

## To Studies Performance of Varieties and Spacing on Growth, Yield and Quality Attributes of Broccoli (*Brassica oleracea* var. *italica* Plenck) in Lucknow Condition

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### ABSTRACT

Studies on performance of varieties and spacing on broccoli at Babasaheb Bhimrao Ambedkar University Lucknow (UP) on Horticulture Research Farm during *rabi* season 2019-2020. We used three varieties ( $V_1$ : Broccoli green,  $V_2$ : Pusa KTS-1, and  $V_3$ : Ganesh) and three spacings ( $S_1$ : 45×45 cm,  $S_2$ : 60×45 cm, and  $S_3$ : 50×45 cm) in an FRBD design with three replications and nine treatments in the research work. We studies different growth attributes (Width of leaves (cm)), Stem diameter (cm), Plant spread (East-West), Plant spread (North–South), yield attributes (Curd size (Horizontal)), Curd size (Vertical), Total curd yield

(q/ha) and Quality attributes (TSS and Ascorbic acid) in broccoli. Found that result in the variety of (Pusa KTS-1) with spacing ( $S_2$ : 60 × 45 cm) in the most of growth, yield and quality parameters as compared to Ganesh with ( $S_3$ : 50 × 45 cm) and lower recorded in the variety Green Broccoli with ( $S_1$ : 45 × 45 cm).

**Keywords** Broccoli, Experiment, Spacing, Varieties, Biochemical traits, Yield attributes.

### INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica* Plenck) is an important vegetable in the cole group of vegetables. Broccoli is related to cauliflower; the edible part of broccoli is called the head. There are different kinds of head varieties available, consisting of white, green, purple and yellow. Yet the cultivation of broccoli crops is not more exploited in India; they are grown in a limited area, especially in hilly areas and near big cities and hotels (Fageria *et al.* 2022). Because of their nutritional value, this has recently become very popular. Broccoli has been revealed to be both an antioxidant and carcinogenic, which is beneficial for lowering the risk of cancer in humans. Broccoli has reported several ingredients, including sulphoraphane, kaemferol and glucoraphanin (Guo *et al.* 2001). Broccoli is an Italian word derived from the Latin word brachium, meaning “an arm or branch.” It has 130 times more vitamin A than cauliflower

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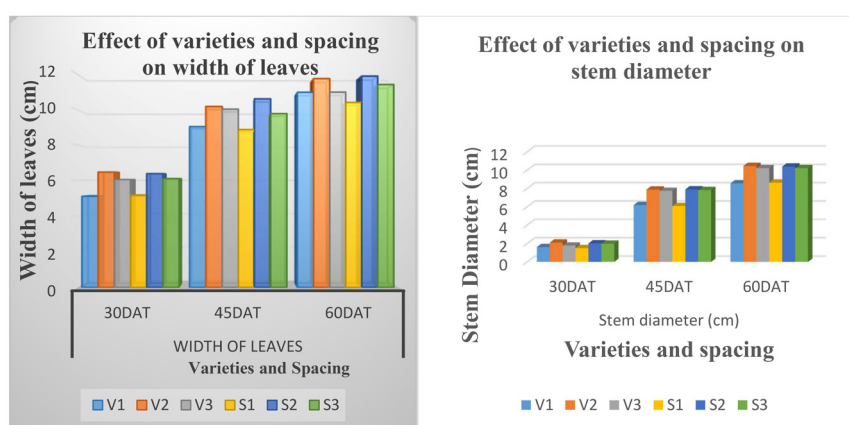


Fig. 1. Showed effect of varieties and spacing on width of leaves, stem diameter 30, 45 and 60 DAT (Days after transplanting).

and 22 times more than cabbage (Singh 2019). The United States is the leading producer of broccoli in India, where it is popular in hotels in Mumbai, Delhi, and Chennai.

Broccoli has a high nutritional value among cole vegetables, with 9000 IU/100 g of vitamin A, 300 mg/100 g of thiamin, 137 mg/100 g of vitamin C, and 205 mg/100 g of iron (Fageria *et al.* 2022). Only a few broccoli varieties, such as Pusa KTS-1, Palam Samridhi, Punjab Broccoli-1, Palam Vichitra and Palam Kanchanand are grown in the cool winters of the north plain. Lucknow is located in the subtropical zone, where the winters are cooler and the summers

are extremely dry. Plant spacing with the best combination is beneficial for influencing broccoli crop growth, yield and development. There is not much research done in this field in Lucknow. The goal of our research is to find a better combination that will help farmers earn more per unit area in a given time.

## MATERIALS AND METHODS

The experiment started on research farm BBAU Lucknow 226025 (UP) during the *rabi* season. Experimental site located 26°50' North latitude, 80°52' East longitude and an altitude of 123 meter mean sea level (MSL). A field trial is laid out in factorial RBD with

Table 1. Effect of different spacing and varieties on growth parameter.

Treatments	Width of leaves (cm)			Stem diameter (mm)			Plant spread East-West (cm)			Plant spread North- South (cm)		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
V <sub>1</sub>	5.11	9.04	10.97	1.62	6.19	8.56	14.49	23.92	30.62	13.58	24.08	36.34
V <sub>2</sub>	6.48	10.17	11.74	2.11	7.88	10.46	16.33	29.18	35.18	17.32	28.50	39.26
V <sub>3</sub>	6.06	10.02	10.98	1.79	7.74	10.22	15.56	28.93	33.61	15.84	27.10	38.01
SEm ±	0.10	0.16	0.20	0.06	0.19	0.24	0.26	0.41	0.50	0.26	0.30	0.35
CD at 5%	0.31	0.47	0.61	0.19	0.57	0.71	0.79	1.25	1.50	0.79	0.90	1.06
Spacing												
S <sub>1</sub>	5.16	8.87	10.40	1.51	6.08	8.63	13.31	25.53	30.98	14.20	24.79	36.13
S <sub>2</sub>	6.39	10.60	11.88	2.02	7.90	10.39	15.82	28.46	34.79	16.33	27.49	39.06
S <sub>3</sub>	6.11	9.77	11.41	1.99	7.83	10.21	15.24	28.04	33.64	16.21	27.41	38.42
SEm ±	0.10	0.16	0.20	0.06	0.19	0.24	0.26	0.41	0.50	0.26	0.30	0.35
CD at 5%	0.31	0.47	0.61	0.19	0.57	0.71	0.79	1.25	1.50	0.79	0.90	1.06

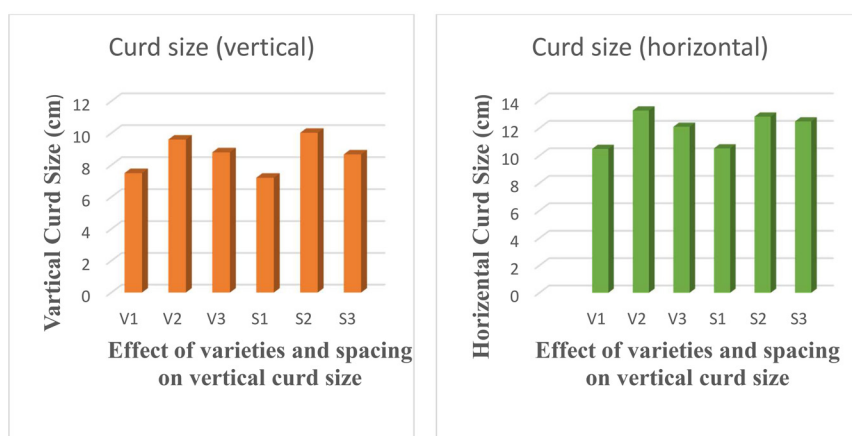


Fig. 2. Showed effect of varieties and spacing on curd size (Vertical and Horizontal).

nine treatments and three replications. I have used three varieties ( $V_1$ : Broccoli green,  $V_2$ : Pusa KTS-1 and  $V_3$ : Ganesh) and three spacings ( $S_1$ : 45×45 cm,  $S_2$ : 60×45 cm and  $S_3$ : 50×45 cm) in our experiment. Seedling transplanting in main field 4-5 leaf stage. Basal dose of half nitrogen and full dose of potash and phosphorus in 100 kg of N and 80 kg of  $P_2O_5$  and as well as 60 kg of  $K_2O$  kg/ha and half doses of N 30 days after and second is 45 days after transplanting. In broccoli, data are collected for growth attributes (width of leaves (cm), stem diameter (cm), plant spread (east-west)). Plant spread (North –South),

**Table 2.** Effect of different spacing and varieties on yield and quality parameter.

Treatments	Curd size (vertical cm)	Curd size (horizontal cm)	Total curd yield q/ha	TSS ( $^{\circ}$ Brix)	Ascorbic acid (mg/100 g)
$V_1$	7.50	10.49	66.78	6.96	56.53
$V_2$	9.60	13.28	76.28	8.70	61.71
$V_3$	8.80	12.10	73.60	8.39	63.13
SEm $\pm$	0.26	0.33	1.25	0.31	0.56
CD at 5%	0.79	1.01	2.67	0.95	1.70
<b>Spacing</b>					
$S_1$	7.21	10.53	74.31	6.71	55.60
$S_2$	10.02	12.84	70.39	8.92	63.78
$S_3$	8.67	12.49	71.96	8.41	61.81
SEm $\pm$	0.26	0.33	1.25	0.31	0.56
CD at 5%	0.79	1.01	2.67	0.95	1.70

yield attributes (Curd size (Horizontal), Curd size (Vertical), total curd yield (q/ha) and quality attributes (TSS and Ascorbic acid) in broccoli. A statistical analysis of data obtained in different sets of experiments was calculated following the standard procedure of Panse and Sukhatme (1985). Quality parameters such as TSS and Vitamin C titration against 2,6-dichlorophenolindophenol dye (AOAC 1995).

## RESULTS AND DISCUSSION

The outcomes of the current investigation have been condensed into the following groups

### Effect of varieties

#### On growth attributes

Recorded data on growth parameter recorded 30, 45, 60 DAT are showed significantly influence on growth parameter are present in Table 1 and Fig. 1. The width of leaves (6.48, 10.17, and 11.74 cm), stem diameter (2.11, 7.88 and 10.46 mm), plant spread (east-west) (16.33, 29.18 and 35.18 cm), and in the case of plant spread (north-south) (17.32, 28.50 and 39.26 cm) were highest in  $V_2$  (Pusa KTS-1) over  $V_3$  (Ganesh), and the minimum was recorded in  $V_1$  (Broccoli Green) as reported by Prasad *et al.* (2010), Thapa and Rai (2012) and Singh *et al.* (2014).

#### On yield parameter

Where in yield attributes present in Table 2 and Fig. 2

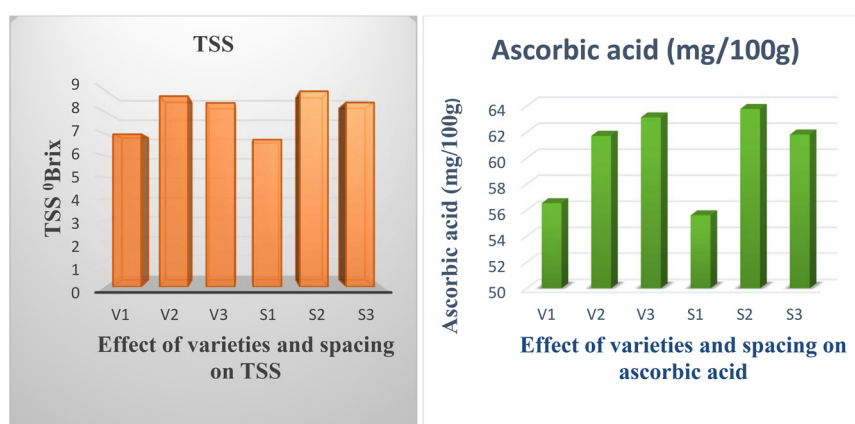


Fig. 3. Showed effect of varieties and spacing on TSS and ascorbic acid.

i.e. Horizontal curd size (13.28 cm) Vertical curd size (9.60 cm) and yield q/ha (76.28 q/ha) recorded that  $V_2$  (Pusa KTS-1) highest as compare to  $V_3$  (Ganesh) reported that respectively (12.10 cm, 8.80 cm, and yield are 73.60 q/ha where minimum are recorded in  $V_1$  (Broccoli green) is 10.49 cm, 7.50 cm and 66.78 q/ha) similar result are found Thapa *et al.* (2013) Prasad *et al.* (2010) and El-Magd (2013) and Ngullie and Biswas (2014).

#### On quality parameter

Where in case of quality attributes present in Table 2 and Fig. 3. Among the variety maximum TSS were determined with variety  $V_2$  (Pusa KTS-1) is (8.70 °Brix) have as compare to  $V_3$  (Ganesh) is (8.39°Brix)

while the lesser TSS are reported  $V_1$  (Broccoli green) (6.96°Brix) similar result found Roni *et al.* (2014). Varieties showed significant on ascorbic acid. The maximum ascorbic acid was reported in  $V_3$  (Ganesh) at 63.13 mg/100 g, as compared to  $V_2$  (Pusa KTS-1) at 61.71 mg/100 g, while the minimum ascorbic acid was reported in  $V_1$  (Broccoli green) at 56.53 mg/100 g, a closely related result found by Dogra and Awasthi (2009) and Singhal *et al.* (2009).

#### Effect of spacing

#### On growth parameter

Growth parameter effect by spacing present in Table 1 and Fig. 1 i.e., plant spread and width of plant are

Table 3. Interaction effect different plant spacing and varieties on growth of broccoli crop.

Treatments	Width of leaves			Stem diameter (mm)			Plant spread East-West (cm)			Plant spread North- South (cm)		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
$V_1S_1$	4.17	8.37	10.40	1.20	4.17	7.70	10.37	20.33	28.07	12.90	22.30	37.30
$V_1S_2$	5.50	9.57	11.47	1.73	6.83	8.63	13.50	25.17	32.00	14.47	24.50	37.37
$V_1S_3$	5.67	9.20	11.03	1.93	7.57	9.33	13.60	26.30	31.80	13.37	25.43	36.34
$V_2S_1$	5.50	8.90	11.07	1.90	7.17	9.07	15.23	28.17	34.17	15.37	26.07	42.57
$V_2S_2$	7.80	12.20	13.30	2.57	9.03	12.27	18.60	31.60	38.87	15.27	32.47	37.60
$V_2S_3$	6.13	9.40	10.87	1.87	7.43	10.03	15.17	27.77	32.50	17.33	26.97	39.26
$V_3S_1$	5.80	9.33	9.73	1.43	6.90	9.13	14.33	28.13	30.70	14.33	26.00	37.30
$V_3S_2$	5.87	10.03	10.87	1.77	7.83	10.27	15.37	28.60	33.50	15.27	25.47	40.30
$V_3S_3$	6.53	10.70	12.33	2.17	8.50	11.27	16.97	30.07	36.63	17.93	29.83	38.01
SEm ±	0.18	0.16	0.35	0.10	0.33	0.41	0.45	0.72	0.86	0.45	0.51	0.61
CD at 5%	0.55	0.81	1.07	0.33	0.99	1.22	1.37	2.17	2.60	1.36	1.55	1.83

**Table 4.** Interaction effect different plant varieties and spacing on yield and quality of broccoli crop.

Treatments	Curd size (horizontal)	Curd size (vertical)	Total curd yield q/ha	TSS (°Brix)	Ascorbic acid (mg/100 g)
V <sub>1</sub> S <sub>1</sub>	9.30	6.47	67.93	6.17	48.87
V <sub>1</sub> S <sub>2</sub>	10.77	8.63	66.43	7.53	61.03
V <sub>1</sub> S <sub>3</sub>	11.40	7.40	65.97	7.17	59.70
V <sub>2</sub> S <sub>1</sub>	12.70	8.40	77.63	6.70	57.47
V <sub>2</sub> S <sub>2</sub>	15.47	12.77	75.10	11.80	68.20
V <sub>2</sub> S <sub>3</sub>	11.67	7.63	76.0	7.60	58.90
V <sub>3</sub> S <sub>1</sub>	9.60	6.77	77.36	7.27	60.47
V <sub>3</sub> S <sub>2</sub>	12.30	8.67	69.63	7.3	62.10
V <sub>3</sub> S <sub>3</sub>	14.40	10.97	73.80	10.47	66.83
SEm ±	0.58	0.46	2.16	0.54	0.97
CD at 5%	1.75	1.38	NS	1.64	2.95

also significant as recorded data at all stages (30, 45, 60 and DAT) shows maximum width of leaves (6.39, 10.60 and 11.88 cm), plant spread (East-West) (15.82, 28.46 and 34.79 cm), and plant spread (North-South) (16.33, 27.49, and 39.06 cm) at spacing S<sub>2</sub> (60×45 cm) as compared to S<sub>3</sub> (50×45 cm), where minimum spread of plant is recorded at spacing S<sub>1</sub> (45×45 cm) reported by Prasad *et al.* (2010). On stem diameter, the maximum stem diameter (2.02, 7.90 and 10.39 mm) is recorded with spacing S<sub>2</sub> (60 × 45 cm) as compared to S<sub>3</sub> (50 × 45 cm), where the minimum stem diameter is recorded at spacing S<sub>1</sub> (45 × 45 cm). Similar results were obtained by Prasad *et al.* (2010), Saikia *et al.* (2010) and Bhangre *et al.* (2011).

#### Yield parameter

In case of yield parameter show in Table 2 and Fig. 2 i.e., Curd size also showed significant effect by spacing maximum curd size vertical and Horizontal observed at S<sub>2</sub> (60×45 cm) is (10.02 and 12.84 cm) as compare to S<sub>3</sub> (50×45 cm) is (8.67 and 12.49 cm) where minimum spread of plant are recorded at spacing S<sub>1</sub> (45 × 45 cm) is (7.21 and 10.53 cm) reported by Prasad *et al.* (2010) and El-Magd (2013). In the case of total curd yield reported, the minimum total curd yield was recorded with spacing S<sub>2</sub> (60 × 45 cm) at 70.39 q/ha, as compared to S<sub>3</sub> (50 × 45 cm) at 71.96 q/ha and the maximum total curd yield was recorded at spacing S<sub>1</sub> (45 × 45 cm) at 74.31 q/ha. The

results obtained are in agreement with those obtained by Bhangre *et al.* (2011) and Hossain *et al.* (2012).

#### On quality parameter

Where in case of quality parameter in spacing effect present in Table 2 and Fig. 3 i.e., maximum TSS of curd was observed at spacing S<sub>2</sub> (60 × 45 cm) at 8.92 °Brix, compared to S<sub>3</sub> (50 × 45 cm) at 8.410 °Brix and minimum TSS of curd was recorded at spacing S<sub>1</sub> (45 × 45 cm) at 6.710°Brix. These results are in accordance with the findings of Roni *et al.* (2014). Where maximum Ascorbic acid of curd observed spacing S<sub>2</sub> (60×45 cm) is (63.78) as compare to S<sub>3</sub> (50×45 cm) is (61.81) where minimum Ascorbic acid of curd are recorded at spacing S<sub>1</sub> (45×45 cm) is (53.60) closely result are confined with Bhangre *et al.* (2011).

#### Interaction effect of varieties and spacing

Combing effect on growth, yield, and quality characteristics was significant at 30, 45 and 60 DAT except yield showed in Tables 3 and 4. Where in growth characteristics V<sub>2</sub>S<sub>2</sub> is best performed (leaf width is 7.80, 12.20, 13.30 cm) and in stem diameter (2.57, 9.03 and 12.27 mm) plant spread east-west is (18.60, 31.60 and 38.87 cm), and plant spread north-south is (at 45 DAT 32.47 cm obtained) V<sub>2</sub>S<sub>2</sub> is best performance. In terms of yield parameters, the combined effect of varieties and plant spacing V<sub>2</sub>S<sub>2</sub> had a significant influence except on yield per hectare (77.63 yield/ha with combination V<sub>2</sub>S<sub>1</sub>) and in vertical curd size (12.77 cm), horizontal curd size (15.77 cm) with best performance for V<sub>2</sub>S<sub>2</sub> over V<sub>3</sub>S<sub>3</sub> and minimum influence for V<sub>1</sub>S<sub>1</sub>. Whereas in the case of quality attributes like TSS (11.80 °B) and ascorbic acid (68.20) highest with combination of V<sub>2</sub>S<sub>2</sub> on broccoli, crop spacing was also influenced.

#### CONCLUSION

On the basis of result finding that variety V<sub>2</sub> Pusa KTS-1 with spacing S<sub>2</sub> (60 × 45 cm) highly influenced over V<sub>3</sub> (Broccoli green) with spacing S<sub>3</sub> (50 × 45 cm) and minimum influenced by V<sub>1</sub> (Ganesh) with spacing S<sub>1</sub> (45 × 45 cm).

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