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Effect of sowing date and plant spacing on seed quality parameter of early cauliflower var. *Sabour agrim*

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Abstract
Present investigation was framed with four sowing date (25thJuly, 10thAugust, 26thAugust 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 R.B.D (Factorial) 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 results revealed that the significantly maximum germination%, seedling length, seedling dry weight, vigour index-I and vigour index-II were recorded when seed were sown on 10th Aug. and transplanted at spacing 60 × 60cm. The electric conductivity was least when seed sown on 10th Aug.

Keywords: Sowing date, plant spacing, seed quality

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 adopted to warm weather conditions, some seeds of which were raised in North Indian plains (Lancaster, 1943; Raula, 1949 and Singh, 1955) [18, 22]. The regions where early cauliflower seeds are commonly produced are U.P. 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 (Gill *et al.*, 1975 and Choudhury, 1987) [9, 5]. A thorough rouging of off-types and undesirable plants is essential for quality seed production (Choudhury, 1987) [5]. According to Choudhury and Ramphal (1961) [6] the plants left in-situ without scooping was a better for commercial seed production of early cauliflower varieties. Cauliflower thrives best in cool and moist climate and it does not withstand very low temperature or too much heat (Din *et al.*, 2007) [7]. 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.

Materials and Methods
The present investigation was conducted in the *Rabi* season at Bihar Agriculture College, Sabour. The design of the experiment was RBD (Factorial), 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, Germination %, Seedling length (cm), Seedling dry weight (g), Vigour Index-1 (VI-1), Vigour Index-2 (VI-2), Electrical conductivity (ds/m/g), Seed viability based on tetrazolium test (tz). 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.).

Results and Discussion

Table 1: Effect of sowing date and plant spacing on germination (%), seedling length (cm), seedling dry weight (g)

Germination (%)

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)	89.67	95.00	94.33	92.00	92.75
S_2(50×50 cm)	91.67	94.67	92.67	92.67	92.92
S_3(60×50 cm)	92.33	91.33	94.00	92.00	92.42
S_4(60×60 cm)	92.67	95.60	95.33	93.00	94.15
MEAN	91.58	94.15	94.08	92.42	

Seedling length (cm)

S_1(50×40 cm)	11.07	12.50	10.77	10.40	11.18
S_2(50×50 cm)	10.87	11.03	10.63	10.30	10.71
S_3(60×50 cm)	10.23	11.50	10.53	10.43	10.68
S_4(60×60 cm)	11.17	10.53	11.20	10.47	10.84
MEAN	10.83	11.39	10.78	10.40	

Seedling dry weight (g)

S_1(50×40 cm)	0.0240	0.0260	0.0240	0.0203	0.0236
S_2(50×50 cm)	0.0220	0.0277	0.0233	0.0250	0.0245
S_3(60×50 cm)	0.0193	0.0270	0.0220	0.0180	0.0216
S_4(60×60 cm)	0.0203	0.0280	0.0243	0.0267	0.0248
MEAN	0.0214	0.0272	0.0234	0.0225	

C.D. at 5%	S	D	S×D
Germination %	0.28	0.28	1.93
Seedling length (cm)	0.06	0.06	0.44
Seedling dry weight (g)	0.0002	0.0002	0.0015

The highest germination % was recorded in seed produced at the spacing of 60 × 60cm and proved its superiority over remaining plant spacing. This may be due to bolder seeds produced at wider spacing. The highest germination % was obtained in seed produced from 10th August of sowing which was statistically similar to 26th August of sowing. This might be due to long duration and favourable climatic conditions for seed development resulted more viable seeds in 10th August of sowing at plant spacing 60 × 60cm (S_4). The maximum germination (%) of seed (95.60%) was reported in treatment combination of D_2S_4, which was statistically comparable to the treatment combination of D_3S_4, D_2S_2 and D_2S_1, producing the germination (%) 95.33, 94.67 and 95.00%, respectively. The minimum germination (%) of seed (89.67%) was observed in treatment combination of D_1S_1. The maximum seedling length (11.39 cm) was observed on 10th August of sowing (D_2). The highest seedling length (11.18 cm) was obtained at spacing of 50 × 40cm (S_1). The highest seedling length (12.50 cm) was recorded in treatment combination of D_2S_1 which was statistically superior to all the treatment combination. The minimum seedling length (10.30 cm) was recorded in treatment combination of D_4S_2. The maximum seedling dry weight (0.0272 g) was observed on 10th August of sowing (D_2). The maximum seedling dry weight (0.0248 g) was obtained at spacing of 60 × 60cm (S_4). The highest seedling dry weight (0.0280 g) was recorded in treatment combination of D_2S_4 which behaved statistically similar to the treatment combination of D_2S_3 and D_2S_2, producing the seedling dry weight 0.0270 and 0.0277 g, respectively. The minimum seedling dry weight (0.0180 g) was recorded in treatment combination of D_4S_3.

Table 2: Effect of sowing date and plant spacing on Vigour index-1, Vigour index-2, Electric conductivity (ds/m/g), Seed viability based on tetrazolium test (%)

Vigour index-1

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)	935.47	1187.60	976.07	930.60	1007.43
S_2(50×50 cm)	938.97	1030.93	993.97	998.57	990.61
S_3(60×50 cm)	954.87	1068.80	988.53	983.97	999.04
S_4(60×60 cm)	978.20	1022.80	984.57	966.83	988.10
MEAN	951.88	1077.53	985.78	969.99	

Vigour index-2

S_1(50×40 cm)	2.15	2.47	2.26	1.87	2.19
S_2(50×50 cm)	2.01	2.61	2.16	2.31	2.28
S_3(60×50 cm)	1.77	2.46	2.06	1.65	1.99
S_4(60×60 cm)	1.88	2.67	2.32	2.48	2.34
MEAN	1.95	2.55	2.20	2.08	

Electric conductivity (ds/m/g)

S_1(50×40 cm)	0.560	0.450	0.487	0.423	0.507
S_2(50×50 cm)	0.460	0.467	0.503	0.440	0.468
S_3(60×50 cm)	0.517	0.483	0.543	0.460	0.501
S_4(60×60 cm)	0.473	0.440	0.540	0.423	0.469
MEAN	0.502	0.460	0.518	0.437	

Seed viability based on tetrazolium test (%)

S_1(50×40 cm)	83.50	93.00	93.67	90.33	90.13
S_2(50×50 cm)	86.80	94.00	90.67	91.67	90.78
S_3(60×50 cm)	89.67	94.33	91.00	91.33	91.58
S_4(60×60 cm)	91.00	95.00	94.00	84.00	91.00
MEAN	87.74	94.08	92.33	89.33	

C.D. at 5%	S	D	S×D
Vigour index-1	5.01	5.01	34.74
Vigour index-2	0.01	0.01	0.09
Electric conductivity (ds/m/g)	0.003	0.003	0.015
Seed viability based on tetrazolium test (%)	0.41	0.41	2.87

The highest vigour index-I and vigour index-II were noticed in the seed obtained from the plant grown at wider spacing. This may be due to that the plants developed at wider spacing received more nutrients, space; aeration and sunlight for better growth of seed which ultimately increased the vigour index. The highest vigour index-I was recorded in seed obtained from 10th August of sowing. The maximum vigour index-I (1077.53) was observed on 10th August of sowing (D_2) and found outstanding being significantly superior to the all sowing date. The highest vigour index-I (1007.43) was obtained at spacing of 50 × 40cm (S_1) which was superior to all the plant spacing. The highest vigour index-I (1187.60) was recorded in treatment combination of D_2S_1 which was statistically superior to all the treatment combinations. The lowest vigour index-1 (935.47) was recorded in treatment combination of D_1S_1. The maximum vigour index-II (2.554) was obtained at 10th August of sowing (D_2) which was found significantly superior to all sowing date. The vigour index-II decreased significantly with advancement of sowing date. The vigour index-II increased with successive increment in the plant spacing. The maximum vigour index-II (2.275) was obtained at plant spacing of 50 × 50cm (S_2). The sowing date D_2 (10th August) at plant spacing S_4 (60 × 60cm) *i.e.* D_2S_4 gave significantly maximum vigour index-II of 2.673, which was statistically superior to the all treatment combinations. Being a thermo-sensitive plant, 10th August of sowing received comparatively low temperature during vegetative and reproductive phase which produced larger size of seed which ultimately enhanced the vigour index.

The lowest value of electrical conductivity was noted when seedlings transplanted at wider spacing. The lowest value was recorded in seed obtained from 10th August of sowing. The significant lowest electric conductivity of seed (0.042 ds/m/g) was recorded when plant sown on 10th August (D_2) which was statistically superior to all sowing date. The minimum electric conductivity of seed (0.440 ds/m/g) was recorded in treatment combination of D_2S_4.which was statistically comparable to the treatment combinations of D_2S_4 and D_4S_2, producing the electric conductivity of seed 0.450 and 0.445 ds/m/g respectively. Low value of electrical conductivity is an indication of seed viability. Since electrical conductivity value is negatively correlated with standard germination and other seed quality traits. The difference in sugar loss from seeds of crops sown on different dates might be due to difference in relative amount of soluble sugars present in seeds or due to difference in sensitivity to the intake of water during imbibitions or both (Perry and Harrison, 1970). The maximum seed viability based on tz test (94.08%) was observed on 10th August of sowing (D_2). The highest seed viability (91.58%) was obtained at spacing of 60 × 50cm (S_3) which was superior to all the plant spacing. The highest seed viability (95.00%) was recorded in treatment combination of D_2S_4 which behaved statistically similar to the treatment combination of D_2S_3, D_2S_2, D_2S_1, $D_3S_1$and D_3S_4, producing the seed viability 94.33%, 94.00%, 93.00%, 93.67% and 94.00%, respectively.

Conclusion

On the basis of results and discussion made so far the present investigation the following conclusions may be drawn. The significantly maximum germination%, seedling length, seedling dry weight, vigour index-I, vigour index-II, and seed viability based on tz test (%) were found on 10th August of sowing and transplanted at spacing of 60 × 60cm. The electric conductivity was least when seed sown on 10th August. 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 with better quality of seed to gain higher return. This date of sowing and spacing also improve the seed quality like germination%, vigour index, seed viability and reduces the electrical conductivity of seed.

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