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Performance of South Indian Chrysanthemum (*Dendranthema grandiflora* T.) Varieties Under High Density Planting in Prayagraj Climatic Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was conducted to evaluate the response of south Indian chrysanthemum (*Dendranthema grandiflora* T.) varieties under high-density planting in Prayagraj climatic conditions at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the period of October, 2022 to January, 2023. The experiment was laid out in Factorial Randomized Block Design (FRBD) comparing two factors with twelve treatment combinations in three replications. Significant improvement in growth and flowering characters was recorded in T_8(Poornima White with spacing of 30 cm x 10 cm, 47.5 cm) was found to be tallest in plant height, T_5(Poornima White with spacing of 30 cm x 30 cm) recorded wider in plant spread (42.6 cm^2), more the number of primary branches (15.7), greater the number of flowers per plant (23.9), bigger size of flower diameter (7.6 cm) and longer shelf life of

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the flower (8.5), T_{12}(Belgium Pink with spacing of 30 cm x 10 cm) found best in parameters i.e., less number of days taken to first flower bud initiation (43 days), and days taken to 50 percent flowering (73 days).

Keywords: Chrysanthemum; variety; spacing; Iceberg; Poornima White; Belgium Pink.

1. INTRODUCTION

"Chrysanthemum is commonly known as Guldaudi, Autumn Queen, or Queen of the East" (Koley and Sarkar, 2013). "It belongs to the family Asteraceae and is native to Northern Hemisphere chiefly Europe and Asia. It has a diverse and beautiful range of color shades, shapes, and sizes. India's total area under floriculture crops is 324.00 thousand hectares with an approximate production of 1962.00 thousand MT of loose flowers and 823.00 thousand MT of cut flowers" [1]. Its commercial cultivation is being done in the states of Maharashtra, Rajasthan, Madhya Pradesh, and Bihar for decoration and participating in flower shows, with the help of pot-grown plants.

"In India, chrysanthemum occupies a place of pride both as a commercial crop and as a popular exhibition flower. The erect and tall growing cultivars are suitable for background planting in borders. The cultivars with the dwarf and compact growing habit, on the other hand, are suitable for a front-row plantation or pot culture" [2]. "The decorative and fluffy bloomed small flowered cultivars are ideal for garland making and hair decoration. The extra-large bloomed cultivars are used for exhibition value. Loose flowers are used for garlands, venis, worship, etc. Long-stem or cut flowers are used for bouquets, vases, etc". [3]. "In North India, various hues of red, yellow, white, and purple chrysanthemums are abundant for decorating the landscape in the ground or pots. But, in South India, mostly yellow-colored flowers are preferred and grown as loose flowers for trade" [4].

"Since the ultimate aim of any crop is productivity and good quality produce different agro-techniques are followed. Also among different crop management practices, planting density influences plant growth to a major extent. Optimum spacing plays a significant role in increasing the higher production of flowers and flower yield" [5]. Mainly it affects flower numbers by modifying the microclimate of the plants, exerting a considerable influence on the performance of the crop by creating competition between plants for nutrients, water, and light. This makes it necessary to study optimum spacing for maximization of the production of quality flowers.

2. MATERIALS AND METHODS

This experiment was laid out at the Horticulture Research field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) during 2022-23. The research field lies between the parallels of 24º 77" and 25^0 47" North latitudes and 81^0 19" and 82^0 21" East longitudes. The experiment was laid out in a Factorial Randomized Block Design (FRBD) consisting of twelve treatments and replicated thrice. Factor A consists of three varieties of chrysanthemum i.e., (Iceberg, Poornima White, Belgium Pink). Factor B consists of four spacings i.e., (30 cm x 30 cm, 30 cm x 20 cm, 30 cm x 15 cm, and 30 cm x 10 cm). Varieties are procured from K.S.R farms, Chittor district, AP at the 3-4 leaf stage of the plant. To identify suitable variety and planting density of chrysanthemum for improved growth, and flower quality. The data recorded during the experiment were subjected to statistical analysis by using analysis of variance (ANOVA). The significant difference among the varieties was compared against the critical difference at a 5% level of significance ($CD_{0.05}$).

Treatment Combination

Notation	Treatment details
T_1	V_1S_1 (Iceberg + 30 cm x 30 cm)
T_2	V_1S_2 (Iceberg + 30 cm x 20 cm)
T_3	V_1S_3 (Iceberg + 30 cm x 15 cm)
T_4	V_1S_4 (Iceberg + 30 cm x 10 cm)
T_5	V_2S_1 (Poornima White + 30 cm x 30 cm)
T_6	V_2S_2 (Poornima White + 30 cm x 20 cm)

Notation	Treatment details
T_7	V_2S_3 (Poornima White + 30 cm x 15 cm)
T_8	V_2S_4 (Poornima White + 30 cm x 10 cm)
T_9	V_3S_1 (Belgium Pink + 30 cm x 30 cm)
T_{10}	V_3S_2 (Belgium Pink + 30 cm x 20 cm)
T_{11}	V_3S_3 (Belgium Pink + 30 cm x 15 cm)
T_{12}	V_3S_4 (Belgium Pink + 30 cm x 10 cm)

3. RESULTS AND DISCUSSION

3.1 Vegetative Parameters

Plant height – A significant difference was observed among all the treatments taller plant height was recorded in (T_8 –V_2S_4, 47.5 cm) followed by (T_7 – V_2S_3, 43.3 cm) and shorter plant height was recorded in (T_9 –V_3S_1, 21.2 cm). Taller plants obtained at a closer spacing might be due to heavy competition between plants for light resulting in elongation of the main stem which tends to grow vertically when the plants are crowded owing to the shadowing effect of the plants on one another. However, the extent of this elongation of stem differs in different spacing as well as varieties which might be due to the genetic potential or its suitability to the climatic conditions prevailing in the region. Similar findings have been reported by Dorajeerao and Mokashi (2013) and Mali et al. [6] in chrysanthemum.

Number of primary branches – Among all the treatments significantly more number of primary branches were recorded in (T_5 –V_2S_1, 15.7) followed by (T_1–V_1S_1, 15.2) and a lower number of branches were recorded in (T_{12}–V_3S_4, 7.0). The favorable effect of wider spacing in promoting plant growth might have helped the individual plant to utilize more soil, water, nutrition, air, and light to put up better growth than those having closer spacing, where the increased plant population per unit area also increased competition among the plants. The difference in the number of branches per plant might also be attributed to the inherent character of a variety whose performance is based on the environmental conditions of the region. Similar results were reported by Aashutosh et al. [5] and Nagdeve et al. [9] in chrysanthemum.

Plant spread – Among all the treatments significantly wider plant spread was recorded in (T_5– V_2S_1, 42.6 cm^2) followed by (T_1–V_1S_1, 40.4 cm^2), and narrow plant spread was recorded in (T_{12} – V_3S_4, 20.1 cm^2). The favorable effect of wider spacing in promoting plant growth might have helped the individual plant to utilize more soil, water, nutrition absorption, air, and sunlight to put up better growth than those having closer spacing, where the increased plant population per unit area also increased competition among the plants. Since more branches were produced and vigorous growth of the plant, spread more and also the genetic nature of the genotype, and its adaptability to the prevailing environmental conditions. These results were in accordance with the findings of Joshi et al. [7] in annual chrysanthemums and Pratibha et al. [8] in French marigold.

3.2 Floral Parameters

The Floral parameters after planting varied significantly among different treatments. The data is recorded in Table 2.

Days taken to first flower bud initiation – A significant difference was observed among all the treatments less number of days taken to first flower bud initiation was recorded in (T_{12}–V_3S_4, 43 days) followed by (T_4–V_1S_4, 44.3 days). Whereas, more number of days was recorded in (T_5–V_2S_1, 51.2 days).

Days taken to 50 percent flowering – A significant difference was observed among all the treatments less number of days taken to 50 percent flowering was recorded in (T_{12}–V_3S_4, 73 days) followed by (T_4–V_1S_4, 75 days). whereas, the more number of days taken to 50 percent flowering was recorded in (T_5–V_2S_1, 86.7 days). Earliness in first flower bud initiation might be ascribed to the fact that individual plants grown at the closer spacing which produced less vegetative growth might have entered their reproductive phase earlier due to more competition among the plants for nutrient absorption, moisture, sunlight exposure, etc. The days for first flower bud initiation directly affect the days taken to 50 percent flowering. Earlier flower bud initiation in closer spacing might be the reason for minimum days to 50 percent flowering in the same treatment along with the variation in the flowering time of different varieties might be due to the genetic makeup of different varieties responsible for plant vigour and environmental effect. The finding is in agreement with the result of Subhramanyam [10] and Sainath (2009) in chrysanthemum.

Table 1. Effect of different spacing and varieties on vegetative parameters of chrysanthemum

		At 90 days*		
Sl. No.	**Treatment combinations**	**Plant height (cm)**	**Plant spread (cm^2)**	**Number of primary branches**
1.	V_1S_1 (Iceberg + 30 cm x 30 cm)	44.9	40.4	15.2
2.	V_1S_2 (Iceberg + 30 cm x 20 cm)	36.3	37.2	14.2
3.	V_1S_3 (Iceberg + 30 cm x 15 cm)	40.7	26.1	12.0
4.	V_1S_4 (Iceberg + 30 cm x 10 cm)	41.9	24.6	11.0
5.	V_2S_1 (Poornima White + 30 cm x 30 cm)	38.9	42.6	15.7
6.	V_2S_2 (Poornima White + 30 cm x 20 cm)	39.5	37.6	14.8
7.	V_2S_3 (Poornima White + 30 cm x 15 cm)	43.3	26.9	12.6
8.	V_2S_4 (Poornima White + 30 cm x 10 cm)	47.5	25.2	11.3
9.	V_3S_1 (Belgium Pink + 30 cm x 30 cm)	21.2	26.9	10.1
10	V_3S_2 (Belgium Pink + 30 cm x 20 cm)	23.0	24.2	9.5
11	V_3S_3 (Belgium Pink + 30 cm x15 cm)	24.3	23.6	7.4
12	V_3S_4 (Belgium Pink + 30 cm x 10 cm)	25.1	20.1	7.0
	F-test	S	S	S
	S.E(d)±	0.837	0.543	0.165
	$CD_{0.05}$	1.746	1.133	0.345

days*- *days after planting*

Flower diameter – Among all the treatments significantly bigger size flower diameter was recorded in (T_5–V_2S_1, 7.6 cm) followed by (T_6–V_2S_2, 7.5 cm) whereas, a smaller flower diameter was recorded in (T_{12}–V_3S_4, 6.5 cm). The increase in flower diameter might be in wider spacing plants due to the fact that at the onset of the reproductive phase, the vegetative growth seized, and thereafter manufactured food material was utilized exclusively by the sink resulting in increased flower diameter along with the variation among the varieties may be due to genetic traits and prevailing environmental conditions. Similar results were recorded by Kour [11] in marigolds, Waded [12], and Taksande et al. [13] in chrysanthemums.

Number of flowers per plant - Data for this attribute revealed that the number of flowers per plant showed significant differences among the treatments. (T_5–V_2S_1, 23.9 flowers) recorded the more number of flowers per plant while (T_{12}–V_3S_4, 3 flowers) recorded the less number of flowers per plant. Number of flowers per plant was increasing as the plants were spaced widely. Plants grew more luxuriantly under wider spacing due to more availability of nutrients, space and resulting in the production of more vegetative growth which is responsible for better mobilization of biomass from source to sink *i.e.,* flowers. Thus, more number of branches provided more sites for flower initiation, resulting in an increased number of flowers. Additionally, more branches allow for increased sunlight exposure and nutrient absorption, promoting robust growth and supporting the plant's metabolic processes involved in flowering. The highest number of flowers per plant was recorded at wider spacing, which was significantly superior to plant spacing from medium spacing to closer spacing along with the genetic inherent character of varieties. The findings are enclosed in conformity with the reports of Dorajeerao et al. [14] and Khobragade et al. [15] on garland chrysanthemum and in china aster.

Shelf life of chrysanthemum flowers - Shelf life is one of the qualities attributing characteristics that varied significantly with the planting densities. The higher number of days of shelf life was recorded in (T_5–V_2S_1, 8.5 days) followed by (T_1–V_1S_1, 7.7 days) whereas, the lower number of days of shelf life was recorded in (T_{12}–V_3S_4, 5 days). Longer shelf life in wider spacing because of greater carbohydrate assimilation of better vegetative growth as well as the variation in shelf life might be attributed loss of weight of flowers and the genetic inherent character of varieties Similar results were reported by Waded [12] and Aashutosh et al. [5] in chrysanthemum [16,17].

Table 2. Effect of different spacing and varieties on floral parameters of chrysanthemum

Sl. No.	Treatment combinations	First flower bud initiation (days)	50 percent flowering (days)	Number of flowers/plant	Flower diameter (cm)	Shelf life (days)
1.	V_1S_1 (Iceberg + 30 cm x 30 cm)	49.6	84.8	20.8	7.4	7.7
2.	V_1S_2 (Iceberg + 30 cm x 20 cm)	48.3	82.6	19.3	7.2	6.9
3.	V_1S_3 (Iceberg + 30 cm x 15 cm)	46.2	77.2	17.0	6.8	5.9
4.	V_1S_4 (Iceberg + 30 cm x 10 cm)	44.3	75	14.6	6.6	5.2
5.	V_2S_1 (Poornima White + 30 cm x 30 cm)	51.2	86.7	23.9	7.6	8.5
6.	V_2S_2 (Poornima White + 30 cm x 20 cm)	49.3	84.1	23.2	7.5	7.6
7.	V_2S_3 (Poornima White + 30 cm x 15 cm)	47.5	80.7	20.6	6.9	6.3
8.	V_2S_4 (Poornima White + 30 cm x 10 cm)	45.3	77.5	18.6	6.7	5.6
9.	V_3S_1 (Belgium Pink + 30 cm x 30 cm)	50.3	85.3	5.6	7.1	7.5
10	V_3S_2 (Belgium Pink + 30 cm x 20 cm)	48.4	83.6	5.3	6.9	6.4
11	V_3S_3 (Belgium Pink + 30 cm x 15 cm)	45.0	76.7	3.4	6.7	5.7
12	V_3S_4 (Belgium Pink + 30 cm x 10 cm)	43.0	73.0	3.0	6.5	5.0
	F-Test	S	S	S	S	S
	S.E(d)±	0.255	0.586	0.287	0.060	0.021
	$CD_{0.05}$	0.532	1.224	0.599	0.126	0.044

4. CONCLUSION

On the basis of the results obtained from the present investigation, it can be concluded that T_8(Poornima White along with spacing of 30 cm x 10 cm) was found best in terms of plant height, T_5(Poornima White with spacing of 30 cm x 30 cm) was found best in parameters like in plant spread, more number of primary branches, the greater number of flowers per plant, the bigger size of flower diameter and longer shelf life of flower. Treatment T_{12}(Belgium pink with spacing of 30 cm x 10 cm) was observed lesser in days taken to first flower bud initiation and 50 percent flowering.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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