

Effect of different varieties and plant spacing on growth yield and quality attribute of sprouting broccoli (*Brassica oleracea* var. *italica* Plenck)

Abstract

The present experiment was conducted at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, India during the Rabi season 2019-2020. The research work was formulated to investigate the effect of different plant spacing S_1 (45x45 cm), S_2 (60x45 cm) and S_3 (50x45 cm) and varieties (V_1 ; Broccoli Green, V_2 ; Pusa KTS-1 and V_3 ; Ganesh) on different growth, yield and quality attributes in sprouting broccoli (*Brassica oleracea* var. *italica* Plenck) with nine treatments which designed as RBD design. We were examined different growth parameters (plant height, number of leaves, length of leaves (cm), days to 50% curd initiation and 50% curd maturity), yield parameters such as the number of auxiliary branches in broccoli, the weight of curd, as well as quality parameters like curd color, the shape of curd and curd compactness. We have found the best performance in the variety of (Pusa KTS-1) with spacing (S_2 ; 60 x 45 cm) in the most of growth, yield, and quality parameters as compared to Ganesh with (S_3 50 x 45 cm) and lower recorded in the variety Green Broccoli with (S_1 45 x 45 cm).

Keywords: Broccoli, Experiment, Spacing, Varieties.

Introduction:-

Broccoli (*Brassica oleracea* var. *italica* Plenck) is a member of the Cole group of crops. It is a native place in the Mediterranean region. The word "Cole" is abbreviated from "Caulis", which means stem. Broccoli belongs to the family Brassicaceae. All the Cole group of crops originated from a common ancestor, wild cabbage/Colewort (*Brassica oleracea* var. *Sylvestris*). (Thamburaj and Singh 2013).

Morphologically, broccoli resembles cauliflower, but the major difference between cauliflower and broccoli is cauliflower's lack of an auxiliary branching habit. The edible parts of the broccoli crop are the modified inflorescence and the flower stalk terminal head.

Broccoli grown in India is commonly known as green sprouting broccoli or Calabrese. In the case of broccoli, after the completion of the growth of the primary inflorescence (terminal head), a small secondary inflorescence (sprout) appears in the axils of the lower leaves. They are used for salads with half-boiled vegetables. It is also used in soups with other vegetable juices or as a single vegetable mixed with potatoes. Broccoli is a rich source of sulforaphane, kaempferol, and Glucoraphanin, which have carcinogenic properties means reducing the risk of cancer and being antioxidant (Guo et al., 2001). Among Cole crops, it has high nutritive. It contain (9000 IU/100g) vitamin A, (300mg/100g) thiamine, (137mg/100g) vitamin C, and iron 137mg/100g (Fageria et al. 2022).

The availability of a suitable high-yielding variety and the ideal plant spacing increase farmers' income per unit area at a given time (Bhangra *et al.* 2011). Because of variations in morphology and phenology, the cultivars exhibit a viable response to plant density (Prasad *et al.* 2010). Different cultivars show varying growth, yield, and quality characteristics depending on the growing environment (Thapa *et al.* 2013). No symmetrical study to measure the response of varieties and spacing in the Lucknow condition. The aim of this research work is to identify and standardise various types of ideal plant spacing and varieties to get better yield in Lucknow climatic conditions.

Materials and methods:-

The experiment was led by the Horticulture Research farm Department of Horticulture, Babasaheb Bhimrao Ambedkar University Lucknow-226025(U.P.) during the Rabi season from October to February 2019-2020. Geographically experimental area is located at 26°50' North latitude, 80°52' East longitude and an altitude of 123 meters mean sea level (MSL). Lucknow has a sub-tropical climate with an average annual rainfall of about 1000 mm. The maximum temperature generally goes to 43°C in summer and the minimum up to 3°C in winter. Monsoon generally sets in during the third week of June and recedes by the end of September with heavy rainfall during the monsoon season. Meteorological observation taken by IISR Lucknow and the soil type of field was sandy clay loam with slightly alkaline while pH is near about 6.5 to 8.5. Factorial RBD design was used in the experiment with two factors (factor.1- variety and factor 2- spacing in 9 treatments. The seedling becomes ready for transplanting 28 days after sowing (4 to 5 leaf stage). The treatments included three varieties (Pusa KTS-1, broccoli green, and Ganesh) as well as three planting spacing (60 x 45cm, 50x45cm, and 45 x 45 cm). the recorded observations in growth parameters, plant height (cm), number of leaves, length of leaves (cm), days to 50% curd initiation and days to 50% curd maturity, and in yield parameters as the number of auxiliary branches, the weight of curd in broccoli, as well as in quality parameter curd color, the shape of curd, curd compactness, etc. Application of fertilizer in the field at the recommended dose of our crop in the field, 100kg of N and 80 kg of P₂O₅ and as well as 60 kg of K₂O kg/ha half dose of N, and a full dose of P, and K at the time of transplanting as per recommended. Half doses of N are given two times in the experiment field, one of them 30 days after and the second 45 days after transplanting. Statistical analysis of data obtained in a different set of experiments was calculated following the standard procedure.

Results and Discussion

Effect of varieties:

Data were collected on a daily basis for the first few days after transplantation 30DAT, 45DAT, and 60DAT. The data presented in Table 1 reveals a significant effect of varieties. Among the varieties V₂ (Pusa KTS-1) reported maximum plant height (36.9 cm), number of leaves (13.1), and length of leaves (20.8 cm), as compared to V₃ (Genesh), and minimum reported V₁ (Broccoli Green) at 60DAT similar result recorded by Singh *et al.* (2014). While in the case of days after 50% curd initiation, it was recorded that varieties reported that V₂ (Pusa KTS 1) take more days (68.4 days) over V₃ (Ganesh) and fewer days taken V₁ (Broccoli Green) reported by Thapa *et al.* (2013) and Thapa and Rai (2012). In 50% curd maturity V₂ (Pusa KTS-1) takes more days to curd maturity (73.2 days) as compared to V₃ (Genesh), and minimum reported V₁ (Broccoli Green) similar results are reported by Singh *et al.* (2014) and Thapa and Rai (2012).

On yield parameter

In the case of yield parameters, the number of auxiliaries branches and curd weight, V₂ (Pusa KTS-1) has the maximum number of the auxiliary branch (10.6) and average curd weight (193.8g) as compared to V₃ (Genesh) and minimum are reported in V₁ (Broccoli Green). A similar result was found by Ngunlie and Biswas (2014).

On quality parameter

In the case of quality parameters shown in Table-3 such as curd color, the shape of curd, and curd compactness, found that Pusa KTS-1, green color, flat shape and slightly loose; and Ganesh, the dark green color is domed and compact; and Broccoli Green, the green color curd, head shape curd and slightly loose similar result found was Bhangre *et al.* (2011).

Effect of spacing:

The data was collected on a regular basis for several days after the broccoli crop was planted 30DAT, 45DAT, and 60DAT. The data presented in Table 1 reveals a significant effect of spacing. Among spacing S₂ (60x45cm), the maximum influence plant height (37.4cm) as compared to S₃ (50x45cm), where minimum reported S₁ (45x45cm) observed by Singh *et al.* (2006), Bhangre *et al.* (2011), and Yadav *et al.* (2016). A maximum number of leaves (13.1) is observed at spacing S₂ (60x45cm) as compared to S₃ (50x45cm), and the minimum recorded at spacing S₁ (45x45cm) closely result reported by Singh *et al.* (2006), Gariya *et al.* (2016). While Maximum leaf length (21.3cm) was found with spacing S₂ (60x45cm) over S₃ (50x45cm), while the minimum leaf length is recorded S₁ spacing (45 x 45 cm) reported by Yadav *et al.* (2016). While in the case of days to 50% curd initiation S₂ (60x45cm) takes more

days (65.3days) as compared to S₃ (50x45cm), where minimum days are recorded at spacing S₁ (45x45cm) Similar results were reported by Thapa and Rai (2012) and Rhapsa *et al.* (2013) and days after 50% curd maturity Plant spacing S₂ (60x45cm) takes more days (71.2 days) as compared to S₃ (50x45cm), where minimum days are recorded at spacing S₁ (45x45cm) reported by Singh *et al.* (2014) and Thapa and Rai (2012).

On yield parameter

In the case of yield parameters, the number of auxiliary branches and curd weight found that at plant spacing S₂ (60x45cm), the maximum influence weight of curd (183.2) and the number of the auxiliary branch (10.22) over S₃ (50x45cm), where the minimum weight of curd is recorded at spacing S₁ (45x45cm) same as result reported by Prasad *et al.* (2010) and Bhangre *et al.* (2011).

On quality parameter

In terms of quality, parameters shown in Table-3, curd color, curd shape, and curd compactness, they found that Pusa KTS-1 in all spacing green color curd, flat shape, and slightly loose curd; Ganesh in all spacing, dark green color curd, dome shape, and compact curd; and Broccoli Green varieties in all spacing, green color curd, head shape, and slightly loose curd Similar results are found by Bhangre *et al.* (2011).

Interaction effect of varieties and spacing:-

Combining the effect of varieties and spacing showed significance for growth parameters in Table 2. The maximum plant height, number of leaves, length of leaves (cm), 50% curd initiation, and 50% curd maturity observed V₂S₂ treatment over V₃S₃ and minimum V₁S₁ treatment respectively (39.1cm), (15.3) (22.5), (75.3 days) and (81.3days). While in the yield parameter, the weight of curd and the number of auxiliary branches were found significantly V₂S₂ followed by V₃S₃ and minimum reported with V₁S₁. In the case of quality parameters, curd color, curd shape, and curd compactness are influenced by varieties but not influenced by spacing showed in Table 3 similar results are Bhangre *et al.* (2011).

Conclusion:

It was found that the combined effect of varieties and spacing on the growth parameters such as plant height, number of leaves, length of leaves (cm), days to 50% curd initiation, and days to 50% curd maturity was and yield parameters such as weight curd, number of auxiliary branches were also significant influence V₂ (Pusa KTS-1) with a wider spacing S₂ (60 x 45 cm) followed by V₃ (Ganesh) with (50 x 45 cm) minimum influence by V₁ (Broccoli Green) with S₁ (45 x 45 cm).

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

Treatments	Plant height (cm)			Number of leaves			Length of leaves (cm)			50% curd initiation	50% curd maturity	Weight of cured	Number of auxiliary branch
	30D	45D	60D	30D	45D	60D	30D	45D	60D				
	AT	AT	AT	AT	AT	AT	AT	AT	AT				
V ₁	14.9	22.9	35.6	6.2	8.9	11.4	7.2	14.3	19.2	57.7	62.6	137.8	6.7
V ₂	16.6	25.3	36.9	8.0	11.0	13.1	8.2	16.2	20.8	68.4	73.2	193.8	10.6
V ₃	15.9	24.13	36.7	7.4	10.4	12.9	7.7	15.5	20.5	62.8	68.9	149.8	10.2
SEm ±	0.24	0.25	0.27	0.22	0.27	0.31	0.16	0.22	0.26	0.54	0.51	8.80	0.18
CD(P=0.05)	0.72	0.76	0.82	0.67	0.81	0.95	0.49	0.65	0.80	1.64	1.55	25.60	0.54
Spacing													
S ₁	15.1	23.3	35.4	6.7	9.4	11.7	7.3	14.3	18.9	59.6	64.3	141.1	7.7
S ₂	16.3	24.7	37.4	7.6	10.6	13.1	8.0	16.2	21.3	65.3	71.2	183.2	10.22
S ₃	15.9	24.4	36.4	7.4	10.3	12.7	7.7	15.5	20.3	63.4	69.1	156.1	9.5
SEm ±	0.24	0.25	0.27	0.22	0.27	0.31	0.16	0.22	0.26	0.54	0.51	8.80	0.18
CD(P=0.05)	0.72	0.76	0.82	0.67	0.81	0.95	0.49	0.65	0.80	1.64	1.55	25.60	0.54

Table-2 Interaction effect different plant spacing and varieties on growth yield and quality of broccoli crop.

Interaction	Plant height (cm)			Number of leaves			Length of leaves (cm)			50% curd initiation	50% curd maturity	Weight of cured	Number of auxiliary branch
	30D	45D	60D	30D	45D	60D	30D	45D	60D				
	AT	AT	AT	AT	AT	AT	AT	AT	AT				
V ₁ S ₁	14.7	22.2	35.2	5.3	7.7	10.7	6.9	12.8	17.5	55.3	60.7	134.5	5.7

V ₁ S ₂	15.5	23.5	36.0	6.7	9.7	11.3	7.1	15.5	21.0	57.3	62.7	141.4	6.7
V ₁ S ₃	14.7	23.1	35.7	6.7	9.3	12.3	7.5	14.6	19.2	58.7	64.3	137.7	7.7
V ₂ S ₁	15.3	24.2	35.3	7.3	10.3	12.7	7.7	15.6	19.7	64.7	67.7	169.9	9.7
V ₂ S ₂	17.9	26.9	39.1	9.3	12.3	15.3	9.2	17.6	22.5	75.3	81.3	259.5	13.3
V ₂ S ₃	16.4	24.9	36.2	7.3	10.3	11.3	7.6	15.4	20.5	65.3	70.7	151.9	8.7
V ₃ S ₁	15.5	23.5	35.7	7.3	10.3	11.7	7.3	14.4	19.7	59.6	64.7	122.1	7.7
V ₃ S ₂	15.4	23.6	36.9	6.7	9.7	12.7	7.7	15.7	20.6	65.3	69.7	148.8	10.2
V ₃ S ₃	16.8	25.2	37.3	8.3	11.3	14.3	8.1	16.4	21.2	63.4	72.3	178.5	9.5
SEm ±	0.41	0.44	0.47	0.39	0.45	0.54	0.28	0.37	0.46	0.94	0.89	15.23	0.31
CD(P=0.05)	1.25	1.32	1.41	1.16	1.41	1.64	0.83	1.12	1.38	2.84	2.68	46.1	0.94

Table -3 Effect of different spacing and varieties on quality parameter of broccoli crop.

Treatment		Colour	Shape	Compactness
Varieties	Spacing			
Ganesh broccoli	S₁(45x45cm)	Dark green	Dome	Compact
	S₂(60x45cm)	Dark green	Dome	Compact
	S₃(50x45cm)	Dark green	Dome	Compact
Pusa KTS-1	S₁(45x45cm)	Green	Flat	Slightly loose
	S₂(60x45cm)	Green	Flat	Slightly loose
	S₃(50x45cm)	Green	Flat	Slightly loose
Broccoli Green	S₁(45x45cm)	Green	Head	Slightly loose
	S₂(60x45cm)	Green	Head	Slightly loose
	S₃(50x45cm)	Green	Head	Slightly loose

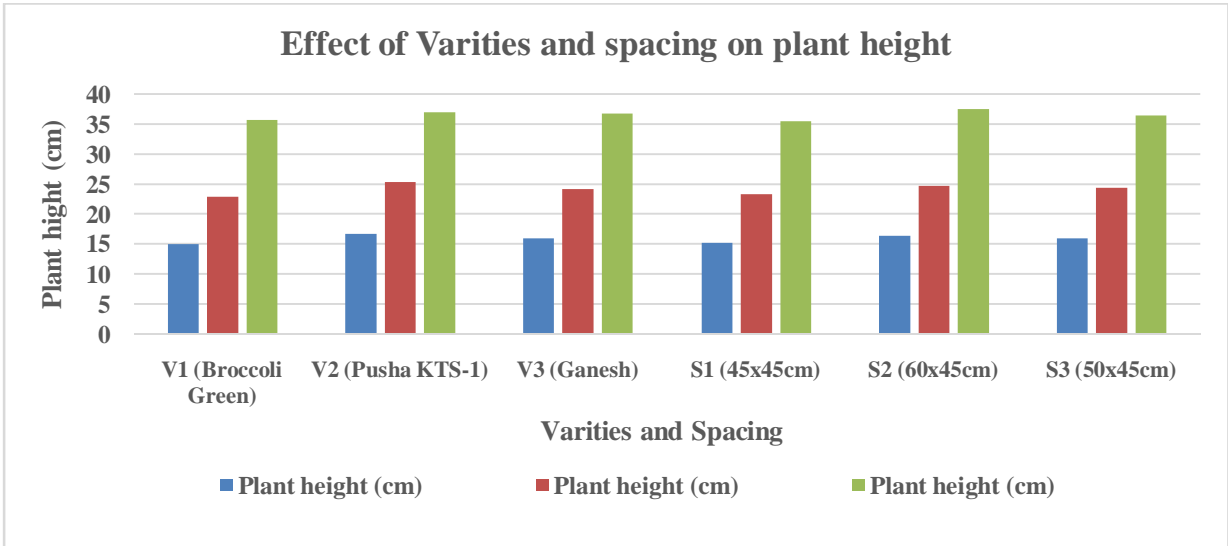


Fig.1 Effect of variety and spacing on plant height 30,45 and 60 DAT (days after transplanting)

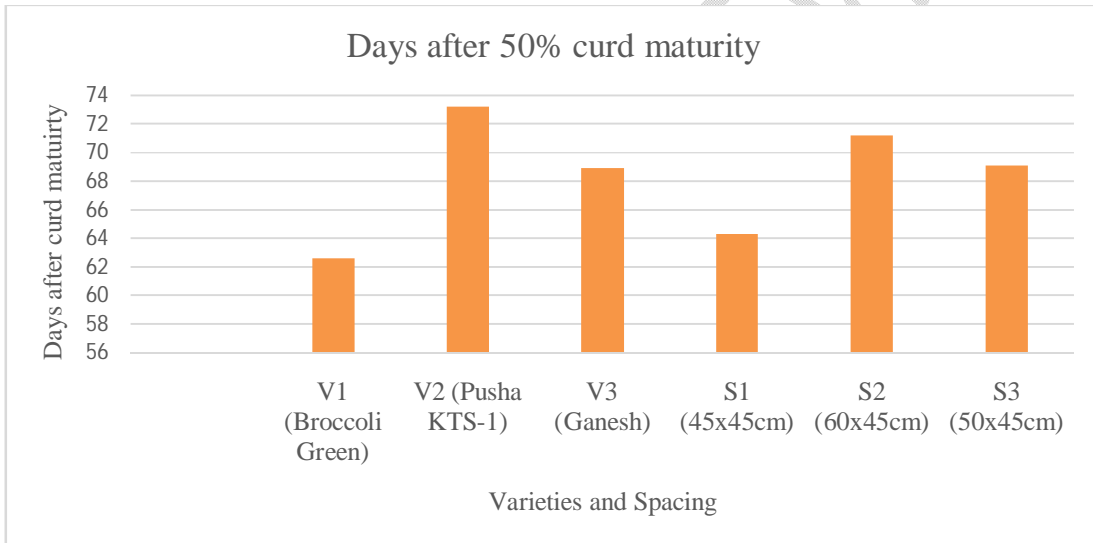


Fig.2 Effect of variety and spacing on 50% curd maturities

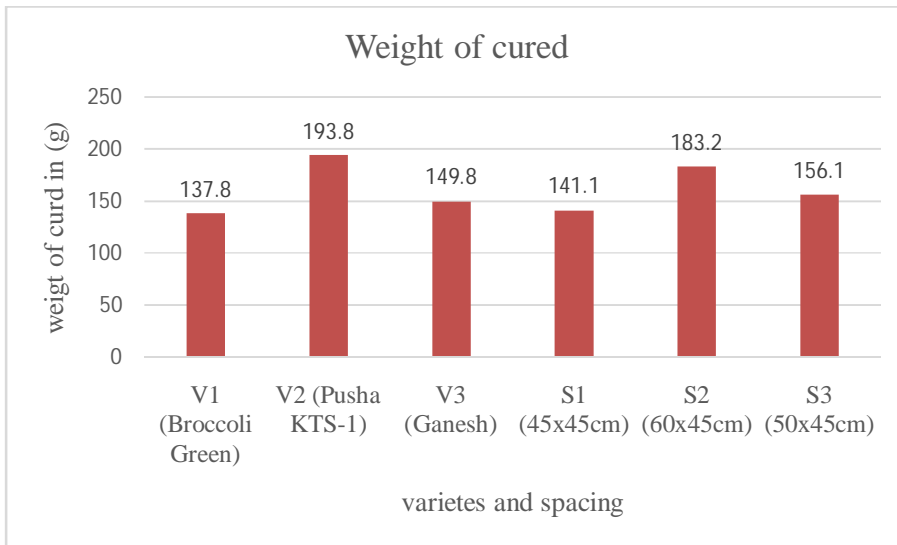


Fig.3 Effect of variety and spacing on the weight of curd

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