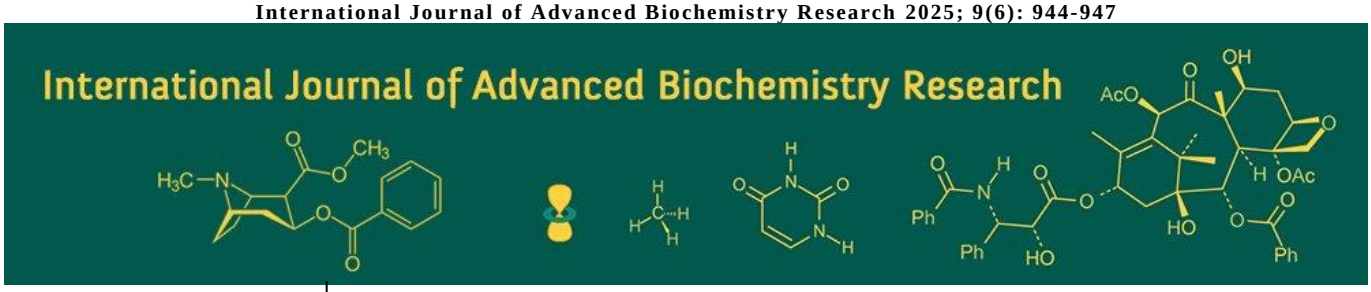

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HV Vasava
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

AM Butani
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Tejal M Chaudhar
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

NN Chauhan
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

KD Mithapara
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
HV Vasava
College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of time of transplanting and spacing on growth of broccoli (*Brassica oleracea var. italica* L) in Saurashtra region

HV Vasava, AM Butani, Tejal M Chaudhar, NN Chauhan and KD Mithapara

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Abstract
The present experiment entitled under "Effect of time of transplanting and spacing on growth of broccoli (*Brassica oleracea var. italica* L) in Saurashtra region" was conducted at Instructional Farm, Jambuvadi, Department of Vegetable science, College of Horticulture, J.A.U., Junagadh, Gujarat, during 2023-24. The experiment was assigned with Randomized Block Design with factorial concept with 16 treatment combinations arising from four time of transplanting (T_1: 2nd fortnight of October, T_2: 1st fortnight of November, T_3: 2nd fortnight of November and T_4: 1st fortnight of December) and four spacing (S_1: 30 cm x 30 cm, S_2: 45 cm x 30 cm, S_3: 45 cm x 45 cm, S_4: 60 cm x 45 cm) with three replications. The all parameters were significantly influenced due to different time of transplanting. The minimum days taken to head initiation (58.17 days), days taken to head harvesting (70.02 days), maximum plant height 30 DAT (30.12 cm), plant height at harvest (43.93 cm), plant spread (E-W) (85.00 cm), plant spread (N-S) (82.25 cm), number of leaves per plant (16.30), leaf area (317.80 cm^2), stem girth (13.80 cm), head diameter (20.36 cm) fresh weight of head (472.75 g) and dry weight of head (92.59 g) were observed with 2nd fortnight of October transplanting (T_1). The all parameters were significantly influenced due to different spacing. The minimum days taken to head initiation (59.19 days), minimum days taken to head harvesting (71.67 days), maximum plant spread (E-W) (83.24 cm), plant spread (N-S) (80.27 cm), no of leaves per plant (17.10), leaf area (327.59 cm^2), stem girth (14.24 cm), head diameter (19.63 cm), fresh weight of head (559.62 g) and dry weight of head (94.37) were observed with spacing 60 cm x 45 cm (S_4). However, in case of maximum plant height 30 DAT (29.45 cm) and plant height at harvest (43.34 cm) were noted with spacing 30 cm x 30 cm (S_1). The interaction effect of transplanting time and plant spacing on the all parameters of broccoli were found to be non significant except fresh weight of head and dry weight of head. Maximum fresh weight of head (651.00 g) and dry weight of head (133.29 g) were recorded with transplanting in the 2nd fortnight of October at spacing of 60 cm × 45 cm (T_1S_4). Though, highest net return (₹ 3,79,262 per hectare) and BCR (1:4.90) were observed in 2nd fortnight of October with 45 cm × 30 cm spacing (T_1S_2). So, broccoli should be cultivate on 2nd fortnight of October with 45 cm × 30 cm spacing for getting maximum net return and higher B:C ratio. Significantly, maximum growth were recorded transplanting on 2nd fortnight of October. Therefore, it is concluded that, broccoli can be transplanting during 2nd fortnight of October with 45 cm × 30 cm spacing in Saurashtra region for higher net return.

Keywords: Broccoli, time of transplanting, spacing, growth, economics

Introduction
Broccoli (*Brassica oleracea var. italica* L.) is a highly nutritious and valuable vegetable belonging to the Brassicaceae (Cruciferae) family. It is commonly known as winter broccoli, heading broccoli or Italian broccoli in the USA and as Italian calabrese in Italy. This vegetable is believed to have originated from wild cabbage (*Brassica oleracea var. sylvestris*), which naturally grows along the Mediterranean region. While its cultivation in India has been relatively low, broccoli has gained popularity in recent years due to its high nutritional value and increasing demand among consumers and tourists. Currently, it is mainly grown in hilly regions of Himachal Pradesh, Uttar Pradesh, Jammu & Kashmir, Nilgiri Hills and parts of northern India. According to FAO (2021) [3], the combined area under cauliflower and broccoli cultivation in India is approximately 4.73 lakh hectares, producing 92.25 lakh tonnes annually, with an average productivity of 19.50 tonnes per

hectare. Globally, China is the largest producer of cauliflower and broccoli, contributing 8.5 million tonnes, followed by India, producing 7.88 million tonnes. The demand and production of broccoli have increased significantly over the years. In the United States, per capita consumption of fresh broccoli rose by nearly 50% in the 1990s, with usage peaking at around 6.0 pounds per capita in 2010, while frozen broccoli consumption also increased in the late 2000s.

The success of broccoli cultivation largely depends on agronomic factors, including transplanting date and plant spacing, which significantly impact growth, yield and quality. The timing of transplanting determines the environmental conditions that the plant experiences during different growth stages. Early transplanting may expose plants to high temperatures, leading to bolting and poor curd formation, whereas late transplanting may cause frost damage, delayed maturity and reduced yield. Optimal transplanting ensures that broccoli develops under favorable climatic conditions, resulting in better curd quality and higher productivity. If transplanted too early or too late, the curds may become small, loose or discolored, reducing their market value. Furthermore, the transplanting date affects the size, firmness, color and taste of the curd and can influence the susceptibility to pests and diseases. Proper scheduling of transplanting helps minimizes pesticide use, making cultivation more environmentally sustainable (Riaz *et al.* 2010) [6].

Similarly, plant spacing is a crucial factor that influences plant population, growth and yield. Proper spacing ensures that plants have adequate access to nutrients, water and light. If planted too closely, plants compete for resources, leading to smaller heads, higher disease incidence and pest infestations due to reduced air circulation. Conversely, excessively wide spacing may result in lower overall yields and inefficient land use. Maintaining optimum spacing is essential to maximize quality and yield while ensuring efficient resource utilization. Studies suggest that proper spacing improves plant health and enhances marketable yield (Tejaswini *et al.* 2018) [12].

In recent years, broccoli cultivation has gained momentum in India, becoming increasingly popular among Indian growers. However, as an exotic, temperate crop, its commercial production is primarily limited to cooler regions. In Gujarat, broccoli is still a newly introduced crop and research on optimal transplanting dates and spacing under Saurashtra conditions is limited. Further studies are needed to determine the best agronomic practices to enhance productivity and profitability in this region.

Materials and Methods

The investigations entitled "Effect of time of transplanting and spacing on growth of broccoli (*Brassica oleracea var. italica* L) in Saurashtra region" was under taken during *rabi* season of the first year 2022-23 and second year 2023-24 under field condition at Instructional farm (Vegetable farm), Jambuvadi, Department of Vegetable Science, College of Horticulture, Junagadh Agricultural University, Junagadh. The details of experimental materials used, procedures followed and techniques adopted during course of present investigation are described in this chapter under the following heads. The experiment was assigned with Randomized Block Design with factorial concept with 16 treatment combinations arising from four time of transplanting (T_1: 2nd fortnight of October, T_2: 1st fortnight of November, T_3: 2nd fortnight of November and T_4: 1st fortnight of December) and four spacing (S_1: 30 cm x 30 cm, S_2: 45 cm x 30 cm, S_3: 45 cm x 45 cm, S_4: 60 cm x 45 cm) with three replications.

Results and Discussion

Time of Transplanting: The growth parameters were significantly influenced due to different time of transplanting. The minimum days taken to head initiation (58.17 days), days taken to head harvesting (70.02 days), maximum plant height 30 DAT (30.12 cm), plant height at harvest (43.93 cm), plant spread (E-W) (85.00 cm), plant spread (N-S) (82.25 cm), number of leaves per plant (16.30), leaf area (317.80 cm^2), stem girth (13.80 cm) head diameter (20.36 cm) fresh weight of head (472.75 g) and dry weight of head (92.59 g) were observed with 2nd fortnight of October transplanting (T_1) in pooled data. Due to favorable climatic conditions such as lower temperatures and higher humidity, which promote better vegetative growth and leaf expansion. The number of leaves per plant increased from 2nd fortnight of October to 1st fortnight of December planting might be due to optimum temperatures that prevailed during vegetative growth period which resulted in greater photosynthetic activity and higher mobilization of assimilates. Higher production of leaves per plant at ambient temperatures was also reported by Saikia *et al.* (2010) [7] in broccoli. Similar result observed by Thirupal, D. (2014) [13], Singhal *et al.* (2009) [10], Singh *et al.* (2011) [9], Kanase *et al.* (2018) [4] and Suthar (2017) [11] in broccoli.

T_1S_4
2nd fortnight of October with 60 cm x 45 cm

T_4S_1
1st fortnight of December with 30 cm x 30 cm

Plate 1: Fresh weight of broccoli head

Treatments	No. of leaves per plant at harvest	Leaf area (cm^2)	Stem girth (cm)	Head diameter (cm)	Fresh weight of head (g)	Dry weight of head (g)
Time of transplanting (T)						
T_1	16.30	317.80	13.80	20.36	472.75	92.59
T_2	15.25	315.97	13.42	19.13	440.37	84.95
T_3	14.67	300.08	12.49	17.90	359.13	65.10
T_4	13.12	272.80	12.71	15.11	340.50	57.83
S.Em.±	0.321	5.164	0.227	0.358	5.705	1.110
C.D. at 5%	0.91	14.61	0.64	1.01	16.13	3.14
Spacing (S)						
S_1	13.21	279.78	12.27	16.69	214.38	44.53
S_2	13.36	288.84	12.68	17.73	370.25	69.31
S_3	15.67	310.10	13.24	18.44	468.50	92.26
S_4	17.10	327.93	14.24	19.63	559.62	94.37
S.Em.±	0.321	5.157	0.227	0.358	5.705	1.110
C.D. at 5%	0.91	14.59	0.64	1.01	16.13	3.14
Interaction (T x S)						
S.Em.±	0.859	11.126	0.371	0.680	26.697	23.999
C.D. at 5%	NS	NS	NS	NS	75.51	67.88

Spacing: The growth parameters were significantly influenced due to different spacing. The minimum days taken to head initiation (59.19 days), days taken to head harvesting (71.67 days), plant spread (E-W) (83.24 cm), plant spread (N-S) (80.27 cm), no of leaves per plant (17.10), leaf area (327.93 cm^2), stem girth (14.24 cm) head diameter (19.63 cm), fresh weight of head (559.62 g) and dry weight of head (94.37 g) were observed with spacing 60 cm x 45 cm (S_4). However, in case of maximum plant height 30 DAT (29.45 cm) and plant height at harvest (43.34 cm) were noted with spacing 30 cm x 30 cm (S_1). This might be due to more terminal increase in closer spaced plants than wider spaced plants, where lateral growth is more. Similar results were reported by Singh *et al.* (2011) [9] and Sharma *et al.* (2020) [8].

Treatments	Days taken to head initiation	Days taken to head harvesting	Plant height (cm) at 30 DAT	Plant height (cm) at harvest	Plant spread (cm) (E-W)	Plant spread (cm) (N-S)
Time of transplanting (T)						
T_1	58.17	70.02	30.12	43.93	85.00	82.25
T_2	60.94	71.88	29.65	43.88	79.63	77.05
T_3	61.86	74.77	26.56	40.51	76.12	73.50
T_4	62.12	75.90	22.24	36.68	73.13	70.01
S.Em.±	0.430	0.426	0.424	0.429	1.028	1.214
C.D. at 5%	1.22	1.20	1.20	1.21	2.91	3.43
Spacing (S)						
S_1	62.31	74.66	29.45	43.34	73.87	71.93
S_2	61.14	73.33	27.90	41.87	77.00	73.94
S_3	60.45	72.91	26.23	40.37	79.76	76.68
S_4	59.19	71.67	24.98	39.41	83.24	80.27
S.Em.±	0.430	0.426	0.424	0.429	1.028	1.214
C.D. at 5%	1.22	1.20	1.20	1.21	2.91	3.43
Interaction (T x S)						
S.Em.±	0.293	0.775	0.636	0.597	1.419	1.717
C.D. at 5%	NS	NS	NS	NS	NS	NS

The interaction between transplanting time and spacing were found to be non-significant except fresh weight of head and dry weight of head in all growth parameters.

Economics

From the present research, it is apparent that the highest net return (₹ 3,79,262 per hectare) and BCR (1:4.90) were observed in 2nd fortnight of October with 45 cm × 30 cm spacing (T_1S_2). The results clearly indicated that the treatment combination T_1S_2 was economically most beneficial for broccoli cultivation.

Conclusion

Based on above study, significantly maximum growth were recorded transplanting on 2nd fortnight of October. Whereas, in case of spacing, maximum growth were noted in 60 cm × 45 cm. Therefore, it is concluded that, broccoli can be transplanting during 2nd fortnight of October with 45 cm × 30 cm spacing in Saurashtra region for better growth and net return.

Reference

1. Arnon DI. Copper enzymes in isolated chloroplasts. Polyphenoloxidase in *Beta vulgaris*. Plant Physiology. 1949;24(1):1-15.
2. AVRDC. Production Guidelines for Broccoli and Other Brassicas. Asian Vegetable Research and Development Center; 2010.
3. Food and Agriculture Organization of the United Nations. FAOSTAT Statistical Database. FAO; 2021 [cited 2025 Jun 25]. Available from: https://www.fao.org/faostat/en/#data/QCL
4. Kanase VJ, Bhosale A, Shinde V. Studies on effect of planting dates on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* L.) cv. Green Magic. International Journal of Current Microbiology and

Applied Sciences. 2018;6:78-86.
5. Patel BB, Patel KD, Vasava HV, Senjaliya HJ. Influence of integrated nutrient management and split application of fertilizers on yield of cucumber (*Cucumis sativus* L.) under protected condition. The Pharma Innovation Journal. 2022;11:840-842.
6. Riaz UD, Subhani GM, Ahmad N. Effect of temperature on development and grain formation in spring wheat. Pakistan Journal of Botany. 2010;42(2):899-906.
7. Saikia BR, Phookan DB, Brahma S. Effect of time of planting and planting densities on growth, yield and economic production of broccoli (*Brassica oleracea* var. *italica* Plenck L.) cv. Pusa broccoli KTS-1. Journal of Hill Agriculture. 2010;1(2):135-139.
8. Sharma A, Gupta N, Kaur P. Effect of planting dates and spacing on growth and yield of broccoli (*Brassica oleracea* var. *italica*) under Punjab conditions. International Journal of Bio-resource and Stress Management. 2020;11(6):569-573.
9. Singh A, Verma RK, Sharma S. Effect of plant spacing on growth and yield of broccoli. Journal of Agricultural Sciences. 2011;23(4):456-460.
10. Singhal P, Srivastava BK, Singh MP, Singh PK. Effect of date of planting and spacing on the performance of broccoli. Indian Journal of Horticulture. 2009;66(1):137-140.
11. Suthar V. Effect of sowing date and spacing on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* L.) var. Green Head. Chemical Science Review and Letters. 2017;6(21):209-212.
12. Tejaswini T, Varma LR, Verma P, Thakur DM, Vani FB. Effect of different plant spacing with respect to growth, yield and quality of broccoli under north Gujarat conditions. International Journal of Current Microbiology and Applied Sciences. 2018;7(5):34-42.
13. Thirupal D. Standardization of optimum planting density and transplanting time for growth and curd yield of broccoli (*Brassica oleracea* var. *italica* L.) [MSc thesis]. Dr. Y.S.R. Horticultural University; 2014.
14. Vasava HV, Chaudhari TM, Parasana JS, Varu DK, Patel S, Mishra S. Performance of different grafted variety and mulching in brinjal (*Solanum melongena* L.). Agricultural Mechanization in Asia, Africa and Latin America. 2023;54(4):12981-12988.
15. Vasava HV, Chudasama VR, Rathva VD. Performance of different varieties of amaranth (*Amaranthus* spp.) under net house and open field conditions. Ecology, Environment and Conservation. 2016;(Suppl.):S169-S176.
16. Vora JS, Patel KD, Senjaliya HJ, Vasava HV. Effect of different levels of NPK on yield and quality of drumstick (*Moringa oleifera* L.) cv. PKM-1. The Pharma Innovation Journal. 2023;2(8):1759-1762.
17. Karagatiya FP, Patel S, Parasana JS, Vasava HV, Chaudhari TM, Kanzaria DR, Paramar V. Adapting fruit crops to climate change: Strengthening resilience and implementing adaptation measures in fruit crops. The Pharma Innovation Journal. 2023;12(7):3159-3164.
18. Padhiyar D, Kanzaria DR, Senjaliya HJ, Vasava HV. Effect of different sowing time and planting distance on okra growth. The Pharma Innovation Journal. 2023;12(7):2676-2680.
19. Padhiyar D, Kanzaria DR, Senjaliya HJ, Vasava HV. Effect of different sowing time and planting distance on pod yield and quality of okra. The Pharma Innovation Journal. 2023;12(7):3155-3158.
20. Patel RP, Purohit VL, Vasava HV, Chaudhari TM, Sentha P. Effect of bio-stimulants on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench). International Journal of Statistics and Applied Mathematics. 2024;9(1):80-85.
21. Senta PB, Purohit VL, Vasava HV, Patel RP, Chaudhari TM. Effect of integrated nutrient management on growth, yield and quality of ridge gourd (*Luffa acutangula* L.) cv. GRG-2. International Journal of Statistics and Applied Mathematics. 2024;9(1):86-89.