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Effect of Different Plant Spacing on the Production of Cauliflower (*Brassica oleraceae* var. Botrytis) Under the Agro-Climatic Conditions of D.I. Khan

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Abstract: A research project to evaluate the effect of different plant spacing on the production of cauliflower was conducted at Horticulture Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan, NWFP, Pakistan. Six different plant spacing viz., 30, 35, 40, 45, 50 and 55 cm were used. The results revealed significant variations in all the parameters and amongst various plant spacing, 45 cm spacing showed the best response for all the parameters. Maximum plant height (49.33 cm), curd diameter (19.13 cm), maximum curd weight (1.23 kg plant^{-1}) and yield (30.77 t ha^{-1}) were recorded in the plots where the plants were spaced 45 cm apart.

Key words: Cauliflower, *Brassica oleraceae* var. botrytis, spacing, curd, yield

INTRODUCTION

Cauliflower (*Brassica oleraceae* var. Botrytis) belongs to the family cruciferae. It is grown for its so-called tender and yellowish white curd, which is formed by the stem system with short internodes. It is used in curries, soups 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 causes the heads to develop prematurely and bolt or button. It requires moderately cool climates during the period of its growth. Crop production is a complex phenomenon and is the outcome of several inter-related factors. Agronomic research in general aims at improving cultural practices of crop varieties to relies 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 acceptable curds were obtained at 20830 to 25640 plants ha^{-1}. 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 with increasing plant density but dry matter yield decreased. Whitwell 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 plants m^{-1}). Park *et al.* (1993) found that planting at a density of 30×30 cm was better than either 15×15 cm, 45×45 cm for increased yield. Rajput *et al.* (1993) observed that spacing of 20 cm was suitable for producing high yields in mung-bean. Baloch (1994) recommended that relatively wide spacing (60×60 cm) promotes earliness and larger heads, but yield per hectare and number of heads harvested are usually increased by close spacing (45×45 cm). Lal (1996) reported that cabbage yield decreased with increasing plant density. Khan *et al.* (1997) found that 30 cm spacing was the most suitable for high yield in Chickpea. Islam *et al.* (2002) reported the highest average yield was obtained from 45×10 cm plant spacing, which was closely followed by 45×20 cm plant spacing in turmeric. Oad *et al.* (2002) recommended 45 cm plant spacing as the most successful plant spacing for getting the higher yield of cotton, whereas the narrow plant spacing could not record satisfactory plant character including ginning out-turn and seed cotton yield. Masood *et al.* (2003) observed the highest number of pods plant^{-1}, number of grains, thousand grain weight and grain yield kg ha^{-1} was observed from plots where row spacing was kept at 45 cm. Mahmood (2005) reported that the transplanting of potato seeds with 50×5 cm spacing produced the maximum yield. Karaaslan *et al.* (2007) suggested that decreasing row spacing increased the yield per hectare of sesame.

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Keeping in view, this project was undertaken to determine the effect of plant spacing on the growth and yield of cauliflower under the agro-climatic conditions of Dera Ismail Khan.

MATERIALS AND METHODS

The research project was carried out to study the effect of different plant spacing on the production of cauliflower at Horticulture Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan. The research project was laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was kept as 3×3 m. Seeds of a cauliflower cultivar Botrytis were sown in nursery in a well-prepared seedbed and were covered with the river sand. The beds were watered by hand sprinkler just after the seed sowing. Transplantation was done on 15th September on one side of the ridge with the selected plant spacing. The field was irrigated immediately after transplantation. Detail of the project treatments is: T_1 = 30 cm, T_2 = 35 cm, T_3 = 40 cm, T_4 = 45 cm, T_5 = 50 cm and T_6 = 55 cm. The data for the following parameters were recorded during the course of study. Mortality percentage, days taken to 1st curd appearance, plant height (cm), number of leaves at the time of curd formation, total number of leaves per plant, curd diameter (cm), weight of curd per plant (kg) and yield per hectare. The statistical analysis was performed by using ANOVA techniques (Steel and Torrie, 1980), while DMR test (Duncan 1955) was adopted to detect the statistical different treatment means

RESULTS AND DISCUSSION

Mortality percentage: Those plants, which died after transplantation were counted and their percentage was calculated. Maximum mortality (30.12%) rate was recorded in T_3 (40 cm spacing), which was statistically at par with T_1 (30 cm) and T_2 (35 cm), as shown in the Table 1. T_4 (45 cm) showed the lowest mortality rate (20.00%).

Days taken to 1st curd appearance: Non-significant variations were recorded regarding days to curd initiation. However, T_4 (45 cm) took the minimum number of days (40.00) to initiate the curds while T_1 (30 cm) took maximum days (45.00) to initiate their curds. Due to the closer spacing, the competition amongst the plants was higher for nutrients and sunlight and thus the curd initiation became delayed and the plant took more time to set their curds. That is why T_1 (30 cm) and T_2 (35 cm) took maximum days to initiate curds.

Plant height (cm): Significant results were recorded for the height of the plants. T_4 (45 cm) produced the tallest plants (49.33 cm). Minimum height (42.93 cm) was noted in T_1 (30 cm). T_2 (35 cm), T_5 (50 cm), T_6 (55 cm) and T_3 (40 cm) produced taller plants of 47.07, 46.20, 46.12 and 45.22 cm height and all these treatments showed non significant behavior and were statistically at par to each other. Closer spacing among the plants resulted in lower plant height due to the competition of nutrients, moisture and CO_2 etc. among the roots of the plants. This might be the reason that by increasing the spacing up to a certain limit had increased the plant height of the cauliflower plant.

Number of leaves at 1st curd appearance: Similar trend was observed in case of leaves at curd appearance. Maximum leaves (26.00) were recorded in T_4 (45 cm) which might be due to the better accumulation of plant food material. Statistically, T_3 (40 cm) and T_5 (50 cm) showed similar results by producing 22.00 and 22.33 leaves per plant. Lowest leaves were counted as 16.00 in T_1 (30 cm) followed by T_6 (55 cm) by giving 19.00 leaves per plant.

Total leaves per plant: Similar trend of results was reported in case of total leaves per plant as was observed in number of leaves at curd appearance. Once again the supremacy of T_4 (45 cm) was unchallengeable as maximum leaves (29.33) were counted in T_4 (45 cm spacing) proving it more suitable spacing level. Statistically, T_2 (35 cm), T_3 (40 cm) and T_5 (50 cm) showed similar results and were at par with each other by producing 24.00, 24.00 and 24.33 leaves per plant. While T_1 (30 cm) produced minimum leaves per plant (18.67). Our results get support from the work done by Masood *et al.* (2003)

Table 1: Mortality percentage, number of days taken to 1st curd appearance, plant height (cm), number of leaves at the time of curd formation, total number of leaves per plant, curd diameter (cm), weight of curd per plant (kg) and yield per hectare as affected by different plant spacing

Treatments	Spacing (cm)	Mortality (%) age	No. of days	Plant height	1st Curd appear	Leaves per plant	Curd diameter	Weight of curd	Yield of curd (t ha^{-1})
T_1	30	30.00a	45.00NS	42.93b	16.00d	18.67c	15.63c	0.80d	19.87d
T_2	35	27.67a	44.00	47.07ab	20.67bc	24.00b	16.33c	0.86d	22.07cd
T_3	40	30.12a	41.33	45.22ab	22.00bc	24.00b	18.17ab	1.07b	23.47bc
T_4	45	20.00c	40.00	49.33a	26.00a	29.33a	19.13a	1.23a	30.77a
T_5	50	21.15c	42.00	46.20ab	22.33b	24.33b	18.70a	1.02bc	29.30a
T_6	55	24.67b	43.33	46.12ab	19.00cd	22.00b	16.80bc	0.90cd	25.57b

Any two means in the column having common letter(s) are non-significant at 5% level of probability, NS: Not Significant

who also recommended 45 cm plant spacing as the best plant spacing in canola.

Curd diameter (cm): Curd diameter is an important yield component. Greater the diameter of curd, more will be the yield. A highly significant data regarding the curd diameter showed the supremacy of T_4 (45 cm) amongst all the other plant spacing, as it produced the maximum curd diameter (19.13 cm), which was very closely followed by T_5 (50 cm) with a diameter of 18.70 cm. However, minimum curd diameter (15.63 cm) was recorded in T_1 (30 cm) followed by T_2 (35 cm) with 16.33 cm curd diameter. The closer plant spacing showed poor results due to close competition for acquiring the nutrients, sunlight and space for better curd growth and development. Similar results were quoted by Oad *et al.* (2002) who reported that narrow plant spacing could not record satisfactory plant characters.

Weight of curd per plant (kg): Curd is the main part of the cauliflower which is used in the human diet. Significant variations were observed for the weight of curd per plant. Maximum curd weight (1.23 kg) was recorded in T_4 (45 cm), followed by 1.07 and 1.02 kg curds obtained from T_3 (40 cm) and T_5 (50 cm) spaced plants. Minimum curd weight was noted in T_1 (30 cm) closely followed by T_2 (35 cm). Both of these treatments produced 0.80 and 0.86 kg curds, respectively and were statistically at par to each other. More weighed curds might be due to the proper utilization of accumulates which were conserved by the plant, which were optimally spaced. The results are supported by the previous findings of Oad *et al.* (2002) who recommended 45 cm plant spacing as the most successful plant spacing for getting higher yield of cotton, whereas the narrow plant spacing could not record satisfactory plant characters.

Yield of curd per hectare (tons): Different plant spacing significantly affected the yield of cauliflower. The cauliflower yield increased with an increase in plant spacing up to a certain limit and after 50 cm spacing, it started decreasing. Maximum yield (30.77 t ha^{-1}) was obtained from T_4 (45 cm) closely followed by T_5 (50 cm), which produced the yield of 29.30 t ha^{-1}, both were statistically the same. The lowest yield was recorded as 19.87 tones per hectare in T_1 (30 cm). T_2 (35 cm) and T_3 (40 cm) were at par with each other by producing a yield of 22.07 and 23.47 tones per hectare, respectively. Low yield in case of close spacing might be due to the higher mortality rate, lower plant height and leaves per plant, shorter diameter of curd and also the competitive growth of the plants. These results coincide with the findings of Sharma and Arora (1984), Islam *et al.* (2002), Oad *et al.* (2002) and Masood *et al.* (2003) who recommended 45 cm plant spacing as the best spacing for getting higher yield.

As the result showed that 45 cm plant spacing excelled in almost all the parameters, so it means that any increase or decrease with in 45 cm plant spacing will have an adverse or decreasing effect of the growth and yield of cauliflower. Increasing the plant spacing will results in low number of heads and thus may lower the yield whereas, on the other hand, if the plant spacing is decreased and number of plants are increased but the competition amongst these high number of plants may cause less curd diameter, weight of curd and hence the yield may be lowered. Therefore, we suggest 45 cm plant spacing as an optimum spacing, which produced high number of heads as well as higher yield of cauliflower.

CONCLUSION

Plant spacing is an important factor for the growth and yield of cauliflower. Amongst various spacing, 45 cm spacing proved better results in all the aspects.

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