

## Original Research Article

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## Performance of Different Varieties with Respect to Growth, Yield and Quality of Broccoli (*Brassica oleracea* var. *italica* L.) under North Gujarat Conditions

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### ABSTRACT

Vegetables play a very important role in our daily diet. As an unconventional vegetable “Broccoli” 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 study was conducted during *rabi* season 2015-16 at Horticulture Instructional Farm, CP College of Agriculture, SD Agricultural University, Sardarkrushinagar, Gujarat to find out performance of different varieties with respect to growth, yield and quality under north Gujarat conditions comprising four varieties [Palam Samridhi (V<sub>1</sub>), Palam Vichitra (V<sub>2</sub>), Pusa Broccoli KTS-1 (V<sub>3</sub>) and Palam Haritika (V<sub>4</sub>)]. The treatments were tested in Split Plot Design with three replications. Observations were recorded on growth, yield and quality parameters. The results revealed that the treatment V<sub>2</sub> (Palam Vichitra) recorded significantly maximum plant height at 45 DAT (40.77 cm), number of leaves at 45 DAT (11.11), fresh weight of head (311.9 g), maximum yield per plot (4.67 kg), yield per hectare (188.7 q), highest head diameter (15.00 cm), maximum dry matter percent (20.68%), protein content (3.53%), potassium content (507.7 mg) and calcium content (47.05 mg). While significantly maximum plant height at harvest (63.07 cm), number of leaves at harvest (22.71) and maximum plant spread at 45DAT [E-W (49.53 cm) and N-S (46.88 cm)] and at the stage of head harvest [E-W (60.94 cm) and N-S (60.94 cm)] were recorded with the treatment V<sub>4</sub> (Palam Haritika) and the treatment V<sub>1</sub> (Palam Samridhi) recorded minimum days taken for head initiation (50.49 days) and for first head harvest (71.11 days).

#### Keywords

Broccoli, Varieties, Growth, Growth attributes, Yield and quality parameters

#### Article Info

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### Introduction

Broccoli (*Brassica oleracea* var. *italica* L.) is one of the most prominent vegetable grown all over the world and is an important fancy and highly nutritive exotic vegetable. It is a

member of cruciferous family having many important vegetables such as Cauliflower, Cabbage, Knol-khol, Brussels sprout, Kale and Chinese cabbage. It is also known as winter broccoli or heading broccoli or Italian broccoli. It is considered to be originated from

wild cabbage, *Brassica oleracea* var. *oleracea* (syn. *Brassica oleracea* var. *Sylvestris* L.), which is found growing wild along the Mediterranean Sea.

This vegetable, closely resembling cauliflower but usually green in color, introduced in India many years after cabbage and cauliflower and has gained popularity in short span of time. Now, India stands at second position for cauliflower and broccoli production with an annual production of 6.7 million tones. Broccoli is a rich source of sulphoraphane which is associated with reducing the risk of cancer (Guo *et al.*, 2001). The primary inflorescence was characterized by higher levels of dry matter, total nitrogen, vitamin-C, chlorophylls,  $\beta$ -carotene, carotenoids and by lower levels of nitrates.

Nutritionally, it is rich in vitamin-A (2500 I.U.), vitamin-C (113 mg), protein (3.6 g), carbohydrates (5.9 g) and minerals like calcium (103 mg), iron (1.1 mg), phosphorous (78 mg), potassium (382 mg) and sodium (15 mg) per 100 gm of edible portion (Rana, 2008). After harvesting the head, its green leaves are also a good source of nutritious green fodder (Kumar *et al.*, 2007).

In India, it is being used as a fresh vegetable, whereas in USA and European countries it is used as fresh as well as frozen form. It is usually boiled or steamed but may be eaten raw as salad and is liked in soups. The anti-cancer benefits of broccoli are greatly reduced if the vegetable is boiled. However, other preparation method such as steaming, microwaving and frying had no significant effect on the constituent compounds (Jeffery, 2005).

There are two types of broccoli, heading and sprouting. Most common broccoli is of the heading type which is closely related to cauliflower and forms a large central head.

Sprouting or Italian broccoli form many florets or small heads but they do not produce a solid head. Its edible portion consists of immature, fully-differentiated flower buds and tender portions of the upper stem.

Numbers of superior broccoli varieties are released by different universities and ICAR Institutes but there is 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 recommendations to generate research evidences with respect to suitability of certain varieties in a specific season to benefit the growers of North Gujarat region.

## **Materials and Methods**

The present experiment was carried out at Horticulture Instructional Farm, CP College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during *rabi* season 2015-16. The soil of the experimental plot was well drained with good water holding capacity. As per recommendation for this zone 20 tonnes of farm yard manure (FYM), 50 kg N, 50 kg P and 50 kg K in the form of urea, single super phosphate and murate of potash were applied at the time of soil preparation. The remaining half dose 50 kg (50%) of nitrogen was applied as top dressing in two splits at 20 and 30 days after transplanting.

The experiment was laid out in a split plot design with three replications. The experimental area was divided into plots of 2.70 m x 1.80 m size. The experiment was carried out with four varieties [Palam Samridhi (V<sub>1</sub>), Palam Vichitra (V<sub>2</sub>), Pusa Broccoli KTS-1 (V<sub>3</sub>) and Palam Haritika (V<sub>4</sub>)]. To raise the crop recommended package of practices was followed. The date of seed sowing in nursery bed was on 23<sup>rd</sup> November 2015 and date of transplanting on 17<sup>th</sup>

December 2015 during Rabi season. The performance of different varieties of broccoli was studied and data recorded on germination, plant height (at transplanting, 45 days after transplanting, at harvest), number of leaves (45 days after transplanting, at harvest), plant spread (45 days after transplanting, at harvest), days taken for head initiation, days taken for harvesting, yield and quality parameters. The mean data were subjected to statistical analysis following analysis of variance technique (Panse and Sukhatme, 1985).

## **Results and Discussion**

### **Growth parameters**

#### **Days taken for germination**

The performance of different varieties with respect to number of days taken for germination was found significant and the data is furnished in table 1. The significantly minimum days taken for germination (3.0) was found with treatment V<sub>3</sub> (Pusa broccoli KTS-1) and V<sub>4</sub> (Palam Haritika). The treatment V<sub>3</sub> and V<sub>4</sub> was found statistically at par with treatment V<sub>1</sub> (Palam Samridhi). The maximum days taken for germination (6.0) was observed with treatment V<sub>2</sub> (Palam Vichitra). The variation on days taken for germination may be due to genetic makeup of individual variety. These results are in accordance with the findings of Singh (2000) in cluster bean, Thakor (2008) in vegetable pea and Gogoi *et al.*, (2016) in broccoli.

#### **Plant height at the time of transplanting, at 45 days after transplanting and at harvest (cm)**

The four different varieties of broccoli were varied significantly as shown in the table 1. The height of the plants varied from (19.55 cm - 22.07 cm). The significantly maximum height of seedling (22.07cm) was observed

with the treatment V<sub>3</sub> (Pusa broccoli KTS-1). The treatment V<sub>3</sub> was found statistically at par with treatment V<sub>1</sub> (Palam Samridhi) (21.95 cm). The minimum height of seedling (19.55 cm) at time of transplanting was recorded with treatment V<sub>4</sub> (Palam Haritika). The significantly maximum plant height (40.77 cm) at 45 DAT was obtained with the treatment V<sub>2</sub> (Palam Vichitra). The minimum plant height (32.12 cm) was recorded with treatment V<sub>3</sub> (Pusa broccoli KTS-1). The highest plant height observed in some varieties might be due to its inherent genotypic characteristics or for the variations in agro-climatic conditions. These findings are in close conformity with that of Chaudari *et al.*, (2015) in Knol-khol, Hafiz *et al.*, (2015) and Islam *et al.*, (2015) in broccoli.

From the data it revealed that the significantly maximum plant height (63.07 cm) at harvest was recorded with treatment V<sub>4</sub> (Palam Haritika) and the minimum plant height (49.37 cm) was observed with treatment V<sub>3</sub> (Pusa broccoli KTS-1). The variation in different varieties with respect to plant height might be due to their genetic makeup and also maximum number of days taken for head harvest in variety Palam Haritika. These findings are in accordance with the findings of Nooprom *et al.*, (2013), El-Bassiony *et al.*, (2014), Singh *et al.*, (2014), Hafiz *et al.*, (2015) and Thakur *et al.*, (2016) in broccoli.

#### **Number of leaves at 45 DAT and at harvest**

The number of leaves per plant is an important character that might influence the yield. The varieties included in the study produced an average variation of (10.16 – 11.11) leaves per plant at 45 DAT and (18.63 - 22.71) leaves per plant at harvest. The performance of different varieties with respect to number of leaves per plant at 45 DAT was found to be not significant but at harvest it was found significant and was shown in the table 2.

**Table.1** Performance of different varieties with respect to days taken for germination, plant height at the time of transplanting, 45DAT and harvesting

Treatments	Days taken for germination	Plant height at (cm)		
		Transplanting	45DAT	Harvesting
V <sub>1</sub> (Palam Samridhi)	3.11	21.95	34.60	53.49
V <sub>2</sub> (Palam Vichitra)	6.00	21.06	40.77	53.98
V <sub>3</sub> (Pusa broccoli KTS-1)	3.00	22.07	32.12	49.37
V <sub>4</sub> (Palam Haritika)	3.00	19.55	36.92	63.07
S.Em±	0.05	0.32	0.69	1.11
C.D. at 5 %	0.16	0.94	2.04	3.30

**Table.2** Performance of different varieties with respect to number of leaves per plant at 45DAT and harvesting, plant spread at 45DAT and harvesting

Treatments	Number of leaves per plant		Plant spread(cm)			
	45DAT	Harvesting	45DAT		Harvesting	
			(E-W)	(N-S)	(E-W)	(N-S)
V <sub>1</sub> (Palam Samridhi)	10.56	18.68	44.08	43.73	55.91	57.00
V <sub>2</sub> (Palam Vichitra)	11.11	21.47	45.90	46.08	59.75	59.32
V <sub>3</sub> (Pusa broccoli KTS-1)	10.58	18.63	43.69	42.21	59.58	55.43
V <sub>4</sub> (Palam Haritika)	10.16	22.71	49.53	46.88	60.94	60.94
S.Em±	0.278	0.438	0.725	1.200	0.809	1.229
C.D. at 5 %	NS	1.301	2.154	3.564	2.405	3.650

**Table.3** Performance of different varieties with respect to days taken for head initiation, days taken for head harvesting, head diameter, yield per plant (gm), yield per plot (kg) and yield per hectare (q)

Treatments	Days taken for head initiation	Days taken for head harvesting	Head diameter (cm)	Yield per plant (gm)	Yield per plot (kg)	Yield per hectare (q)
V <sub>1</sub> (Palam Samridhi)	50.49	71.11	13.6	280.3	4.24	178.9
V <sub>2</sub> (Palam Vichitra)	70.67	90.67	15.0	311.9	4.67	188.7
V <sub>3</sub> (Pusa broccoli KTS-1)	54.91	75.20	13.0	251.6	4.00	157.3
V <sub>4</sub> (Palam Haritika)	85.20	103.67	10.2	133.0	0.83	85.6
S.Em±	0.46	0.62	0.43	11.86	0.11	8.16
C.D. at 5 %	1.37	1.84	1.28	35.24	0.33	24.25



**Table.4** Performance of different varieties with respect to quality parameters

Treatments	Total dry matter content of the head (%)	Crude protein (%)	Potassium (mg/100gm)	Magnesium (mg/100gm)
V <sub>1</sub> (Palam Samridhi)	19.37	2.80	455.5	45.61
V <sub>2</sub> (Palam Vichitra)	20.68	3.53	507.7	47.05
V <sub>3</sub> (Pusa broccoli KTS-1)	18.54	2.60	444.4	40.71
V <sub>4</sub> (Palam Haritika)	20.46	2.62	437.7	36.75
S.Em±	0.088	0.04	3.993	0.44
C.D. at 5 %	0.26	0.11	11.86	1.32



**VARIETAL TREATMENT VIEW**

The significantly maximum number of leaves (22.71) per plant at was observed with treatment V<sub>4</sub> (Palam Haritika) and the minimum number of leaves at harvest (18.63) was observed with treatment V<sub>3</sub> (Pusa broccoli KTS-1). In this investigation variation in number of leaves per plant under different varieties, might be due to differences in their genetic inherent capacity, and suitability under this climate. The lower number of leaves in some cultivars was probably due to slow rate in leaf initiation. These findings are in close accordance with the findings of El- Magd *et al.*, (2006), El-Magd *et al.*, (2013), Thapa and Rai (2012) in broccoli.

#### **Plant spread (E-W and N-S) at 45 DAT and at harvest**

In this present investigation, plant spread in each variety were recorded and found significant difference as shown in table 2. The significantly maximum plant spread at 45 DAT [E-W (49.55 cm) and N-S (46.86 cm)] and at harvest [E-W (60.94 cm) and N-S (60.94 cm)] was recorded with treatment V<sub>4</sub> (Palam Haritika). The treatment V<sub>4</sub> was found statistically at par with treatment V<sub>2</sub> (Palam Vichitra) and the minimum plant spread was recorded with treatment V<sub>3</sub> (Pusa broccoli KTS-1) at 45 DAT and V<sub>1</sub> (Palam Samridhi) at harvest. The variation in different varieties with respect to plant spread [E-W and N-S] may be due to their inherent genetic makeup, number of days taken for head harvesting and suitability under this climate. These findings are in accordance with the findings of El-Bassiony *et al.*, (2014), Singh *et al.*, (2014), Hafiz *et al.*, (2015) and Thakur *et al.*, (2016) in broccoli

#### **Days taken for head initiation**

From the data as shown in table 3 it revealed that the significantly minimum days taken for head initiation (50.49 days) was recorded with

treatment V<sub>1</sub> (Palam Samridhi). The maximum days taken for head initiation (85.20 days) was observed in treatment V<sub>4</sub> (Palam Haritika). This similarity and dissimilarity among the varieties in number of days taken for head initiation may be attributed to the variability in their genetic configuration and variability with respect to suitability of the climate of the particular region. These results are in corroborate with findings of Dev (2012), Thapa and Rai (2012), Nooprom and Santiprachi (2013), Gogoi *et al.*, (2016), and Thakur *et al.*, (2016) in broccoli.

#### **Days taken for first head harvesting**

The performance of different varieties on days taken for first head harvest was found significant and data was shown in table 3. The significantly minimum days taken for first head harvest (71.11 days) was recorded with treatment V<sub>1</sub> (Palam Samridhi). The treatment V<sub>1</sub> was found statistically at par with treatment V<sub>3</sub> (Pusa broccoli KTS-1) (75.20 days). The maximum days taken for first head harvest (103.67 days) was observed with treatment V<sub>4</sub> (Palam Haritika). The earliness in edible maturity might be due to genetical difference among the different varieties. These results are collaborating with the findings of Thapa and Rai (2012), Nooprom and Santiprachi (2013), Gogoi *et al.*, (2016), and Thakur *et al.*, (2016) in broccoli.

#### **Head diameter**

The performance of different varieties with respect to head diameter was found to be significant (Table 3). The significantly maximum head diameter (15.00 cm) was obtained with treatment V<sub>2</sub> (Palam Vichitra). The treatment V<sub>2</sub> was found statistically at par with treatment V<sub>1</sub> (Palam Samridhi) (13.6 cm). The minimum head diameter (10.2 cm) was obtained with treatment V<sub>4</sub> (Palam Haritika). The difference in diameter of head

might be due to genetic makeup of different varieties and adaptability to soil and climatic condition of this region. These finding in accordance with the finding of Sharma *et al.*, (2005) in Brussels sprout, Kumar *et al.*, (2007) in broccoli, Bhangre *et al.*, (2011) in broccoli, Uddain *et al.*, (2012) in knol-khol, Kumar *et al.*, (2012) in cabbage, Yadav *et al.*, (2013) in cauliflower and Giri *et al.*, (2013) in broccoli.

### **Yield parameters**

Yield and yield attributing characters of different varieties (Table 3) showed significant differences. The highest fresh weight of head (311.9 g), maximum head yield per plot (4.67 kg), head yield per hectare (188.75 q) was found with treatment V<sub>2</sub> (Palam Vichitra). The treatment V<sub>2</sub> (Palam Vichitra) was found statistically at par with the treatment V<sub>1</sub> (Palam Samridhi) and the minimum fresh weight of head (133.0 g), head yield per plot (0.83 kg), head yield per hectare (85.59 q) was obtained with treatment V<sub>4</sub> (Palam Haritika). These significant differences with respect to fresh weight of head, head yield per plot and head yield per hectare among different varieties may be due to their own-genetic makeup and the suitability of varieties to the weather conditions of this zone. These findings are in conformity with the results, El-Bassiony *et al.*, (2014) in knol-khol, Bhangre *et al.*, (2011) in broccoli, Moniruzzaman (2011) in cabbage, Thapa and Rai (2012) of broccoli, Uddain *et al.*, (2012) in knol-khol, Thapa *et al.*, (2013), Chandan *et al.*, (2013) in broccoli, El-Magd (2013), Giri *et al.*, (2013), Nooprom *et al.*, (2013), Nguille *et al.*, (2014), Singh *et al.*, (2014) and Islam *et al.*, (2015) and Thakur *et al.*, (2016) in Broccoli.

### **Quality parameters**

The quality parameter were also analysed and were shown in table 4 such as total dry matter content of the head, crude protein content, potassium content and calcium content was found significant. Significantly maximum total dry matter content of head (20.68 %), highest protein content (3.53 %), maximum potassium

content (507.7 mg) and calcium content (47.05 mg) was obtained with treatment V<sub>2</sub> (Palam Vichitra). The minimum dry matter content (18.54 %), crude protein content (2.60 %) was observed with treatment V<sub>3</sub> (Pusa broccoli KTS-1) whereas the minimum potassium and calcium content was observed with treatment V<sub>4</sub>. The variation in dry matter content of the head, crude protein content, potassium and calcium content of different varieties may be due to inherent characters of different genotype and their genetic setup. This showed that the cultivars represent a good range of genetic diversity in response of quality parameters. These findings are in accordance with the findings of Kalloo *et al.*, (2005) in vegetable pea, Bhangre *et al.*, (2011) in broccoli, Uddain *et al.*, (2012) in knol-khol, Chandan *et al.*, (2013) in broccoli, El-Magd *et al.*, (2013), Amin *et al.*, (2014) in cowpea, Islam *et al.*, (2015) in broccoli and Patel (2015) in cowpea.

The present study revealed that the growth, yield and quality attributing characters significantly differed within the different varieties. On the basis of performance of different varieties on growth attributes like plant height, number of leaves per plant at 45DAT, yield parameters like fresh weight of head (311.9 g), head yield per plot (4.67 kg), head yield per hectare (188.75 q) quality parameters like total dry matter content of head (20.68 %), crude protein content (3.53 %), potassium content (507.7 mg) and calcium content (47.05 mg) was obtained with treatment V<sub>2</sub> (Palam Vichitra).

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