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Effect of spacing on Growth, Yield and Quality characters of cauliflower (*Brassica oleracea* var. *botrytis*)

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ABSTRACT

Optimum plant spacing is important for crop production through the plants' efficient utilization of light, nutrients, and water. The present study was done to find out the impact of spacing on growth, yield and quality of cauliflower. The work was carried out with five different spacing along with three replications in randomized block design. It was observed that treatment S (60 X 50 cm) was the best treatment for more growth, high yield, and better quality with more profit it may be due to wide spacing and more absorptions of nutrients by plant from soil then the lesser spacing.

Key words: *Cauliflower, Spacing, Growth, Yield, Quality, Zero Hunger*

Introduction

Cauliflower (*Brassica oleracea* var *botrytis*) is a major cole crop grown for its curd in many countries like China, India, Italy, Europe and America. It (2n=18) belongs to the family Brassicaceae.Dr. Jameson, Company Bagh Garden incharge in 1822 first time brought cauliflower from England to Saharanpur, UP, India. Protein, different carbohydrates, P, Fe and Ca are important components found in cauliflower curd (Devi *et al*., 2018) It is utilized in cooked form as alone or in mixed form (Bashyal, 2011). Cauliflower grows best in a moist cool climate. It does not bear very low or high temperature (Din *et al*., 2007). It is a sensitive crop and can be damaged by frost particularly in winter season.

Yield per unit area, head size and seed maturity are adversely affected by spacing (Ullah *et al*., 2013). Wider plant spacing produces head of larger size and narrow row spacing produces smaller heads. Appropriate plant spacing is important aspect for crop production (Rahman *et al*., 2007). It influences light, nutrient, and water uptake by the plants. Optimum spacing confirms the appropriate use of natural resources and makes different interculture operations easy (Hasan *et al*., 2017). The spacing of crop variesaccording to climatic conditions, soil fertilityand cultivars adaptation to area (Bairwa *et al*., 2017). So, it is very important to maintain optimum plant spacing for maximum growth, yield, and quality of cauliflower. Thus, keeping the above fact in mind present investigation was conducted to find out the optimum plant spacing for production of cauliflower.

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Materials and Methods

The Field trial was carried out at Vegetable Research Farm, Department of Horticulture, Lovely Professional University, Phagwara, Punjab during September to December 2020. The Variety Hansa received from local market of Phagwara, were planted in RBD with 3 replications and 5 treatments. Cauliflower was sown at different spacing of S_0 (60cm x 45cm, S_1 (60cm x 30cm), S_2 (60cm x 40 cm), S (60cm x 50 cm) and S_4 (60cm x 60cm). Among the plants, five plants were randomly selected in each treatment to record the observations like height of plant, number of leaves per plant, leaf length, curd length, curd width,curd weight, leaf area, curddepth and days to curd maturity and curd yield. Qualitative characters like dry matter content of leavesand dry matter content of curd and ascorbic acid content were estimated in laboratory. The mean data of randomly selected plants were statistically analyzed with OP Stat software to find out variability of material for each trait (Panse and Sukhatme, 1985).

Results and Discussion

Growth characters

The data mentioned in Table 1 that plant height was impacted by various plants spacing. The maximum plant height i.e., 21.04 cm was acquired from the treatment S (60cm x 50cm) whereas minimum plant height was observed in S1 (60cm x 30 cm) i.e13.53 cm. Data presented in Table 1 that maximum number of leaves per plant was found in S (60cm x 50 cm), i.e 10.13, which was at par with S (60cm x 45 cm) i.e., 10.07 whereas a less number of leaves was found in S1 (60cm x 30 cm), i.e. 7.93 .Wider plant spacing increases plant height and number of leaves because of lesser competition between the plants for different inputs like nutrients, moisture and carbon dioxide content and more exposed area for photosynthesis. The lowest plant height, i.e. 13.53 cm was observed in S (60cm x 30 cm) as plants in closer spacing had more competition for different inputs. Similar results were also reported by Zaki *et al*. (2015) in broccoli, Kannan *et al*., (2016) in cabbage, Joshi *et al*. (2018), Gable *et al*. (2014), Singh *et al*. (2019), Srivastava *et al*. (2011) in cauliflower, Bacha *et al*. (2017) in Chinese cabbage and EI-Bassiony *et al*. (2014) in kohlrabi.

According to data presented in Table 1 that maximum lengthy leaf was recorded from S (60cm x 60 cm), i.e 35.07 cm whereas minimum length of leaf was observed in spacing of 60 cm X 40 cm, i.e. 29.68 cm. Due to wider spacingless competition was exist between the plants for light, moisture and other important input required for growth and development. Therefore, leaf length was increased by wider spacing. Similar results were mentioned by Shrestha and Thapa, 2018 in their experiment.

Leaf area is a very important component that determines plant water relationship. 60 cm x 45 cm had showed significantly highest leaf area (152.73cm^2) among all treatment at harvest whereas minimum in S (60cm x 50 cm), i.e. 148.09cm^2. Similar results were also observed in study of Moratagi *et al*., 2021 in cauliflower.

Yield and yield contributing characters

The data related to yield are mentioned in Table 2. Maximum curd length (14.23 cm) was observed in the wider spacing, i.e. S (60cm x 50 cm) which was at par with S (60cm x 60cm) treatment, i.e.13.10 cm. Minimum curd length was observed in treatment S_2 (8.29 cm), i.e. closer plant spacing because more competition exhibited for water, fertilizers, and proper space for development of curd. Whereas

Table 1. Effect of different spacing on growth characters of cauliflower

Treatments	Plant height (cm)	Number of leaves per plant	Leaf length (cm)	Leaf area (cm^2)
S	20.64	10.07	33.60	152.73
S	13.53	7.93	32.17	151.95
S	16.86	8.80	29.68	150.77
S	21.04	10.13	30.78	148.09
S	19.15	9.73	35.07	150.30
C.D	2.44	1.43	1.41	1.13
S.E	0.74	0.43	0.43	0.34
CV	6.88	8.02	2.28	0.39

wider spacing had proper area for development of curd and they exhibited minimum competition between the plants. Similar study was also supported by Moratagi *et al*., (2021) and Kumari *et al*., 2019. Maximum curd width was found in treatment S_1 (60 cm X 30 cm) followed by S (60 cm x 45 cm) whereas minimum, i.e. 8.39 (cm) in S (60 cm x 40 cm).

Curd weight is an important yield contributing character. Maximum curd weight was observed in treatment S (60 cm x 50 cm), i.e 619.58 g followed by S (60 cm x 45 cm) i.e. 585.20 g. Minimum curd weight was observed in S (60 cm x 60 cm), i.e 523.10 g. Similar findings was also supported by Moratagi *et al*., 2021. Highest curd weight might be due to production of dry matter in high amount and minimum competition between plants for different inputs like nutrients, moisture and light.

Among all the treatments maximum depth of curd was found in S (60 cm x 30 cm), i.e 6.90 cm whereas minimum depth was found in S (60 cm x 50 cm), i.e 5.51cm. Among all the treatments curd sown at spacing of 60 cm X 30 cm took maximum days (103.97) for curd maturity while it was observed less in S (60 cm x 45 cm), i.e. 102.79 days.

Curd yield (Table 2) was found maximum in treatment S_1 (60 cm x 30 cm), i.e. 321.45g while minimum in S_4, i.e. 165.30g. Due to closer spacing size of curd is reduced but more yield is observed as compared to optimum spacing and it matures earlier. This study is also supported by Sani *et al*., 2018. In wider plant spacing reduced yield per ha was observed because of low plant population. Similar finding was observed by Kaur *et al*., 2020, Baloch *et al*., 2014 and Hiwale *et al*., 2010).

Quality characters

Data related to quality characters was mentioned in Table 3. Among all the treatments treatment S (60 cm x 30 cm) exhibited maximum dry matter content of leaves, i.e 12.80 while minimum dry matter of leaves was found in the treatment S (60 cm x 60 cm), i.e 9.87. Maximum curd dry matter content was found in treatment S (60 cm x 50 cm), i.e 25.87 while minimum in S (60 cm x 30 cm), i.e. 23.83. The highest dry matter content is observed due to greater plant height and greater number of leaves and leaf area. Similar results was also supported by Sani *et al*., 2018 and Fatimah *et al*., 2019.

Table 2. Effect of different spacing on yield characters of cauliflower

Treatments	Curd depth (cm)	Curd Length (cm)	Curd width (cm)	Days to curd maturity	Curd weight (g)	Curd yield (q/ha)
S	6.83	12.95	10.15	102.79	585.20	230.07
S	6.90	11.97	10.57	103.97	584.60	321.45
S	6.75	8.29	8.39	103.40	573.97	249.15
S	5.51	14.23	8.59	103.07	619.58	216.52
S	6.47	13.10	9.71	102.98	523.10	165.30
C.D	0.61	2.03	0.64	0.22	47.02	23.156
S.E	0.18	0.61	0.19	0.74	14.19	6.992
CV	4.90	8.78	3.52	-	4.26	5.292

Table 3. Effect of different spacing on quality characters of cauliflower

Treatments	Dry matter content of leaves (%)	Dry Matter Content of Curd (%)	Chlorophyll content (nmol/cm)	Ascorbicacid content (mg/100 g)
S	10.83	24.93	41.90	50.26
S	12.80	23.83	46.63	44.29
S	11.30	24.67	37.77	46.78
S	11.20	25.87	32.80	48.51
S	9.87	24.57	40.73	49.10
C.D	0.68	0.96	2.39	0.88
S.E	0.21	0.29	0.72	0.27
CV	3.18	2.03	3.14	0.96

Chlorophyll content was found maximum in S (60 cm x 30 cm), i.e. 46.33 mg/100 g and least in S (60 cm x 50 cm), i.e. 32.80 nmol/cm. According to the data presented in Table 3, ascorbic acid content was found maximum in S (60 cm x 45 cm), i.e. 50.26 mg/100 g and minimum was found in S (60 cm x 30 cm), i.e. 44.29 mg/100 g. Due to wider spacing more exposure of sunlight is possible and therefore it accumulates more photosynthates and dry matter content was increased and therefore ascorbic acid content was increased. Similar results was also supported by Bola *et al*., 2017.

Conclusion

It was concluded from above study that treatment S (60 cm × 50 cm) was best treatment for most of growth, yield and quality characters. Besides this, other profitable treatment which could also be recommended to farmers is S_0 (60 cm × 45 cm).

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Conflict of Interests

The authors have not declared any conflict of interests.

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