International Journal of Advanced Chemistry Research

ISSN Print: 2664-6781
ISSN Online: 2664-679X
Impact Factor: RJIF 5.32
IJACR 2022; 4(1): 71-75
www.chemistryjournals.net
Received: 11-05-2022
Accepted: 04-06-2022

Pankaj Kumar Sankhyan
Department of Soil Science, CSKHPKV Palampur, Himachal Pradesh, India

Dr. DK Parmar
Department of Soil Science, CSKHPKV Palampur, Himachal Pradesh, India

Corresponding Author:
Pankaj Kumar Sankhyan
Department of Soil Science, CSKHPKV Palampur, Himachal Pradesh, India

Effect of foliar application of boron and molybdenum on yield and yield attributes of cauliflower in Kullu valley of Himachal Pradesh

Pankaj Kumar Sankhyan and Dr. DK Parmar

DOI: https://doi.org/10.33545/26646781.2022.v4.i1a.122

Abstract
A field experiment was carried out during *kharif* 2021 at experimental farm of CSK HPKV Hill Agriculture Research and Extension Centre, Bajaura, Kullu comprising of eleven treatments replicated thrice in randomized block design to evaluate the effect of foliar application of boron and molybdenum on productivity and quality of cauliflower. All these combinations received recommended dose of FYM @20 q ha^{-1} uniformly except the treatment NPK alone. Three foliar applications of boron at three concentrations (0.034%, 0.051% and 0.068%) and molybdenum (0.10%, 0.15% and 0.20%) were done at 30, 45 and 60 days after transplanting. The yield attributes and yield were significantly affected by the foliar spray of boron and molybdenum. Although the interaction between boron and molybdenum was found to be non-significant for yield and significant for yield attributes except curd diameter. Among three boron and molybdenum levels maximum marketable curd yield (257.5 q ha^{-1}), (257.2 q ha^{-1}) was obtained from the treatment where B @ 0.068% and Mo @ 0.20 % was applied respectively. But the interaction effect of boron and molybdenum on curd yield was found to be non-significant. To conclude, foliar application of B and Mo positively influenced the productivity and quality in Kullu valley of Himachal Pradesh.

Keywords: Yield, yield attributes, Boron, Molybdenum

Introduction
In Himachal Pradesh, it is grown throughout the year particularly in mid-hills in Kullu valley and bring remunerative returns to the small and marginal hill farmers. In Himachal Pradesh, cauliflower occupy 5.5 thousand hectares and 131 thousand MT production of (Anonymous, 2018) [15]. Among many constraints for low productivity in cauliflower, unbalanced nutrition is the main limiting factor. The farmers indiscriminately apply N fertilizer while P and K fertilizers are either negligible or very limited, whereas the use of micronutrients is negligible. Thus, imbalanced fertilizer use has led to multi nutrient deficiencies particularly of micronutrients. The intensive cropping system having extensive use of micronutrients free material mostly boron and molybdenum and less addition of organic matter have rendered the soil boron and molybdenum deficient. Cauliflower is a heavy feeder crop and require high amount of NPK and micronutrients to meet nutrient demand. Micronutrients are important for better growth, development and productivity and needed for meristematic development, chlorophyll formation, photosynthesis, and transpiration as well as tannin and phenolic compound (Tripathi *et al*., 2015) [13]. Boron is indispensable for the growth and development of plants as it plays crucial role in flowering and fertilization, curd quality, curd yield and seed yield of cauliflower. It is also associated with several physiological processes like calcium metabolism, auxin synthesis, sugar metabolism, translocation of solutes and protein synthesis Poor boron supply also reduces the enzymatic activities which are directly responsible for potassium uptake. If boron is inadequate then plants show some characteristic deficiency symptoms which first appear on growing tips and younger leaves as it is not readily translocated from old to actively growing tissues. In advanced stage of deficiency, brown- or pink-coloured areas are formed on curd surface called brown rot or red rot or browning of the curd. Several previous studies have proved that B application to cauliflower enhanced yield and yield attributes (Thapa *et al*., 2016; Hossain *et al*., 2018; Sarker *et al*., 2018) [14, 16, 12] due to its effect on growth and development because B is involved in cell division, root elongation, calcium metabolism, auxin synthesis, sugar metabolism translocation of solutes and protein synthesis (Camacho-Cristobal *et al*., 2018) [1].

Molybdenum (Mo) is one of the other essential micronutrients and likely to become critical in the future for sustaining high productivity. It helps in biological N fixation and is a component of the enzymes nitrogenase and nitrate reductase required in N fixation and also plays an important role in P utilization and protein synthesis. Molybdenum is essential for the growth and development of the plant as it plays a crucial role in the formation and viability of pollens, and development of anthers. Molybdenum is also involved in the protein biosynthesis through its effect on ribonuclease and alanine aminotransferase activity. Boron and molybdenum deficiency can be corrected by foliar application and could correct deficiencies and help in minimizing the risk of deficiency later in the season. Thus, keeping in view the importance of boron and molybdenum in cauliflower nutrition, optimum concentration at vital growth stages is important for getting higher curd yield, and improving growth and quality of cauliflower. The reports on effect of B and Mo on cauliflower is still lacking and therefore, the present investigation entitled "Effect of foliar application of boron and molybdenum on productivity and quality of cauliflower in Kullu valley of Himachal Pradesh" was planned.

Methods and materials

The experiment entitled “effect of foliar application of boron and molybdenum on productivity and quality of cauliflower in Kullu valley of Himachal Pradesh” was carried out at the experimental farm of CSK HPKV, Hill Agriculture Research & Extension Centre, Bajaura, Kullu, during Kharif 2021.

Experimental site, climate, and weather

The experimental farm is situated at 31.84°N latitude and 77.17°E longitude at an elevation of 1091 m above mean sea level. The soil of the experimental site at initiation of the experiment was near neutral in reaction, silt loam in texture, medium in organic carbon. The experimental site had available status of N, P, K as 235, 14.7, 195 kg ha^{-1} respectively. The study location is represented by zone II of Himachal Pradesh. The experimental site is characterized by sub humid rainy season hot dry summers and cool winters and receives an average rainfall of 873 mm per annum and 55% of the rainfall is received during winter monsoon, whereas dry spells are common from October to December.

Boron and molybdenum application

The experiment was laid out in a factorial randomized block design (RBD) consisting of 3 levels of each B (0.017, 0.034 and 0.051 %) and Mo (0.10, 0.15 and 0.20 %). The levels of B and Mo were compared with NPK alone and NPK + FYM. In all, the experiment has 11 treatments including 9 combinations of B and Mo and two controls (NPK alone and NPK+FYM) were replicated three times. The foliar application of boron and molybdenum was done at 30, 45 and 60 days after transplanting. The data generated for different soil and parameters was statistically analysed using Factorial Randomized Design.

Curd depth

It was measured in cm. after cutting the curd into two halves, curd depth was measured from top inflorescence bud to the point of emergence of first inflorescence segment.

Curd diameter (cm)

The diameter of the curd was measured with the help of the thread in cm.

Equatorial length (cm)

Equatorial length was measured horizontally from the first inflorescence segment after cutting curd into two halves.

Curd size index

It was calculated by multiplying the equatorial length and polar length and is expressed in cm^2.

Results and discussion

Curd depth

Effect of boron

There was a significant increase in the curd depth with increasing concentration of the boron. The curd depth was maximum (13.1 cm) in the treatment where boron was applied @ 0.068% as compared to other levels of boron (Table 1).

Effect of molybdenum

The data in table 1 demonstrated that with increase in the concentration of molybdenum, there was a significant increase in the curd depth. The maximum curd depth (13.0 cm) was found in the treatment where Mo was applied @ 0.20% as compared to other levels of Mo.

Interaction effect

The interaction between foliar spray of B and Mo was found significant for the curd depth (Table 1) and the maximum curd depth (14.6 cm) was in treatment which received spray of B @ 0.068% and Mo 0.20% as compared to the other combinations (Table 2).

NPK v/s other treatments

The comparison of curd depth among NPK alone and other treatments revealed significant increase in curd depth (11.8 cm) for other treatments as compared to sole application of NPK (7.9 cm) (Table 1).

NPK+FYM v/s other treatments

A significant increase in the curd depth was recorded due to other treatments (11.4 cm) when compared with application of NPK+FYM (9.1 cm).

Table 1: Effect of foliar application of B and Mo on yield attributes of cauliflower

Treatment	Curd depth (cm)	Curd diameter (cm)	Equatorial length (cm)	Curd size index (cm^2)
A. B Levels (%)				
0.034	10.5	21.8	11.5	121.4
0.051	11.7	23.3	12.5	146.5
0.068	13.1	25.4	13.3	175.7
CD (5%)	0.2	0.7	0.3	3.8
B. Mo Levels (%)				
0.10	10.8	22.2	11.7	126.1
0.15	11.6	23.5	12.4	145.3
0.20	13.0	24.8	13.2	172.2
CD (5%)	0.2	0.7	0.3	3.8
Interaction A×B	0.36	NS	0.51	6.65
NPK v/s Others				
NPK	7.9	16.7	9.3	74.1
Others	11.8	23.5	12.4	147.9
CD (5%)	0.27	0.93	0.38	4.96
NPK+FYM v/s Others				
NPK+FYM	9.1	18.9	10.1	91.6
Others	11.4	22.8	12.1	140.5
CD (5%)	0.3	0.9	0.4	4.9

Table 2: Interaction effect of foliar application of B and Mo on curd depth

B (%)	Mo (%)		
	0.10	0.15	0.20
0.034	9.7	10.8	11.8
0.051	10.4	11.6	12.9
0.068	11.5	12.8	14.6
CD	0.36		

Curd diameter

Effect of boron

The data presented in table 1 demonstrated that there was a significant increase in the curd diameter with increase in the concentration of the boron. The maximum curd diameter (25.4 cm) was recorded in the treatment where boron was applied @ 0.068% as compared to other levels of boron.

Effect of molybdenum

There was a significant increase in the curd diameter with increasing the concentration of molybdenum from 0.10% to 0.20% and maximum curd diameter (24.8 cm) was found with application of Mo @ 0.20% as compared to other levels of Mo (Table 1).

Interaction effect

The interaction among different combinations of B and Mo was however, found to be non-significant for curd diameter.

NPK alone v/s other treatments

In general, all the treatments significantly increased the curd diameter as compared to the NPK and the value of curd diameter for other treatment was 23.5 cm as compared to NPK (16.7 cm).

NPK+FYM v/s other treatments

A significant increase in the curd diameter was recorded in case of other treatments (22.8 cm) as compared to the application of NPK along with FYM (18.9 cm).

Equatorial length

Effect of boron

The data presented in the table 1 depicted that foliar spray of boron at higher rates exerted a significant effect on equatorial length of cauliflower and the maximum equatorial length (13.3 cm) was in the treatment where boron was applied @ 0.068% as compared to other levels of boron application.

Effect of molybdenum

Data presented in table 1 revealed that foliar applied Mo at 0.10% to 0.20%, brought out a significant enhancement in the equatorial length of the cauliflower and maximum equatorial length (13.2 cm) was found with @ 0.20% Mo in comparison to to the other foliar spray of Mo.

Interaction effect

The combined application of B and Mo observed significant interaction for the equatorial length (Table 4.5) and the maximum equatorial length (14.4 cm) was found in treatment where foliar spray of B @ 0.068% and Mo 0.20% was provided.

Table 3: Interaction effect of foliar application of B and Mo on equatorial length

B (%)	Mo (%)		
	0.10	0.15	0.20
0.034	10.9	11.9	12.2
0.051	11.5	12.4	13.4
0.068	12.1	13.1	14.4
CD	0.51		

NPK alone v/s other treatments

The data in table 4.3 indicated a significant increase in the equatorial length due to other treatments (12.4 cm) when compared to application of NPK alone (9.3 cm).

NPK+FYM v/s other treatments

A significant increase in the equatorial length of cauliflower was observed under other treatments (12.1 cm) than application of NPK+ FYM (10.1cm).

Curd size index

Effect of boron

About the effect of boron spray, there was a significant increase in the curd size index with increase in the concentration of the boron (Table 1) and maximum curd

size index (175.7cm^2) was found in the treatment where boron was applied @0.064% as compared to the other concentrations of boron.

Effect of molybdenum

The increased concentration of molybdenum brought out a significant increase in the curd size index (Table 1) and maximum curd size index (172.2cm^2) was found in foliar of Mo @ 0.20% as compared to the other concentration levels of molybdenum.

Interaction effect

The interaction between boron and molybdenum at different combinations for curd size index was found significant and the maximum curd size index (210.7cm^2) was found due to foliar spray of B @ 0.064% and Mo @ 0.20% as compared to the other combinations of boron and molybdenum (Table 4).

Table 4: Interaction effect of foliar application of B and Mo on curd size index

B (%)	Mo (%)		
	0.10	0.15	0.20
0.034	105.7	129.3	143.1
0.051	119.3	143.5	173.3
0.068	139.2	166.8	210.7
CD	6.65		

NPK alone v/s other treatments

In comparison to the control (74.1cm^2), other treatments recorded highest curd size index (147.9cm^2) as compared to NPK applied without FYM (Table 1).

NPK+FYM v/s other treatments

Data from table 1 depicted that there was a significant increase in the curd size index for other treatments (140.5 cm^2) as compared to NPK+FYM (91.6 cm^2).

Significant improvement in yield attributes of cauliflower at higher boron concentration might be due to the role of boron in development of meristematic tissues and cell division which indirectly influence tissue formation and consequently vegetative growth of plant. Moreover, it also increases the permeability of cell membrane which leads to better transportation of sugars. The observed better growth might also be due to the availability of nutrients at appropriate growth stages through foliar spray of boron along with recommended dose of NPK and FYM that enhanced the rate of photosynthesis and production of photosynthates which ultimately got translocated from site of synthesis to site of storage (Jayaramaiah *et al*. 2018) [4]. Similar results with respect to better growth and yield parameters with foliar applied B were also reported by Deepika and Pitagi (2015) [2] in radish, Kumar and Khare (2015) [5] in cabbage, Thapa *et al*. (2016) [14] in broccoli and Moklikar *et al*. (2018) [7] in cauliflower crop.

Also, Mo is a component of enzyme nitrogenase and nitrate reductase which are required for nitrogen assimilation. As nitrogen is responsible for vegetative growth (Sahito *et al*. 2018) [9] and so Mo have played a significant role to enhance the plant growth factors like curd diameter, curd depth, curd size index and curd equatorial length. A similar increase in plant growth factors due to Mo application was reported by Kumar *et al*. (2010b) [17], Singh *et al*. (2018) [11], and Sani *et al*. (2018) [10].

Effect of foliar application of B and Mo on marketable curd yield of cauliflower

The data pertaining to the effect of foliar application of B and Mo on marketable curd yield have been presented in table 5.

Curd yield

Effect of boron

The data presented in table 8 depicted that there was a significant increase in the curd yield of cauliflower with increasing the B concentration and the maximum curd yield (257.5 q ha^{-1}) was noticed in with foliar applied boron @ 0.068 % as compared to B @ 0.051% (250.2 qha^{-1}) and 0.034% (242.2q ha^{-1}).

Effect of molybdenum

The increase in concentration of Mo spray had a significant effect on the curd yield of cauliflower (Table 5) and maximum curd yield (257.2 q ha^{-1}) was obtained in treatment where molybdenum was applied @ 0.20% as compared to the other Mo levels.

Interaction effect

The interaction between boron and molybdenum was found to be non-significant for the marketable curd yield of cauliflower (Table 5).

NPK alone v/s other treatments

The data from table 5 indicated that the curd yield in other treatments was significantly higher (249.9q ha^{-1}) as compared to application of NPK alone (195.3q ha^{-1}).

NPK+FYM v/s other treatments

The results revealed that other treatments were significantly superior with yield level of (244. 5q ha^{-1}) when compared to recommended dose of NPK and FYM (226.5 q ha^{-1}).

Table 5: Effect of B and Mo on marketable curd yield of cauliflower

Treatment	Curd yield (q ha^{-1})
A. B Levels (%)	
0.034	242.2
0.051	250.2
0.068	257.5
CD (5%)	2.8
B. Mo Levels (%)	
0.10	242.3
0.15	250.3
0.20	257.2
CD (5%)	2.8
Interaction A×B	NS
NPK v/s Others	
NPK	195.3
Others	249.9
CD (5%)	3.59
NPK+FYM v/s Others	
NPK+FYM	226.5
Others	244.5
CD (5%)	3.6

Conclusions

The foliar spray of B @ 0.068% and Mo @ 0.20% given at 30, 45 and 60 DAT recorded better yield attributes and registered maximum marketable curd yield as compared to lower concentration levels of B and Mo. It is therefore,

concluded from the study that application of B @ 0.068% and Mo @ 0.20% at 30, 45 and 60 DAT along with basal dose of recommended NPK+FYM was found best combination for kharif cauliflower production in Kullu valley of Himachal Pradesh.

References

1. Camacho-Cristobal JJ, Navarro-Gochicoa MT, Rexach J, Gonzalez-Fontes A, Herrera-Rodriguez MB. Plant Response to Boron Deficiency and Boron Use Efficiency in Crop Plants. Plant Micronutrient Use Efficiency. New York: Academic press; c2018 Jan 1. p. 109-121.
2. Deepika C, Pitagi A. Effect of zinc and boron on growth, seed yield and quality of radish (*Raphanus sativus* L.) cv. Arka Nishanth. Current Agriculture Research Journal. 2015 Jun 1;3(1):85-89.
3. Rajput S, Bisen RK, Raj S, Varma SK, Agrawal HP. Performance of cauliflower varieties under different Spacings in Chhattisgarh plain. Int. J. Agric. Food Sci. 2020;2(2):04-07. DOI: 10.33545/2664844X.2020.v2.i2a.34
4. Jayaramaiah R, Nataraja A, Kumar BTN, Pramod G. Effect of calcium metalosate on growth and yield of tomato (*Lycopersicon esculentum* Mill.). International Journal of Current Microbiology and Applied Sciences. 2018;7(10):1371-1375.
5. Kumar A, Khare A. Nutrient management in cabbage for higher production in Bundelkhand region of Uttar Pradesh. Annals of Plant and Soil Research. 2015;17(1):33- 36
6. Ghode N, Choudhary AS, Raj S, Sahu S, Kumar A. Effect of weed management on yield parameters of cauliflower. Int. J. Agric. Food Sci. 2022;4(1):17-20. DOI: 10.33545/2664844X.2022.v4.i1a.60
7. Moklikar MS, Waskar DP, Maind MM, Bahiram VK. Studies on effect of micronutrients on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis)* cv. Sungro-anandi. International Journal of Current Microbiology and Applied Science. 2018;6:2351-2358
8. Ningawale DK, Singh R, Bose US, Gurjar PS, Sharma A, Gautam US. Effect of boron and molybdenum on growth, yield, and quality of cauliflower (*Brassica oleracea* var. botrytis) cv. Snowball 16. Indian Journal of Agricultural Sciences. 2016 Jun 1;86(6):825-829.
9. Sahito MA, Laghari MH, Agro AH, Kubar AA, Khuhro WA, Laghari FR, *et al*. Effect of various levels of nitrogen and phosphorus on plant growth and curd yield of cauliflower (*Brassica oleracea* L.). International Journal of Development Research. 2018;8(3):19184-19184.
10. Sani MNH, Tahmina E, Hasan MR, Islam MN, Uddain J. Growth and Yield attributes of Cauliflower as Influenced by Micronutrients and Plant Spacing. Journal Agriculture and Ecology Research International. 2018;16(1):1-10.
11. Singh G, Sarvanan S, Rajawat KS, Rathore JS, Singh G. Effect of different micronutrients on plant growth, yield and flower bud quality of broccoli (*Brassica oleracea* var. Italica) cv. Green Bud. International Journal of Advanced Research. 2018;4(9):2018-2043.
12. Sarker MMH, Jahiruddin M, Moslehuddin AZM, Islam MR. Micronutrient responsiveness of cauliflower, okra, and rice in a pattern in piedmont soil. Journal of Plant Nutrition. 2018;41(11):1358-1367.
13. Tripathi DK, Singh S, Mishra S, Chauhan DK, Dubey NK. Micronutrients and their diverse role in agricultural crops: advances and future prospective. *Acta Physiologiae Plantarum*. 2015 Jul;37(7):1-14.
14. Thapa U, Prasad PH, Rai R. Studies on growth, yield and quality of broccoli (*Brassica oleracea* L. var. Italica Plenck) as influenced by boron and molybdenum. Journal of Plant Nutrition. 2016;39(2):261-267.
15. Li X, Niu J, Kumari S, Wu F, Sangaiah AK, Choo KK. A three-factor anonymous authentication scheme for wireless sensor networks in internet of things environments. Journal of Network and Computer Applications. 2018 Feb 1;103:194-204.
16. Hossain MF, Uddin MR, Humauan MR, Hossain J. Effect of molybdenum and its application on seed production of cauliflower. Bulletin of the Institute of Tropical Agriculture, Kyushu University. 2018;41:67-72.
17. Kumar SP, Bhagawati R, Choudhary VK, Devi P, Ronya T. Effect of boron and molybdenum on growth, yield and quality of cauliflower in mid-altitude conditions of Arunachal Pradesh. Vegetable Science. 2010(b);37(2):190-193.