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Response of boron and lime application on growth and seed yield of snowball cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. PSBK-1

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ABSTRACT : In order to study the effect of lime and boron in different combinations as soil, soil + foliar and foliar application on the growth dynamics and seed yield performance of snowball cauliflower PSBK-1, a field experiment was conducted during *Rabi* season of 2008-09 under rainfed mid hill condition of Uttarakhand. It was found that application of lime and borax as basal @ 500 kg/ha and 5.0 kg/ha followed by foliar spray of boron @ 0.25% at 40,60,80 DAT was the best treatment for maximum number of leaves per plant (16.13), number of primary branches per plant (12.53), seed yield per plant (28.31g) and seed yield per hectare (7.96q) whereas, application lime and borax as basal @ 500 kg/ha and 5.0 kg/ha followed by foliar spray of boron @ 0.50% at 40,60,80 DAT was second superior treatment for highest plant height (92.06 cm), siliqua per plant (1100.11), siliqua length (6.14cm), seeds per siliqua (20.34) and at par with seed yield per hectare (7.65q) in cauliflower cv. Pusa Snowball K-1 in rainfed mid hill conditions of Uttarakhand.

KEY WORDS : Cauliflower, Growth, Seed yield, Lime, Boron, Snowball

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Cauliflower (*Brassica oleracea* var. *botrytis* L.), a cool season vegetable belongs to the family Brassicacea. Pusa Snowball K-1, a late variety is most popular among the growers of hilly regions, since it fetches a good premium both as a curd as well as a seed crop. Varietal sensitivity to fluctuating temperature and faulty management practices by the vegetable growers are some of the reasons for low productivity. The soil of mid hill region of Uttarakhand are generally clay loam in texture and acidic reaction with pH range of 5.40 to 6.20. Cauliflower is a very sensitive crop to both acidic soil and boron deficiency. It directly or indirectly affects the curd and seed yield of *Brassica* species. Boron plays an important role in flowering and fertilization processes (Saha *et al*., 1999). Its deficiency leads to sterility in plants by malformation of reproductive tissues affecting pollen germination and ultimately resulting in reduced seed set. Similarly, lime application has also been observed to influence the seed yield of cauliflower. It increases the curd diameter, weight and yield by improving the base saturation (Kotur, 1993). Due to high rainfall in mid hills, leaching of nutrients and micronutrients is a common incidence leading to frequent deficiency of the elements in soil. Therefore, it should be overcome to get sustained and increased production. In order to formulate the correct dose of boron and lime for getting higher growth and seed yield in small and scattered land holding of hilly area, the present investigation was undertaken.

RESEARCH METHODS

The present investigation was carried out at research block of Department of Vegetable Science, G.B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Uttarakhand during the year 2008-09. Ranichauri is located at an elevation of about 2000 meters above mean sea level with 30018' N latitude and 78024' E longitude. It falls under mid-hills of Western Himalayas.

The experiment was laid out in Complete Randomized

Block Design (CRBD) with three replications. The treatments were comprised of two levels of lime as basal (0 and 500 kg ha^{-1}) and five levels of boron in the form of borax (0, 5, 7.5, 10, 15 kg ha^{-1}) applied either as basal or in combination of foliar sprays (0.25 % and 0.50 % concentration) at 40, 60 and 80 days after transplanting of cauliflower variety Pusa Snowball K-1. A total of ten treatments combinations including soil application of lime alone @ 500 kg ha^{-1} (T_1 : $L_{500}B_0$) lime @ 500 kg and borax @ 10 kg ha^{-1} soil application (T_2 : $L_{500}B_{10}$), lime @ 500 kg and borax @ 15 kg ha^{-1} soil application (T_3 : $L_{500}B_{15}$), lime @ 500 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.25 % at 40, 60, 80 DAT, (T_4 : $L_{500}B_{0.25\,\%}$), lime @ 500 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.50 % at 40, 60, 80 DAT (T_5 : $L_{500}B_{0.50\,\%}$), lime @ 500 kg and borax @ 5 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.25 % at 40, 60, 80 DAT (T_6 : $L_{500}B_{5.0+0.25\,\%}$), lime @ 500 kg and borax @ 5 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.50 % at 40, 60, 80 DAT (T_7 : $L_{500}B_{5.0+0.50\,\%}$), lime @ 500 kg and borax @ 7.5 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.25 % at 40, 60, 80 DAT (T_8 : $L_{500}B_{7.5+0.25\,\%}$), lime @ 500 kg and borax @ 7.5 kg ha^{-1} soil application followed by foliar sprays of borax @ 0.50 % at 40, 60, 80 DAT (T_9 : L500 $B_{7.5+0.50\,\%}$), control *i.e.* without lime and borax application (T_{10} : L_0B_0). The soil of experimental field was clay loam and had pH 6.06 and organic matter 2.05 %. The available N, P_2O_5, K_2O was 326.14, 17.70, 480.48 kg/ha, respectively. Seeds were sown in nursery bed in 1st week of September and the seedlings were transplanted after 45 days of sowing with a spacing of 60×50 cm. A dose of NPK @ 300,125 and 100 kg/ ha as recommended for cauliflower seed crop was applied uniformly to each plot. Other cultural operations were also performed uniformly in all treatments and data were recorded on plant height (cm), number of leaves per plant, number of primary branches, number of siliqua per plant, siliqua length (cm), seeds per siliqua, seed yield per plant and seed yield per hectare. The analysis of variance was done as procedure given by Panse and Sukhatme (1978). All the package of practices recommended for Western Himalayas region was followed during the study.

RESEARCH FINDINGS AND DISCUSSION

Result revealed that plant growth and seed yield characters were significantly affected by different levels of boron and lime application in soil as well as foliar spray (Table 1). Application of lime and boron as basal @ 500 kg and 5.0 kg ha^{-1}, respectively, followed by sprays of borax @ 0.50% at 40, 60 and 80 DAT (T_7: $L_{500}B_{5.0+0.50\%}$) exhibited highest plant height (92.06 cm), siliqua per plant (1100.11), siliqua length (6.14 cm) and seeds per siliqua (20.34) whereas lowest plant height (76.98cm), siliqua per plant (875.95), siliqua length (4.84 cm) and seeds per siliqua (15.06) in the treatment T_{10} *i.e.*, control. The siliqua per plant (1100.11) was statistically at par with the treatment T_8 *i.e.*, lime and boron as basal @ 500 kg and 7.5 kg

Table 1 : Vegetative growth and seed yield of cauliflower (PSBK-1) as influenced by various combinations of boron and lime

Treatments	Plant height (cm)	Number of leaves per plant	Number of primary branches per plant	Siliqua per Plant	Siliqua length (cm)	Seeds per Siliqua	Seed yield per plant (g)	Seed yield (q ha^{-1})
$T_1 = L_{500}\ B_0$	79.43	11.80	10.71	0993.21	5.37	15.13	20.15	4.77
$T_2 = L_{500}\ B_{10}$	80.43	12.20	10.97	0986.28	5.43	15.76	20.59	4.88
$T_3 = L_{500}\ B_{15}$	82.46	12.40	11.00	0990.80	5.58	16.76	20.87	4.94
$T_4 = L_{500}\ B_{0.25\%}$	83.13	12.86	12.01	1045.83	5.68	17.96	22.89	5.59
$T_5 = L_{500}\ B_{0.5\%}$	86.86	14.66	12.33	1023.36	5.75	18.83	27.47	7.32
$T_6 = L_{500}\ B_{5.0+0.25\%}$	88.00	16.13	12.53	1084.41	5.80	19.66	28.31	7.96
$T_7 = L_{500}\ B_{5.0+0.50\%}$	92.06	14.66	12.00	1100.11	6.14	20.34	26.50	7.65
$T_8 = L_{500}\ B_{7.50+0.25\%}$	86.93	13.93	11.46	1100.11	5.58	19.40	24.10	6.42
$T_9 = L_{500}\ B_{7.50+0.50\%}$	85.26	13.13	10.86	0956.83	5.51	18.36	20.60	5.19
T_{10} (c) = $L_0\ B_0$	76.98	11.80	09.53	0875.95	4.84	15.06	19.44	3.59
S. E. ±	0.32	0.10	0.09	4.05	0.04	0.19	0.18	0.21
C.D. (P=0.05)	0.95	0.30	0.27	12.05	0.12	0.58	0.54	0.62

ha^{-1}, respectively, followed by sprays of borax @ 0.25% at 40, 60 and 80 DAT. The variation in plant height, siliqua per plant, siliqua length and seeds per siliqua among the treatment might due to the enhancement in translocation of carbohydrate from the site of synthesis to storage tissue in plant as lime and boron application.

According to Nason and Mc Elory (1963) boron had key role in many plant metabolism processes such as cell development and differentiation. Similar to boron positive influence of lime in cauliflower was also observed by Kotur (1993) and justified that addition of calcium in the soil increases the boron availability in soil which eventually promotes the vegetative growth of plants. Basal dose and foliar application of boron was inductive to vegetative growth and seed yield characters to a great extent because boron helps in photosynthesis and growth of meristematic tissues, carbohydrate and auxin metabolism, cell development and differentiation which ultimately increase vegetative growth. Increase in vegetative growth of different crops by boron application was reported by earlier workers Godvindan (1952), Dinger (1962), Venkataratnam (1961), Mishra (1992), and Sharma (1995).

Various treatments gave significantly effect on number of leaves, number of primary branches per plant, seed yield per plant and seed yield per hectare. Maximum number of leaves (16.13), number of primary branches per plant (12.53), seed yield per plant (28.31g) and seed yield per hectare (7.96q) was recorded when lime and borax were applied as basal @ 500kg and 5.0 kg ha^{-1}, respectively, followed by foliar sprays of borax @ 0.25% at 40, 60 and 80 days after transplanting (T_6: L_{500} $B_{5.0+0.25\%}$) whereas, minimum value of aforsaid attributes were obtained in control plot without lime and boron application (L_0B_o). The number of primary branches per plant (12.33) with treatment T_5 *i.e.* L_{500} $B_{0.50\%}$ and seed yield per hectare (7.65q) with treatment T_7 *i.e.* $L_{500}B_{5+0.50\%}$ were statistically at par with treatment T_6. Correlative response of the crop to vegetative growth and seed yield was probably due to more number of leaves produced more photosynthates through enhanced photosynthetic surface area index which might have helped the plant to remain more active for efficient physiological activities for longer period.

Increase in seed yield attributes in these treatments might be due to boron which checks the formation of hollowness in stem and browning or brown rot of curds ultimately leading to development of healthy flower stalks. It is also needed for the growth of the pollen tube during flower pollination and, therefore, important for good seed set and siliqua development. Boron is thought to increase nectar production in flowers which attracts pollinating insects. Reduction in pod production in boron deficient plant might be due to death of terminal growing point of the stem, breaking down of conductive tissues and inadequate fertilization. In accordance with the present findings the positive relationship of borax application with seed yield of cauliflower was also recorded by Venkataratnam (1961), Mishra (1992), Sharma (2002) and Jana (2004). While working in yellow Sarson Saha *et al.* (1999) reported special significance of boron in the formation of reproductive organ (pollen growth), fertilization and fruit production and consequently its ability to improve the translocation of carbohydrate from source to sink. Application of boron involved in transportation of sugar across cell membranes, cellular differentiation and development, nitrogen metabolism, active salt absorption, water retention etc.

Lime restricted boron fixation by raising pH towards neutrality which helped in increasing boron availability to plants. Alone lime application decreased the hot water soluble boron in soil. Thus liming, in general, increased the boron retention capacity of soil as well as helps in total boron uptake. Calcium, a constituent of lime also helps in the growth of meristematic tissues and the functioning of root tips (Sharma, 1995). Positive response of lime application for seed yield attributes has also been reported by Chaudhury and Debnath (2008), Sharma (1999) and Kushwaha *et al.* (2009).

Conclusion:

Based on the findings of present investigation, it can be concluded that under the prevalent climatic/cultivation conditions, T_6 ($L_{500}B_{5.0+0.25\%}$) proved the best treatment combination, because of boron mobility in cauliflower to increase fertilization efficiency and commercial yield, with the goal of reducing hollow stem disorder in cauliflower plant. While the application of lime increased the availability of boron by improved base saturation of plant.

Future line of work:

For the view of future prospect and response of boron application of cauliflower especially foliar application we can increase the number of foliar application at the time of flowering to seed development stage. In hills microclimate affects the crop condition and response of treatments so that we shall require number trial at different zone on these aspects.

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