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Effect of sowing dates and spacing on broccoli (*Brassica oleracea* var. *italica*) seed production

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ABSTRACT

A field experiment was conducted during the *rabi* seasons of 2010 to 2013 to find out the optimum time of sowing and plant spacing for broccoli (*var*. KTS-1) seed production. Seedlings raised by sowing on four different dates *viz*. 10th October, 30th October, 20th November and 10th December were transplanted at two spacing *viz*. 45 cm x 45 cm and 60 cm x 45 cm. Yield and yield attributing characters were significantly influenced by the treatments. Sowing on 10th October produced the highest head yield (137.81q/ha) while 10 December sowing produced the lowest head yield (6.75 q/ha) of broccoli. Closer spacing (45 cm x 45 cm) gave significantly higher head yield (88.28 q/ha) than planting at 60 cm x 45 cm distance. The highest seed yield (177 kg/ha) was obtained on planting 10 October sown seedlings at 45 cm x 45 cm distance and was the most remunerative (B: C ratio of 6.44) among all the treatment combinations. Plants from delayed sowing of 20th November and 10th December failed to produce viable seeds under agro-climatic condition of Assam.

Key words: Broccoli, Planting Date, Seed production, Seed quality, Spacing.

INTRODUCTION

Broccoli (*Brassica oleracea* L.) is one of the most prominent vegetables grown all over the world. This vegetable, closely resembling cauliflower but usually green in colour, introduced in India many years after cabbage and cauliflower, has gained popularity in short span of time. Now, India stands at second position for cauliflower and broccoli production with an annual production of 6.7 million tones.

Besides being used as vegetable, the tender fresh leaves are served as salad and are extensively used in the preparation of pickles. It has very high nutritional value due to its high content of protein, carbohydrates, fibers, calcium, iron, β-carotene, thiamine, riboflavin and ascorbic acid. It also helps in digestion and assimilation of food in human body. High level of cancer fighting chemical "sulforaphane" in it mobilizes the human body to combat cancer naturally and increase resistance to cancer.

Climatic condition of Assam suits formation of compact heads and also favours floral stock emergence and development of bold, viable broccoli seeds. Seed retention of this high value nutraceutical vegetable by the growers can boost availability of good quality seeds at competitive price. Many experiments revealed that yield of cole crops is markedly influenced by sowing time and spacing (Saikia *et al*., 2010 and Das *et al*., 2000), however, no study was conducted with regards to broccoli seed production. Keeping all these aspects in view an experiment was, therefore, planned to assess the effect of planting geometry and sowing time on broccoli seed production under plains of Assam.

MATERIALS AND METHODS

The present experiment was carried out at Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati during *rabi* seasons of 2010-11, 2012-12 and 2012-13. The soil of the experimental plot was well drained, slightly acidic (pH 5.8 - 6.5) with high water holding capacity. As per recommendation for this zone, 80 kg P_2O_5 (as SSP), and 60 kg K_2O (as MOP) along with 10 kg Borax and FYM @ 10 t per hectare were applied at the time of final land preparation. 120 kg N (as Urea) was applied in two equal spilt doses as basal application and top dressing at 40 days after planting. The experiment comprised four dates of sowing *viz*. 10th October, 30th October, 20th November and 10th December and two spacing *viz*. 45 cm x 45 cm and 60 cm x 45 cm and laid out in randomized block design with three replications. 30 day old broccoli seedlings of variety KTS-1 were transplanted and normal package of practices for the cultivation were followed. Ten random plants were selected in each plot to take the observations of vegetative growth, flowering, seed yield and quality parameters. However, for computing the total head production and seed yield the actual plant stand was taken into consideration. Data recorded during the three years were pooled and analyzed statistically as suggested by Gomez and Gomez (1984).

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RESULTS AND DISCUSSION

Effect of sowing time on broccoli seed production: Growth characters of broccoli were significantly influenced by the dates of sowing (Table 1). The maximum plant height (50.44 cm), leaf number (18.66) and canopy spread (67.66 cm) was observed in 10th October sowing while minimum was recorded in plants sown on 10th December. Height is related with the vegetative growth of the plant *i.e.* more leaf number and canopy coverage which helps in more light harvesting and better yield. The minimum number of days required for heading (36.67) was recorded in 20th November sown plants and for flowering (69.0 days) was recorded in 10th December treatment while 30th October planting recorded the maximum (46.50 and 75.3 days, respectively). Broccoli sowing on 10th Oct gave the highest (137.81 q/ha) head yield among all the sowing dates, followed by 30 Oct treatment. Prevailing suitable temperature range 13 – 18 °c after transplanting can be attributed for better vegetative growth in 10th Oct sown crop (Ahmed and Siddique, 2004). Early head development without enough vegetative growth owing to rise in environmental temperature might have resulted in smaller heads leading to decreased yield which was also observed by Kaluzewicz *et al*, (2009) and Karistsapol *et al.*, (2013).

Seed yield and yield attributing characters of broccoli were also significantly influenced by the time of sowing (Table 2). Maximum siliqua per plant, seeds per siliqua, 1000 seed weight and total seed yield were measured in 10th October sown plants. On the other hand, 20th November and 10th December sowing produced negligible or no seed formation. Being a thermo sensitive plant, the early crop received comparatively low temperature ideal for better vegetative growth resulting in bigger head size, better floral stalk development for higher yield and better seed quality (Hossain *et al.*, 2011). Maximum temperature results in the incomplete head development and yields decrease drastically (Bjorkman and Pearson, 1998).

Effect of spacing on broccoli seed production: Most of the growth parameters were not influenced by planting distances except for canopy spread, days to heading and days to flowering (Table 1). Variation in the head size, head weight was comparable but closer planting distance recorded in significantly higher total head yield (88.28 q/ha) owing to the increase in plant population per unit area. Better food accumulation in the plants grown at wider spacing might have resulted in larger size and higher weight of heads. The present findings are partially similar with the results obtained by Griffith and Carling (1991). Similar reasons may be attributed to higher seed yield (1.22q/ha) with closer planting distances (45 cm x 45 cm). Increasing the planting density reduced the individual head size but increased the total curd and seed yield in cauliflower (Nassar *et al.*, 1972).

Interaction effect of sowing date and plant spacing on broccoli seed production: Interaction effect of sowing

Table 1: Effect of sowing dates and spacing on plant growth parameters, head yield parameters of broccoli

Treatments	Plant height (cm)	Leaves per plant	Canopy spread (cm)	Days to heading	Days to flowering	Head dia (cm)	Head weight (g)	Total head yield (q/ha)
D_1 10 Oct	50.44	18.66	67.66	45.83	74.9	18.25	403.33	137.81
D_2 30 Oct	43.94	18.62	61.83	46.50	75.3	14.92	366.67	119.52
D_3 20 Nov	34.87	10.73	54.39	36.67	69.7	9.08	67.50	21.18
D_4 10 Dec	25.83	7.65	24.97	37.83	69.0	4.92	24.58	6.75
S. Ed. (±)	2.67	0.41	3.12	0.88	2.5	1.04	24.16	8.07
C. D. (0.05)	5.75	0.87	6.70	1.89	5.4	2.24	51.95	17.36
S_1 45 cm x 45 cm	40.13	13.73	49.23	49.25	76.3	11.63	213.13	88.28
S_2 60 cm x 45cm	37.41	14.10	55.19	34.17	68.2	11.96	242.92	64.34
S. Ed. (±)	1.89	0.29	2.20	0.62	3.6	0.74	17.08	5.71
C. D. (0.05)	NS	NS	4.70	1.33	7.4	NS	NS	12.27

Table 2: Effect of sowing dates and spacing on seed yield parameters of broccoli

Treatments	Siliquaperplant	Seedspersiliqua	1000seed wt. (g)	Seedyield(g/plant)	Total seedyield(q/ha)
D_1 10 Oct	(175.30) 13.24	(11.21) 2.87	(2.42) 1.85	(3.04) 2.01	(1.24) 1.49
D_2 30 Oct	(154.75) 12.48	(4.48) 2.34	(2.31) 1.82	(2.42) 1.85	(0.63) 1.29
D_3 20 Nov	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00
D_4 10 Dec	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00
S. Ed. (±)	0.34	0.06	0.03	0.17	0.02
C. D. (0.05)	0.73	0.12	0.06	0.37	0.04
S_1 45 cm x 45 cm	(55.25) 7.50	(2.20) 1.79	(1.01) 1.42	(1.10) 1.45	(0.46) 1.22
S_2 60 cm x 45 cm	(39.32) 6.35	(2.80) 1.95	(1.03) 1.42	(1.19) 1.48	(0.40) 1.18
S. Ed. (±)	2.76	0.05	3.38	0.24	0.01
C. D. (0.05)	NS	NS	NS	NS	0.02

* Data in parentheses are actual values

date and spacing significantly influenced seed production by individual plant and total seed yield of broccoli (Table 3). The plants from October sowing and 60 cm x 45 cm spacing produced the highest (4.94 g) seed yield, whereas, the highest total seed yield (1.77 q/ha) was recorded with 10th October sowing combined with 45 cm x 45 cm plant spacing. Muhammad and Muhammad (2002) explained the increased seed yield per plant with increasing plant to plant distance. Similar findings were also reported by Rubtazky findings of Keng *et al.* (2004). Nevertheless, high density planting increased the seed yield per unit area without significant effect on quality but sowing dates were more important in affecting seed quality than planting density. Comparison of production economics revealed that sowing on 10th October and planting at a spacing of 45 cm x 45 cm was the most remunerative treatment with a benefit: cost ratio of 6.44 (Table 4). Results of the present study showed that broccoli sown in 1st fortnight of October and transplanted

Table 3: Interaction effect of sowing date and spacing on seed yield parameters of broccoli

Treatments	Siliqua per plant	Seeds per siliqua	1000 seedwt. (g)	Seed Yield (g/plant)	Total seed yield (q/ha)	Seed viability (%) 6 MAS
D_1 S_1	(183.2) 13.57	(7.04) 2.84	(2.36) 1.83	(4.63) 2.33	(1.77) 1.66	(70.8) 8.48
D_1 S_2	(165.7) 12.91	(7.35) 2.89	(2.48) 1.87	(4.94) *2.38*	(1.67) 1.63	(72.3) *8.55*
D_2 S_1	(207.7) 14.45	(4.43) 2.33	(2.38) 1.84	(4.64) 2.24	(1.61) 1.59	(72.9) *8.59*
D_2 S_2	(109.4) 10.51	(4.53) 2.35	(2.24) 1.80	(4.78) *2.37*	(1.47) 1.53	(66.8) 8.23
D_3 S_1	(77.9) 7.56	(1.65) 1.58	(1.40) 1.52	(0.31) 1.15	(0.07) 1.03	(39.2) 5.45
D_3 S_2	(93.4) 8.21	(2.44) 1.77	(1.22) 1.49	(0.56) 1.57	(0.11) 1.05	(38.9) 5.43
D_4 S_1	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00
D_4 S_2	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00	(0.00) 1.00
S. Ed. (±)	2.65	0.22	0.14	0.16	0.07	1.56
C. D. (0.05)	2.975.70	0.47	0.32	0.34	0.15	3.36

* Data in parentheses are actual values

D_1 10 Oct **D_2** 30 Oct **D_3** 20 Nov **D_4** 10 Dec **S_1** 45 cm x 45 cm **S_2** 60 cm x 45 cm

Table 4: Economics of broccoli seed production

Treatments	Cost of Production (Rs)	SeedYield (q/ha)	Gross Return (Rs)	Net Return (Rs)	B: C ratio
D_1 S_1	59450	1.77	442500	383050	6.44
D_1 S_2	58550	1.67	417500	358950	6.13
D_2 S_1	57950	1.61	402500	344550	5.95
D_2 S_2	56600	1.47	367500	310900	5.49
D_3 S_1	51480	0.07	17500	(-) 33980	-
D_3 S_2	52080	0.11	27500	(-) 24580	—
D_4 S_1	45600	0.00	0.00	—	—
D_4 S_2	45600	0.00	0.00	—	—

* Data in parentheses are actual values Price of seed: Rs 2,500 per kg

D_1 10 Oct **D_2** 30 Oct **D_3** 20 Nov **D_4** 10 Dec **S_1** 45 cm x 45 cm **S_2** 60 cm x 45 cm

et al., 1999 and Solunke *et al.* (2011). Seed quality parameters were also significantly affected by different treatment combinations. The highest test weight (2.48 g) was recorded with treatment combination of 10th October sowing and 60 cm x 45 cm spacing, while the highest seed viability (72.9 %) after 6 months of storage was recorded with treatment combination of 30th October and 45 cm x 45 cm spacing. Irrespective of planting distances crop sown in 10th December failed to produce any seed. This agrees with the at 45 cm x 45 cm distance is the most profitable for seed production of broccoli under the agro- climatic condition of Assam.

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