



Performance of North Indian Chrysanthemum (*Dendranthema grandiflora* T.) Varieties under High Density Planting in Prayagraj Agro-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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ABSTRACT

An experiment was carried out in the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the period of October, 2022 to February, 2023. The experiment was conducted in FRBD with twelve treatments replicated thrice consisting of Two factors, Factor A (varieties: Royal Princess, Snowball, Pink Palasol, and Starlin Queen) and Factor B (spacing: 30 cm x 30 cm, 30 cm x 20 cm, and 30 cm x 15 cm). It was reported that treatment T₉ (Pink Palasol + 30 cm x 15 cm) produced significantly taller plants (47.4 cm), and treatment T₇ (Pink Palasol + 30 cm x 30 cm) was better in parameters like

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plant spread (25.1 cm), number of primary branches (6.2), number of flowers per plant (11.9), duration of flowering (57.7 days) and vase life of flower (10 days) whereas days taken to first bud initiation (37 days) was better in treatment T₃ (Royal Princess + 30 cm × 15 cm).

Keywords: *Chrysanthemum; royal princess; snowball; pink Palasol; starlin queen; spacing; varieties.*

1. INTRODUCTION

Floriculture is a fast-emerging industry with a higher potential for returns than most field and other Horticultural crops. Chrysanthemum belongs to the Asteraceae family. The name "Chrysanthemum" comes from the Greek words "Chryos" (gold) and "Anthemion" (flower). Chrysanthemum has a diploid chromosome number of 2n=18 and is believed to have originated from Northern Hemisphere chiefly Europe and Asia. Various names of Chrysanthemum, such as Guldaudi, the Autumn Queen, or the Queen of the East.

Chrysanthemum production in the world was 10.4 million tonnes in 2020. Japan was the leading producer, with 3.1 million tonnes. China was the second largest producer, with 2.6 million tonnes. The Netherlands was the third largest producer, with 1.2 million tonnes. Italy was the fourth largest producer, with 0.8 million tonnes. Colombia was the fifth largest producer, with 0.7 million tonnes.

India produced 40,000 tonnes of Chrysanthemum in 2020. Tamil Nadu was the leading producer, with 18,000 tonnes. Karnataka was the second largest producer, with 10,000 tonnes. Maharashtra was the third largest producer, with 6,000 tonnes. Andhra Pradesh was the fourth largest producer, with 4,000 tonnes. Kerala was the fifth largest producer, with 2,000 tonnes.

Chrysanthemums such as cut flowers or long-stem are used for bouquets, vases, etc. [1]. In North India, various hues of red, yellow, white, and purple chrysanthemums are abundant for decorating the landscape in the ground or pots. To produce cut and loose flowers is possible in high density planting which can fulfil the demand of the market. However, the research work on this aspect in chrysanthemum is lacking.

There is a great scope for increasing the area under this crop. Increasing flower yield with quality flowers, extending vase life, and duration of flower production are the prime importance in the cultivation of chrysanthemum. This can be

achieved under a high density of planting with suitable cultivars.

The main aim of the present study was to identify suitable variety and planting density of chrysanthemum for improved growth, flower quality, and yield under high density planting in the Prayagraj region.

2. MATERIALS AND METHODS

The field experiment entitled "Performance of north Indian Chrysanthemum (*Dendranthema grandiflora* T.) varieties under high density planting in Prayagraj agro-climatic conditions" was carried out at the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, during October, 2022 to February, 2023. The experimental field is situated on the left side of Prayagraj - Rewa Road, near the river Yamuna, and approximately 7 km from Prayagraj city.

2.1 Geographical Location and Climatic Conditions

"Geographically, Prayagraj is situated in the South-Eastern part of Uttar Pradesh. It lies between the parallels of 24° 77" and 25° 47" north latitudes and 81° 19" and 82° 21" east longitudes" [2]. "The area of Prayagraj district comes under agro climatic zone V (Upper Gangetic Plain region) and sub-zone of Central Plains. The climate ranges from dry sub-humid to semi-arid and the soil is alluvium calcareous sandy loam. The district experiences an average maximum temperature range between 43° - 47°C which may go as high as 48°C during peak summers (May-June). The minimum average temperature is 2-4°C, which may fall as low as 1°C during peak winter months (December-January) The average rainfall of the district is 960 mm and the monsoon season is spread between July-September" [2].

2.2 Experimental Details

The trial was laid out in a Factorial Randomized block design with twelve treatments replicated thrice. Use two factors, Factor A (varieties-Royal

Princess, Snowball, Pink Palasol, Starlin Queen) and Factor B (spacing- 30 cm x 30 cm, 30 cm x 20 cm, 30 cm x 15 cm). Considering 9, 15, and 18 plants according to spacing respectively. Varieties are procured from Maa Sarada Seeds and Nursery, Majlishpur, Kolkata. 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 ($CD_{0.05}$).

2.2.1 Observation details

Plant height, plant spread, number of primary branches, days taken to first bud initiation, duration of flowering, vase life of the flower, and number of flowers per plant.

3. RESULTS AND DISCUSSION

3.1 Vegetative Parameters

Plant height - Plant height varied from 31.6cm to 47.4cm. Significantly taller plants (47.4 cm) were recorded in treatment T₉ (Pink Palasol + 30 cm x 15 cm), followed by treatment T₁₂ (Starlin Queen + 30 cm x 15 cm, 45.2 cm), whereas shorter plants were recorded in treatment T₄ (Snowball + 30 cm x 30 cm, 31.6 cm). Similar findings have been reported by Dorajeero and Mokashi [3] and Mali et al. [4] in chrysanthemum. Increase in plant height at closer spacing might be due to heavy competition between plants for light, moisture, space, and aeration which increases the stem elongation by increasing the cell size

and cell number to compensate for reduction in light interception.

Plant spread – The plant spread varied from 16.7 cm to 25.1 cm. Significantly wider plants (25.1 cm) were recorded in treatment T₇ (Pink Palasol + 30 cm x 30 cm), followed by treatment T₁ (Royal Princess + 30 cm x 30 cm) and T₄ (Snowball + 30 cm x 30 cm, 24.4 cm), whereas skinnier plants were recorded in treatment T₁₂ (Starlin Queen+ 30 cm x 15 cm, 16.7 cm). Plant spread was more under wider spacing which might be due to the favorable growing conditions like more space available for growth of roots and shoots, which ultimately helps in higher uptake of nutrients and water from the soil. Similarly, more amount of sunshine was also available in wider spacing which might have increased the rate of photosynthesis and thereby, growth of plants. Similar results were obtained by Joshi et al. [5] in annual chrysanthemum and Pratibha et al. [6] in French marigold.

Number of primary branches - Primary branches 30 days after pinching varied from 3.3 to 6.2. More primary branches (6.2) were recorded in treatment T₇ (Pink Palasol + 30 cm x 30 cm), followed by treatment T₈ (Pink Palasol + 30 cm x 20 cm, 5.6), whereas the least number of primary branches were recorded in treatment T₆ (Snowball + 30 cm x 15 cm, 3.3). According to Harper [7] at higher planting density, per plant light interception is less which results in lower per plant carbon fixation thus reducing the plant's ability of carbon assimilation and translocation towards new branch production and therefore, potentially reduced the size and number of branches per plant.

Chart 1. Details of the treatment combinations

Notations	Treatments combinations
T ₁	V ₁ S ₀ (Royal Princess + 30cm x30cm)
T ₂	V ₁ S ₁ (Royal Princess + 30cmx 20cm)
T ₃	V ₁ S ₂ (Royal Princess + 30cmx 15cm)
T ₄	V ₂ S ₀ (Snowball + 30cmx 30cm)
T ₅	V ₂ S ₁ (Snowball + 30cmx 20cm)
T ₆	V ₂ S ₂ (Snowball + 30cmx 15cm)
T ₇	V ₃ S ₀ (Pink Palasol + 30cmx 30cm)
T ₈	V ₃ S ₁ (Pink Palasol+ 30cm x20cm)
T ₉	V ₃ S ₂ (Pink Palasol + 30cm x15cm)
T ₁₀	V ₄ S ₀ (Starlin Queen + 30cmx 30cm)
T ₁₁	V ₄ S ₁ (Starlin Queen+ 30cm x20cm)
T ₁₂	V ₄ S ₂ (Starlin Queen + 30cmx 15cm)

Table 1. Effect of spacing and varieties on vegetative parameter of chrysanthemum

Notations	Treatment combinations	Plant height 90 days (cm)	Plant spread 60 days (cm ²)	No. of primary branches 60 days
T ₁	V ₁ S ₀ (Royal Princess + 30 cm x 30 cm)	35.3	24.4	5.4
T ₂	V ₁ S ₁ (Royal Princess + 30 cm x 20 cm)	40.7	21	5.2
T ₃	V ₁ S ₂ (Royal Princess + 30 cm x 15 cm)	40.5	18.5	4.6
T ₄	V ₂ S ₀ (Snowball + 30 cm x 30 cm)	31.6	24.4	5.1
T ₅	V ₂ S ₁ (Snowball + 30 cm x 20 cm)	34.3	21.7	4.8
T ₆	V ₂ S ₂ (Snowball + 30 cm x 15 cm)	35.1	18.7	3.3
T ₇	V ₃ S ₀ (Pink Palasol + 30 cm x 30 cm)	39	25.1	6.2
T ₈	V ₃ S ₁ (Pink Palasol + 30 cm x 20 cm)	44.5	22.5	5.6
T ₉	V ₃ S ₂ (Pink Palasol + 30 cm x 15 cm)	47.4	19.6	5.2
T ₁₀	V ₄ S ₀ (Starlin Queen + 30 cm x 30 cm)	40.5	23	5.2
T ₁₁	V ₄ S ₁ (Starlin Queen + 30 cm x 20 cm)	44.6	21.8	5
T ₁₂	V ₄ S ₂ (Starlin Queen + 30 cm x 15 cm)	45.2	16.7	4.2
	F-Test	S	S	S
	SE(d)+-	0.359	0.349	0.175
	CD0.005	0.748	0.729	0.364

Table 2. Effect of spacing and varieties on floral, quality, and yield parameters of Chrysanthemum

Notations	Treatment combinations	Days taken to bud initiation after planting (days)	Duration of flowering (days)	Vase life of the flowers (days)	No. of flowers per plant
T ₁	V ₁ S ₀ (Royal Princess + 30 cm x 30 cm)	40	53	9	7.5
T ₂	V ₁ S ₁ (Royal Princess + 30 cm x 20 cm)	38.3	50.3	8	7.3
T ₃	V ₁ S ₂ (Royal Princess + 30 cm x 15 cm)	37	48	7	6
T ₄	V ₂ S ₀ (Snowball + 30 cm x 30 cm)	57	50.3	9	2.6
T ₅	V ₂ S ₁ (Snowball + 30 cm x 20 cm)	54.3	48.7	8	2.4
T ₆	V ₂ S ₂ (Snowball + 30 cm x 15 cm)	53.3	47	6	1.2
T ₇	V ₃ S ₀ (Pink Palasol + 30 cm x 30 cm)	44.3	57.7	10	11.9
T ₈	V ₃ S ₁ (Pink Palasol + 30 cm x 20 cm)	42.3	56.3	9	11.2
T ₉	V ₃ S ₂ (Pink Palasol + 30 cm x 15 cm)	40.3	55	8	7.5
T ₁₀	V ₄ S ₀ (Starlin Queen + 30 cm x 30 cm)	48.3	52.3	9	7
T ₁₁	V ₄ S ₁ (Starlin Queen + 30 cm x 20 cm)	46.3	50.7	8	6.6
T ₁₂	V ₄ S ₂ (Starlin Queen + 30 cm x 15 cm)	43.3	48.3	7	5.1
	F-Test	S	S	S	S
	SE(d)+-	0.249	0.43	0.189	0.194
	CD0.005	0.52	0.898	0.394	0.406

3.2 Floral Parameter

Days taken to first bud initiation – Significantly, the minimum (37 days) taken to first bud initiation was recorded in treatment T₃ (Royal Princess + 30 cm x 15 cm), followed by treatment T₂ (Royal Princess + 30 cm x 20 cm, 38.3 days), whereas the maximum was recorded in treatment T₄ (Snowball + 30 cm x 30 cm, 57 days). Earliness in commencement of bud initiation in closer spacing might be ascribed to the fact that individual plant grown at the closer spacing produced less vegetative growth and might have entered its reproductive phase earlier due to more competition among the plants for nutrients, moisture, sunlight, etc. Similar findings were reported by Subramanyam [8] in chrysanthemum cv. kasturi and Kale [9] and Kour [10] in chrysanthemum.

3.3 Quality Parameters

Duration of flowering – The duration of flowering varied significantly among different treatments. A significantly shorter duration of flowering was recorded in treatment T₆ (Snowball + 30 cm x 15 cm, 47 days), followed by treatment T₃ (Royal Princess + 30 cm x 15 cm, 48 days), whereas a longer duration of flowering was recorded in treatment T₇ (Pink Palasol + 30 cm x 30 cm, 57.7 days). Plants spaced widely remained in the vegetative phase for a longer duration on account of less competition from the adjacent plants for space and sunlight. The variation in the blooming period among the varieties could potentially be linked to the presence of vegetative growth in the prevailing agroclimatic conditions, leading to increased assimilation and subsequently increasing the duration of flowering. These results are in line with the findings of Kour [10] in Marigold, Waded [11], and Taksande et al. [12] in chrysanthemum.

Vase life of chrysanthemum flowers- A significantly longer period of vase life (10 days) was recorded in treatment T₇ (Pink Palasol + 30 cm x 30 cm), followed by treatments T₁ (Royal Princess + 30 cm x 30 cm), T₄ (Snowball + 30 cm x 30 cm), T₈ (Pink Palasol + 30 cm x 20 cm), and T₁₀ (Starlin Queen + 30cm x 30 cm, 9 days), whereas a shorter period of vase life (6 days) was recorded in the treatment T₆ (Snowball +30 cm x 15 cm). The variation in vase life might be due to increasing levels of spacing which significantly increase the flower weight due to the greater accumulation of carbohydrates (source for respiration) from source to sink i.e., flower,

and also due to genetic variation of varieties as reported earlier in chrysanthemum by Waded [11] and Aashutosh et al. [13].

3.4 Yield Parameter

Number of flowers per plant – Significantly more flowers per plant (11.9) were registered in treatment T₇ (Pink Palasol + 30 cm x 30 cm), whereas fewer flowers per plant were registered in treatment T₆ (Snowball + 30 cm x 15 cm, 1.2). Plants grew more luxuriantly under wider spacing due to more availability of nutrients and space and resulting in the production of more vegetative growth which might be responsible for better mobilization of biomass from source to sink i.e., flowers. Dorajeero et al. [14] reported in garland chrysanthemum. As a result of this, the widely spaced plants had comparatively higher levels of organic reserves, conducive for better floral development which thereby increased the number of flowers per plant. Nagdeve et al. [15] reported in annual chrysanthemum [16-18].

4. CONCLUSION

It is concluded that treatment T₉ (Pink Palasol + 30 cm x 15 cm) was found to be better in terms of plant height, and treatment T₇ (Pink Palasol + 30 cm x 30 cm) was better in terms of parameters like plant spread, number of primary branches, number of flowers per plant, duration of flowering and vase life of flowers, while days taken to first bud initiation were better in treatment T₃ (Royal Princess + 30 cm x 15 cm).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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