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Study the effect of different dates of transplanting and spacing on yield and quality of broccoli (*Brassica oleracea var. italica*) cv. Palam samriddhi in middle Gujarat condition

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Abstract
The investigation entitled on "Study the effect of different dates of transplanting and spacing on yield and quality of broccoli (*Brassica oleracee var. italica*) cv. Palam samriddhi in middle Gujarat condition" was laid out and conducted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during *Rabi* season of the year 2018-19. The experiment consisted of nine treatment combinations comprising of three transplanting dates *viz.*, 17th October (D_1), 1st November (D_2) and 16th November (D_3) and three plant spacing *viz.*, 60 x 30cm (S_1), 60x45cm (S_2) and 45 x 45cm (S_3). The experiment was laid out in factorial randomized block design (FRBD) with three replications. Among all the different dates of transplanting, October 17th dates of transplanting Maximum stem diameter (40.50 cm) maximum curd weight (426.44 g), highest curd length (12.33 cm), highest curd diameter (140.44 cm), maximum curd volume (472.00 cm^3), curd yield per plot (16.25 kg), curd yield per hectare (17.60 t), minimum days to harvest (55.91) whereas November 16th transplanting (D_3) gave highest leaf length (37.84 cm) and least days to 50 % curd initiation (41.56) Among all the different spacing's treatment S_1 (60x 30 cm) gave maximum curd diameter (14.44 cm) curd volume (472 cm^3) curd yield per plot (18.63 t) and curd yield per hectare (19.70 t). Among the interaction effect of different transplanting dates and spacing's, yield attributes, highest curd diameter (14.66 cm) and curd volume (499.00 cm^3) were recorded on November 1st transplanting with spacing of 60 x 30 cm (D_2S_1). Chlorophyll content had non significant effect among different dates of transplanting and spacing.

Keywords: Broccoli, transplanting, spacing, growth and yield

1. Introduction
Broccoli (*Brassica oleracea* var italica.) is an important exotic and highly nutritive vegetable. It has created a new interest as a vegetable quality production of broccoli is very important depending upon production technology in the view above. It is also known as winter broccoli or Heading broccoli in the USA. It is a member of Cruciferae family. In India, its cultivation is negligible but now gaining popularity with Indian growers for the last couple of years due to its high nutritive value. Broccoli like other cole crops prefers a cool moist climatic condition which helps in the developing quality heads. It is more sensitive to temperatures. When the plants are small and tender, they are susceptible to cold injury so transplanting date is very important. Warm weather is disadvantageous; since the bad clusters grow loose quickly. Broccoli will not stand temperatures as high or low as cabbage. High temperatures delay maturity and increase vegetative growth (number of leaves) and cool temperatures hasten maturity and may induce "bolting". Young hardened plants can withstand -5 to -10 ^{o}C. Yield of broccoli is very important attributes, which will determine success in the commercial production of broccoli for processing or for the fresh market. Spacing of plant affects both total yield and the size of broccoli curd. According to recent field tests, wider spacing contributes towards larger and heavier heads while, yield per hectare can be increased by close spacing. Hence, it is necessary to optimize proper plant spacing for obtaining higher yield with better quality. On the other hand, knowledge of optimum time of transplanting and optimum plant spacing would be useful to achieve good yield and quality of broccoli.

2. Materials and Methods

An field experiment was conducted during winter season of 2018-19 Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, A.A.U., Anand "Study on effect of different date of transplanting and spacing on growth and yield of broccoli cv Palam Samriddhi in middle Gujarat condition". The treatment details are given below. The experiment consisted of nine treatment combinations comprising of three transplanting dates *viz.*, 17th October (D_1), 1st November (D_2) and 16th November (D_3) and three plant spacing *viz.*, 60 x 30cm (S_1), 60 x45 cm (S_2) and 45 x 45 cm (S_3).

Blanket application of FYM @10 T/ha was applied 1 month before transplanting. N: P: K @ 100:50:50 kg /ha was applied. Full dose of P and K and 50% N as a basal dose and remaining half dose was applied in 2 splits, 1st at 30 DAT and next at 45 DAT.

Observations of growth attributes like Minimum days to 50% curd initiation, days to final harvest, curd length (cm), curd diameter (cm), curd volume (cm^3), yield per plot (kg),yield per hectare(t) AND chlorophyll content(100 mg/g).

3. Results and Discussion

November 16th transplanting (D_3) taken Minimum days to 50% curd initiation(41.56) while, November 1st transplanting (D_2) Transplanting of broccoli took minimum days to curd harvest (55.92) highest curd weight (426.44 g), maximum curd length (12.23 cm), maximum curd diameter (14.16 cm), maximum curd volume (497.22 cm^3) maximum curd yield per plot (16.25 kg) and curd yield per hectare (17.60 t) and yield attributes like Highest curd diameter (14.04cm)curd volume (472 cm^3)curd yield per plot (18.63 kg) and curd yield per hectare (19.70 t) were noticed in 60 x 30 cm spacing (S_1). These results are in the accordance with the findings of Sing *et al.* (2011), Kanase *et al*. (2017) [5], Suthar *et al*. (2014), Moniruzzaman (2011) [7] Thirupal *et al.* (2016) [12] and Sinhal *et al.* (2009). El-Magad (2013), Marshall and Thompson (1987) [6], Gogoi *et al.* (2015) [3], Ara *et al*. (2009) [1], Saikia *et al.* (2010) [9] and Hossian *et al*. (2011).

Among the interaction effect of different transplanting dates and spacings, on growth attributes there was non-significant effect was founded yield attributes like highest curd diameter (14.66 cm) was recorded on November 1stwith spacing of 60 x 30 (D_2S_1) and curd volume (499.00 cm^3). There was non-significant effect on days to 50 % curd initiation, average days to harvest, curd weight, curd length and curd yield per plot. These results are in the accordance with the findings of Prabakar and Srinivas (1993), Sharma and Narayan (1995) and Nooproom *et al*. (2013).

Table 1: Effect of transplanting dates and spacing on yield attributes

Treatments	Days to 50% curd initiation (days)	Days to harvest (days)	Curd weight (g)	Curd length (g)	Curd diameter (cm)	Curd volume (cm^3)	Curd yield per plot (kg)	Curd yield per hectare (t)	Chlorophyll content (100mg/g)
A. Dates of transplanting (D)									
D_1 October 17th	48.77	59.33	407.22	11.87	13.30	445.33	15.70	16.50	0.15
D_2 November 1st	45.11	55.92	426.44	12.23	14.16	497.22	16.25	17.60	0.16
D_3 November 16th	41.56	56.75	421.67	10.21	13.66	433.55	15.80	17.07	0.16
S.Em. ±	0.21	0.31	4.37	0.39	0.14	3.09	0.14	0.189	0.003
C.D. at 5%	0.65	0.94	13.10	1.17	0.44	9.28	0.43	0.56	NS
B. Spacing (S)									
S_1 60 x 30 cm	45.00	57.11	421.66	11.25	14.04	472.0	18.63	19.70	0.15
S_2 60 x 45 cm	45.00	57.45	414.22	11.21	13.72	453.88	15.44	15.83	0.15
S_3 45 x 45 cm	45.44	57.44	419.44	11.85	13.62	450.22	13.71	15.65	0.16
S.Em. ±	0.21	0.31	4.37	0.39	0.14	3.09	0.43	0.189	0.003
C.D. at 5%	NS	NS	NS	NS	0.442	9.28	0.43	0.56	NS
D ×S Interaction									
S.Em.±	0.38	0.54	7.57	0.67	0.14	5.36	0.25	0.28	0.004
C.D. at 5%	NS	NS	NS	NS	0.25	16.07	NS	NS	NS
C.V. %	1.46	1.65	3.13	10.24	4.22	2.02	2.72	3.32	4.81

4. Conclusion

Transplanting of broccoli on November 1st (D_2) was found effective due to maximum values for growth and yield attributes. The spacing of 45 x 45 cm appeared optimum for vegetative character and spacing 60 x 30 cm with respect of yield per plot and yield per hectare. Where Interaction effect of transplanting at 1st November and spacing of 60 x 30 cm (D_2S_1) gave highest curd yield per plot and per hectare.

The result obtained from research experiment, it can be concluded that transplanting of broccoli on November 1stwith spacing of 60 x 30 cm was found ideal for getting higher yield under middle Gujarat condition.

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