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EFFECT OF SOWING DATE ON GROWTH AND YIELD OF BROCCOLI (*BRASSICA OLERACEA* VAR. *ITALICA*)

Vipul Pratap Singh, V. M. Prasad and Deepanshu

Department of Horticulture, Naini Agricultural Institute,
Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P.), India.

Abstract

The present investigation entitled "Effect of sowing date on growth and yield of broccoli (*Brassica oleracea* var. *italica*)" was carried out at the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P.), India during the winter (*Rabi*) season of 2016-2017. The objective is to find out the best treatment for best growth, yield and quality of Broccoli for this region. The results of the investigation, regarding the effect of dates of sowing and different varieties on growth, yield and quality of broccoli have been presented in tables and bar- diagrams wherever required. In view of experimental results obtained during the present Investigation, treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi emerged as superior over all other treatments, in relation to growth, yield, quality and cost benefit ratio 1:4.05 of Broccoli under the agro-climatic condition of Allahabad. However, since this is based on one – season experiment, further trails may be needed to substantiate the results.

Key words : Broccoli (*Brassica oleracea* var. *italica*), agro-climatic condition, yield and quality.

Introduction

Vegetables play a major role in daily human diet, since they are most important source of vitamins and minerals, are required for maintaining of good health. Since India's population is mostly vegetarian, vegetables are the most important component of vegetarian diet of Indian population. The present production in India is approx 90 million tonnes of vegetable from 6.2 million hectare of land .As far as vegetable consumption per capita per day is concerned at present it is 210 g/capital/day, whereas according to nutritional experts it should not be less than 300g/capita/day. To fill up this consumption gap of vegetables, India need to enhance its vegetable production so as to make excess a minimum of 300 gm vegetable availability per capita per day.

Of the various vegetable grown in India, broccoli is one of the rare vegetable grown on a small scale. Broccoli (*Brassica olerasia* var. italica) is a Cole crop from the family cruciferae. It was introduction in England in the early 16th century known as "Italian asparagus'' or ''sprout cauliflower''. In 1775, John Randolph described broccoli as "The head like cauliflower and the stem to be eaten like asparagus".

India second world wide in farm output and shares 8.6% of vegetable production. Agriculture and allied sector accounted for 15.7% of the GDP in 2009-10 (Economy of India, 2011). The production of vegetable crops is expected to go up from 365.20 Lakh-MT(2009-10) to 401.72 Lakh-MT during (2010-2011) (Annual Action Plan-Mission, 2011).

Broccoli are two types – heading and purple or green broccoli is more popular in India. Heading broccoli forms curd like cauliflower while broccoli contains a group of green, immature buds and thick fleshy flower stalk forming a head.

Broccoli is known as the "crown of jewel nutrition" because it is rich in vitamins and minerals. It contains vitamins A, B_1 and B_2 and is a good source of potassium, iron and fiber.

Broccoli has lots of medicinal importance. The national research council committee on diet, nutrition and cancer has recommended increased consumption of broccoli to decrease the incidence of cancer. *Brassica* vegetables contain high concentrations of carotenoids,

which are believed to be chemo preventive and associated with a decreased risk for various human cancers in epidemiological studies. It has about 130 times more vitamin A content than cauliflower and 22 times more than cabbage. It contains Sulforphane, which block growth of tumour and reduce the risk of cancer. it also contain a few important phytochemicals, beta-carotene, indoles and isothiocyanates.

Broccoli is a cool season crop. It is more sensitive when the plants are small and tender. They are susceptible to cold injury. Warm weather is disadvantageous, since the bud cluster loose quickly. In Northern India, it is generally in the month of September and October and is ready for harvest from the November to early December and may continue till early February.

The excessive use of chemical fertilizers has caused tremendous harm to environment Although the use of chemical fertilizers have become essential part of production and a balanced form of fertilizer use is always a pre-requisite to higher yield. However, these chemical fertilizers are costlier and also pollute the environment through the process of de-nitrification and volatilization and soil water through leaching, only 50% of available nitrogen being used and rest 50% goes as waste , which is an environmental hazard.

Materials and Methods

The present investigation entitled "Effect of sowing of dates on growth and yield of Broccoli" was carried out at the Vegetable Research Farm, Department of Horticulture. Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during the winter (*Rabi*) season of 2016-2017. The objective is to find out the best treatment for best growth, yield and quality of broccoli for this region. The details of various materials used and the methods employed in carrying out the experiment are described in detail in this chapter, under appropriate heading. The experiment was laid in Factorial Randomized Block Design with 3x3 treatments, each replicated three times, thus making a total of 27 plots. The unit plot size was 1.8 x 1.5 m^2. The plants were spaced at 45cm between the rows and 45 cm between the plants. There were total of 9 plants in each plot. The treatments were allocated randomly to a unit plot in each replication.

Table 1 : Effect of sowing of dates and different varieties on plant height (cm) of Broccoli.

Varieties / Date of sowing	Plant height (cm)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	52.26	50.85	51.20	**51.44**
D2- 4 Nov.	55.75	49.85	51.27	**52.29**
D3-19 Nov.	54.24	50.21	51.17	**51.87**
Mean	**54.083**	**50.304**	**51.212**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.368	0.787	S	
Due to varieties	0.368	0.787	S	
Due to date of sowing × varieties	0.638	1.363	S	

Table 2 : Effect of sowing of dates and different varieties on number of leaves per plant of Broccoli.

Varieties / Date of sowing	Number of leaves per plant			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	30.27	26.25	27.87	**28.128**
D2- 4 Nov.	33.26	29.07	29.47	**30.598**
D3-19 Nov.	31.66	29.00	29.11	**29.924**
Mean	**30.930**	**28.106**	**29.614**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.230	0.491	S	
Due to varieties	0.230	0.491	S	
Due to date of sowing × varieties	0.398	0.851	S	

Observations were recorded on three randomly selected plants of each treatment to assess the effect of treatments on growth, development, yield and quality of the broccoli in the following characters. All the recorded observations were subjected to the statistical analysis.

Results and Discussion

The present investigation entitled "Effect of sowing date on growth and yield of broccoli (*Brassica oleracea* var. italica)" was carried out at the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Deemed -to -be -University, Allahabad during the winter (*Rabi*) season of 2016-2017. The objective is to find out the best treatment for best growth, yield and quality of Broccoli for this region. The results of the investigation, regarding the effect of dates of sowing and different varieties on growth, yield and quality of broccoli have been presented in tables and bar-diagrams wherever required. The results of the investigation, regarding the effect of date of sowing and different varieties on growth, yield, and quality of broccoli have been presented Results of the experiment are summarized below. The maximum plant height (55.75) was obtained with treatment $T_4D_2V_1$ 04 November + V_1 Palam Samridhi and the minimum (49.85) remained with treatment T_5 D_2V_2 04 November + V_2 Pusa Kanchan. The maximum number of leaves per plant (33.26) was obtained with treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi and the minimum number of leaves per plant (26.25) remained with treatment T_2 D_1V_2 20 October + V_2 Pusa Kanchan. The maximum plant spread (71.30) was obtained with treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi and the minimum plant spread (61.42) remained with treatment T_9 $D_3V_3$19 November + V_3 Lufa F_1 Hybrid. The maximum Days to first curd information (57.28) was obtained with treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi and the minimum Days to first curd information (48.60) remained with treatment T_2 D_1V_2 20 October + V_2 Pusa Kanchan. The maximum Duration from transplanting to harvest (71.53) was obtained with treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi the minimum Duration from transplanting to harvest (64.29) remained with treatment T_8 $D_3V_2$19 November + V_2 Pusa Kanchan. The

Table 3 : Effect of sowing of dates and different varieties on plant spread (cm) of Broccoli.

Varieties / Date of sowing	Plant spread (cm)60 DAT			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	67.39	65.29	61.25	**64.64**
D2- 4 Nov.	71.30	65.23	65.60	**67.38**
D3-19 Nov.	70.32	61.43	61.42	**64.39**
Mean	**69.671**	**63.987**	**62.756**	
	S.Ed.	**C.D.**	**F-test**	
Due to Date of sowing	0.253	0.542	S	
Due to varieties	0.253	0.542	S	
Due to date of sowing × varieties	0.439	0.939	S	

Table 4 : Effect of sowing of dates and different varieties on Days to first curd information of Broccoli.

Varieties / Date of sowing	Days to first curd information			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	55.67	48.60	51.87	**52.04**
D2- 4 Nov.	57.28	53.58	53.47	**54.78**
D3-19 Nov.	55.26	53.80	53.74	**54.26**
Mean	**56.068**	**51.993**	**53.023**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.049	0.104	S	
Due to varieties	0.049	0.104	S	
Due to date of sowing × varieties	0.084	0.181	S	

Table 5 : Effect of sowing of dates and different varieties on duration from transplanting to harvest of Broccoli.

Varieties / Date of sowing	Duration from transplanting to harvest			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	68.28	64.58	64.43	**65.76**
D2- 4 Nov.	71.53	67.05	66.25	**68.28**
D3-19 Nov.	69.80	64.29	65.28	**66.46**
Mean	**69.868**	**65.309**	**65.320**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.116	0.248	S	
Due to varieties	0.116	0.248	S	
Due to date of sowing × varieties	0.201	0.429	S	

Table 6 : Effect of sowing of dates and different varieties on curd diameter (cm) of Broccoli.

Varieties / Date of sowing	Curd diameter (cm)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	14.57	11.23	13.15	**12.98**
D2- 4 Nov.	16.10	12.50	12.91	**13.84**
D3-19 Nov.	13.18	11.91	11.72	**12.27**
Mean	**14.62**	**11.88**	**12.60**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.077	0.166	S	
Due to varieties	0.077	0.166	S	
Due to date of sowing × varieties	0.134	0.287	S	

Table 7 : Effect of sowing of dates and different varieties on weight of untrimmed curd (g) to harvest of Broccoli.

Varieties / Date of sowing	Weight of untrimmed curd (g)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	655.25	645.58	745.47	**682.00**
D2- 4 Nov.	894.00	717.87	726.53	**779.47**
D3-19 Nov.	819.73	673.40	673.25	**722.13**
Mean	**789.66**	**678.85**	**715.08**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	1.060	2.267	S	
Due to varieties	1.060	2.267	S	
Due to date of sowing × varieties	1.836	3.926	S	

maximum Curd diameter (16.10) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Curd diameter (11.23) remained with treatment $T_2 D_1 V_2$ 20 October + V_2 Pusa Kanchan. The maximum Weight of untrimmed curd (g) (894.00) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Weight of untrimmed curd (g) (645.58) remained with treatment $T_2 D_1 V_2$ 20 October + V_2 Pusa Kanchan. The maximum Weight of trimmed curd (g) (408.93) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Weight of trimmed curd (g) (336.20) remained with

Table 8: Effect of sowing of dates and different varieties on weight of trimmed curd (g) to harvest of Broccoli.

Varieties / Date of sowing	Weight of trimmed curd (g)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	363.27	336.20	358.80	**352.76**
D2- 4 Nov.	408.93	349.27	352.73	**370.31**
D3-19 Nov.	402.15	346.13	345.82	**364.70**
Mean	**382.43**	**352.89**	**352.45**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.690	1.475	S	
Due to varieties	0.690	1.475	S	
Due to date of sowing × varieties	1.195	2.555	S	

Table 9: Effect of sowing of dates and different varieties on Curd yield per plot (kg) to harvest of Broccoli.

Varieties / Date of sowing	Curd yield per plot (kg)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	5.19	3.40	4.27	**4.30**
D2- 4 Nov.	6.29	3.54	3.60	**4.48**
D3-19 Nov.	4.30	3.52	3.53	**3.77**
Mean	**4.65**	**4.08**	**3.81**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.011	0.024	S	
Due to varieties	0.011	0.024	S	
Due to date of sowing × varieties	0.020	0.042	S	

Table 10 : Effect of sowing of dates and different varieties on curd yield (t ha^{-1}) to harvest of Broccoli.

Varieties / Date of sowing	Curd yield (t ha^{-1})			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	15.22	12.43	13.27	**13.64**
D2- 4 Nov.	16.25	12.92	13.04	**14.07**
D3-19 Nov.	14.20	12.80	12.24	**13.08**
Mean	**14.29**	**13.65**	**12.85**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.023	0.048	S	
Due to varieties	0.023	0.048	S	
Due to date of sowing × varieties	0.039	0.084	S	

treatment $T_2 D_1 V_2$ 20 October + V_2 Pusa Kanchan. The maximum Curd yield per plot (kg) (6.29) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Curd yield per plot (kg) (3.40) remained with treatment $T_2 D_1 V_2$ 20 October + V_2 Pusa Kanchan. The maximum Curd yield (t ha^{-1}) (16.25) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Curd yield (t ha^{-1}) (12.24) remained with treatment $T_9 D_3 V_3$ 19 November + V_3 Lufa F_1 Hybrid. The maximum Total soluble solids (^{0}Brix) (5.17) was obtained with treatment $T_4 D_2 V_1$ 04 November + V_1 Palam Samridhi and the minimum Total soluble

Table 11 : Effect of sowing of dates and different varieties on total soluble solids (^{0}Brix) of Broccoli.

Varieties / Date of sowing	Total soluble solids (^{0}Brix)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	4.07	3.18	3.53	**3.59**
D2- 4 Nov.	5.17	3.30	3.40	**3.96**
D3-19 Nov.	4.55	3.27	3.15	**3.66**
Mean	**4.30**	**5.34**	**3.36**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.026	0.055	S	
Due to varieties	0.026	0.055	S	
Due to date of sowing × varieties	0.044	0.095	S	

Table 12 : Effect of sowing of dates and different varieties on ascorbic acid (mg/100 g edible portion) to harvest of Broccoli.

Varieties / Date of sowing	Ascorbic acid (mg/100 g edible portion)			Mean
	Palam Samridhi	Pusa Kanchan	Lufa F-1	
D1-20 Oct	110.33	109.63	108.67	**112.64**
D2- 4 Nov.	117.97	116.90	113.57	**113.04**
D3-19 Nov.	115.32	109.60	107.56	**110.82**
Mean	**113.98**	**112.04**	**110.49**	
	S.Ed.	**C.D.**	**F-test**	
Due to date of sowing	0.192	0.410	S	
Due to varieties	0.192	0.410	S	
Due to date of sowing × varieties	0.332	0.711	S	

solids (^{0}Brix) (3.15) remained with treatment T_9 $D_3V_3$19 November + V_3 Lufa F_1 Hybrid. The maximum Ascorbic acid (mg/100 g edible portion) (117.97) was obtained with treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi and the minimum Ascorbic acid (mg/100 g edible portion) (107.56) remained with treatment T_9 $D_3V_3$19 November + V_3 Lufa F_1 Hybrid.

Conclusion

In view of experimental results obtained during the present Investigation, treatment T_4 D_2V_1 04 November + V_1 Palam Samridhi emerged as superior over all other treatments, in relation to growth, yield, quality and cost benefit ratio 1:4.05of Broccoli under the agro- climatic condition of Allahabad. However, since this is based on one – season experiment, further trails may be needed to substantiate the results.

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