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Effect of Different Plant Spacing, Boron and Their Combination on The Production of Cauliflower (*Braccica oleraceae var. botrytis l.)* Under The Tarai Region of Uttarakhand

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ABSTRACT

A research project to evaluate the effect of different plant spacing and boron on the production of cauliflower was conducted at Vegetable Research Station (VRC), G.B.P.U &T, Pantnagar, Uttarakhand. Four different plant spacing and boron *viz*., 60 x 50 cm without boron, 60 x 50 cm with boron, 40 x 50 cm without boron and 40 x 50 cm with boron were used. The result revealed significant variation in all the parameters and amongst various plant spacing & boron, The result concluded that yield per formed better in environments E_1 for normal spacing 60 x 50 cm without boron, decided that cauliflower yield mostly influenced by spacing than boron while environments E_2 days to curd formation, days to 50% maturity preformed better with boron at normal spacing 60 x 50 cm but another two environments high density spacing (E_3) 40 x 50 cm with boron & (E_4) 40 x 50 cm without boron only favorable for vegetative growth. Maximum plant weight (731.53g), curd weight (506.02 g), curd length (12.82 cm), curd breadth (6.94 cm), number of leaves (20.60), days to curd formation (99.79 days) and days to 50% maturity (129.77 days) were recorded in the plots where the plants were spaced 60 x 50 cm without boron.

Key words : *Braccica oleraceae var. botrytis,* Boron, Cauliflower, Production and Spacing.

Cauliflower (*Braccica oleraceae var. botrytis l)* belongs to the family cruciferous. It is grown for its tender and yellowish white curd, which is formed by the stem system with short internodes. It is used in curries, soup and for pickles. It is rich in minerals, carbohydrates and vitamins A and C. it is a delicate crop and can be damaged by freezing weather near harvesting. The plants may fail to form desirable heads in dry and hot weather which cause the heads to develop prematurely and bolt or button. It requires moderately cool climates during the periods of its growth. Crop production is a complex phenomenon and is the outcome of several inter-ranked factors. Agronomic research in general aims at improving cultural practices of crop varieties to rely optimum yield. In recent years, there has been a growing interest in the use of narrow rows as well as narrow plant spacing for the production of cauliflower because of higher labour energy and equipments required for the cultivation. Minami and Victoria (1981) reported that in cauliflower cv. Snow ball, the best yields of commercially accepted curds were obtained at 20830 to 25640 plants / ha. Highest seed yield and total return were obtained from the plants spaced at 45 and 30 cm in spinach (Singh and Gill, 1983). Sharma and Arora (1984) reported that curd yield increased within creasing plant density but dry matter yield decreased. White well and Senior (1988) suggested that the best cultivar for curd yield and floret quality i.e., Plana, Revito, Vernan, Linas and Cervina should be grown at 440 mm (3.8 plant / m). Baloch (1994) recommended that relatively wide spacing (60 x 60 cm) promotes earlier and larger heads, but yield per hectare and number of heads harvested are usually increased by close spacing (45 x 45 cm). Lal (1996) reported that cabbage yield decreased with increasing plant density. Islam *et al*. (2002) reported the highest average yield was obtained from 45 x 10 cm plant spacing, which was closely followed by 45 x 10 cm plant spacing in cauliflower. Keeping in view, this project was undertaken to determine the effect of plant spacing and boron on the growth and yield of cauliflower under Tarai region of Uttarakhand.

MATERIAL AND METHOD

The present experiment was conducted at Vegetable Research Station (VRC), U. S. Nagar,

Uttarakhand in the experimental area to study the effect of different levels of boron & plant spacing and its methods of application on yield and other ancillary characters of cauliflower (29.0^0N and 79.3^0E longitude and at an altitude of 243.84 m above the mean sea level) the foothills of the Shivalik ranges of the Himalayas in a narrow belt called 'Tarai. The experiment was conducted in augmented block design (ABD) with three replications. There were four environments viz., E_1 (60 x 50 cm without boron), E_2 (60 x 50 cm with boron), E_3 (40 x 50 cm without boron) and E_4 (40 x 50 cm with boron). Material for investigation consisted of sixty genotypes of mid cauliflower namely were evaluated with including three checks PCF201, PCF202, PCF203, PCF204, PCF205, PCF206, PCF207, PCF208, PCF209, PCF210, PCF211, PCF212, PCF213, PCF214, PCF215, PCF21 6, PCF217, PCF218, PCF219, PCF220, PCF221, PCF222, PCF223, PCF224, PCF225, PCF226, PCF227, PCF228, PCF229, PCF230, PES3, PCF231, PCF232, PCF233, PCF234, PCF235, PCF236, PCF237, PCF238, PCF239, PCF240, PCF241, PCF242, PCF243, PCF244, PCF245, PCF246, PCF247, PCF248, PCF249, PCF250, PCF251, PCF252, PCF253, PCF254, PCF255, PCF256, PG-3, PG-5 and PG-6. Observations were recorded on five random plants of each variety per genotypes in each replication whole plant weight (g), leaf length (cm), leaf breath (cm), curd weight (g), curd length (cm), curd diameter (cm), plant height (cm), plant diameter (cm), number of leaves per plant, petiole length (cm), days to first curd formation, days to 50% maturity, qualitative characters curd compactness, curd shape, leaf angle, leaf apex shape, seedling leaf color, seedling leaf, juvenile development, leaf blade thickness, leaf tip attitude, leaf color, leaf bloom, curd formation. The statistical analysis was performed by using ANOVA techniques while DMR test (Duncan 1955) was adopted to detect the statistical treatment means.

RESULT AND DISCUSSION

Plant height:

Plant height over environments with normal spacing without boron fertilizer was found to be (673g), with boron fertilizer (585.58g), high density spacing 40 x 50 cm without boron (731.53 g) and with boron (607.44g). Among these four environment 40 x 50 cm without boron gave best performance with pooled values (649.57g) with highest c. v values (34.19).

Leaf length:

Leaf length over environment normal spacing without boron fertilizer (42.27cm), without boron fertilizer (44.64cm), high density spacing without boron (43.56cm) and without boron 39.89 cm. Among these environments without boron with high density spacing 40 x50cm performed better and spacing 60 x 50 cm with boron performed better with pooled values of (42.59).

Leaf breadth:

Leaf breadth over environment with normal spacing without boron 60 x 50 cm gave (33.69cm), with boron (36.02cm), high density spacing without boron (33.15 cm) and with boron (34.20cm). Among these environments second environments 60 x 50 cm with boron performed better with pooled values of (34.77 cm).

Curd weight:

Curd weight over environment with normal spacing 60 x 50 cm without boron having (506.02g) and with boron having (463.91g), high density spacing 40 x 50 cm without boron (469.05g) with boron (465.91g). Among these environment normal spacing 60 x 50 cm without boron performed better and the high density spacing 40 x 50 without boron performed better with mean pooled values of (476.22 g).

Curd length:

Curd length over environment with normal spacing 60 x 50 cm without boron (12.82 cm), with boron (12.33cm) and high density spacing without boron (12.08cm), with boron (12.51) among these environments 40 x 50 cm with boron gave best performance having highest 12.51 cm with mean pooled values (12.44cm).

Curd breadth:

Curd breadth over environment with normal spacing 60 x 50 cm without boron (6.94cm), with boron 6.32 cm (Table 2) and high density spacing without boron (6.38cm), with boron (6.79). Among these environment 60 x 50 cm without boron and high density spacing 40 x 50 cm with

Table 1. Effect of spacing and boron on plant growth and yield attributing characters.

Character	Plant weight (g)			Leaf length (cm)			Leaf breadth (cm)			Curd weight (g)		
	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled
Boron -	673.75	731.53	702.64	42.27	43.56	42.92	33.69	35.15	34.42	506.02	469.05	487.54
Boron +	585.58	607.44	596.51	44.64	39.89	42.27	36.02	34.20	35.11	463.91	465.91	464.91
Mean	629.67	669.48	649.57	43.46	41.73	42.59	34.86	34.67	34.77	484.97	467.48	476.22

Table 2. Effect of spacing and boron on plant growth and yield attributing characters.

Character	Curd length (cm)			Curd breadth (cm)			Number of leaves			Plant height (cm)		
	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled
Boron -	12.82	12.08	12.45	6.94	6.38	6.66	20.31	20.28	20.30	39.32	43.671	41.50
Boron +	12.33	12.51	12.42	6.32	6.79	6.56	19.08	20.60	19.84	41.77	44.124	42.95
Mean	12.58	12.29	12.44	6.63	6.58	6.61	19.70	20.44	20.07	40.55	43.898	42.22

Table 3. Effect of spacing and boron on plant growth and yield attributing characters .

Character	Plant diameter (cm)			Petiole length (cm)			Days to first curd formation			Days to 50% maturity		
	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled	60x50cm	40x50cm	Pooled
Boron -	43.17	45.35	44.26	7.40	9.15	8.28	99.79	99.8	99.8	132.0	131.8	131.9
Boron +	46.18	49.53	47.85	8.72	8.92	8.82	104.0	102.5	103.2	137.8	129.7	133.8
Mean	44.67	47.44	46.06	8.06	9.04	8.55	101.9	101.2	101.5	134.9	130.8	132.8

Table 4. Effect of genotypes, density, boron, both boron and density for yield traits.

Source of variance	df	Plant weight (g)	Leaf length (cm)	Leaf breadth (cm)	Curd weight (g)	Curd length (cm)	Curd breadth (cm)	Plant height (cm)	Plant diameter (cm)	Leaves per plant	Petiole length (cm)	Days to curd formation	Days to 50% maturity
Genotypes	59	58879.64**	61.53**	99.34**	46116.07**	6.98**	2.20	195.13**	206.08**	20.76**	7.03**	197.07**	165.07**
Density	1.0	107794.34**	203.95**	2.26	20785.96**	5.38**	0.15	761.1 **	519.70**	112. **	65.3 **	33.49**	1168.51**
Boron	1.0	765957.2 **	29.04**	32.60**	34819.93**	0.07	0.69	143.03**	875.52**	1.55	20.12**	809.51**	242.64**
Boron density	1.0	21933.33**	621.3 **	182.37**	25816.90**	13.95**	17.80**	67.65**	23.41**	2.77*	40.55**	41.05**	1064.95**

boron having best performance with mean pooled mean values 6.61cm among these environments one 6.94 cm.

Number of leaves:

Total number of leaves over environment with normal spacing 60 x 50 cm without boron 20.31 with boron 19.08 with high density spacing 40 x 50 cm without boron 20.28 and with boron gave 20.68 among these environment normal spacing 60 x 50 cm without boron having 20.31 and high density spacing 40 x 50 cm with boron (20.60) gave best performance with an pooled mean values of (20.07).

Plant height:

Plant height over environment with normal spacing 60 x 50 cm without boron (39.32cm) with boron (41.77) and high density spacing 40 x 50 cm without boron (43.67), with boron (44.12), among these environment normal spacing 60 x 50 cm without spacing (39.32cm) and high density spacing 40 x 50 cm with boron have highest values (44.12cm) and overall mean pooled values 42.22cm.

Plant diameter:

Plant diameter over environment with normal spacing 60 x 50 cm without boron 43.17

cm, with boron 46.18cm and high density 40 x 50 cm spacing without boron 45.32cm and with boron 49.53cm. Among these environments normal spacing 60 x 50 cm with boron 46.18 cm and high density spacing with boron have best performance with an overall pooled mean value of 47.85 cm.

Petiole length:

Petiole length over environments with normal spacing 60 x 50 cm without boron 7.40cm, with boron 8.72cm and high density spacing without boron 9.15cm and with boron gave 8.92 cm. Among these environment normal spacing 60 x 50 cm have 8.72 cm, high density spacing 40 x 50 cm without boron have best performance 9.15cm with overall pooled mean values 8.55cm.

Days to first curd formation:

Days to curd formation over environment with normal spacing 60 x 50 cm without boron 99.79, without boron 104.02 and high density spacing 40 x 50 cm without boron 99.86, with boron 102.54. Among these environment three normal spacing 60 x 50cm with boron 104.02 and high density spacing 40 x 50 cm with boron gave best performance with overall pooled mean values 101.55.

Days to 50% maturity:

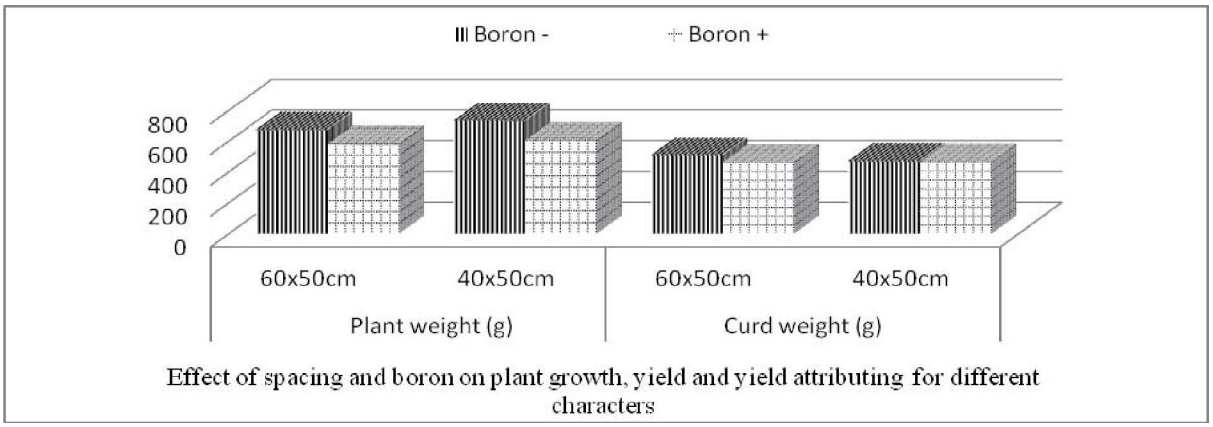
Days to 50% maturity over environment with normal spacing 60 x 50 cm without boron 132.02, with boron 137.87 and high density spacing 40 x 50 cm without boron 131.83, with boron 129.77 (Table 3). Among these environments normal spacing 60 x 50 cm with boron 137.87 and high density spacing 40 x 50 cm with 129.77 days with overall pooled mean values 132.87.

Among the four environments comprising different spacing and boron with thirteen characters, the normal spacing 60 x 50 cm with boron performed better in leaf length with 44.64 cm, leaf breadth with 36.02 cm, days to first curd formation with 104.02 days taken and days to 50% maturity with 137.87 days taken. Another environments normal spacing 60 x 50 cm without boron performed better in curd weight with highest value 506.02 g, curd length with highest 12.82 cm and curd breadth with highest 6.94 cm. Another environment high density spacing40 x 50 cm with boron per formed better in number of leaves with 20.60, plant diameter with 49.53cm and petiole length. High density spacing without boron petiole length with 9.15cm and plant weight with 731.53 (g) performed better (Table 4). Effect of different level boron for influencing yield and stability also reported earlier studies by Chander and Verma (2009), Dhakal *et al* (2009) and Firoz *et al* (2008). Effect of different spacing for influencing yield and stability on different environments also reported in earlier studies by Prakash *et al* (2014), Khan *et al* (2015), Dev (2012), Khanal *et al* (2014), Lavanya *et al* (2014).

Similarly, the effect of methods of application differed significantly in respect of all the characters. The maximum values of these characters were recorded with application of boron and plant spacing in four installments. The maximum values were recorded as plant weight cm at 40 x 50 cm without boron, leaf length 44.64 cm at 60 x 50 cm with boron, leaf breadth 36.02 cm at 60 x 50 cm with boron, curd weight 506.02 g at 60 x 50 cm without boron (Plate 1), curd length 12.82 cm at 60 x 50 cm without boron (Plate 2), curd breadth 6.94 cm at 60 x 50 cm without boron, plant height 44.12 cm at 40 x 50 cm with boron (Plate 2), days to first curd formation 99.79 days at 60 x 50 cm without boron and days to 50% maturity 131.83 days 40 x 50 days at 40 x 50 cm without boron.

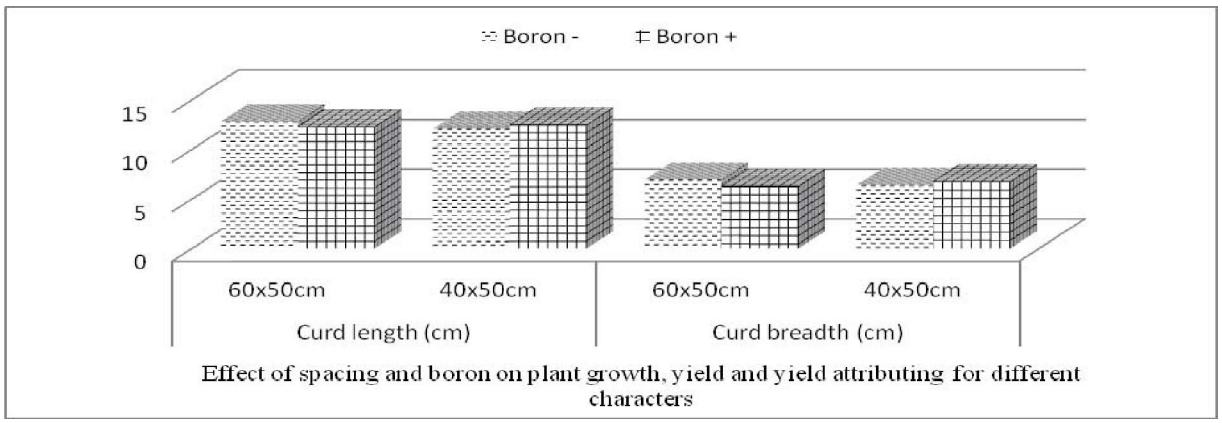
Analyzed pooled data (Table 2) clearly indicated that the different doses of boron and plant spacing and its methods of applications had produced significant interaction effects. The result concluded that yield per formed better in environments E_1 for normal spacing 60 x 50 cm without boron, so decided that cauliflower yield mostly influenced by spacing than boron while environments E_2 days to curd formation and days to 50% maturity preformed better with boron at normal spacing 60 x 50 cm (Plate 3) but another two environments high density spacing 40 x 50 cm with boron (E_3) & 40 x 50 cm without boron (E_4) only favorable for vegetative growth these findings also are in conformity with the finding of Kumar and Choudhary (2002), Singh (2003) as well as Pizeetta *et al*. (2005) in cauliflower.

Plate 1. Effect of spacing and boron on plant weight (g) and curd weight (g) characters.



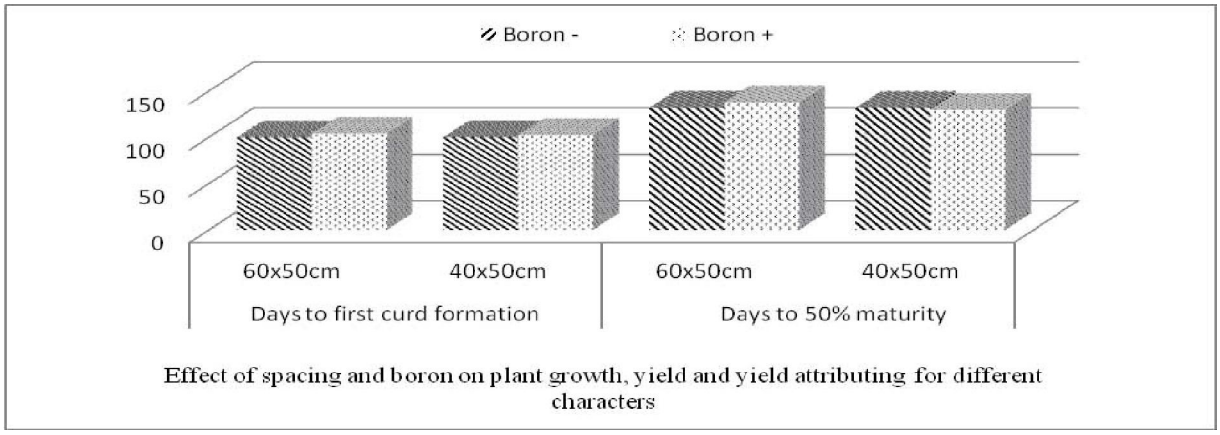
Effect of spacing and boron on plant growth, yield and yield attributing for different characters

Plate 2. Effect of spacing and boron on curd length and curd breadth characters.



Effect of spacing and boron on plant growth, yield and yield attributing for different characters

Plate 3. Effect of spacing and boron on days to curd formation and days to 50% maturity.



Effect of spacing and boron on plant growth, yield and yield attributing for different characters

Conclusion

Results of the present study revealed that plant spacing and boron important factor for the growth and yield of cauliflower. The result concluded that yield per formed better in environments E_1 for normal spacing 60 x 50 cm without boron, decided that cauliflower yield mostly influenced by spacing followed by boron while environments E_2 days to curd formation, days to 50% maturity preformed better with boron at normal spacing 60 x 50 cm but another two environments high density spacing (E_3) 40 x 50 cm with boron and (E_4) 40 x 50 cm without boron only favorable for vegetative growth.

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