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EFFECT OF SOWING DATE AND PLANT SPACING ON SEED PRODUCTION OF CAULIFLOWER

M. F. HOSSAIN[1], N. ARA[2], M. R. UDDIN[3]
M. R. ISLAM[4] AND M. G. AZAM[5]

Abstract

The experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during rabi season of 2011-2012 and 2012-2013 to find out the appropriate sowing date and optimum plant spacing for seed production of cauliflower (var. BARI Phulcopi-1). Four sowing dates viz. 20 September, 1 October, 10 October and 20 October and three plant spacing viz. 60 cm × 50 cm, 60 cm × 60 cm and 60 cm × 70 cm were used as treatment variables. Significant variation in seed yield and yield contributing characters of cauliflower were observed due to execution of different sowing dates and plant spacing. Number of branches plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} showed the highest in 1 October sowing as a result the highest seed yield (361.69 kgha^{-1}) was obtained from same date of sowing. Sowing on 10 October and 20 October reduced seed yield drastically compared to that obtained from 1 October sowing. The lowest seed yield (188.54 kgha^{-1}) was obtained from 20 October sowing. On the contrary, closer spacing (60 cm × 50 cm) produced the highest seed yield (315.88 kgha^{-1}) and the wider spacing (60 cm × 70 cm) produced the lowest seed yield (254.07 kgha^{-1}). However, combination of 1 October sowing with 60 cm × 50 cm plant spacing produced the highest seed yield (414.81 kgha^{-1}) due to higher number of seeds pod^{-1}. The seed yield decreased after 10 October sowing irrespective of plant spacing. So, early sowing (1 October) with closer spacing (60 cm× 50 cm) would be economically profitable for cauliflower seed production in North-Western part of Bangladesh.

Keywords: Cauliflower, sowing, spacing, yield and seed.

Introduction

Cauliflower (*Brassica oleracea var. botrytis* L.) is a biannual and herbaceous vegetable crop belonging to the family Cruciferae. It is one of the popular winter vegetables in Bangladesh. Cauliflower thrives best in a cool moist climate and it does not withstand very low temperature or too much heat (Din *et al.*, 2007). The temperature in the country remains higher up to mid October after which gradually comes down in mid-December and extends up to mid-February. The

[1]Senior Scientific Officer, Bangladesh Agricultural Research Institute, RARS, Ishwardi, Pabna, [2]Principal Scientific Officer, Bangladesh Agricultural Research Institute, Gazipur, [3]Principal Scientific Officer, Bangladesh Agricultural Research Institute, RARS, Ishwardi, Pabna, [4]Senior Scientific Officer, Bangladesh Agricultural Research Institute, RARS, Ishwardi, Pabna, [5]Scientific Officer, Bangladesh Agricultural Research Institute, PRC, Ishwardi, Pabna, Bangladesh.

temperature increases sharply thereafter. Optimum plant spacing is important for crop production through efficient utilization of light, nutrients and water by the plants. In some cases higher plant population adversely affect yield per unit area hampering vegetative and reproductive growth of plant specially head size and delay in seed maturity. So, it is essential to maintain optimum plant spacing for maximum seed yield of cauliflower. Baloch (1994) recommended that relatively wide spacing (60 cm × 60 cm) promotes earliness and larger heads, but yield and number of curds usually increased by close spacing (45 cm × 45 cm). Increase the plant density limits the availability of space for lateral growth, resulting in increase in plant height (*Pandita et al.,* 2005). Seeds of cauliflower are produced in the country in a small scale but the maximum amount of seeds of cauliflower is imported from other countries. The meteorological data for the last 10 years indicated that the crop suffer from cold injury during the month of January (Anon, 2007) which resulted low yield of crop. The optimum temperature for cauliflower withstands is 10 to 15^0C (Din *et al.,* 2007) but in the north-western part of the country, the night temperature falls even below 5-6^0C which affects crop yield loss. Early sowing recorded maximum vegetative growth and higher yield than late planting (Alam *et al*., 2010). Lavanya *et al*., (2014) recommended that early sowing (1^{st} October) with closer spacing is suitable treatment combination for higher seed yield of radish. So, it is needed to optimize sowing date for quality seed production of cauliflower. Keeping in view, the present experiment was conducted to find out the suitable sowing date and determine the optimum plant spacing for seed production of cauliflower.

Materials and Method

The experiment was carried out at Regional Agricultural Research Station, Ishurdi, Pabna during rabi season of 2011-12 and 2012-13. The initial soil samples were collected from the experimental field for a depth of 0-15 cmprior to application of fertilizers. The nutrient status of soil of the experimental plot was determined at the Soil Science Lab of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. Results of soil analysis are presented in Table 1. Four sowing dates viz. 20 September, 1 October, 10 October and 20 October and three plant spacing viz. 60 cm × 50 cm, 60 cm × 60 cm and 60 cm × 70 cm were used as treatment variables. The treatments were factorial combination of the two factors and the experiment was conducted using a randomized complete block design with three replications. The unit plot size was 10 m ×1.2 m. Seeds of variety BARI Phulcopi-1 were sown in the nursery beds at an interval of 10 days started from 20 September. Beds were immediately irrigated with the help of watering cane. After germination, when the seedlings were attained at a height of 3 cm then the seedlings were transplanted in the other nursery beds 10 cm apart for proper growth and development of the seedlings. Thirty days old seedlings were transplanted in the evening time in the

experimental plot according to the treatment. Healthy seedlings of uniform size were selected for planting. Before transplantation, the nursery beds were irrigated so that the seedlings could be easily uprooted from the beds without any damage of the root. After one week of transplantation, dead seedlings were replaced by planting fresh seedlings to obtain a uniform stand. The land was fertilized with well decomposed cowdung @ 15 tha^{-1} and 120, 55, 100, 15 1.5, 2 and 1 $kgha^{-1}$ N P K S B Zn and Mo, respectively as a source of Urea, TSP, MoP, Gypsum, Boric acid, Zinc sulphate and Sodium molybdate, respectively. Curds with hollow stem disorder is a major problem in cauliflower production and is associated with Mo deficiency. So, Mo application is a crucial factor for yield and quality as well as to control curds with hollow stem disorder. Total amount of cow dung, TSP, gypsum, zinc sulphate, boric acid and sodium molybdate were applied in the plot during final land preparation. Urea and MoP were applied in four equal installments at 20, 40, 60 and 90 days after planting. After transplantation, the experimental plot was irrigated by watering cane and second irrigation (flood irrigation) was done 3 days after transplantation. After this, irrigations were done after fertilizer application and as and when required. Three weeding were done for weed control at 20, 40 and 60 DAT. In the early stage of transplantation damping off disease was occurred in early sowing but serious in late sowing and it was controlled by spraying Bavistin @ 2 g $liter^{-1}$ water. In the seed maturation stage, the plant was attacked by Cercospora leaf spot disease and controlled by spraying Rovral @ 2 g $liter^{-1}$ water. Scooping (removing centre portion of curd) was done when it is fully formed to help the easy emergence of the flower stalks. The flower stalks were supported with bamboo stakes to avoid lodging. Ten plants were selected randomly for data collection. Harvesting was done on 16 to 30 March in 2012 and 14 to 30 March in 2013 when the pods were brown in colour. The collected data were analyzed statistically and the means were separated by Duncan Multiple Range Test (DMRT). The crop received 273 mm and 351 mm total rainfall during crop period of 2011-12 and 2012-13, respectively. A little bit more rainfall occurred in 2012-13. The mean monthly maximum air temperature was 30.66 ^{0}C &30.96 ^{0}C and minimum was 18.36 ^{0}C and 16.92 ^{0}C during crop period of 2011-12 and 2012-13, respectively. The lowest mean (10 days) maximum (21^{0}C) and minimum (13^{0}C) air temperature was occurred in 20 to 31 December (Fig. 1).

Table1. Chemical properties of initial soils of the experimental field.

pH	OM (%)	Ca	Mg	K	Total N %	P	S	B	Cu	Fe	Mn	Zn
		meq100^{-1} g				µgml^{-1}						
7.16	1.35	11.20	1.6	0.12	0.049	11	15	0.2	1.5	18	11	1.9
Critical level		2.0	0.8	0.2	-	14	14	0.2	1.0	10	5.0	2.0

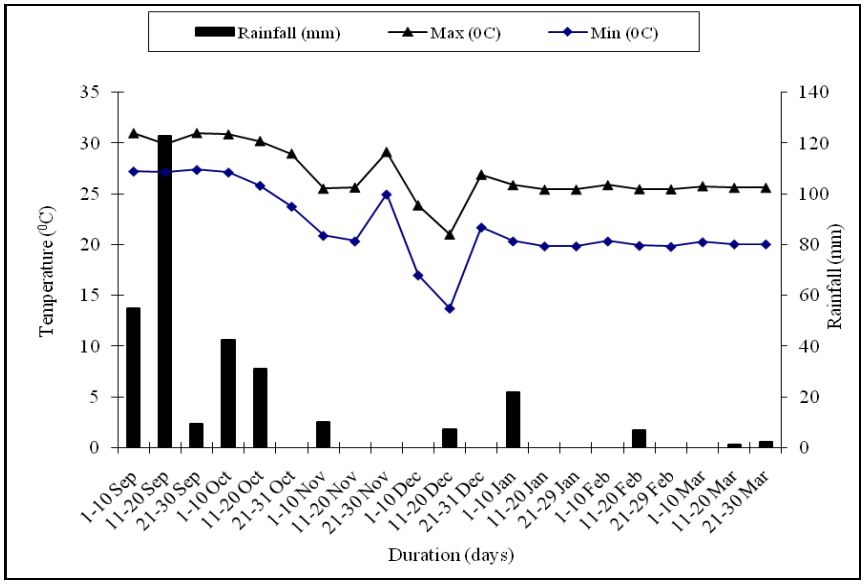

Fig. 1 Average maximum and minimum air temperature (^{0}C) and total rainfall (mm) during the growing period (pooled data of 2011-2012 and 2012-2013)

(Source: Bangladesh Sugarcane Research Institute, Ishurdi, Pabna).

Results and Discussion

Significant variation was not found in years. So, pooled analysis on seed yield and yield attributes were done and discussed accordingly.

Effect of sowing date on plant character and seed yield of cauliflower

Plant height was significantly affected by sowing dates. The maximum plant height (94 cm) was measured from 20 September sowing which was statistically similar to 1 October sowing (92 cm) and the minimum plant height (84 cm) from 20 October sowing (Table 1). This might be due to favourable conditions prevailing during the growing period when planted earlier *i.e.*, 1 October and also due to longer growth experienced by plants resulted from the seeds sown earlier. Similar results were obtained under different climatic conditions as influenced sowing time by Jaiswal *et al.*, (1996). Number of plants m^{-2} was same (2.83) in all the sowing dates as no plants were dead in the later stage and in very early stage of planting dead plants were replaced with the same aged seedlings. Early flowering was enhanced by different sowing dates. The earliest 50% flowering (105 days) occurred on 20 October sowing whereas, delayed flowering (120 days) on 20 September sowing. Sowing on 20 October took shorter cool period

for vegetative growth and it turned quickly for reproductive phase. These results coincide with the findings of Castillo *et al.,* (1992) who reported that the short growing cycle in winter enhanced flowering. Similar trend was observed in case of seed harvest. Early sowing (20 September) required the maximum days (176) whereas, the last sowing (20 October) required the minimum days (161) for pod harvest. Early sowing received long cool period for growth of the plant resulted delayed flowering as well as harvesting. The maximum number of branches plant^{-1} (11.84) was obtained from 1 October sowing followed by 20 September sowing (10.86) and the minimum number of branches plant^{-1} (9.10) from 10 October sowing. Being a thermo sensitive plant, the early planted plant received comparatively low temperature during vegetative growth which produced bigger sized head which ultimately produced branches (Kanwar, 1996). Number of pods plant^{-1} is an important yield contributing factor for cauliflower seed production, which is significantly influenced by the prevailing growing conditions of a crop. The maximum number of pods plant^{-1} was produced from 1 October sowing (1263) which was statistically similar to 20 September sowing (1238) and the lowest was produced from 20 October sowing (863). These results are in agreement with the findings of Incalcaterr *et al.,* (2000). The maximum number of seeds pod^{-1} (16.22) was recorded from 1 October sowing and while the minimum number of seeds pod^{-1} (14.47) was recorded from 20 September sowing which was statistically similar to 10 October sowing. This might be due to plants sowing on 1 October took the optimum growing period which produced the optimum size of pod as well as the maximum number of seeds pod^{-1}. Patil *et al.,* (1995) reported that plants grown in early winter produced large sized pod and increased number of seeds pod^{-1} because of proper growth and development of the cauliflower plants. There was no significantly difference among the sowing dates in respect of 1000-seed weight. However, 1000-seed weight was decreased with the advancement of date from 1 October sowing. The highest seed yield (361.69 kgha^{-1}) was obtained from 1 October sowing possibly due to higher number of branches as well as pods plant^{-1}. Moreover, by sowing the crop on 1 October, the phonological phase of plant influenced to thermal regimes conceded with optimum temperature (Fig.1). These results are almost similar to Gurusamy (1999) who reported that early sowing increased head size and produced the highest seed yield. Significantly the lower seed yield (188.54 kgha^{-1}) was obtained from 20 October sowing. Shorter growing period experienced by the crop sown on 20 October caused reduction in seed yield. Castillo *et al.,* (1992) also observed that the short growing cycle in winter cultivars both stages (curd and seed yield) were decreased at later sowing dates.

Table 2. Effect of sowing date on plant characters and seed yield of cauliflower (pooled data of 2011-2012 and 2012-2013).

Date of sowing	Plant height (cm)	Plants m^{-2} (no)	Days to 50% flowering	Days to harvest	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	1000-seed weight (g)	Seed yield ($kgha^{-1}$)
20 September	94 a	2.83	120 a	176 a	10.86 a	1238 a	14.47 b	2.38	304.20 b
1 October	92 a	2.83	112 b	171 b	11.84 a	1263 a	16.22 a	2.50	361.69 a
10 October	88 b	2.83	113 b	167 c	9.10 b	1059 b	14.64 b	2.37	280.83 b
20 October	84 b	2.83	105 c	161 d	9.15 b	863 c	15.43 ab	2.08	188.54 c
CV (%)	4.32	1.20	1.21	1.02	10.73	14.09	4.25	7.66	3.14

Means bearing same or without letter in a column do not differ significantly at 5% level of probability.

Table 3. Effect of plant spacing on plant characters and seed yield of cauliflower (pooled data of 2011-2012 and 2012-2013).

Plant spacing	Plant height (cm)	Plants m^{-2} (no)	Days to 50% flowering	Days to harvest	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	1000-seed weight (g)	Seed yield ($kgha^{-1}$)
60cm×50cm	92	3.33a	113	169	9.41 b	1096 b	15.97 a	2.36	315.88 a
60cm×60cm	89	2.83b	112	169	9.80 b	1108 b	15.27 ab	2.39	281.51 b
60cm×70cm	88	2.33c	112	168	11.51 a	1140 a	14.34 b	2.25	254.07 c
CV (%)	4.32	1.20	1.21	1.02	10.73	14.09	4.25	7.66	3.14

Means bearing same or without letter in a column do not differ significantly at 5% level of probability.

Effect of plant spacing on plant characters and seed yield of cauliflower

Number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1} and seed yield ha^{-1} were significantly affected by plant spacing. Number of plants m^{-2} was maximum (3.33) in 60cm × 70cm followed by 60cm × 60cm (2.83) and minimum in 60cm × 70cm (2.33) according to the treatments. Variation of plant population did not show significant effect in respect of days to 50% flowering, days to harvest, plant height and 1000-seed weight (Table3). The highest number of branches plant^{-1} (11.51) was recorded from 60cm × 70cm spacing and the minimum number of branches plant^{-1} (9.41) from 60cm × 50cm 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 diameter and enhanced more branching. Similar results were quoted by Rahman *et al.,* (2007). The highest number of pods plant^{-1} (1140) was produced from 60cm × 70cm spacing, while closer spacing (60cm × 50cm) produced the minimum number of pods plant^{-1} (1096). The more branches plant^{-1}produce more number of pods per plant. On the contrary, the maximum number of seeds plant^{-1} (15.97) was counted from 60cm×50cm spacing which was statistically similar to 60cm×60cm spacing and the minimum number of seeds plant^{-1} (14.34) was counted from wider spacing (60cm×70cm). The plants which produced less number of pods required more nutrient and produce comparatively long pod resulted more number of seeds plant^{-1}. Plant spacing had a significant effect on seed production of cauliflower. The highest seed yield (315.88 kgha^{-1}) was obtained from 60cm×50cm plant spacing due to closer spacing accumulates more number of plants which ultimately increased seed yield. Increasing the plants number plot^{-1} decreased the head size but increased the seed yield. Sharma and Arora (1984) reported that curd yield as well as seed yield increased with increasing plant density. There was a trend to decrease seed yield with the increase in plant spacing.

Combined effect of sowing date and plant spacing on plant characters and seed yield of cauliflower

Most of the parameters were not significant except number of pods plant^{-1}and seed yield ha^{-1} of cauliflower (Table 4). The maximum number of pods plant^{-1} (1392) was counted from 1 October sowing with 60cm×70cm spacing, whereas the minimum number of pods plant^{-1} (840) from 20 October sowing with 60cm×70cm spacing. The highest yield (414.81 kgha^{-1}) was obtained from 1 October sowing with 60cm×50cm spacing due to more number of seeds pod^{-1} though branches plant^{-1}and pods plant^{-1}lower than I October sowing with wider spacing (60cm×70cm). The higher yield in above treatment is due to better plant survival owing to the favourable conditions for growth and development of plant and the closer spacing accommodates more number of plants per unit area. Similar results were reported by Azizur Rehman and Nawab Ali (2000). Seed yield was considerably decreased in late sowing (20 October).

Table 4. Combined effect of sowing dates and plant spacing on plant characters and seed yield of cauliflower (pooled data of 2011-2012 and 2012-2013).

Treatment combination	Plant height (cm)	Plants m^{-2} (no)	Days to 50% flowering	Days to harvest	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	1000- seed weight (g)	Seed yield ($kgha^{-1}$)
T_1 S_1	95	3.33	120	176	10.17	1164 c	13.97	2.50	332.30 c
T_1 S_2	94	2.83	120	177	10.67	1280 b	15.00	2.40	302.47 d
T_1 S_3	93	2.33	119	176	11.77	1268 b	14.10	2.17	269.84 ef
T_2 S_1	95	3.33	113	172	10.83	1169 c	18.36	2.51	414.81 a
T_2 S_2	89	2.83	112	171	11.67	1228 b	15.96	2.51	352.88 b
T_2 S_3	90	2.33	111	170	13.03	1392 a	14.33	2.47	320.98 c
T_3 S_1	92	3.33	113	168	8.31	1094 cd	14.67	2.26	303.70 d
T_3 S_2	89	2.83	113	167	8.66	1024 e	14.70	2.31	281.89 e
T_3 S_3	84	2.33	112	166	10.37	1059 d	14.56	2.36	261.90 f
T_4 S_1	86	3.33	105	160	8.33	850 h	16.53	2.60	233.30 g
T_4 S_2	82	2.83	104	161	8.21	900 g	14.40	2.41	206.78 h
T_4S_3	83	2.33	105	161	10.90	840 h	14.36	2.51	182.54 i
CV (%)	4.32	1.20	1.21	1.02	10.73	14.09	4.25	7.66	3.14

Means bearing same or without letter in a column do not differ significantly at 5% level of probability.

T_1=20 Sep, T_2=1 Oct, T_3=10 Oct, and T_4=20 Oct, S_1=60 cm × 50 cm, S_2=60 cm × 60 cm and S_3=60 cm × 70 cm.

Economic performance

The economic performances of sowing date and plant spacing on seed production of cauliflower are presented in Table 5. The highest gross return (Tk. 4148100 ha^{-1}) and gross margin (Tk. 3967125 ha^{-1}) was obtained from the crop sown on 1 October with 60cm×50cm plant spacing. Maximum benefit cost ratio (23.18) was also obtained from the same treatment combination. Hence early sowing (1 October) with 60cm×50cm plant spacing would be economically profitable for cauliflower seed production.

Table 5. Benefit-cost analysis of cauliflower seed production under different sowing dates and plant spacing (pooled data of 2011-2012 and 2012-2013).

Treatments	Seed yield ($kgha^{-1}$)	Gross return ($Tkha^{-1}$)	Cost of production (Tk/ha)	Net margin (Tk/ha)	BCR
T_1 S_1	332.30	3323000	178975	3144025	18.57
T_1 S_2	302.47	3024700	178975	2845725	16.90
T_1 S_3	269.84	2698400	178975	2519425	15.08
T_2 S_1	414.81	4148100	178975	3969125	**23.18**
T_2 S_2	352.88	3528800	178975	3349825	19.72
T_2 S_3	320.98	3209800	178975	3030825	17.93
T_3 S_1	303.70	3037000	178975	2858025	16.97
T_3 S_2	281.89	2818900	178975	2639925	15.75
T_3 S_3	261.90	2619000	178975	2440025	14.63
T_4 S_1	233.30	2333000	178975	2154025	13.04
T_4 S_2	206.78	2067800	178975	1888825	11.55
T_4S_3	182.54	1825400	178975	1646425	10.20

T_1=20 September, T_2=1 October, T_3=10 October, T_4=20 October, S_1=60cm×50cm, S_2=60cm×60cm and S_3=60cm×70cm

Marked price: Seed = Tk. 10,000 kg^{-1} (OP variety)

Conclusion

The study revealed that the seed yield of cauliflower was significantly affected by different sowing dates. Early October sowing with 60cm×50cm plant spacing produced the highest seed yield due to higher yield attributes as well as prevail longer period of cool. So, early sowing (1October) with 60cm×50cm plant spacing would be economically profitable for enhancing growth parameters and seed production of cauliflower in North-western part of Bangladesh.

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