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Effect of Sowing Date and Plant Geometry on Seed Yield of Early Cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Sabour Agrim

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Present investigation was framed with four sowing date (25th July, 10th August, 26th August and 10th September) and four plant spacing (50 × 40 cm, 50 × 50 cm, 60 × 50 cm and 60 × 60 cm) having 16 treatment combinations. The experiment was laid out in Factorial Randomize Block Design and replicates thrice. The result of the present investigation indicates that the main effect of date of sowing and plant spacing as well as their interaction effect were found significant. The significantly highest plant height (63.93 cm), leaf area (97.00 cm^2), polar diameter (10.3 cm) and equatorial diameter (21.20 cm) were recorded on 10th August and seedlings were transplanted at spacing of 60 × 60 cm. Significantly number of branches/plant, number of siliqua/plant, Number of seed/siliqua, seed yield/plant, seed yield (q/ha) and 1000 seed weight were obtained when sowing was done on 10th August and transplanted at spacing of 60 × 60 cm. Therefore, it may be concluded that combined effect of sowing date (10th August) and plant spacing (60 × 60 cm) was the most effective treatment combination for growth and seed yield in early cauliflower.

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Keywords: Cauliflower; sowing date; plant spacing.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most important vegetable in India and belongs to the family cruciferae. It is comparatively easy to grow seeds of cauliflowers as it is well adapted to warm weather conditions, some seeds of which were raised in North Indian plains [1,2,3]. The regions where early cauliflower seeds are commonly produced are Uttar Pradesh and Bihar. Seeds can, however, be produced in other regions like Delhi, Punjab and Rajasthan. But it is not possible to grow seeds of late types of cauliflower in the plains of the country. Techniques have now been developed and seed production of late varieties of cauliflower is now possible in the Kulu Valley, parts of the Kashmir Valley, Himachal Pradesh, the Darjeeling Hills and the Nilgiris [4,5]. The temperature in Bihar remains higher up to end October and after which gradually comes down in mid December and extend up to mid February and temperature increases sharply thereafter. It is highly sensitive to temperature variations and slight variation in temperature may cause complete crop failure and low yield and productivity. Traditionally cauliflower is planted at a wider spacing resulting into low productivity. The planting density and time of sowing play an important role in improving the productivity of curd and quality seed yield of cauliflower. The sowing and transplanting time is to be adjusted for proper seed production of cauliflower. Chilling is required after the full vegetative phase is completed. If the temperature become very low before the vegetative growth is full, the plant remains small and when temperature again rises, very small curd forms, thus giving a very low yield of curd and seeds. If the planting is done early curd may form before the commencement of chilling temperature, the plant fails to produce seeds. The sowing and transplanting time should be adjusted in such a manner that plants put up maximum vegetative growth before the temperature goes very low. Date of sowing is an important non-monitory input which plays an important role in deciding growth and yield of crops. All the physiological processes in the plants other than photochemical depend on temperature modification in environment by sowing date, gave a great opportunity of getting optimum temperature at the time of germination and subsequent growth stages to maximize the production.

2. MATERIALS AND METHODS

The present experiment entitled “Effect of sowing date and plant spacing on seed yield of early cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Sabour Agrim” was designed and laid out in the vegetable research farm of Bihar Agricultural College, Sabour, Bhagalpur during the *kharif* season of 2016-17. The design of the experiment was Factorial Randomize Block Design and replicated thrice. Seeds were sown and covered with thin layer of soil mixed with FYM. There after the bed was covered with paddy straws. Twenty five days old seedlings were used for transplanting in the main field. The soil and the weather condition prevailing during the period of investigation was close to normal for the place and could be termed congenial for growth and development of cauliflower.

The treatment comprised of four date of sowing (D_1- 25th July 2016, D_2- 10th August 2016, D_3-26th August 2016, D_4- 10th September) and four plant spacing (S_1-50×40cm, S_2-50×50cm, S_3-60×50cm, S_4-60×60cm) in different combinations. Half dose of nitrogen as urea with full dose of phosphorus (P_2O_5) as single super phosphate and potash (K_2O) as murate of potash were applied before planting of seedling as basal dressing as per the treatment specification. The desired quantity of fertilizers as per treatments were mixed thoroughly and the mixture was placed and incorporated in the top 6-8 layer of soil on the point marked for transplanting of each seedlings. After placement and incorporation of the fertilizer mixtures, seedlings were transplanted. The remaining half amount of nitrogen was top dressed in two equal split doses at 25 days and 50 days after transplanting. Five plants in each treatment combination and each replication were randomly selected and tagged properly for recording various observations. The observation recorded for the aforesaid five plants were worked out to give mean in respect of all the characters, *viz*. plant height (cm), leaf area (cm²), days to 50% curd initiation, curd polar diameter (cm), curd equatorial diameter (cm), days to 50% flowering, number of bolters/plant, numbers of siliqua/plant, number of seed/plant, days to harvest of seed, test weight (1000 seed wt.), seed yield/plant (g), seed yield (q/ha). The statistical analysis of the data recorded in all observations was carried out by the method of “Analysis of the variance” prescribed by Fisher

and Yates (1963). Comparison of treatment was made with the help of critical difference (C.D.).

3. RESULTS AND DISCUSSION

The growth of plant in terms of height and leaf area increased significantly due to different plant spacing. The tallest plant height and leaf area were obtained when plant developed under spacing of 60×60 cm (S_4). This may be due to food accumulation was more in the plant which was grown at wider spacing. As a result the plant height and leaf area become maximum. The present results are partially with results obtained by Griffith and Carling [6]. The maximum plant height and leaf area were associated with 10th August of sowing. The sowing date D_2 (10 August) at plant spacing S_4 (60 × 60cm) *i.e.* D_2S_4 gave significantly maximum plant height of 63.93 cm and leaf area (95.75 cm^2). The present trend was in agreement with the results of Singh et al. [7] and Gautam et al. [8] who also reported reduced plant height in late planting. Better growth of 10th August sowing might be due to the conducive climatic conditions. The significant least number of days taken to 50% curd initiation (51.33 days) was recorded on 10 September of sowing (D_4) which was found significantly superior to all sowing date. The plant transplanted at the spacing of 60 × 50cm (S_3) took least number of days to 50% curd initiation. The least number of days taken to 50% curd initiation (50.67 days) was noted when plant sown on 10th September (D_4) and transplanted at spacing of 50 × 50cm (S_2) *i.e.* D_4S_2. This might be due to the wider spacing where plant received more nutrients, space, aeration and sunlight which causes completion of vegetative growth at faster rate and entered into reproductive phase earlier, resulted in earlier curd formation. Rahman et al. [9] also obtained the least number of days taken to 50% initiation on late sowing (10th September) and maximum days taken in 25th July of sowing. This might be due to favourable conditions prevailing during the growing period when sown on 10th August. Similar results were obtained under different climatic conditions as influenced time by Jaiswal et al. [10].

Table 1. Effect of sowing date and plant spacing on plant height (cm), leaf area (cm²) and days to 50% curd initiation

Plant height (cm)					
Plant spacing (S)	**Sowing date (D)**				
	D_1 (25 July)	**D_2 (10 Aug.)**	**D_3 (26 Aug.)**	**D_4 (10 Sept.)**	**MEAN**
S_1(50×40 cm)	44.77	62.30	58.33	52.88	54.57
S_2(50×50 cm)	49.33	62.47	58.73	53.00	55.88
S_3(60×50 cm)	53.67	62.87	60.27	54.20	57.75
S_4(60×60 cm)	55.67	63.93	61.00	56.23	59.21
MEAN	50.86	62.89	59.58	54.08	
Leaf area (cm²)					
S_1(50×40 cm)	86.00	94.00	90.33	90.00	90.08
S_2(50×50 cm)	89.33	95.67	88.67	82.67	89.08
S_3(60×50 cm)	84.67	96.33	92.67	88.33	90.50
S_4(60×60 cm)	90.33	97.00	88.67	90.00	91.50
MEAN	87.58	95.75	90.08	87.75	
Days to 50% curd initiation					
S_1(50×40 cm)	80.00	67.33	62.33	52.33	65.50
S_2(50×50 cm)	77.00	67.33	62.00	50.67	64.25
S_3(60×50 cm)	72.67	67.33	62.33	51.33	63.42
S_4(60×60 cm)	72.33	68.00	62.67	51.00	63.50
MEAN	75.50	67.50	62.33	51.33	

C.D. at 5%	**S**	**D**	**S×D**
Plant height	0.45	0.45	3.12
Leaf area	0.58	0.58	4.00
Days to 50% curd initiation	0.43	0.43	2.96

Table 2. Effect of sowing date and plant spacing on curd polar diameter (cm) and curd equatorial diameter (cm)

Curd polar diameter (cm)

Plant spacing (S)	Sowing date (D)				
	D_1 (25 July)	D_2 (10 Aug.)	D_3 (26 Aug.)	D_4 (10 Sept.)	MEAN
S_1(50×40 cm)	7.50	8.80	7.83	7.67	7.95
S_2(50×50 cm)	7.53	9.73	7.97	7.87	8.28
S_3(60×50 cm)	7.80	10.00	9.10	8.40	8.83
S_4(60×60 cm)	7.93	10.37	9.50	8.97	9.19
MEAN	7.69	9.73	8.60	8.23	

Curd equatorial diameter (cm)

S_1(50×40 cm)	12.70	19.27	19.00	15.50	16.62
S_2(50×50 cm)	15.35	19.73	19.49	15.92	17.62
S_3(60×50 cm)	15.94	20.63	19.87	16.32	18.19
S_4(60×60 cm)	16.16	21.20	19.98	18.32	18.91
MEAN	15.04	20.21	19.58	16.51	

C.D. at 5%	S	D	S×D
Curd polar diameter	0.06	0.06	0.36
Curd equatorial diameter	0.14	0.14	0.97

The highest polar and equatorial diameter of curd was obtained from the plant grown at wider spacing (60 × 60 cm). The maximum curd polar diameter (9.71 cm) and highest curd equatorial diameter (20.21cm) was observed on 10th August of sowing date (D_2) which was found significantly superior to all the sowing date. The maximum curd polar diameter (9.19 cm) and maximum curd equatorial diameter (18.91 cm) was recorded when the plant was transplanted at spacing of 60 × 60 cm *i.e.* S_4 which was found significantly superior to all the plant spacing. The interaction effect of sowing date and plant spacing was found significant in respect of curd polar diameter and equatorial 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 reported by Oad et al. (2002) who observed that narrow plant spacing could not record satisfactory plant characters. The highest polar and equatorial diameters of curd were recorded on 10th August of sowing. Similar results were obtained by Singh et al. [11], Sharma et al. [12], Lawande et al. [13] and Gautam et al. [8].

Table 3. Effect of sowing date and plant spacing on days to 50% flowering, number of bolters/plant, number of siliqua/plant and number of seed/siliqua

Days to 50% flowering

Plant spacing (S)	Sowing date (D)				
	D_1 (25 July)	D_2 (10 Aug.)	D_3 (26 Aug.)	D_4 (10 Sept.)	MEAN
S_1(50×40 cm)	129.67	109.67	96.33	95.67	107.83
S_2(50×50 cm)	127.33	111.33	93.67	87.00	104.83
S_3(60×50 cm)	127.33	109.00	97.33	91.67	106.33
S_4(60×60 cm)	128.00	108.67	98.33	94.00	107.25
MEAN	128.08	109.67	96.42	92.08	

Number of bolters/plant

S_1(50×40 cm)	32.00	47.00	43.33	41.00	40.83
S_2(50×50 cm)	42.67	48.00	44.00	43.00	44.42
S_3(60×50 cm)	43.00	48.33	45.67	44.67	45.42
S_4(60×60 cm)	43.33	48.67	46.67	45.00	45.92
MEAN	40.25	48.00	44.92	43.42	

Number of siliqua/plant					
S_1(50×40 cm)	1259.67	1613.33	1513.00	1432.67	1454.67
S_2(50×50 cm)	1261.33	1641.67	1529.33	1452.00	1471.08
S_3(60×50 cm)	1415.33	1675.00	1554.00	1470.33	1528.67
S_4(60×60 cm)	1458.00	1682.67	1582.67	1474.33	1549.42
MEAN	1348.58	1653.17	1544.75	1457.33	
Number of seed/siliqua					
S_1(50×40 cm)	11.00	19.00	17.00	16.33	15.83
S_2(50×50 cm)	14.00	19.67	19.00	16.67	17.33
S_3(60×50 cm)	15.00	20.00	19.67	17.00	17.92
S_4(60×60 cm)	17.00	21.00	20.67	16.00	18.67
MEAN	14.25	19.92	19.08	16.50	

C.D. at 5%	**S**	**D**	**S×D**
Days to 50% flowering	0.48	0.48	3.30
Number of bolters/plant	0.41	0.41	2.81
Number of siliqua/plant	8.90	8.90	61.65
Number of seed/siliqua	0.24	0.24	1.70

Table 4. Effect of sowing date and plant spacing on days to harvest of seed, seed yield/plant and test weight (1000 seed wt.)

Days to harvest of seed					
Plant spacing (S)	**Sowing date (D)**				
	D_1 (25 July)	**D_2 (10 Aug.)**	**D_3 (26 Aug.)**	**D_4 (10 Sept.)**	**MEAN**
S_1(50×40 cm)	187.00	175.00	163.67	156.33	170.50
S_2(50×50 cm)	188.33	172.00	164.00	158.00	170.58
S_3(60×50 cm)	189.00	172.67	165.67	158.00	171.33
S_4(60×60 cm)	187.67	176.33	162.00	154.00	170.00
MEAN	188.00	174.00	163.83	156.58	
Seed yield/plant (g)					
S_1(50×40 cm)	41.00	53.67	49.00	42.00	46.42
S_2(50×50 cm)	44.00	54.00	50.00	45.33	48.33
S_3(60×50 cm)	45.00	55.00	51.00	48.00	49.75
S_4(60×60 cm)	46.67	56.33	52.00	50.00	51.25
MEAN	44.17	54.75	50.50	46.33	
Test weight (1000 seed wt.)					
S_1(50×40 cm)	2.14	3.20	2.74	2.36	2.61
S_2(50×50 cm)	2.37	3.50	3.31	2.48	2.91
S_3(60×50 cm)	2.81	3.85	3.43	2.85	3.23
S_4(60×60 cm)	2.91	3.91	3.58	3.40	3.45
MEAN	2.56	3.62	3.26	2.77	

C.D. at 5%	**S**	**D**	**S×D**
Days to harvest of seed	0.39	0.39	1.73
Seed yield/plant (g)	0.25	0.25	1.72
Test weight (1000seed wt.)	0.01	0.01	0.30

The plant develop under closer spacing took least took least days to 50% flowering and harvest of seed. Similar results were quoted by Rahman et al. [9]. The least number of days taken to 50% flowering (92.08 days) and harvest of seed (156.58 days) was recorded in 10th September sowing which was significantly superior to rest of the sowing date. The least number of days taken to 50% flowering (87.00 days) and harvest of seed (154.00 days) was reported in treatment combination of D_4S_2 which was statistically superior to all treatment

combinations. This might be due to conducive conditions prevailing during the growing period which favoured to complete vegetative and reproductive phase earlier. Similar results were obtained under different climatic conditions as influenced time by Jaiswal et al. [10].

The highest number of bolters, siliqua and seed yield per plant were recorded when plants developed under wider spacing. This may be due to the wider spacing where plant received more nutrients, space aeration and sunlight for better curd growth and development which increased curd size and enhanced more bolters, number of siliqua and seed yield per plant. These results are in agreement with the findings of Rahman et al. [9]. Sowing on 10th August received comparatively low temperature during vegetative growth which produced bigger size curd which ultimately produced higher number of bolters, siliqua and seed yield per plant. These results are in consonance with the findings of Kanwar [14]. The plant grown under the wider spacing produced higher number of seeds per siliqua and 1000 seed weight. These results are similar to the findings of Hossain et al. [15]. Among the four sequential sowings, plants from 10th August sowing exhibited the maximum seeds per siliqua and 1000 seed weight as compared to remaining date of sowing. These results are in conformity with findings of Mishra [16] and Halim et al. [17]. This might be due to proper plant growth and more favourable climatic conditions prevailed during flowering and seed setting in 10th August of sowing.

4. CONCLUSION

On the basis of results and discussion made so far the present investigation the following conclusions may be drawn. The sowing date and plant spacing showed significant effect on growth and seed production of early cauliflower. The plant height, leaf area, polar diameter, equatorial diameter, number of bolters/plant, number of siliqua/plant, number of seed/siliqua, seed yield/plant and 1000 seed weight were found significant when seeds were sown on 10th August (D_2) and transplanted at spacing of 60 × 60cm (S_4). It is concluded that early variety of cauliflower should be sown on 10th August and transplanted at 60 × 60 cm spacing for harvesting higher yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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