



## Research Article

# EFFECT OF DIFFERENT DATES OF PLANTING ON PERFORMANCE OF DIFFERENT VARIETIES WITH RESPECT TO GROWTH OF BROCCOLI (*Brassica oleracea* var. *italica*)

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**Abstract:** The present investigation was carried out during *rabi* season-2015-16 at Horticulture Instructional Farm, CP College of Agriculture, SD Agricultural University, Sardarkrushinagar, Gujarat to find out the effect of different plant spacing on performance of different varieties with respect to growth of broccoli (*Brassica oleracea* var. *italica* L.). Three different plant spacing viz., D<sub>1</sub>: 1<sup>st</sup> December, D<sub>2</sub>: 15<sup>th</sup> December and D<sub>3</sub>: 30<sup>th</sup> December. Four varieties viz., V<sub>1</sub>: Palam Samridhi, V<sub>2</sub>: Palam Vichitra, V<sub>3</sub>: Pusa Broccoli KTS-1 and V<sub>4</sub>: Palam Haritika. was analyzed statistically on growth, growth attributes parameters of broccoli and are summarized below. The results revealed that the treatment attained significantly maximum plant height at 45 DAT (32.90 cm) and at the stage of head harvest (64.23 cm) was found with treatment d<sub>2</sub> (15<sup>th</sup> December). while significantly maximum number of leaves per plant at 45 DAT (10.62) and at the stage of head harvest (22.11) was observed with treatment v<sub>2</sub> (Palam Vichitra) and significantly maximum plant spread (E-W and N-S) with (37.47 cm and 39.04 cm, respectively) was observed with treatment d<sub>2</sub> (15<sup>th</sup> December). The significantly maximum plant spread (E-W and N-S) with (65.75 cm and 66.63 cm, respectively) was observed with treatment v<sub>2</sub> (Palam Vichitra).

**Keywords:** Growth of Broccoli, Growth Parameters, Germination

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## Introduction

Broccoli (*Brassica oleracea* var. *italica* L.) is an important and highly nutritive exotic vegetable. It is also known as winter broccoli or heading broccoli or Italian broccoli in the USA or Italian calabrese in Italy and is a member of cruciferae or brassicaceae family. It is considered to be originated from wild cabbage syn. (*Brassica oleracea* var. *sylvestris*), which is found growing wild along the Mediterranean Sea. In India, its cultivation is negligible but now it is gaining popularity among Indian growers from last few years due to its high nutritive value and increased tourist influx. It is mostly cultivated in the hilly areas of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Nilgiri hills and northern plains of India. In India, cauliflower and broccoli is cultivated in an area of 3.69 lakh ha<sup>-1</sup> with an annual production of 67.45 tonne and productivity of 18.27 t ha<sup>-1</sup> [7]. Broccoli has large flower head composed of differentiated flower bud rather than curd. Its edible portion consists of immature, fully-differentiated flower buds and tender portions of the upper stem. The highly branched primary inflorescence forms at the terminus of the elongated unbranched stem. The floral buds at the terminus of each branch of inflorescence collectively produce a compact and somewhat hemispherical head. The head is usually green in color, arranged in a tree like structure on branches sprouting from a thick, edible stalk. The mass of flower heads is surrounded by leaves. Broccoli mostly resembles to cauliflower, which is different cultivar group of the same species. Sprouting or Italian broccoli forms many florets or small heads but they do not produce a solid head. Sprouting broccoli is an annual crop, does not require vernalization to enter into reproductive (bolting and flowering) phase. Whereas, heading broccoli is a biennial and requires vernalization for heading and seed production [10]. Several public and private sector organizations developed broccoli hybrids of white, green and purple colour with improved quality and increased production, suitable for different conditions. Broccoli is a rich source of folic acid and a compound sulphoraphane

which is associated with reducing the risk of cancer [11]. The primary inflorescence was characterized by higher levels of dry matter, total nitrogen, vitamin-C, chlorophyll, beta-carotene, carotenoids and by lower levels of nitrates. Nutritionally, it is rich in vitamin-A (2500 IU), vitamin- C (113 mg), protein (3.6 g), carbohydrates (5.9 g) and minerals like calcium (103 mg), iron (1.1 mg), phosphorus (78 mg), potassium (382 mg) and sodium (15 mg) per 100g of edible portion [22]. After harvest of the head, its green leaves are used as fodder during acute shortage in winter due to its high nutritive value [17]. The 3; 3-Di indolylmethane found in broccoli is a potent modulator of the innate immune response system with anti-viral, anti-bacterial and anti-cancerous activity [23]. In India, it is being used as a fresh vegetable, where as in USA and European countries it is used as fresh as well as frozen form. The anti-cancerous benefits of broccoli are reduced if the vegetable is boiled. However other preparation methods such as steaming, microwaving and frying had no significant effect on the compounds [23]. Numerous broccoli varieties have been released till date from different SAUs and ICAR institutes for various specific regions. But none of the variety is recommended for North Gujarat condition. Hence there is need to develop a suitable variety which thrives well and can become profitable crop for the farmers of this region. Hence by sowing different broccoli varieties under different dates of planting could give a promising result under north Gujarat condition.

## Material and Methods

The present experiment was carried out at Horticulture Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during *rabi* season 2015-16. The soil of the experimental plot was well drained and loamy sand with appropriate textural make-up.

Table-1 Effect of different dates of planting on performance of different varieties with respect to days taken for germination, Plant height at the time of transplanting, 45 DAT and head harvest

Treatments	Days taken for germination	Plant height(cm)		
		at the time of transplanting	At 45 DAT	At head harvest
Dates of planting (D)				
D <sub>1</sub> : 1 <sup>st</sup> December	3.84	20.41	28.78	58.33
D <sub>2</sub> : 15 <sup>th</sup> December	3.75	20.38	32.90	64.23
D <sub>3</sub> : 30 <sup>th</sup> December	3.75	20.49	29.15	55.83
S. Em. $\pm$	0.060	0.390	0.682	1.635
C. D. at 5%	NS	NS	2.678	6.418
C.V. %	5.47	6.61	7.80	9.52
Varieties (V)				
V <sub>1</sub> : Palam Samridhi	3.11	20.07	29.94	57.17
V <sub>2</sub> : Palam Vichitra	6.00	20.45	32.46	62.07
V <sub>3</sub> : Pusa Broccoli KTS-1	3.00	20.78	26.20	56.25
V <sub>4</sub> : Palam Haritika	3.00	20.40	32.51	62.36
S. Em. $\pm$	0.056	0.436	0.707	1.797
C. D. at 5%	0.165	NS	2.100	5.341

Table-2 Effect of different dates of planting on performance of different varieties with respect to number of leaves at 45 DAT and at the stage of head harvest, Plant spread at 45 DAT and harvesting

Treatments	Number of leaves		Plant spread			
	At 45 DAT	At head harvest	At 45 DAT		head harvest	
			E-W	N-S	E-W	N-S
Dates s. of planting (D)						
D <sub>1</sub> : 1 <sup>st</sup> December	9.92	19.72	27.92	31.93	62.68	64.77
D <sub>2</sub> : 15 <sup>th</sup> December	10.27	19.79	37.47	39.94	64.34	65.62
D <sub>3</sub> : 30 <sup>th</sup> December	9.18	18.45	35.13	36.68	60.98	61.68
S. Em. $\pm$	0.212	0.430	0.726	0.804	1.358	1.332
C. D. at 5%	NS	NS	2.851	3.157	NS	NS
C.V. %	7.48	7.71	7.51	7.70	7.51	7.21
Varieties (V)						
V <sub>1</sub> : Palam Samridhi	9.65	16.99	34.21	34.90	61.92	61.61
V <sub>2</sub> : Palam Vichitra	10.62	22.11	35.05	39.02	65.75	66.63
V <sub>3</sub> : Pusa Broccoli KTS-1	9.56	17.68	32.40	34.68	59.27	62.12
V <sub>4</sub> : Palam Haritika	9.34	20.50	32.36	36.14	63.71	65.75
S. Em. $\pm$	0.222	0.418	0.804	1.130	1.462	1.422
C. D. at 5%	0.660	1.243	NS	NS	4.345	4.225

Table-3 Effect of different dates of planting on performance of different varieties with respect to days taken for head initiation and days taken for first head harvest

Treatments	Days taken for head initiation	Days taken for first head harvest
Dates of planting (D)		
D <sub>1</sub> : 1 <sup>st</sup> December	68.44	88.18
D <sub>2</sub> : 15 <sup>th</sup> December	64.08	83.41
D <sub>3</sub> : 30 <sup>th</sup> December	69.35	91.26
S. Em. $\pm$	1.398	1.498
C. D. at 5%	NS	5.882
C.V. %	7.20	5.92
Varieties (V)		
V <sub>1</sub> : Palam Samridhi	50.53	72.85
V <sub>2</sub> : Palam Vichitra	73.57	93.94
V <sub>3</sub> : Pusa Broccoli KTS-1	55.09	76.01
V <sub>4</sub> : Palam Haritika	89.96	107.68
S. Em. $\pm$	1.357	1.665
C. D. at 5%	2.351	4.946

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 of nitrogen was applied as top dressing in two splits at 20 and 30 days after transplanting. The experiments were laid out in a split plot design with three replication. The experimental area was divided into plots of 2.70 m X 1.80 m size. The experiments were carried out with three different dates of planting (1<sup>st</sup> December, 15<sup>th</sup> December and 30<sup>th</sup> December) and four varieties (Palam Samridhi, Palam Vichitra, Pusa Broccoli KTS-1 and Palam Haritika). The raise the crop recommend package of practices was followed. The date of seed sowing in nursery bed was on d<sub>1</sub> - 6<sup>th</sup> November, d<sub>2</sub> -21<sup>th</sup> November and d<sub>3</sub> -6<sup>th</sup> December 2015. and 24 days old, healthy and uniform seedling having about 15-22 cm height was used for transplanting.

## Results and Discussion

### Growth Parameters

#### Days taken for germination

Dates of planting, different varieties and their combined effects with respect to days taken for germination are presented [Table-1] and Influence of different dates of planting on days taken for germination was found not-significant.

#### Plant height at the time of transplanting (cm)

Influences of different dates of planting on performance of different varieties with respect to height of seedling at the time of transplanting were found non-significant variation

#### Plant height at 45 DAT and at the stage of head harvest (cm)

Dates of planting, different varieties and their combined effect with respect to plant

height at 45 DAT and at the stage of head harvest are presented in [Table-1]. The plant height as influenced by different dates of planting was found significant at 45 DAT and at the stage of head harvest [Table-1]. The significantly maximum plant height at 45 DAT (32.90 cm) and at the stage of head harvest (64.23 cm) was found with treatment d<sub>2</sub> (15<sup>th</sup> December). The treatment d<sub>2</sub> was found statistically at par with treatment d<sub>3</sub> (30<sup>th</sup> December) at the stage of head harvest (58.83 cm) and minimum plant height at 45 DAT (28.78 cm) and at harvest (55.83 cm) was recorded with treatment d<sub>1</sub> (1<sup>st</sup> December) and treatment d<sub>3</sub> (30<sup>th</sup> December) respectively. In the present investigation significant variation in plant height among different planting dates might be due to their adaptability under different environmental conditions. These findings are in accordance with the findings of Kurtar (2006) in Brussels Sprout and Ara *et al.* (2009) and Saikia *et al.* (2010) in broccoli. The performance of different varieties also differed significantly with respect to plant height at 45 DAT and at the stage of head harvest [Table-1]. The significantly maximum plant height at 45 DAT (32.51 cm) and at head harvest (62.36 cm) was recorded with treatment v<sub>4</sub> (Palam Haitika). The treatment v<sub>4</sub> was found statistically at par at 45 DAT (32.46 cm) with treatment v<sub>2</sub> (Palam Vichitra) and at harvest with treatment v<sub>1</sub> and v<sub>2</sub> i.e. 57.17 cm and 62.07 respectively. The minimum plant height at 45 DAT (26.20 cm) and at head harvest (56.25 cm) was observed with treatment v<sub>3</sub> (Pusa Broccoli KTS-1). Varietal differences are genetical trait which has been the major cause of difference in performance of different varieties. These findings are in close accordance with the findings of Thapa and Pati (2003) in cauliflower, Kurtar (2006) in Brussels sprout and Saikia *et al.* (2010) and Bhargre *et al.* (2010) in broccoli.



Fig-1 Overview of the experimental field

#### Number of leaves at 45 DAT and at the stage of head harvest

Dates of planting, performance of different varieties and their combined effects on number of leaves are presented in [Table-2]. The number of leaves as influenced by different dates of planting was found not-significant at 45 DAT and at the stage of head harvest [Table-2]. In case of performance of different varieties on number of leaves per plant at 45 DAT and at the stage of head harvest were found significant variation. The significantly maximum number of leaves per plant at 45 DAT (10.62) and at the stage of head harvest (22.11) was observed with treatment v<sub>2</sub> (Palam Vichitra). The minimum number of leaves per plant at 45 DAT (9.34) and at the stage of head harvest (16.99) was recorded with treatment v<sub>4</sub> (Palam Haritika) and v<sub>1</sub> (Palam Samridhi), respectively. In this investigation variation in number of leaves per plant may be due to genetic constitution of genotype and their adaptability to existing environmental conditions. The results are in conformity with findings of Ahmed and Siddique (2004), Kumar *et al.* (2007), Thapa and Rai (2012), Ngullie and Biswas (2014) and Abou El-Magd *et al.* (2015) in broccoli and Kurtar (2006) in Brussels sprouts and Moniruzzaman (2011) in cabbage.

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

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

Data presented in [Table-2] revealed that the influences of different dates of planting with respect to plant spread at 45 DAT was found significant variation. The significantly maximum plant spread (E-W and N-S) with (37.47 cm and 39.04 cm, respectively) was observed with treatment d<sub>2</sub> (15<sup>th</sup> December). The treatment d<sub>2</sub> was found statistically at par with treatment d<sub>3</sub> (30<sup>th</sup> December). The minimum plant spread E-W (27.92 cm) and N-S (31.93 cm) was obtained with treatment d<sub>1</sub>

(1<sup>st</sup> December). Significant variation in plant spread may be due to changes in environmental conditions occurs at different dates of planting. The results are in conformity with findings of AbouEl-Magd (2013), Giri *et al.* (2013) and Hafiz *et al.* (2015) in broccoli and Kumar *et al.* (2013) in cabbage and Yadav *et al.* (2013) in cauliflower. Perusal of data presented in [Table-2] indicated that the individual effect of different varieties, date of planting and the interaction effect between different dates of planting and different varieties with respect to plant spread at 45 DAT (E-W and N-S) were found not-significant.

#### Plant spread at the stage of head harvest (E-W and N-S)

Close review of data presented in [Table-2] exhibited the non-significant result of different dates of planting with respect to plant spread at the stage of head harvest (E-W and N-S). Data presented in [Table-2] indicated the performance of different varieties on plant spread at the stage of head harvest (E-W and N-S) was found significant. The significantly maximum plant spread (E-W and N-S) with (65.75 cm and 66.63 cm, respectively) was observed with treatment v<sub>2</sub> (Palam Vichitra). The treatment v<sub>1</sub> (Palam Samridhi) and v<sub>4</sub> (Palam Haritika) was found statistically at par with treatment v<sub>2</sub> (E-W). The minimum plant spread were obtained with treatment v<sub>3</sub> (E-W) with (59.27 cm) and treatment v<sub>1</sub> (N-S) with (61.61). Variation in plant spread among different varieties of broccoli may be due to genetical makeup of varieties and its suitability under different environmental condition. The results are corroborate with the finding of Sharma *et al.* (2005) and Kurtar (2006) in Brussels Sprouts and Kumar *et al.* (2007), Bhargre *et al.* (2011) and Shapla *et al.* (2014) in Broccoli.

#### Days taken for head initiation

The performance of different varieties with respect to days taken for head initiation [Table-3] was significantly varied. The significantly minimum days taken for head initiation (50.53 days) was recorded with treatment v<sub>1</sub> (Palam Samridhi) while maximum days taken for head initiation (89.96 days) was observed in treatment v<sub>4</sub> (Palam Haritika). The significant difference in days taken for head initiation by different varieties might be due to differences in their genetic characteristics and variability with respect to suitability to environment of the particular region. The result corroborate with finding of Dev (2012), Thapa and Rai (2012), Karistasapol and Quanchit (2013), Gogoi *et al.* (2016), and Thakur *et al.* (2016) in broccoli.

#### Days taken for first head harvest

Data presented in [Table-3] clearly showed that days taken for first head harvest were significantly influenced by different dates of planting. The significantly minimum days taken for first head harvest (83.41 days) were recorded with treatment d<sub>2</sub> (15<sup>th</sup> December). The treatment d<sub>2</sub> was statistically at par with treatment d<sub>1</sub> (88.18 days) while the maximum days taken for first head harvest (91.26 days) were observed with treatment d<sub>3</sub> (30<sup>th</sup> December). The significant difference in days taken for first head harvest by different dates of planting might be due to the favorable growing condition, short day and low temperature during head formation. These findings are in accordance with the findings of Karistasapol and Quanchit (2013), Gogoi *et al.* (2016), and Thakur *et al.* (2016) in broccoli. Four varieties in the study differed significantly with respect to days taken for first head harvest [Table-3]. The significantly minimum days taken for first head harvest (72.85 days) was recorded with treatment v<sub>1</sub> (Palam Samridhi). The treatment v<sub>1</sub> was statistically at par (76.01 days) with treatment v<sub>3</sub> (Pusa Broccoli KTS-1) while the maximum days taken for first head harvest (107.68 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 corroborate with finding of Dev (2012), Thapa and Rai (2012), Karistasapol and Quanchit (2013), Gogoi *et al.* (2016), and Thakur *et al.* (2016) in broccoli.

**Application of research:** To find out the suitable date of planting and varieties of broccoli of North Gujarat region

**Research Category:** Vegetable Science

**Abbreviations:** cm : Centimetre, cm<sup>2</sup> : Centimetre Square, g : Gram, ha : Hectare, IU : International Unit, E-W: East to West, N-S: North to South

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**Study area / Sample Collection:** Horticulture Instructional Farm, C.P.tableCollege of Agriculture

**Cultivar / Variety / Breed name:** Palam Samridhi, Palam Vichitra, Pusa Broccoli KTS-1, Palam Haritika

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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