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The Pharma Innovation

**ISSN (E): 2277-7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2022; 11(8): 290-292

www.thepharmajournal.com
Received: 02-05-2022
Accepted: 09-06-2022

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# Studies on interaction effect of different plant spacing on Performance of different varieties with respect to yield and quality attributes of broccoli (*Brassica oleracea* var. *italica.* L)

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**Abstract**
Vegetables are rich source of nutrients, besides their medicinal values. Vegetables as food and diet supplements are gaining momentum in most countries in the recent years. Vegetables are higher in productivity than other crops. They provide more food per unit time and area of land. Broccoli as an unconventional vegetable is yet to gain the desired popularity in our country. However, considerable attention is being given on production technology of broccoli which is rich in nutrient content and greater yield potential. But yet no systematic work has been done on evaluation and commercialization of high value nutrient rich varieties of broccoli. Therefore, the present investigation was carried out during *Rabi*, 2015-16 at Horticulture Instructional Farm, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar, Gujarat with 12 treatments replicated thrice in Split Plot Design. The treatment combinations include three plant spacings *viz*., $S_1$: 30 cm × 30 cm, $S_2$: 45 cm × 30 cm and $S_3$: 45 cm × 45 cm with four varieties *viz*., Palam Samridhi ($V_1$), Palam Vichitra ($V_2$), Pusa Broccoli KTS-1 ($V_3$) and Palam Haritika ($V_4$). Results revealed that $S_1V_2$ recorded highest yield per plot (7.80 kg) and yield per hectare (283.47 q), while $S_3V_4$ recorded lowest yield per plot (0.57 kg) and yield per hectare (64.53 q), whereas maximum head diameter recorded with the treatment combination $S_3V_2$ [ N-S (15.06 cm) & E-W (15.33 cm)].With respect to quality parameters *i.e* total dry matter content, crude protein, potassium (mg/100 g) and calcium content (mg/100 g) $S_3V_2$ treatment combination recorded highest.

**Keywords:** Broccoli, spacings, varieties, yield and quality attributes

## 1. Introduction
Vegetables in its broadest sense refers to any kind of plant life or plant product which in the narrow sense, it refers to the fresh edible portion of a herbaceous plant consumed in either raw or cooked form. Increased production and consumption of horticultural crops particularly vegetables with its wide adoption and provider of important nutrients offers promise for the future.

Broccoli (*Brassica oleracea*. var. *italica.* L) belongs to the family cruciferae. In Hindi it is known as Hari Phool Gobhi. The broccoli grown in India is commonly known as the green sprouting broccoli. Broccoli is an edible green plant which is rich in vitamin -C, dietary fibre and also contain glucoraphin, sulforaphane, selenium and iso-thiocyanates. It is an excellent source of Indole-3-carbinol and the constituents present in broccoli are known to be very popular since they possess several anti-cancer properties and benefits. These anti-carcinogenic compounds have a wide variety of uses and benefits for the treatment of various diseases and disorders. Broccoli is widely used in the treatment of several forms of cancer and also treats other neural disorders. The therapeutic potential of broccoli has been explained under its role in cancer, diabetes and other diseases. In the treatment of cancer, most of the constituents or the phytochemicals of broccoli such as brassinin, iso-thiocyanates, indole-3-carbinol *etc*. have been proved to be effectively beneficial. The antioxidant activity of broccoli is induced by other phytochemicals such as glucosinolates, glucoraphin and sulforaphane. Sulforaphane in broccoli sprouts also has the potential to cure neural disorders such as Alzheimer's disease and Parkinson's disease. It is also used to bring about cure in asthma and diabetic patients. Flavonoids have the effect of reducing the risk of diabetes. It is rich source of sulphoraphane associated with reducing the risk of cancer (Guo *et al*. 2001) [2]. Nutritionally, it is rich in vitamin-A, C, protein, carbohydrates and minerals (Rana, 2008) [7]. After harvesting the head, its green leaves are also a good source of nutritious green fodder and serves in acute shortage in winter season (Kumar *et al*. 2007).

Plant spacing is an important factor that will influence the plant population per unit area plays an important role in growth and development of the crop. Optimum plant spacing is one of the important factors in increasing the yield and quality of crops. 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 is important for North Gujarat. There are no any recommendation has been available with respect to suitability of specific variety for certain region. So, there is a research need to make a certain recommendation to generate research evidences with respect to suitability of certain varieties in a specific season to benefit the growers of North Gujarat region.

## 2. Material and Methods

The present investigation was executed at Horticulture Instructional Farm, CP College of Agriculture, Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during 2015-16. The experiment was laid out in a split plot design with three replications with plots of 2.70 m x 1.80 m size. The experiment was carried out with three different plant spacing ($S_1$ 30 cm × 30cm, $S_2$ 45 cm × 30 cm and $S_3$ 45 cm × 45 cm) and four varieties (Palam Samridhi, Palam Vichitra, Pusa broccoli KTS-1 and Palam Haritika) (table.1). Recommended package of practices were followed to keep good crop stand. The mean data were subjected to statistical analysis following analysis of variance technique suggested by Panse and Sukhatme, 1985 [6].

**Table 1:** Details of treatment combinations

| S. No | Treatment Notations | Treatment Combinations |
|---|---|---|
| 1. | $S_1V_1$ | Plant spacing (30 cm × 30 cm) with variety Palam Samridhi |
| 2. | $S_1V_2$ | Plant spacing (30 cm × 30 cm) with variety Palam Vichitra |
| 3. | $S_1V_3$ | Plant spacing (30 cm × 30 cm) with variety Pusa broccoli KTS-1 |
| 4. | $S_1V_4$ | Plant spacing (30 cm × 30 cm) with variety Palam Haritika |
| 5. | $S_2V_1$ | Plant spacing (45 cm × 30 cm) with variety Palam Samridhi |
| 6. | $S_2V_2$ | Plant spacing (45 cm × 30 cm) with variety Palam Vichitra |
| 7. | $S_2V_3$ | Plant spacing (45 cm × 30 cm) with variety Pusa broccoli KTS-1 |
| 8. | $S_2V_4$ | Plant spacing (45 cm × 30 cm) with variety Palam Haritika |
| 9. | $S_3V_1$ | Plant spacing (45 cm × 45 cm) with variety Palam Samridhi |
| 10. | $S_3V_2$ | Plant spacing (45 cm × 45 cm) with variety Palam Vichitra |
| 11. | $S_3V_3$ | Plant spacing (45 cm × 45 cm) with variety Pusa broccoli KTS-1 |
| 12. | $S_3V_4$ | Plant spacing (45 cm × 45 cm) with variety Palam Haritika |

## 3. Results and Discussion

The interaction effect between different plant spacing and varieties with respect to yield per plot and yield per hectare was found to be significant. The significantly maximum yield per plot was recorded (7.80 kg) with treatment combination $S_1V_2$ and was found to be statistically at par with treatment combination $S_1V_1$ (7.23 kg). The minimum yield per plot (0.57 kg) was observed with treatment combination $S_3V_4$ (table 2). The maximum yield per hectare (283.47 q) was recorded with treatment combination $S_1V_2$ which was found statistically at par with the treatment combination $S_1V_1$ (261.85 q) and the minimum yield per hectare (64.53 q) was recorded with treatment combination $S_3V_4$. These findings are in accordance with the findings of Bhangre *et al*. (2011) [1], Solunke *et al.* (2011) [8] and Vinod *et al.* (2017) [9] in broccoli.

The interaction effect between different plant spacing and varieties with respect to head diameter (N-S) & (E-W) was found to be non-significant (table 2). The maximum head diameter was recorded with the treatment combination $S_3V_2$ (15.06 cm) N-S & (15.33 cm) (E-W) and the minimum head diameter was observed with the treatment combination $S_1V_4$ (9.68 cm N-S & 9.68 cm E-W) (table 2). These findings are in accordance with the findings of Bhangre *et al.* (2011) [1], Solunke *et al.* (2011) [8] and Vinod *et al.* (2017) [9] in broccoli. The highest total dry matter content of the head (20.33%), crude protein (3.64%), potassium (513.3 mg/100g) and calcium (47.97 mg/ 100g) was recorded with interaction treatment combination $S_3V_2$. Whereas, the lowest total dry matter content was recorded with the treatment combination $S_1V_4$ (18.20%). The minimum crude protein content (2.57%) was observed with treatment combination $S_1V_3$ and $S_2V_3$. The lowest potassium content (423.3 mg /100 g) and calcium content (36.06 mg / 100g) was recorded with treatment combination $S_3V_4$. These findings are in accordance with the findings of Bhangre *et al*. (2011) [1] and Gurjeet (2016) [3] in broccoli and Moniruzzaman *et al*. (2011) [5] in cabbage.

**Table 2:** Interaction effect of plant spacings on different varieties with respect to Yield per plot, Yield per hectare and head diameter (N-S) & (E-W)

| Treatment combinations | Yield per plot (kg) | Yield per hectare (q) | Head diameter (N-S) (cm) | Head diameter (E-W) (cm) |
|---|---|---|---|---|
| $S_1V_1$ | 7.23 | 261.85 | 13.54 | 13.30 |
| $S_1V_2$ | 7.80 | 283.47 | 14.76 | 15.10 |
| $S_1V_3$ | 6.80 | 231.17 | 12.82 | 12.95 |
| $S_1V_4$ | 1.10 | 100.94 | 9.68 | 9.68 |
| $S_2V_1$ | 3.53 | 138.89 | 12.82 | 13.08 |
| $S_2V_2$ | 3.93 | 153.88 | 13.90 | 14.48 |
| $S_2V_3$ | 3.37 | 124,07 | 12.72 | 13.04 |
| $S_2V_4$ | 0.83 | 91.29 | 9.69 | 9.69 |
| $S_3V_1$ | 1.97 | 136.21 | 13.51 | 13.58 |
| $S_3V_2$ | 2.27 | 128.89 | 15.06 | 15.33 |
| $S_3V_3$ | 1.83 | 116.73 | 12.90 | 12.92 |
| $S_3V_4$ | 0.57 | 64.53 | 9.98 | 10.24 |

| | | | | |
|---|---|---|---|---|
| S.Em± | 0.19 | 14.13 | 0.75 | 0.76 |
| CD at 5% | 0.56 | 41.99 | NS | NS |
| CV | 9.59 | 16.04 | 10.00 | 10.00 |

**Table 3:** Interaction effect of plant spacings on different varieties with respect to total dry matter content of the head, crude protein (%), potassium content (mg/100g) and calcium content (mg/100g)

| Treatment combinations | Total dry matter content of the head (%) | Crude protein (%) | Potassium content (mg / 100 g) | Calcium content (mg / 100 g) |
|---|---|---|---|---|
| $S_1V_1$ | 19.43 | 2.81 | 456.6 | 45.85 |
| $S_1V_2$ | 20.26 | 3.61 | 500.0 | 46.34 |
| $S_1V_3$ | 18.96 | 2.57 | 443.3 | 39.72 |
| $S_1V_4$ | 18.20 | 2.62 | 436.6 | 36.86 |
| $S_2V_1$ | 19.53 | 2.82 | 446.6 | 45.66 |
| $S_2V_2$ | 20.30 | 3.50 | 510.0 | 46.84 |
| $S_2V_3$ | 18.83 | 2.57 | 443.3 | 41.13 |
| $S_2V_4$ | 19.46 | 2.63 | 453.3 | 37.33 |
| $S_3V_1$ | 19.06 | 2.81 | 460.0 | 45.30 |
| $S_3V_2$ | 20.33 | 3.64 | 513.3 | 47.97 |
| $S_3V_3$ | 18.80 | 2.71 | 446.6 | 41.26 |
| $S_3V_4$ | 19.13 | 2.67 | 423.3 | 36.06 |
| S.Em± | 0.15 | 0.06 | 6.92 | 0.77 |
| CD | NS | NS | NS | NS |
| CV | 1.34 | 2.84 | 3.03 | 2.80 |

## 4. Conclusion

From the above study, it is concluded that among the different plant spacing and varieties interaction with respect to yield parameters $S_1V_2$ recorded highest yield per plot and yield per hectare while the lowest yield per plot and yield per hectare was recorded with treatment combination $S_3V_4$. With respect to quality parameters maximum head diameter, total dry matter content, crude protein, potassium (mg / 100 g) and calcium content (mg / 100 g) was observed with treatment combination $S_3V_2$.

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