

## Response of different genotypes of broccoli (*Brassica oleracea* var. *italica*) under different plant spacing on growth and yield parameters

AKASHDEEP SINGH, HARPREET KAUR\* AND TALWINDER SINGH

PG Department of Agriculture, General Shivdev Singh Diwan Gurbachan Singh Khalsa College, Patiala. 147001

\*Email- caukamlesh@gmail.com

### Abstract

The present investigation entitled “Response of different genotypes of broccoli (*Brassica oleracea* var. *italica*) under different plant spacing on growth and yield parameters” was conducted during 2019-2020 at the Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala. The experiment was laid out in a factorial randomized block design with three replications. The treatment consisted with three varieties viz,  $V_1$ : AR-712,  $V_2$ : Tahoe,  $V_3$ : Palamsamridhi with four plant spacing viz,  $S_1$ : 60×45 cm,  $S_2$ : 45×30 cm,  $S_3$ : 45×45 cm,  $S_4$ : 60×40 cm. The variety  $V_3$  (Palamsamridhi) had obtained highest plant height at harvest (44.53cm), plant spread (56.43cm) and number of leaves plant<sup>-1</sup> (19.87), Leaf length (27.53cm), Leaf breadth (21.47cm), Curd length (18.49cm), Curd diameter (14.45 cm), Stalk length (19.53 cm). Among the plant spacing  $S_1$  (60×45 cm) had observed highest plant height at harvest (41.34 cm), Plant spread (54.17 cm) and number of leaves plant<sup>-1</sup> (18.57), Leaf length (26.02cm), Leaf breadth (19.39cm), Curd length (17.06cm), Curd diameter (13.83 cm), Stalk length (18.49 cm).

**Keywords:** Plant spacing, varieties, growth

### Introduction

Broccoli (*Brassica oleracea* var. *italica*) is the member of Brassicaceae family with chromosome number 18. It is one of the most prominent vegetables grown all over the world and its native is Italy. According to Ngullie and Biswas (2014) the word broccoli is taken from the Italian plural of broccolo which means flowering top of a ‘cabbage’. It looks like a tree-like structure branching out from a thick, edible stalk. It is also known as harigobhi. The curd is formed from a solid flower head, green in colour and surrounded by several leaves (Jayawant 2017). Mainly three types of broccoli viz., Green, White, Purple are founded. Green type broccoli is grown all over in the world. Broccoli is cultivated all over the world especially in China, India, United States, Spain, Mexico, Japan (Anonymous 2014). Broccoli is always considered as the “Crown of jewel nutrition”. It is appreciated for finger licking taste and flavour (Bhangreet al. 2011). It has highly organoleptic value and nutritious vegetable and rich in vitamins, iron, calcium, protein, lutein, zeaxanthin and beta-carotene. It contains high quantity

of vitamin A (2500 IU), calcium (103 mg), phosphorus (78 mg), potassium (382 mg), protein (3.3%), vitamin C (100g) along with appreciable quantity of thiamine, niacin, riboflavin. Cultivation of crop depends upon plant spacing and different genotype. It is well established fact that plant spacing has significant impact on the growth and yield of crop. Optimal plant spacing may help the farmer to achieve more returns per unit area because of coherent utilization of light, nutrients and water by the plants. Increasing the plant density reduced the curd size but increased the total curd. Plant grown at distance spacing received more sunlight and nutrients, moisture, soil aeration and increased the curd size, curd weight and number of leaves plant<sup>-1</sup> (Gogoi et al. 2016).

### Materials and Methods

The field Studies “Response of different genotypes of broccoli (*Brassica oleracea* var. *italica*) under different plant spacing on growth and yield parameters” were conducted at the Campus for Research and Advanced studies Dhablan, G.S.S.D.G.S. Khalsa

College, Patiala, during October to January. The soil of experimental field was clay with pH 7.3. The experiment was laid out in the Factorial randomized block design (FRBD) with 12 treatments and 3 replications. There are three varieties V<sub>1</sub> : AR-712, V<sub>2</sub> : Tahoe, V<sub>3</sub> : PalamSamridhi and four plant spacing S<sub>1</sub> : 60 cm×45 cm, S<sub>2</sub> : 45 cm×30 cm, S<sub>3</sub> : 45 cm×45 cm, S<sub>4</sub> : 60 cm×40 cm was used. The gross and net plot sizes were 2.9 m ×2.9 m and 2.7 m × 2.7 m respectively. The treatments details along with symbols are used as: T<sub>1</sub>: 60 cm×45 cm + AR-712, T<sub>2</sub>: 45 cm×30 cm + AR-712, T<sub>3</sub>: 45 cm×45 cm + AR-712, T<sub>4</sub>: 60 cm×40 cm + AR-712, T<sub>5</sub>: 60 cm×45 cm + Tahoe, T<sub>6</sub>: 45 cm×30 cm + Tahoe, T<sub>7</sub>: 45 cm×45 cm + Tahoe, T<sub>8</sub>: 60 cm×40 cm + Tahoe, T<sub>9</sub>: 60 cm×45 cm + Palam Samridhi, T<sub>10</sub>: 45 cm×30 cm + Palam Samridhi, T<sub>11</sub>: 45 cm×45 cm + Palam Samridhi, T<sub>12</sub>: 60 cm×40 cm + Palam Samridhi.

**Results and Discussion**

*Growth parameters (30 DAT, 60 DAT and at the time of harvesting)*

Plant height was recorded at 30 DAT, 60 DAT and at the time of harvesting and data presented in table 1 show significant impact of genotypes and plant spacing on plant height at all stages. Among the varieties V<sub>3</sub> (Palam Samridhi) had obtained highest plant height (44.53cm) as compare to V<sub>1</sub> (AR-712) (33.93cm) and V<sub>2</sub> (Tahoe) (40.00cm) at all stages. The plant spacing show significant effect on plant height at all stages. Plant spacing S<sub>1</sub> (60×45 cm) had recorded highest plant height (41.34cm) and minimum plant height (37.49cm) was determined in S<sub>2</sub> (45×30 cm) at all stages. The at par result was measured (40.13cm) with S<sub>4</sub> (60×40 cm)

Table 1: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on plant height (cm) at 30 DAT, 60 DAT and at harvest

Treatments	Plant height (cm)		
	30 DAT	60 DAT	At Harvest
AR-712 (V <sub>1</sub> )	18.71	30.04	33.93
Tahoe (V <sub>2</sub> )	24.23	34.90	40.00
PalamSamridhi (V <sub>3</sub> )	26.83	42.34	44.53
Sedm	0.549	1.173	0.476
CD (0.05)	1.138	2.433	0.987
60×45 cm (S <sub>1</sub> )	24.99	39.17	41.34
45×30 cm (S <sub>2</sub> )	21.53	32.02	37.49
45×45 cm (S <sub>3</sub> )	22.75	34.03	38.98
60×40 cm (S <sub>4</sub> )	23.73	37.82	40.13
SEm±	0.634	1.354	0.550
CD (0.05)	1.314	2.809	1.140

Table 2: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on plant spread (cm) at 30DAT, 60 DAT and at harvest

‘Treatments	Plant spread(cm)		
	30 DAT	60 DAT	At Harvest
AR-712 (V <sub>1</sub> )	31.53	42.84	50.13
Tahoe (V <sub>2</sub> )	34.86	46.30	53.00
PalamSamridhi (V <sub>3</sub> )	37.05	49.57	56.43
Sedm	0.419	0.232	0.223
CD (0.05)	0.868	0.482	0.463
60×45 cm (S <sub>1</sub> )	35.48	47.18	54.17
45×30 cm (S <sub>2</sub> )	33.46	45.10	52.03
45×45 cm (S <sub>3</sub> )	34.33	46.00	52.83
60×40 cm (S <sub>4</sub> )	34.66	46.67	53.70
SEm±	0.483	0.268	0.258
CD (0.05)	1.002	0.557	0.534

at all stages. More vegetative growth of broccoli is under wider plant spacing. In the research finding, it might be because of wider plant spacing which gave more space, receiving maximum sunlight and more photosynthesis rather than close spacing. The genetic behavior of Palam Samridhi is superior than Tahoe and AR-712. The findings are also in close agreement with those of reported by Sharma *et al.* (2018). Plant spread was noticed at 30, 60 DAT and at a time of harvesting. The data showed in table 2 revealed significant impact of varieties and plant spacing on plant spread at all stages. From the varieties V<sub>3</sub> (PalamSamridhi) (56.43cm) had observed maximum plant spread as compare to V<sub>1</sub> (AR-712) (50.13cm) and V<sub>2</sub> (Tahoe) (53.00cm) at all stages. Plant spacing S<sub>1</sub> (60×45 cm) had revealed maximum plant spread (54.17cm) and minimum plant spread (52.03cm) was noted in S<sub>2</sub> (45×30 cm) at all stages. The at par result was noticed with S<sub>4</sub> (60×40 cm) (53.70cm) at all stages. The wider spacing can gave wider space for plant spread. Consequently, plant received more sunlight and more nutrients, aeration. Due to closer spacing a tough competition for nutrients and aeration. The genetic structure Tahoe and AR-712 is not superior than PalamSamridhi. PalamSamridhi gave maximum plant spread at all stages. The same findings had also observed by Tejaswini *et al.* (2018). Number of leaves plant<sup>-1</sup> was counted at 30, 60 DAT and at time of harvesting. The findings represented in table 3 showed significant influence of varieties and plant spacing. Varieties showed significant influence on number of

Table 3: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on number of leaves per plant at 30 DAT, 60 DAT and at harvest

Treatments	Number of leaves plant <sup>-1</sup>		
	30 DAT	60 DAT	At Harvest
AR-712 (V <sub>1</sub> )	7.16	12.43	15.66
Tahoe (V <sub>2</sub> )	8.68	14.90	17.89
PalamSamridhi (V <sub>3</sub> )	10.07	16.33	19.87
Sedm	0.108	0.163	0.169
CD (0.05)	0.224	0.338	0.350
60×45 cm (S <sub>1</sub> )	9.13	15.12	18.57
45×30 cm (S <sub>2</sub> )	8.06	13.86	17.04
45×45 cm (S <sub>3</sub> )	8.40	14.40	17.46
60×40 cm (S <sub>4</sub> )	8.94	14.83	18.16
SEm±	0.125	0.188	0.195
CD (0.05)	0.258	0.391	0.404

leaves plant<sup>-1</sup>. The V<sub>3</sub> (PalamSamridhi) had noticed maximum number of leaves plant<sup>-1</sup> (19.87) and more superior than V<sub>1</sub> (AR-712) (15.66) and V<sub>2</sub> (Tahoe) (17.89) at all stages. Among the plant spacing S<sub>1</sub> (60×45 cm) had attained highest number of leaves plant<sup>-1</sup> (18.57) and lowest number of leaves plant<sup>-1</sup> (17.04) was observed in S<sub>2</sub> (45×30cm) at all stages. At the all stages at par result (18.16) was investigated with S<sub>4</sub> (60×40 cm). In the observed results, wider spacing gave more space and plant attained more nutrients, photosynthesis, aeration, sunlight rather than closer spacing. The PalamSamridhi is observed better at all stages as compare Tahoe and AR-712. These Similar observations were concluded by Thirupalet *et al.* (2014). Leaf length had taken at 30, 60 DAT and at a time of harvesting. The data presented in the table 4 appear significant effect of varieties and plant spacing. Among the varieties V<sub>3</sub> (PalamSamridhi) had reported maximum leaf length (27.53 cm) as compared to V<sub>1</sub> (AR-712) (23.43 cm) and V<sub>2</sub> (Tahoe) (25.38 cm) at all stages. Plant spacing exerted impact on leaf length. Maximum leaf length (26.02 cm) was investigated in S<sub>1</sub> (60×45 cm) and minimum leaf length (24.74 cm) was reported with S<sub>2</sub> (45×30 cm). The S<sub>4</sub> (60×40 cm) (25.70 cm) was given at par at all the stages. More growth of broccoli is under wider plant spacing. The more space was revealed with the distance spacing due to more space plant receiving maximum sunlight and more photosynthesis rather than

Table 4: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on leaf length (cm) at 30 DAT, 60 DAT and at harvest

Treatments	Leaf length (cm)		
	30 DAT	60 DAT	At Harvest
AR-712 (V <sub>1</sub> )	9.50	16.61	23.43
Tahoe (V <sub>2</sub> )	11.39	18.68	25.38
PalamSamridhi (V <sub>3</sub> )	13.21	21.39	27.53
Sedm	0.268	0.304	0.138
CD (0.05)	0.555	0.631	0.286
60×45 cm (S <sub>1</sub> )	12.04	19.86	26.02
45×30 cm (S <sub>2</sub> )	10.64	17.88	24.74
45×45 cm (S <sub>3</sub> )	11.02	18.60	25.31
60×40 cm (S <sub>4</sub> )	11.76	19.24	25.70
SEm±	0.309	0.351	0.159
CD (0.05)	0.641	0.728	0.330

close spacing. When plant grown at distance spacing leaves attained their proper shape and size. The genetic behavior of PalamSamridhi is good than Tahoe and AR-712. Similar findings were also found by Chand and Singh (2017). Leaf breadth had also measured at 30, 60 DAT and at a time of harvesting. The findings showed in table 5 showed significant impact of varieties as well as plant spacing. Variety V<sub>3</sub> (PalamSamridhi) gained more leaf breadth (21.47 cm) rather than V<sub>1</sub> (AR-712) (16.07 cm) and V<sub>2</sub> (Tahoe) (18.33 cm) at all stages. Highest leaf breadth (19.39 cm) was observed with S<sub>1</sub> (60×45 cm) as well as lowest leaf breadth (17.10 cm) was given with S<sub>2</sub> (45×30 cm). At the all stages at par result (18.78 cm) was concluded with S<sub>4</sub> (60×40 cm). Wider plant spacing can gave more growth of broccoli. The results observed that wider spacing gave wider space due to more space plant receiving maximum aeration, soil moisture than close spacing. For growth PalamSamridhi is the finest variety. The genetic structure of PalamSamridhi is always better than Tahoe and AR-712. The results were also corroborated with the findings of Chand and Singh (2017).

#### Yield Parameters

Curd length was observed at the time of harvesting. The data presented in table 6 showed significant effect of varieties and plant spacing. Among the varieties V<sub>3</sub> (palamSamridhi) gave maximum curd length (18.49 cm) as compare V<sub>1</sub> (AR-712) (14.81

Table 5: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on leaf breadth (cm) at 30 DAT, 60 DAT and at harvest

Treatments	Leaf breadth (cm)		
	30 DAT	60 DAT	At Harvest
AR-712 (V <sub>1</sub> )	11.00	15.53	16.07
Tahoe (V <sub>2</sub> )	13.72	17.75	18.33
PalamSamridhi (V <sub>3</sub> )	15.72	20.32	21.47
Sedm	0.163	0.232	0.370
CD (0.05)	0.337	0.482	0.768
60×45 cm (S <sub>1</sub> )	14.36	19.11	19.39
45×30 cm (S <sub>2</sub> )	12.51	17.29	17.10
45×45 cm (S <sub>3</sub> )	13.07	17.98	17.53
60×40 cm (S <sub>4</sub> )	13.98	18.58	18.78
SEm±	0.188	0.268	0.428
CD (0.05)	0.390	0.557	0.887

Table 6: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on curd length (cm) at harvest

Treatments	Curd length (cm)
AR-712 (V <sub>1</sub> )	14.81
Tahoe (V <sub>2</sub> )	16.04
PalamSamridhi (V <sub>3</sub> )	18.49
Sedm	0.369
CD (0.05)	0.765
60×45 cm (S <sub>1</sub> )	17.06
45×30 cm (S <sub>2</sub> )	15.66
45×45 cm (S <sub>3</sub> )	16.10
60×40 cm (S <sub>4</sub> )	16.98
SEm±	0.426
CD (0.05)	0.884

cm) and V<sub>2</sub> (Tahoe) (16.04 cm). Plant spacing showed significant effect on curd length. Highest curd length (17.06 cm) was notice with S<sub>1</sub> (60×45 cm) as well as lowest (15.66 cm) was given with S<sub>2</sub> (45×30 cm). The at par result (16.98 cm) was measured with S<sub>4</sub> (60×40 cm). The curd length is the important yield parameters and it is also influenced by different spacing. The wider spacing can gave more space for curd length. As a result, plant received more sunlight and more nutrients, aeration. Closer spacing showed poor result because close competition for nutrients and aeration. The genetic structure of Tahoe and AR-712 is not superior than PalamSamridhi. PalamSamridhi gave maximum curd length at all stages. These Similar results on curd

Table 7: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on curd diameter (cm) at harvest

Treatments	Curd diameter (cm)
AR-712 (V <sub>1</sub> )	12.07
Tahoe (V <sub>2</sub> )	13.16
PalamSamridhi (V <sub>3</sub> )	14.45
Sedm	0.296
CD (0.05)	0.614
60×45 cm (S <sub>1</sub> )	13.83
45×30 cm (S <sub>2</sub> )	12.59
45×45 cm (S <sub>3</sub> )	12.94
60×40 cm (S <sub>4</sub> )	13.53
SEm±	0.342
CD (0.05)	0.709

Table 8: Response of different genotypes of broccoli (*Brassica oleracea var. italica*) under different plant spacing on stalk length (cm) at harvest

Treatments	Stalk length (cm)
AR-712 (V <sub>1</sub> )	16.00
Tahoe (V <sub>2</sub> )	17.98
PalamSamridhi (V <sub>3</sub> )	19.53
Sedm	0.400
CD (0.05)	0.830
60×45 cm (S <sub>1</sub> )	18.49
45×30 cm (S <sub>2</sub> )	17.15
45×45 cm (S <sub>3</sub> )	17.44
60×40 cm (S <sub>4</sub> )	18.26
SEm±	0.462
CD (0.05)	0.958

length was also founded by Suthar *et al.* (2017). Curd diameter was observed at the time of harvesting. The findings presented in table 7 appeared significant effect of varieties and plant spacing. Variety V3 (PalamSamridhi) had noted maximum curd breadth (14.45 cm) as compared to V<sub>1</sub> (AR-712) (12.07 cm) and V2 (Tahoe) (13.16 cm). Among the plant spacing S<sub>1</sub> (60×45 cm) had attained highest curd breadth (13.83 cm) and lowest curd breadth (12.59 cm) was revealed in S<sub>2</sub> (45×30 cm). The at par result (13.53 cm) was measured with S<sub>4</sub> (60×40 cm). Wider plant spacing can gave more curd breadth of broccoli. Maximum curd diameter represented the highest yield of broccoli. In the results, it may be because of wider spacing gave more space due to more space plant receiving maximum sunlight and nutrients, soil moisture

and more photosynthesis than close spacing. PalamSamridhi is the superior variety. The genetic structure of PalamSamridhi is always better than Tahoe and AR-712. The results were also confirmed with results of Suthar *et al.* (2017). Stalk length was measured at the time of harvesting. The perusal of data presented in table 8 reveal significant impact of varieties and plant spacing. Stalk length was significantly influenced with varieties. Highest stalk length (19.53 cm) was found with V<sub>3</sub> (Palamsamridhi) rather than V<sub>1</sub> (AR-712) (16.00 cm) and V<sub>2</sub> (Tahoe) (17.98 cm). Among the different plant spacing S<sub>1</sub> (60×45 cm) had noticed highest stalk length (18.49 cm) and lowest stalk length (17.15 cm) was observed in S<sub>2</sub> (45×30 cm). The at par result (18.26 cm) was measured with S<sub>4</sub> (60×40 cm). Wider plant spacing can gave more stalk length of broccoli. It will be because of wider spacing revealed more space. Consequently, plant receiving maximum sunlight and soil aeration than dense spacing. PalamSamridhi is also better variety for yield parameters. The genetic structure of PalamSamridhi is always superior than Tahoe and AR-712. The same observations had also revealed by the Sharma *et al.* (2018).

### Conclusion

Based on present research, concluded that plant spacing S<sub>1</sub> (60×45 cm) gave highest growth attributes at all stages as compare S<sub>2</sub> (45×30cm), S<sub>3</sub> (45×45cm), S<sub>4</sub> (60×40cm). Among the varieties, V<sub>3</sub> (PalamSamridhi) demonstrate superior than Tahoe and AR-712 at all stages.

### References

Anonymous (2014). *Package of practices for cultivation of vegetable crops*. Pp. 20-25. Punjab Agricultural University, Ludhiana.

Bhangre, K.K.; Sonawane, P.C. and Warade, S.D. (2011). Effect of different varieties and spacing on growth and yield parameters of broccoli under Pune conditions. *Asian Journals Horticulture*. 6(1):74-76.

Chand, T. and Singh, M.K. (2017). Effect of different doses of NPK and plant spacing on growth and yield of broccoli. *Bulletin of environment, Pharmacology and Life Sciences*. 7(1):69-74.

Gogoi, S.; Das, M.R.; Bora, P.; Mazumdar, N. and Das, B.K. (2016). Effect of sowing dates and spacing on broccoli. *Indian journals agriculture research*. 50(4): 350-53.

Jayawant, V.K. (2017). *Studies on effect of planting dates on growth, yield and quality of broccoli*. M.Sc. Thesis, College of Agriculture, Parbhani, India.

Ngullie, R. and Biswas, P.K. (2014). Performance of different varieties of broccoli under rainfed mid-hill conditions of Mokokchung district of Nagaland. *International Journal of Farm Science*. 4(2): 76-79.

Sharma, C.; Kang, B.S.; Kaur, R.; Singh, S.K. and Aulakh, K. (2018). Effect of integrated nutrient management on growth and quality of broccoli. *International Journal of chemical studies*. 6(2): 1296-1300.

Suthar, V.; Aravindakshan, K. and Bolia, P.K. (2017). Effect of sowing date and spacing on growth, yield and quality of broccoli. *Creative Commons Attribution License*. 7(5):640-43.

Tejaswini, T.; Varma, L.R.; Verma, P.; Kumar, A. and Prajapatii, R.I. (2018). Studies on interaction of plant spacing on different varieties with respect to growth and yield of broccoli. *Journal of Pharmacognosy and Phytochemistry*. 7(5):733-36.

Thirupal, D.; Madhumathi, C. and Syam, P. (2014). Effect of planting dates and plant spacing on growth, yield and quality of broccoli. *Plant Archives*. 14(2): 1095-98.