Original Research Article

PERFORMANCE OF VARIETIES ANDSTANDARDIZATION OF PLANT DENSITY ON GROWTH PARAMETERS IN PALAK (*Beta vulgaris* var.*bengalensis*Roxb.) UNDER SUMMER CONDITIONS IN THE CENTRAL TELANGANA ZONE

ABSTRACT

It was a Factorial Randomized Block Design, with two factors (three varieties (Arka Anupama, All Green, Mulayam) and four plant densities (25 cm × 10 cm, 25 cm × 15 cm, 30 cm × 10 cm, 30 cm × 15 cm) and three replications, conducted at Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University, Mulugu from March to June 2024. The results revealed that Arka Anupama recorded maximum number of leaves per plant (10.51, 13.76, 12.36 and 11.35), length of leaves, width of leaves at 1st, 2nd, 3rd and 4th cuttings, leaf area (100.00 cm^2) and leaf area index (1.51). The maximum plant height (23.35 cm, 26.99 cm, 25.59 cm and 20.46 cm) and length of leaf petiole was recorded in All Green at all cuttings. A 30 cm × 15 cm plant density ` recorded maximum plant height (23.53 cm, 27.11 cm, 25.46 cm and 20.36 cm), number of leaves per plant, length of leaf petiole, length of leaves, width of leaves at all cuttings and leaf area (109.96 cm^2). Highest leaf area index (1.11) was recorded in 30 cm × 10 cm plant density. The V_1S_4(Arka Anupama, 30 cm × 15 cm) exhibited maximum number of leaves, length of leaves, width of leaves and leaf area, while plant height and length of leaf petiole were highest in V_2S_4(All Green, 30 cm × 15 cm). V_1S_1(Arka Anupama, 25 cm × 10 cm) recorded highest leaf area index on par with V_1S_3 (Arka Anupama, 30cm × 10 cm).

Keywords: Palak, varieties, plant density, growth

1. INTRODUCTION

Palak (*Beta vulgaris* var. *bengalensis*Roxb.) is a major leafy vegetable crop [4], belongs to the family Chenopodiaceae [5] and is closely related to beetroot and chard, with a diploid chromosome number of 2*n*=18. Palak originated in the Indo-Chinese region. Other names for palak include spinach beet, desi palak and beet leaf.

The edible parts of palak are the tender, succulent leaves and petioles [4].Palak leaves are a rich source of vitamin A (9770 IU), vitamin C (70 mg), calcium (380 mg), phosphorus (30 mg) and iron (16.2 mg). Palak also contains considerable amounts of protein (3.4 g), minerals (2.2 g), carbohydrates (6.5 g), fat (0.8 g), fiber (0.7 g), nicotinic acid (3.3 mg), thiamine (0.26 mg), riboflavin (0.56 mg) and moisture (86.4 %) [5].

Varieties of palak include All Green, PusaJyoti, Jobner Green, HS 23 and Arka Anupama. Pusa Bharati was an IARI-released variety, best suited for the winter and early spring season. And yielded about 500 q/ha. Arka Anupama was a multi-cut variety, late to bolt, produced four cuttings and yielded about 410 q/ha. All Green variety was a pure line, IARI-released variety. It produced tender, green leaves and yielded about 6-7 cuttings

and 125 q/ha.Varietal assessment among different varieties is necessary to compare varieties with local cultivars[2]. Among various agronomic techniques, optimizing plant density was fundamental for increasing yield and the benefit-cost ratio per unit area. Higher plant density could maximize competition between plants for essential growth resources, which led to decreased yield. Conversely, lower plant density could diminish the effectiveness of inputs. Therefore, achieving the ideal plant density was crucial for allowing crops to reach their genetic potential through the effective use of growth resources [8].

Considering the above factors, the present study titled "Performance of varieties and standardization of plant density on growth parameters in palak (*Beta vulgaris* var.*bengalensis*Roxb.) underSummer conditions in the Central Telangana Zone" wasinitiated.

2. MATERIAL AND METHODS

The experiment was conducted at the university farm of the Post Graduate Institute for Horticultural Sciences, Mulugu, Siddipet, Sri Konda Laxman Telangana Horticultural University, from March 2024 to June 2024. The experimental site was located at a latitude of 17°43'02" N and a longitude of 78°37'48"E. The experiment design was a Factorial Randomized Block Design with two factors (varieties, plant density) and three replications. There were three levels of varieties and four levels of plant density.

2.1 Treatment details

Factor 1: Varieties

V_1: Arka Anupama
V_2: All Green
V_3: Mulayam

Factor 2: Plant density

S_1: 25 cm × 10 cm
S_2: 25 cm × 15 cm
S_3: 30 cm × 10 cm
S_4: 30 cm × 15 cm

2.2 Treatment combinations

V_1S_1 : Arka Anupama + 25 cm × 10 cm
V_1S_2 : Arka Anupama + 25 cm × 15 cm
V_1S_3 : Arka Anupama + 30 cm × 10 cm
V_1S_4 : Arka Anupama + 30 cm × 15 cm
V_2S_1 : All Green + 25 cm × 10 cm
V_2S_2 : All Green + 25 cm × 15 cm
V_2S_3 : All Green + 30 cm × 10 cm
V_2S_4 : All Green + 30 cm × 15 cm
V_3S_1 : Mulayam + 25 cm × 10 cm
V_3S_2 : Mulayam + 25 cm × 15 cm
V_3S_3 : Mulayam + 30 cm × 10 cm
V_3S_4 : Mulayam + 30 cm × 15 cm

The experimental field was thoroughly tilled, divided into 36 beds, each measuring 1 m × 3 m with a height of 0.15 m. At the time of the last ploughing, FYM (20 t/ha) was applied. The seeds were sown by opening the small furrows, 3 cm deep, with the help of a sickle. The seeds were dibbled into the soil and then covered with fine soil. Immediate irrigation

after sowing and regular irrigation was provided. Regular weeding was done at 15-20 days intervals. Thinning and gap filling were performed 15 days after sowing. Four cuttings were performed at 35, 55, 75 and 95 days after sowing by cutting the green leaves with the petiole from 5 cm above ground level.

Observations on growth parameters were taken one day before harvesting (cutting) from ten tagged plants in each treatment. Data on plant height (cm), length of leaf petiole (cm), length of leaves (cm), width of leaves (cm) were measured using a meter scale and number of leaves per were counted. Leaf area was recorded using a Leaf area meter. Leaf area index was calculated by the leaf area per plant (cm^2) to the land area occupied by each plant (cm^2) [17]. The data were analyzed statistically using the analysis of variance procedure for a factorial randomized block design [11].

3. RESULTS AND DISCUSSION

3.1 Plant height (cm)

The data presented in Table 1 showed that there was significant variation among varieties and plant density with respect to the plant height (cm).

Among the varieties, highest plant height (23.35 cm, 26.99 cm, 25.59 cm and 20.46 cm) was recorded for V_2 (All Green) and lowest plant height (18.93 cm, 22.53 cm, 21.04 cm and 16.83 cm) was observed for V_3 (Mulayam) at the initial, second, third and fourth cutting phases. Height of the plant (23.53 cm, 27.11 cm, 25.46 cm and 20.36 cm) was recorded highest in S_4 (30 cm × 15 cm), while the lowest plant height (18.90 cm, 22.57 cm, 21.24 cm and 16.99 cm) was recorded in S_1 (25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

The interaction between varieties and plant density significantly affected plant height at 3rd and 4th cuttings. The maximum height of the plant (27.11 cm and 21.68 cm) was observed in V_2S_4 (All Green, 30 cm × 15 cm) and least height of the plant (18.87 cm and 15.09 cm) was recorded in V_3S_1 (Mulayam, 25 cm × 10 cm) at the 3rd and 4th cuttings.

Greater airspace for vegetative growth, reduced competition between plants and improved access to derive soil nutrients contributed to the increased plant height observed with wider plant density. This investigation provided results similar to those of Tiwari *et al*. [16] in fenugreek, Chavan *et al*. [2] in amaranthus,Mahindrakar and Kulkarni [8] in palak and Shah[13] in palak.

3.2 Number of leaves per plant

The data presented in Table 1 showed that there was significant variation among varieties and plant density with respect to the number of leaves per plant.

A greater leaf number per individual plant (10.51, 13.76, 12.36 and 11.35) was noted in V_1 (Arka Anupama), while the least number of leaves per plant (6.92, 10.23, 8.52 and 7.51) was obtained in V_2 (All Green) at the initial, second, third and fourth cutting phases. Maximum leaf number per individual plant (10.13, 13.55, 12.13 and 11.11) was recorded in S_4 (30 cm × 15 cm), while the least number of leaves per plant (7.18, 10.44, 8.89 and 7.90) was recorded in S_1 (25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

The interaction between varieties and plant density significantly impacted the leaf number per individual plant at 1st and 2nd cuttings. The maximum leaf number per individual plant (12.17 and 15.50) was obtained in V_1S_4 (Arka Anupama, 30 cm × 15 cm), while the least leaf number per individual plant (5.61 and 8.89) was noted in V_2S_1 (All Green, 25 cm × 10 cm) at the 1st and 2nd cuttings.

Due to competition between plants for growth resources caused by increased plant population with narrower plant density showed fewer leaves. On the other hand, plants that were widely spaced showed improved resource consumption, likely resulting in a greater leaf number per individual plant. This investigation provided results similar to those of Mahindrakar and Kulkarni [8] in palak, Jha *et al*. [3] in okra, Kadam [4] in beetroot, Jagdishbhai (2020) in palak, Addula [1] in beetroot, Shah[13] in palak and Sruthy [14] in palak.

3.3 Length of leaf petiole (cm)

The data presented in Table 2 showed that there was significant variation among varieties and plant density with respect to the length of leaf petiole (cm).

V_2 (All Green) showed the maximum length of the leaf petiole (8.99 cm, 10.50 cm, 9.88 cm and 7.90 cm), while the shortest length of the leaf petiole (7.19 cm, 8.41 cm, 7.90 cm and 6.32 cm) was recorded in V_3 (Mulayam) at the initial, second, third and fourth cutting phases. S_4 (30 cm × 15 cm) recorded the maximum length of leaf petiole (9.38 cm, 10.97 cm, 10.31 cm and 8.24 cm), while the shortest length of the leaf petiole (6.67 cm, 7.78 cm, 7.33 cm and 5.86 cm) was recorded in S_1 (25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

The interaction between varieties and plant density significantly affected length of leaf petiole at 2nd cutting. Maximum length of leaf petiole (12.32 cm) was obtained in V_2S_4 (All Green, 30 cm × 15 cm), while the shortest length of the leaf petiole (6.80 cm) was recorded in V_3S_1 (Mulayam, 25 cm × 10 cm) at the 2nd cutting.

The increase in the length of leaf petiole under wider plant density was attributed to the ideal growing environment for vegetative development. The decrease in length of leaf petiole under narrower plant density may have been due to the minimum area available for plant development.

3.4 Length of leaves (cm)

The data presented in Table 2 showed that there was significant variation among varieties and plant density with respect to the length of leaves (cm).

The highest leaf length(13.88 cm, 14.64 cm, 12.85 cm and 12.53 cm) was observed in V_1 (Arka Anupama). Lowest leaf length(10.67 cm, 11.61 cm, 10.25 cm and 10.01 cm) was recorded in V_3 (Mulayam) at the initial, second, third and fourth cutting phases. The maximum length of leaves was obtained in S_4 (30 cm × 15 cm) (15.20 cm, 15.89 cm, 13.92 cm and 13.57 cm) and lowest leaf length (9.32 cm, 10.34 cm, 9.16 cm and 8.95 cm) was recorded in S_1 (25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

Highest leaf length (17.26 cm, 17.84 cm, 15.60 cm and 15.20 cm) was obtained in V_1S_4 (Arka Anupama, 30 cm × 15 cm), followed by V_2S_4 (All Green, 30 cm × 15 cm) with leaf length of 14.88 cm, 15.59 cm, 13.66 cm and 13.32 cm. The lowest leaf length (7.95 cm, 9.04 cm, 8.04 cm and 7.86 cm) was recorded in V_3S_1 (Mulayam, 25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

Decreased leaf length in narrower plant density may have resulted from increased competition between plants for air and exposure to sunlight. Similar findings were reported by Rana [12] in cabbage, Jha *et al*. [3] in okra, Kaur *et al*. [6] in cauliflower and Addula [1] in beetroot.

Table.1 Effect of varieties and spacings on plant height (cm) and number of leaves per plant in palak

Treatments	Plant height (cm)				Number of leaves per plant			
	1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
Varieties								
V_1	21.16	24.80	23.34	18.67	10.51	13.76	12.36	11.35
V_2	23.35	26.99	25.59	20.46	6.92	10.23	8.52	7.51
V_3	18.93	22.53	21.04	16.83	8.64	11.93	10.60	9.59
S.E.m±	0.11	0.14	0.12	0.10	0.04	0.06	0.06	0.05
CD (5 %)	0.31	0.40	0.36	0.29	0.11	0.17	0.16	0.15
Plant density								
S_1	18.90	22.57	21.24	16.99	7.18	10.44	8.89	7.90
S_2	21.76	25.31	23.99	19.19	9.24	12.57	11.09	10.09
S_3	20.40	24.09	22.59	18.07	8.21	11.34	9.86	8.84
S_4	23.53	27.11	25.46	20.36	10.13	13.55	12.13	11.11
S.E.m±	0.13	0.16	0.14	0.12	0.04	0.07	0.06	0.06
CD (5 %)	0.36	0.46	0.41	0.33	0.13	0.20	0.18	0.17
Interaction								
V_1S_1	19.00	22.56	21.05	16.83	8.90	12.21	10.72	9.70
V_1S_2	21.61	25.26	24.25	19.39	11.06	14.39	12.89	11.91
V_1S_3	20.38	24.08	22.28	17.82	9.92	12.94	11.77	10.75
V_1S_4	23.65	27.30	25.80	20.63	12.17	15.50	14.07	13.05
V_2S_1	20.99	24.78	23.80	19.04	5.61	8.89	7.09	6.11
V_2S_2	24.14	27.56	26.15	20.91	7.29	10.58	9.14	8.12
V_2S_3	22.74	26.50	25.29	20.22	6.52	9.83	7.77	6.76
V_2S_4	25.55	29.12	27.11	21.68	8.26	11.62	10.07	9.05
V_3S_1	16.72	20.38	18.87	15.09	7.02	10.22	8.88	7.90
V_3S_2	19.52	23.10	21.59	17.27	9.38	12.75	11.25	10.23
V_3S_3	18.10	21.71	20.22	16.17	8.20	11.24	10.03	9.01
V_3S_4	21.40	24.92	23.48	18.78	9.97	13.52	12.24	11.22
S.E.m±	0.22	0.28	0.25	0.20	0.08	0.12	0.11	0.10
CD (5 %)	NS	NS	0.71	0.58	0.22	0.35	NS	NS

Factor 1: V_1: Arka Anupama, V_2: All Green, V_3: Mulayam
Factor 2: S_1: 25 cm × 10 cm, S_2: 25 cm × 15 cm, S_3: 30 cm × 10 cm, S_4: 30 cm × 15 cm

3.5 Width of leaves (cm)

The data presented in Table 3 showed that there was significant variation among varieties and plant density with respect to the width of leaves.

The highest leaf width (9.00 cm, 9.28 cm, 7.87 cm and 7.15 cm) was noted in V_1 (Arka Anupama), while the lowest leaf width(6.85 cm, 7.06 cm, 5.98 cm and 5.43 cm) was obtained in V_2 (All Green) at the 1st, 2nd, 3rd and 4th cuttings. The highest leaf width (9.89 cm, 10.20 cm, 8.64 cm and 7.85 cm) was noted in S_4 (30 cm × 15 cm) and lowest leaf width (5.94 cm, 6.12 cm, 5.19 cm and 4.71 cm) was noted in S_1 (25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

Highest leaf width (11.28 cm, 11.63 cm, 9.86 cm and 8.96 cm) was obtained in V_1S_4 (Arka Anupama, 30 cm × 15 cm) and lowest leaf width (5.01 cm, 5.17 cm, 4.38 cm and

3.98 cm) was recorded in V_2S_1 (All Green, 25 cm × 10 cm) at the initial, second, third and fourth cutting phases.

Table.2 Effect of varieties and plant density on length of leaf petiole (cm) and length of leaves (cm) in palak

Treatments	Length of leaf petiole (cm)				Length of leaves (cm)			
	1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
Varieties								
V_1	7.87	9.20	8.65	6.91	13.88	14.64	12.85	12.53
V_2	8.99	10.50	9.88	7.90	11.91	12.78	11.25	10.98
V_3	7.19	8.41	7.90	6.32	10.67	11.61	10.25	10.01
S.E.m±	0.04	0.05	0.05	0.04	0.06	0.07	0.05	0.06
CD (5 %)	0.12	0.13	0.13	0.10	0.18	0.19	0.16	0.18
Plant density								
S_1	6.67	7.78	7.33	5.86	9.32	10.34	9.16	8.95
S_2	8.40	9.82	9.23	7.38	12.95	13.77	12.10	11.81
S_3	7.62	8.91	8.37	6.69	11.13	12.05	10.62	10.37
S_4	9.38	10.97	10.31	8.24	15.20	15.89	13.92	13.57
S.E.m±	0.05	0.05	0.05	0.04	0.07	0.08	0.06	0.07
CD (5 %)	0.13	0.15	0.15	0.12	0.21	0.22	0.18	0.20
Interaction								
V_1S_1	6.64	7.76	7.29	5.83	10.92	11.85	10.45	10.20
V_1S_2	8.24	9.64	9.06	7.24	14.78	15.49	13.58	13.24
V_1S_3	7.52	8.80	8.26	6.60	12.55	13.39	11.77	11.49
V_1S_4	9.08	10.62	9.98	7.98	17.26	17.84	15.60	15.20
V_2S_1	7.57	8.78	8.32	6.65	9.11	10.13	8.98	8.78
V_2S_2	9.33	10.91	10.25	8.19	12.65	13.48	11.86	11.57
V_2S_3	8.54	9.99	9.39	7.50	11.00	11.92	10.51	10.27
V_2S_4	10.53	12.32	11.58	9.25	14.88	15.59	13.66	13.32
V_3S_1	5.82	6.80	6.39	5.11	7.95	9.04	8.04	7.86
V_3S_2	7.64	8.93	8.39	6.71	11.43	12.33	10.87	10.61
V_3S_3	6.80	7.95	7.47	5.97	9.85	10.84	9.59	9.36
V_3S_4	8.53	9.97	9.37	7.49	13.45	14.24	12.50	12.19
S.E.m±	0.08	0.09	0.09	0.07	0.13	0.13	0.11	0.12
CD (5 %)	NS	0.25	NS	NS	0.36	0.38	0.33	0.35

Factor 1: V_1: Arka Anupama, V_2: All Green, V_3: Mulayam
Factor 2: S_1: 25 cm × 10 cm, S_2: 25 cm × 15 cm, S_3: 30 cm × 10 cm, S_4: 30 cm × 15 cm

This was probably due to the greater plant density between plants, which resulted in more nutrient absorption, sunlight exposure and soil moisture reaching the growing regions of the plant, thereby leading to a greater leaf width. The results were consistent with findings by Rana (2019) in cabbage, Kaur *et al*. [6] in cauliflower and Addula [1] in beetroot.

3.6 Leaf area (cm^2)

The data presented in Table 3 showed that there was significant variation among varieties and plant density with respect to the leaf area (cm^2).

V_1 (Arka Anupama) exhibited the maximum leaf area(100.00 cm^2), and the lowest leaf area(75.79 cm^2) was recorded in V_2 (All Green). S_4 (30 cm × 15 cm) exhibited the maximum leaf area(109.96 cm^2), while the minimum leaf area(65.63 cm^2) was noted in S_1 (25 cm × 10 cm).

The maximum leaf area (125.57 cm^2) was obtained in V_1S_4 (Arka Anupama, 30 cm × 15 cm), followed by V_3S_4 (Mulayam, 30 cm × 15 cm) with 107.56 cm^2. The lowest leaf area (55.22 cm^2) was recorded in V_2S_1 (All Green, 25 cm × 10 cm).

Plants under wider plant density created a more beneficial environment for water, solar energy exposure and nutrient absorption, which may have resulted in the largest leaf area. This investigation was comparable to those of Kapuriya*et al*. [5] in cucumber, Yadav *et al*. [18] in tomato, Addula [1] in beetroot, Shah [13] in palak, Sruthy [14] in palak and Tandle*et al*. [15] in amaranthus.

3.7 Leaf area index (LAI)

The data presented in Table 3 showed that there was significant variation among varieties and plant density s with respect to the Leaf area index (LAI).

The maximum leaf area index (1.51) was obtained in V_1 (Arka Anupama), while least leaf area index (0.63) was noted in V_2. (All Green). The greatest leaf area index (1.11) was obtained in S_3 (30 cm × 10 cm). The smallest leaf area index (1.03) was recorded in S_4 (30 cm × 15 cm). The varieties and plant density recorded a positive impact on leaf area index.

Maximum leaf area index (1.57) was obtained in V_1S_1 (Arka Anupama, 25 cm × 10 cm) on par with V_1S_3 (Arka Anupama, 30 cm × 10 cm) with a leaf area index of 1.56, while the smallest leaf area index (0.60) was recorded in V_2S_1 (All Green, 25 cm × 10 cm).

Larger plant-to-plant density resulted in a lower calculated LAI, despite the increase in leaf area with plant density. Since the leaf area index considers plant density, widely separated plants had a lower LAI even if their leaf area was larger. Similar findings were reported by Sruthy [14] in palak.

Table.3 Effect of varieties and plant density on width of leaves (cm), leaf area (cm^2) and leaf area index in palak

Treatments	Width of leaves (cm)				Leaf area (cm^2)	Leaf area index
	1st cut	2nd cut	3rd cut	4th cut		
Varieties						
V_1	9.00	9.28	7.87	7.15	100.00	1.51
V_2	6.85	7.06	5.98	5.43	75.79	0.63
V_3	7.68	7.91	6.71	6.09	85.13	1.05
S.E.m±	0.04	0.04	0.04	0.03	0.41	0.01
CD (5 %)	0.12	0.13	0.12	0.09	1.55	0.02
Plant density						
S_1	5.94	6.12	5.19	4.71	65.63	1.06
S_2	8.38	8.64	7.32	6.65	93.03	1.06
S_3	7.16	7.38	6.25	5.68	79.28	1.11
S_4	9.89	10.20	8.64	7.85	109.96	1.03
S.E.m±	0.04	0.05	0.05	0.03	0.46	0.01
CD (5 %)	0.13	0.15	0.14	0.10	1.33	0.02

Interaction						
V_1S_1	7.01	7.23	6.13	5.57	77.68	1.57
V_1S_2	9.61	9.90	8.40	7.63	106.78	1.48
V_1S_3	8.11	8.36	7.09	6.44	89.97	1.56
V_1S_4	11.28	11.63	9.86	8.96	125.57	1.44
V_2S_1	5.01	5.17	4.38	3.98	55.22	0.60
V_2S_2	7.36	7.59	6.43	5.84	81.57	0.64
V_2S_3	6.30	6.49	5.50	5.00	69.63	0.63
V_2S_4	8.71	8.98	7.61	6.92	96.75	0.66
V_3S_1	5.79	5.97	5.06	4.60	63.98	1.02
V_3S_2	8.18	8.43	7.14	6.49	90.75	1.05
V_3S_3	7.06	7.28	6.17	5.61	78.25	1.15
V_3S_4	9.68	9.98	8.45	7.68	107.56	0.99
S.E.m±	0.08	0.09	0.08	0.06	0.81	0.01
CD (5 %)	0.23	0.26	0.24	0.18	2.31	0.03

Factor 1: V_1: Arka Anupama, V_2: All Green, V_3: Mulayam
Factor 2: S_1: 25 cm × 10 cm, S_2: 25 cm × 15 cm, S_3: 30 cm × 10 cm, S_4: 30 cm × 15 cm

4. CONCLUSION

Based on the results from this experiment, it was concluded that the variety Arka Anupama with plant density of 30 cm ×15 cm exhibited maximum number of leaves, length of leaves, width of leaves and leaf area, while plant height and length of leaf petiole were highest in variety All Green with plant density of 30 cm × 15 cm. Variety Arka Anupama with plant density of 25 cm × 10 cm recorded maximum leaf area index on par with Arka Anupama with plant density of 30 cm × 10 cm.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

The authors have stated that they have no conflicting interests.

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