Influence of varieties and spacing on yield and quality of sprouting broccoli (*Brassica oleracea* L.)

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Received: September, 2020; Revised accepted: November, 2020

ABSTRACT

A field experiment was undertaken at B.B.A. University, Lucknow (UP) during rabi season to study the effect of varieties and spacings on yield and quality characters of sprouting broccoli (*Brassica oleracea* L. var. *italica* Plenck). Four varieties viz. V₁- Pusa Broccoli KTS-1, V₂-Palam Kanchan, V₃-Palam Vichitra, V₄-Palam Samridhi and four spacings viz. S₁- 60x45 cm, S₂- 60x30 cm, S₃- 45x45 cm, S₄- 45x30 cm were evaluated in factorial randomized block design with three replications. Among the varieties, Pusa Broccoli KTS-1 had taken earliest days for curd initiation (47.9) and day taken to curd harvest after curd initiation (22.5). Variety Pusa Broccoli KTS-1 significantly produced the highest curd diameter (118.9 mm), weight of curd with gourd leaf (0.9 kg), weight of curd without gourd leaf (0.4 kg), yield (24.5 t ha⁻¹), ascorbic acid (79.1 mg/100g) and total soluble solids (8.5°Brix). On the other hand, minimum values of these parameters were recorded in Pusa Samridhi. Spacing of 60x45 cm took minimum days (48.9) for curd initiation, (22.5) and days taken to curd harvest after curd initiation. Maximum curd diameter (116.8 mm), weight of curd with gourd leaf (0.9 kg), weight of curd without gourd leaf (0.4 kg) were recorded in 60x45 cm spacing. Quality parameters were also markedly affected with variety Pusa Broccoli KTS-1 and spacing 60x45 cm and relatively higher value of vitamin C (79.9 mg/100g) and total soluble solids (8.8°Brix) were recorded under V₁S₁ treatment.

Keywords-Broccoli, varieties, spacing, yield, quality characters.

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*), belongs to family cruciferae, is a member of Cole group having 18 chromosomes (2n=18, x=9). It is botanically classified as a variety of *Brassica oleracea* species, grown during cool-season for its green flowering head. Broccoli has large flower heads, usually green in color, arranged in a tree-like structure on branches sprouting from a thick, edible stalk. Broccoli is a high-quality vegetable for fresh use and is one of the most popular frozen vegetables. It is highly nutritious crop containing high amount of vitamins (A and C) and minerals (K, P, Ca and Fe). Moreover, it also contains thiamine, riboflavin and niacin. Broccoli is the richest source of protein among cole crops. It is additionally a rich source of sulphoraphane, a compound related with decreasing the risk of cancer and also prevents heart disease. India is the second largest producer of broccoli after China, while the US ranks third. Growth, yield and quality of crop plant are mainly influenced by two major factors viz. genotype and spacing. The existing varieties have emerged mostly through selection from

wide variability available. The improvement in the crop is mainly achieved through selection and evaluation. For successful cultivation of any crop in any area, the identification of suitable varieties is of prime importance (Bhagare *et al.* 2011). Optimum plant spacing is one of the important factors in increasing the yield and quality of crops (Singh *et al.* 2006, Yadav *et al.* 2016). Therefore, present studies were aimed at promotion of high valued broccoli by identifying and standardization of optimum plant spacing to obtain better growth, yield and quality of broccoli in Lucknow region. There is no any recommendation has been available with respect to suitability of specific variety for certain region. Therefore it is necessary to make a certain recommendations to generate research evidences with respect to suitability of certain varieties in a specific season to benefit the growers of Lucknow region.

MATERIALS AND METHODS

The field experiment was conducted at Babasaheb Bhimrao Ambedkar University, Lucknow (UP), during rabi season of 2017-18

and 2018-19. The experimental site is situated at 26°50' N latitude, 80°52' E longitude and altitude of 111 meter above mean sea level (MSL). The area experiences rainfall from April to October with many rains from June to early September. The area receives average rainfall between 800 and 1000 mm with temperature ranging from 15 to 30°C. Transplanting was done when the seedlings were 30 days old on 24th Nov. 2017 and 26th Nov. 2018 in first and second year, respectively. Four varieties viz. V₁- Pusa Broccoli KTS-1, V₂-Palam Kanchan, V₃-Palam Vichitra, V₄-Palam Samridhi with four spacings viz.- S₁- 60x45 cm, S₂- 60x30 cm, S₃- 45x45 cm, S₄- 45x30 cm were evaluated in factorial randomized block design with three replication. The soil of the experimental site was sandy loam in texture having pH of 7.9, organic carbon 4.2 g kg⁻¹, available N, P and K content 200, 12 and 185 kg ha⁻¹, respectively. Recommended dose of N, P₂O₅ and K₂O was supplied through urea, single super phosphate and muriate of potash, respectively. FYM was applied 20 days before

transplanting. The crop was grown with standard agronomic practices and plant protection measures were adopted as per schedule. The observations were recorded on yield and quality characters viz.-curd initiation day, day taken to curd harvest after curd initiation, curd diameter, weight of curd with gourd leaf, weight of curd without gourd leaf, yield, total soluble solids, total sugar, reducing and non reducing sugar were determined as per methods adopted by Ranganna (1977). The data were statistically analysed as per procedure of Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Varieties

Results revealed that all the varieties of broccoli exhibited significant variation in their performance in terms of yield attributes and quality characters. Among the genotypes, Pusa Broccoli KTS-1 recorded the minimum

Table 1: Influence of varieties and spacing's on yield attributing and yield of sprouting broccoli

Treatment	Curd initiation days	Day taken to curd harvest after curd initiation	Curd diameter (mm)	Weight of curd with gourd leaf (kg)	Weight of curd without gourd leaf (kg)	Yield (t ha ⁻¹)
Varieties (V)						
V ₁ (Pusa Broccoli KTS-1)	47.9	22.5	118.9	0.9	0.4	24.5
V ₂ (Palam Kanchan)	48.5	22.9	114.1	0.9	0.4	23.5
V ₃ (Palam Vichitra)	52.5	24.2	115.8	0.9	0.4	24.2
V ₄ (Palam Samridhi)	50.6	22.9	109.1	0.8	0.4	23.2
CD (P=0.05)	2.27	0.34	1.39	0.08	0.01	0.03
Spacing (S)						
S ₁ (60x45 cm)	48.9	22.5	116.8	0.9	0.4	17.9
S ₂ (60x30 cm)	49.5	23.0	116.2	0.9	0.4	26.0
S ₃ (45x45 cm)	50.2	23.6	114.3	0.8	0.4	21.8
S ₄ (45x30 cm)	51.0	24.1	111.3	0.8	0.4	29.7
CD (P=0.05)	2.27	0.34	1.39	0.08	0.01	0.04
(Interaction) (VxS)						
V ₁ S ₁	46.4	21.5	121.1	1.0	0.5	18.5
V ₁ S ₂	47.4	22.2	120.6	1.0	0.4	27.2
V ₁ S ₃	48.6	23.2	116.4	0.9	0.4	22.1
V ₁ S ₄	49.1	23.4	117.5	0.8	0.4	30.3
V ₂ S ₁	47.5	22.5	117.8	0.9	0.4	17.6
V ₂ S ₂	48.0	23.0	116.9	0.9	0.4	25.3
V ₂ S ₃	48.6	23.1	113.2	0.8	0.4	21.3
V ₂ S ₄	49.9	23.9	108.6	0.8	0.4	29.7
V ₃ S ₁	51.9	23.0	118.7	1.0	0.4	18.1
V ₃ S ₂	52.3	23.8	117.6	0.9	0.4	25.9
V ₃ S ₃	52.7	24.7	115.7	0.9	0.4	22.7
V ₃ S ₄	53.1	25.2	111.2	0.8	0.4	30.1
V ₄ S ₁	49.9	22.5	110.3	0.9	0.4	17.3
V ₄ S ₂	50.1	23.0	109.7	0.9	0.4	25.6
V ₄ S ₃	50.6	23.2	109.0	0.8	0.4	21.2
V ₄ S ₄	51.8	23.6	108.0	0.8	0.3	28.7
CD (P=0.05)	4.54	0.68	2.78	0.16	NS	0.24

days (47.9) for curd initiation, (22.4) days taken to curd harvest after curd initiation and maximum days were taken by PalamVichitra for these two yield attributes. The maximum curd diameter (118.9 mm), weight of curd with gourd leaf (0.9 kg), weight of curd without gourd leaf (0.4 kg) and curd yield (24.5 t ha⁻¹) were recorded with Pusa Broccoli KTS-1 variety. These results are in close conformity with the results of Bhangre *et al.* (2011). Pusa KTS-1 performed better over the cv. PalamKanchan. On the other hand minimum values of these parameters were recorded with PalamSamridhi. The curd of Pusa Broccoli KTS-1 contained relatively high amount of vitamin C (79.1mg/100g) and total soluble solids (8.5 °Brix) while higher values of total sugar (3.9 %), reducing sugar (3.3 %) and non-reducing sugar (0.7 %) were recorded in curd of PalamVichitra. These findings are in close conformity with Singhal *et al.* (2009).

Spacing

The data (Table 1 and 2) showed that yield and quality parameters were significantly affected with spacings. The spacing of 60x45 cm

took minimum days (48.9) for curd initiation and days taken to curd harvest after curd initiation (22.5). Maximum curd diameter (116.8 mm), weight of curd with gourd leaf (0.9 kg), weight of curd without gourd leaf (0.4 kg) was recorded in 60x45 cm. On the other hand, maximum curd yield (29.7 t ha⁻¹) was recorded with 45x30 cm spacing. These results are in close conformity with the results of Solunke *et al.* (2011) and Khetan *et al.* (2016). The maximum yield per plot was found recorded at higher plant density which was possibly due to more number of plants per unit area; higher ground covers of leaf area resulted in higher light interception and hence, higher assimilate production. Similar results have been reported by Agarwal *et al.* (2007), Khatan *et al.* (2016) and Gogoi *et al.* (2016) in broccoli. Quality parameters were also significantly affected with spacing. The maximum value of vitamin C (79.1mg/100g) and total soluble solids (8.3 °Brix) were recorded with 60x45 cm spacing. While total sugar (3.8 %), reducing sugar (3.3 %) and non-reducing sugar (0.6 %) were recorded maximum in 60x30 cm spacing (Vinod sutar *et al.* 2017).

Table 2: Influence of varieties and spacing's on yield and quality characters of sprouting broccoli

Treatment	Yield and yield attributing characters				
	Vitamin-C (mg/100g)	Total soluble solids (°Brix)	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar
Varieties (V)					
V ₁ (Pusa Broccoli KTS-1)	79.1	8.5	3.8	3.2	0.6
V ₂ (PalamKanchan)	78.2	8.2	3.7	3.2	0.5
V ₃ (PalamVichitra)	78.0	7.9	3.9	3.3	0.7
V ₄ (PalamSamridhi)	78.3	8.0	3.8	3.3	0.6
sCD _{5%}	1.00	1.03	NS	NS	0.11
Spacing (S)					
S ₁ (60x45 cm)	79.1	8.3	3.8	3.2	0.5
S ₂ (60x30 cm)	78.9	8.2	3.8	3.3	0.6
S ₃ (45x45 cm)	78.1	8.1	3.8	3.3	0.6
S ₄ (45x30 cm)	77.5	7.9	3.8	3.2	0.5
CD _{5%}	1.00	1.03	NS	NS	0.11

Interaction

Data (Table 1, 2&3) revealed that yields were significantly affected with interaction. Among the interaction, V₁S₁ recorded the minimum days (46.4) for curd initiation, days taken to curd harvest after curd initiation (21.5 days). The maximum curd diameter (121.1 mm), weight of curd with gourd leaf (1.0 kg), weight of curd without gourd leaf (0.5 kg) were recorded

under V₁S₁ treatment. The maximum curd yield (30.3 t ha⁻¹) was recorded in V₁S₄ treatment. These results are in close conformity with the findings of Bhangre *et al.* (2011) and Gariya *et al.* (2016). Quality parameters were also significantly affected with varieties and spacing's interaction and V₁S₁ recorded relatively high value of vitamin C (79.9 mg/100g). These findings were in close conformity with those of Singhal *et al.* (2009).

It may be concluded from the results that the varieties and spacings showed significant variation among the different parameters. When the distance between plants increased, the quality related parameters were also increased.

Generally, the wider the plant spacing the better is the performance of the broccoli. Thus, variety Pusa Broccoli KTS-1 and spacing 60x45 cm) and their interaction significantly affected that yield attributes and yield of broccoli.

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