.87	5.23	46.12	10.01	152.59	8.56	62.62	8.64	38.87	17.2	125.82
T_8- Boron @ 0.4% + Zinc@ 0.3%	5.25	82.81	5.97	51.51	11.22	176.97	9.19	65.50	9.41	40.53	18.6	132.57
T_9- Boron @ 0.4% + Zinc@ 0.5%	**5.88**	**85.71**	**6.93**	**54.40**	**12.81**	**186.73**	10.82	77.67	10.92	44.12	21.74	156.07
SEm (±)	**0.034**	**0.701**	**0.049**	**0.500**	**0.125**	**1.716**	**0.090**	**0.733**	**0.079**	**0.429**	**0.179**	**1.380**
C.D. (p=0.05)	**0.104**	**2.120**	**0.148**	**1.511**	**0.378**	**5.188**	**0.271**	**2.217**	**0.238**	**1.296**	**0.541**	**4.174**

Table 3. Effect of foliar application of boron and zinc on width of leaf plant^{-1}and Plant spread of cauliflower

	Increase in width of leaf						Increase in plant spread					
Treatment	**Increase in no. (30-45 DAT)**	**Increase in % (30-45 DAT)**	**Increase in no. (45-60 DAT)**	**Increase in % (45-60 DAT)**	**Total Increase in no. (30-60 DAT)**	**Total Increase in % (30-60 DAT)**	**Increase in cm (30-45 DAT)**	**Increase in % (30-45 DAT)**	**Increase in cm (45-60 DAT)**	**Increase in % (45-60 DAT)**	**Total Increase in cm (30-60 DAT)**	**Total Increase in % (30-60 DAT)**
T_1- Control	3.29	56.34	3.44	37.68	6.73	58.90	9.1	52.75	9.21	34.95	18.31	106.14
T_2- Boron @ 0.2%	3.58	58.40	4.36	44.90	7.94	71.13	10.1	54.54	10.13	35.39	20.23	109.23
T_3-Boron@ 0.4%	3.62	64.07	4.89	52.75	8.51	86.55	10.65	59.76	10.86	38.15	21.51	120.71
T_4-Zinc@0.3%	3.8	61.00	4.65	46.36	8.45	74.64	10.55	55.61	11.14	37.74	21.69	114.34
T_5- Zinc@0.5%	4.28	66.25	5.72	53.26	10	88.54	10.8	61.12	11.46	40.25	22.26	125.98
T_6- Boron @ 0.2% + Zinc @ 0.3%	4.8	70.07	6.31	54.16	11.11	92.12	11.4	62.02	12.54	42.11	23.94	130.25
T_7- Boron @ 0.2% + Zinc @ 0.5%	5.27	77.27	6.77	56.00	12.04	99.27	11.57	63.71	12.84	43.19	24.41	134.42
T_8- Boron @ 0.4% + Zinc@ 0.3%	5.3	88.48	7.07	62.62	12.37	118.03	12.01	64.29	14.04	45.75	26.05	139.45
T_9- Boron @ 0.4% + Zinc@ 0.5%	6.08	95.75	8.11	65.25	14.19	127.72	13.24	73.84	15.66	50.24	28.9	161.18
SEm (±)	**0.063**	**0.789**	**0.065**	**0.661**	**0.137**	**0.994**	**0.138**	**0.615**	**0.155**	**0.426**	**0.239**	**1.763**
C.D. (p=0.05)	**0.190**	**2.385**	**0.195**	**2.000**	**0.415**	**3.004**	**0.418**	**1.858**	**0.470**	**1.289**	**0.724**	**5.332**

Table 4. Effect of foliar application of boron and zinc on yield and yield attributes of cauliflower

Treatment	**Curd diameter (cm)**	**Number of floret/curd**	**Fresh weight of curd (g)**	**Curd yield/ plot (Kg)**	**Curd yield/ha (q)**	**Day of first curd initiation (DAT)**	**Day of first marketable curd harvesting (DAT)**	**Day of curd initiation to marketable harvesting (Days)**
T_1- Control	9.67	8.33	256.5	4.1	126.66	61.37	80.65	19.28
T_2- Boron @ 0.2%	11.55	10.89	270.75	4.33	133.7	59.35	78.47	19.12
T_3-Boron@ 0.4%	12.12	12.67	273.53	4.38	135.06	58.41	77.43	19.02
T_4-Zinc@0.3%	11.12	11.23	264.25	4.23	130.49	60.73	79.59	18.86
T_5- Zinc@0.5%	11.31	12.75	267.53	4.28	132.09	59.68	78.47	18.79
T_6- Boron @ 0.2% + Zinc @ 0.3%	12.37	13.25	275.08	4.4	135.83	59.4	78.06	18.66
T_7- Boron @ 0.2% + Zinc @ 0.5%	12.68	13.73	279.58	4.47	138.05	58.53	77.07	18.54
T_8- Boron @ 0.4% + Zinc@ 0.3%	13.25	15.66	284.66	4.56	140.58	57.73	75.86	18.13
T_9- Boron @ 0.4% + Zinc@ 0.5%	13.87	14.45	289.47	4.63	142.96	56.23	74.13	17.9
SEm (±)	**0.175**	**0.136**	**3.779**	**0.049**	**1.923**	**0.93**	**1.176**	**0.199**
C.D. (p=0.05)	**0.53**	**0.412**	**11.427**	**0.15**	**5.813**	**2.813**	**3.555**	**0.603**

The results revealed that different doses of Boron and Zinc significantly improved the day of first curd initiation, day of first marketable curd harvesting, curd diameter, fresh weight of curd, curd yield/plot and curd yield/ha was found superior under the treatment of T_9 (Boron @ 0.4% + Zinc@ 0.5%) then control treatment (T_1). Application of Boron @ 0.4% + Zinc@ 0.5% (T_9) caused earliness in curd initiation and days to first marketable harvesting as compared to other treatments. The maximum floret of cauliflower curd obtained by the foliar application of T_8 treatment (Boron @ 0.4% + Zinc@ 0.3%) is superior the T_9 treatment. Similarly, result was also found by Kumar et al. (2023), who observed cauliflower plants got maximum yield in terms of greatest net curd weight (410g) and marketable curd weight (695g) by the application of Boron (2 kg ha^{-1}) and Zinc (2.5 kg ha^{-1}). It was also found by Sardar et al. (2022) that the foliar application of Zn (0.5%) and B (0.5%) on broccoli observed maximum effect on yield. Moniruzzaman et al. (2007), found the maximum effect of the application of Boron @ 2 kg ha^{-1} in yield of broccoli. Similarly, Alam and Jahan (2007) obtained the highest yield of cauliflower. These effects also sawed in crops of cauliflower the application of 3–4 kg Boron ha^{-1} (0.4–0.6 g boric acid pot^{-1}) has increased superior yield. Correspondingly, Prasad and Rai 2008, found out the maximum yield by the 5 kg ha^{-1} @ boron application on cauliflower cv. Pusa Snowball. A 133% increase in the final yield (15.4 t ha^{-1}) was discovered.

4. CONCLUSION

The results revealed that foliar application of Zinc and Boron significantly influenced the growth and yield of cauliflower cv. Pusa Snowball K-1. Foliar application of Boron @ 0.4% + Zinc@ 0.5 % showed significant maximum growth, curd diameter, fresh weight of curd, curd yield/plot and curd yield/ha, and reduced curd initiation and maturity period. Thus, it was concluded that foliar application of Boron @ 0.4% + Zinc @ 0.5% at 30 and 45 days after transplanting was good for better growth and yield of cauliflower.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Alam, M.N. and Jahan, J.S. (2007). Effect of boron levels on growth and yield of cabbage in calcareous soils of Bangladesh. *The Asian Journal of Horticulture*, 3(6): 858-865.

Anonymous, (2022). Agricultural Statistics at a Glance. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, New Delhi.

Choudhary D. and Mukherjee, S. (1999). Effect of boron and zinc concentration on growth and yield of cauliflower cv. Snowball-16. *Haryana Journal of Horticultural Science*. 28(1-2): 119- 120.

Kant, Kamal, Singh, K.P., Anonymous Singh, V.K. and Ranjan, A. (2013). Effect of boron, zinc and their combinations on the yield of cauliflower (*Brassica oleracea* var. *Botrytis* Linn.) hybrid cultivar – Himani, *Asian Journal Horticulture*, 8(1): 238-240.

Kanujia, S.P., Ahmed, N., Chattoo, M.A., Jabeen, N. And Naryan, S. (2006). Effect of micronutrients on growth and yield of cabbage (*Brassica oleracea* var. *Capitata* L.) *Applied Biological Research*.8: 15-18.

Kumar, M. Choudhary, S.K. Kumar, R. Singh, S.K. Prabhakar, M.K. Singh, P.K. (2023). Effect of Boron and Zinc on Growth and Yield Attributes in Early Cauliflower (*Brassica oleracea* var. *Botrytis* L*). International Journal of Plant & Soil Science.* 35(6): 104-110.

Kumar, S., Chaudhury, D.R., Kumar, S. (2002). Effect of FYM, molybdenum and boron application on yield attributes and yields of cauliflower. *Crop Research Hisar.* 24(3): 494–496.

Lashkari C.O., Parekh, H.B., Sharma, S.J., Karetha, K.M. and Kakade, D.K. (2008). Influence of zinc and iron on yield and quality of cauliflower (*Brassica oleracea* var. *Botrytis Linn*.) cv. Snowball-16. *Asian Journal Horticulture*.; 3(2): 380-381.

Meena, S.L., Aravindakshan, K., Arya, C.K., Meena, K.K. and Meena, M.K. (2019). Effect of bioregulators and boron on growth attributes of cabbage (*Brassica* *oleracea* var. *capitata* L.) cv. Golden Acre, *International Journal of Chemical Studies*, 7(3): 1540-1543.

Moniruzzaman, M., Rahman, S.M., Rahman, M.A. (2007). Effect of boron on yield and hollow stem of cauliflower and broccoli. *Journal Soil Science*.1(3): 24-29.

Pandey, S., Parajuli, S., Oli, b. and Dhungana, S. (2020). Effect of different doses of boron on growth and yield of off-season cauliflower (*Brassica oleracea* var. *botrytis*) in Arghakhanchi, Nepal. Reviews in Food and Agriculture. 1(1): 12–17.

Panse, V.G. and Sukhatme, P.V. (1985). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research Publication, 87-89.

Prasad, T.H. and Rai, C.H. (2008). Studies on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*) as influenced by boron and molybdenum, *Journal of Plant Nutrition*, 39(2): 167-169.

Praveena, R., Ghosh, G. and Singh, V. (2018). Effect of foliar spray of boron and different zinc levels on the growth and yield of kharif green gram (*Vigna radiata*). *International Journal Current Microbiological Applied Science*. 7(8): 1422–1428.

Sardar, H., Irshad, M., Anjum, M. A., Hussain, S., Ali, S., Ahmad, R. and Ejaz, S. (2022). Foliar application of micronutrients improves the growth, yield, mineral contents, and nutritional quality of broccoli (*Brassica oleracea* var. *italica* L.), *Turkish Journal of Agriculture and Forestry*: 46: 6.

Sharma, S.K., Singh, H. and Kohli, U.K. (1999). Influence of boron and zinc on seed yield and quality of radish. Seed Research. 27(2): 154–158.

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.

Singh, G., Saravanan, S., Rajawat, K.S., Rathore, J.S. and Singh, G. (2017). Effect of different micronutrients on plant growth, yield and flower bud quality of broccoli (*Brassica oleracea* var. *italica* L.), *Current Agriculture Research Journal*. 5(1): 108-15.

Thambhuraj (2018). Textbook of Vegetables, Tuber crops and Spices, Indian Council of Agricultural Research, New Delhi, edition 7, p. 76-97.

Yang, X., X.Y. Chen and Z.C. Liu. (2000). Effects of boron and molybdenum nutrition on curd yield and active oxygen metabolism in broccoli *(Brassica oleracea* var*. italica*). *Acta Horticultural. Science*. 27(2): 112–116.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/128024