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INFLUENCE OF VARIETIES AND PLANT DENSITIES ON GROWTH AND QUALITY OF BROCCOLI (*BRASSICA OLERACEA* VAR. *ITALICA* L.) UNDER CENTRAL TELANGANA CONDITIONS OF INDIA

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ABSTRACT

The present investigation was conducted during *Rabi* 2024–25 at the Post Graduate Institute for Horticultural Sciences, SKLTGHU, Mulugu, Telangana, to evaluate the performance of broccoli (*Brassica oleracea* var. *italica* L.) varieties under different plant densities with emphasis on growth and quality parameters. The experiment was laid out in a factorial randomized block (FRBD) design with two factors: Factor 1 – Varieties (V_1- Palam Samridhi, V_2- Palam Vichitra, V_3- Pusa Purple Broccoli-1, V_4- Saki) and Factor 2 – Spacings (S_1: 60 cm × 30 cm, S_2: 60 cm × 40 cm, S_3: 60 cm × 50 cm, S_4: 60 cm × 60 cm) replicated twice. Among the varieties, Palam Samridhi (V_1) consistently recorded the highest values across most growth traits: plant height (60.56 cm), number of leaves per plant (27.81), leaf area index (0.84), chlorophyll content (63.65 SPAD), earliest head initiation (43.70 days) and shortest maturity duration (21.23 days). It also showed the best quality traits with the highest ascorbic acid content (89.00 mg/100g) and dry matter content (12.13%), while Palam Vichitra (V_2) recorded the highest TSS (11.18°Brix). In terms of spacing, the widest spacing (60 cm × 60 cm – S4) resulted in the maximum plant height (59.61 cm), number of leaves (25.13), leaf area index (0.81), and chlorophyll content (55.62 SPAD). It also enhanced quality traits, recording the highest ascorbic acid (87.63 mg/100g), TSS (9.15°Brix) and dry matter content (11.13%). However, closer spacing (60 cm × 30 cm – S_1) led to earliest head initiation (52.97 days) and shortest maturity period (22.41 days). The interaction of variety and spacing had a significant impact on most parameters. The combination Palam Samridhi × 60 cm × 60 cm (V_1S_4) recorded the highest plant height (63.16 cm), number of leaves (30.10), leaf area index (1.02) and earliest maturity (20.00 days) and chlorophyll content (69.51 SPAD). It also achieved the highest ascorbic acid content (96.50 mg/100g).

Key words: Broccoli, Varieties, Plant spacing, Interaction, Palam Samridhi, Growth parameters, Quality traits.

Introduction

Broccoli (*Brassica oleracea* var. *italica* L.) is a nutritious vegetable of the Brassicaceae family, also known as winter or Italian broccoli. It originated from wild cabbage (*B. oleracea* var. *sylvestris* L.) in the Mediterranean region, with Italy considered the main centre of diversification. Introduced to India in the 20th century, broccoli resembles cauliflower but is typically green in color and is gaining popularity due to its nutritional and medicinal importance (Guo *et al*., 2001). Broccoli is mainly of two types: heading broccoli, forming a large central head and sprouting broccoli, producing many smaller florets without a solid head (Tejaswini *et al*., 2018). The edible portion includes immature flower buds and the upper stem. It is available in various colors such as white, green, purple and yellow, but its cultivation in India remains underutilized (Fagaria *et al*., 2022). Broccoli is a rich source of sulphoraphane, a compound associated

Table 1: Performance of different varieties of Broccoli with varied levels of spacing plant populations on Growth parameters.

	Plant height (cm)	Number of leaves	Days to head initiation	Days taken from head initiation to harvestable maturity	Leaf area index	Total chlorophyll content (SPAD)
Varieties						
Palam Samridhi	60.56	27.81	43.7	21.23	0.84	63.65
Palam Vichitra	52.77	19.98	72.6	26.75	0.55	37.34
Pusa Purple Broccoli-1	57.20	22.63	48.7	24.06	0.71	49.34
Saki	54.51	20.38	59.1	25.08	0.63	41.09
SEm±	0.97	0.86	1.32	0.79	0.03	1.50
CD (p=0.05)	2.97	2.60	3.98	2.38	0.09	4.53
Spacing						
60cm × 30 cm	52.72	20.78	52.97	22.41	0.57	41.58
60 cm × 40 cm	55.15	21.86	56.15	23.66	0.63	45.61
60 cm × 50 cm	57.56	23.03	57.03	24.84	0.72	48.60
60 cm × 60 cm	59.61	25.13	57.90	26.20	0.81	55.62
SEm±	0.97	0.86	1.32	0.79	0.04	1.50
CD (p=0.05)	2.92	2.60	3.98	2.38	0.13	4.53
Interaction						
V1S1	56.14	24.50	42.2	20.0	0.68	56.25
V1S2	61.00	28.95	43.4	20.4	0.70	60.50
V1S3	61.92	27.70	44.5	20.4	0.96	68.32
V1S4	63.16	30.10	44.7	24.2	1.02	69.51
V2S1	49.72	18.20	67.5	22.6	0.46	30.65
V2S2	52.30	17.50	73.6	25.3	0.56	34.10
V2S3	52.53	22.30	73.8	29.5	0.57	35.08
V2S4	56.54	21.90	75.7	29.6	0.60	49.52
V3S1	54.93	21.40	47.2	23.5	0.58	43.76
V3S2	56.54	21.80	48.0	23.9	0.64	48.72
V3S3	57.65	22.00	49.6	24.0	0.70	50.92
V3S4	59.67	25.30	49.8	24.9	0.90	53.94
V4S1	50.11	19.00	55.0	23.6	0.56	35.65
V4S2	50.74	19.20	59.6	25.1	0.60	39.10
V4S3	58.13	20.10	60.2	25.5	0.65	40.08
V4S4	59.06	23.20	61.4	26.2	0.72	49.52
SEm±	1.94	1.73	2.64	1.58	0.06	3.00
CD (p=0.05)	5.84	5.20	NS	4.76	0.19	9.06

with cancer prevention (Guo *et al*., 2001) and is high in vitamins A and C, proteins, carbohydrates and minerals. It contains 130 times more vitamin A than cauliflower and 22 times more than cabbage (Rana, 2008). After harvest, its green leaves serve as nutritious winter fodder (Kumar *et al*., 2007). Flavonoids present in broccoli have anti-inflammatory and antioxidant effects, offering protection against diabetes, neurodegenerative diseases and respiratory issues (Tarozzi *et al*., 2013; Heber *et al*., 2014).

Selecting appropriate high-yielding varieties and plant spacing can optimize yield and nutrient uptake (Bhangre *et al*., 2011; Prasad *et al*., 2010; Thapa *et al*., 2013). However, no comprehensive studies have yet been conducted on variety and spacing interaction in Telangana.

Materials and Methods

The experiment entitled "Performance of Broccoli *(Brassica oleracea* var. *italica* L.) varieties under different plant densities in Telangana" was conducted during *Rabi* 2024–2025 at the Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University SKLTGHU, Mulugu, Siddipet district, Telangana, located at 17°43'16'' N latitude, 78°37'30'' E longitude and 451 m altitude. The experiment was laid out in a factorial randomized block (FRBD) design with two factors: Factor 1 – Varieties (Palam Samridhi- CSKHPV, Palampur, Palam Vichitra-

CSKHPV, Palampur, Pusa Purple Broccoli-1- IARI, New Delhi, Saki- Sakata Seed Corporation) and Factor 2 – Spacings (S_1: 60 cm × 30 cm, S_2: 60 cm × 40 cm, S_3: 60 cm × 50 cm, S_4: 60 cm × 60 cm) replicated twice. The soil of the experimental site was well-drained, sandy loam soil fertile rich in organic matter crop was grown with standard agronomic practices and plant protection measures were adopted as per schedule. The observations were recorded on growth and quality characters *viz.*, Plant height (cm), Number of leaves per plant, Days to head initiation, Days taken for head initiation to harvestable maturity, Leaf area index (LAI), Total chlorophyll content (SPAD), Ascorbic acid (mg/100g) were determined as per method adopted by Ranganna (1977), Total soluble solids (°Brix) and Total dry matter content (%) . The data was statistically analysed as per the procedure of Panse and Sukhatme (1985).

Results and Discussion

Varieties

The data (Table 1) showed that significant differences were observed in all growth parameters across varieties, spacings and their interactions. Among varieties, Palam Samridhi (V_1) consistently performed best compared to remaining varieties by recording the tallest plants (60.56 cm), maximum number of leaves per plant (27.81), earliest head initiation (43.70 days), shortest duration to harvestable maturity (21.23 days), highest leaf area index (0.84) and maximum chlorophyll content (63.65 SPAD). On the other hand, Palam Vichitra (V_2) showed the lowest performance across all parameters: shortest plant height (52.77 cm), minimum number of leaves (19.98), late head initiation (72.60 days), longest time to maturity (26.75 days), lowest LAI (0.55) and least chlorophyll content (37.34 SPAD). These varietal differences can be attributed to genetic potential, as supported by Prasad *et al.*, (2010), Ngullie and Biswas (2014) and Singh *et al.*, (2014).

The data (Table 2) showed that Quality traits such as ascorbic acid, total soluble solids (TSS) and dry matter content varied significantly among varieties, spacing levels and interactions. Among varieties, the highest ascorbic acid content (89.00 mg/100g FW) was recorded in Palam Samridhi (V_1), followed closely by Saki (V_4) (86.25 mg/100g), while the lowest was in Pusa Purple Broccoli-1 (V_3) (68.50 mg/100g). TSS was highest in Palam Vichitra (V_2) (11.18°Brix), which was on par with V_1 (11.09°Brix) and lowest in V_3 (6.33°Brix), indicating significant varietal differences in sugar content as also reported by Singh *et al.*, (2022). For dry matter content, Palam Samridhi (V_1) again ranked highest (12.13%), while the lowest was in Palam Vichitra (V_2) (8.90%).

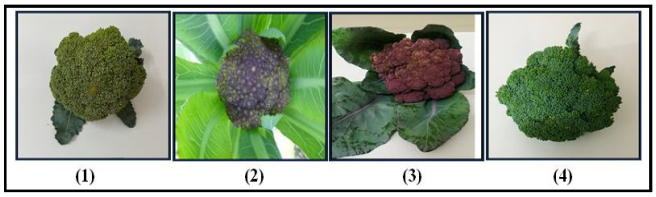

Fig. 1: Different varieties of Broccoli **1.** Palam Samridhi; **2.** Palam Vichitra; **3.** Pusa Purple Broccoli-1; **4.** Saki.

Table 2: Performance of different varieties of Broccoli with varied levels of spacing plant populations on quality parameters.

	AC	TSS	TDMC
Varieties			
Palam Samridhi	89.00	11.09	12.13
Palam Vichitra	77.75	11.18	8.90
Pusa Purple Broccoli-1	68.50	6.33	11.53
Saki	86.25	7.41	11.20
SEm±	0.96	0.13	0.19
CD (p=0.05)	2.90	0.39	0.58
Spacing			
60cm × 30 cm	72.38	8.83	10.74
60 cm × 40 cm	77.50	8.95	10.89
60 cm × 50 cm	84.00	9.08	11.00
60 cm × 60 cm	87.63	9.15	11.13
SEm±	0.96	0.13	0.19
CD (p=0.05)	2.90	0.39	0.58
Interaction			
V1S1	81.50	10.95	11.95
V1S2	86.50	11.05	12.05
V1S3	91.50	11.15	12.20
V1S4	96.50	11.20	12.30
V2S1	72.50	10.95	8.65
V2S2	75.00	11.20	8.85
V2S3	80.00	11.25	9.00
V2S4	83.50	11.30	9.10
V3S1	57.50	6.05	11.30
V3S2	64.00	6.25	11.50
V3S3	74.50	6.45	11.60
V3S4	78.00	6.55	11.70
V4S1	78.00	7.35	11.05
V4S2	84.50	7.30	11.15
V4S3	90.00	7.45	11.20
V4S4	92.50	7.55	11.40
SEm±	1.92	0.26	0.39
CD (p=0.05)	5.80	NS	NS

AC: Ascorbic acid (mg/100 FW);
TSS: Total soluble solids (°Brix);
TDMC: Total Dry matter content (%)

Spacing

The data in Table 1 indicated that the widest spacing of 60 cm × 60 cm (S_4) led to the maximum plant height

(59.61 cm), maximum number of leaves (25.13), maximum LAI (0.81) and chlorophyll content (55.62 SPAD), though it resulted in delayed head initiation (57.90 days) and extended maturity duration (26.20 days). In contrast, the closest spacing (60 cm × 30 cm – S_1) resulted in earliest head initiation (52.97 days) and shortest time to maturity (22.41 days) but had the lowest values for plant height (53.91 cm), number of leaves (20.78), LAI (0.57) and SPAD (41.58). These findings affirm the role of wider spacing in enhancing canopy development and resource uptake, as also reported by Singh *et al*., (2006), Gariya *et al*., (2016) and Agarkar *et al*., (2010).

The data in Table 2 indicated that the quality traits, the widest spacing of 60 cm × 60 cm (S_4) consistently produced the highest values across all parameters—ascorbic acid (87.63 mg/100g), TSS (9.15°Brix) and dry matter (11.13%). In contrast, the closest spacing 60 cm × 30 cm (S_1) showed the lowest values for all three traits, with ascorbic acid at 72.38 mg/100g, TSS at 7.28°Brix and dry matter at 8.30%. These findings align with earlier studies by Yadav *et al*., (2016), Singh *et al*., (2022), Kumar and Rawat *et al*., (2002) and Firoz *et al*., (2015), highlighting the role of wider spacing in enhancing biochemical composition and head quality.

Interaction

According to the data in Table 1, the most effective variety × spacing combination was Palam Samridhi at 60 cm × 60 cm spacing (V_1S_4). This combination resulted in the tallest plants (63.16 cm), the highest number of leaves (30.10), the maximum leaf area index (1.02), and the highest chlorophyll content (69.51 SPAD), along with early maturity (20.00 days). In contrast, the poorest interaction was Palam Vichitra at 60 cm × 30 cm (V_2S_1) with the lowest plant height (49.72 cm), LAI (0.46) and SPAD (30.65) while Palam Vichitra at 60 cm × 40 cm V_2S2 with lowest number of leaves (17.50). These interactions underscore the importance of aligning variety with optimal spacing for enhanced growth, as corroborated by Solunke *et al*., (2011), Thapa *et al*., (2013), Malviya (2017) and Kumar *et al*., (2021). Notably, the interaction effect was non-significant only for days to head initiation, where closer spacing still led to earlier reproductive transition, consistent with findings from Bhangre *et al*., (2011), Tejaswini *et al*., (2018) and Patil *et al*., (2003) in related crops like knolkhol and cabbage.

According to the data in Table 2, the interaction effect was significant only for ascorbic acid content. The highest value (96.50 mg/100g) was observed in the combination of Palam Samridhi with 60 cm × 60 cm spacing (V_1S_4), which was statistically similar to Palam Samridhi at 60 cm × 50 cm (V_1S_3) and Saki at 60 cm × 60 cm (V_4S_4).These results support the findings of Dogra and Awasthi (2009) and Gautam *et al*., (2005), who suggested that ascorbate accumulation is closely linked to cell wall biosynthesis. Interaction effects were non-significant for both TSS and dry matter, indicating that these traits responded more to the independent impacts of variety and spacing rather than their combinations.

Conclusion

Palam Samridhi (V_1) showed the best performance in terms of growth and quality traits. The widest spacing (60 cm × 60 cm) enhanced vegetative growth and nutrient content. The combination Palam Samridhi × 60 cm × 60 cm (V_1S_4) was the most effective, indicating it as the ideal choice for maximizing broccoli growth and quality under Telangana conditions.

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