Original Research Article

Performance of north Indian chrysanthemum (*Dendranthema grandiflora*) varieties under high density planting in Prayagrajagro-climatic conditions

ABSTRACT

The 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 an FRBD with twelve treatments replicated thrice. Using two factors, A (varieties: Royal Princess, Snowball, Pink Palasol, and Starlin Queen) and Factor B (spacing: 30 cm × 30 cm, 30 cm x 20 cm, and 30 cm × 15 cm). From the present investigation, it is concluded that treatment T_9 (Pink Palasol + 30 cm × 15 cm) was found to be better in terms of plant height (47.4 cm), and treatment T_7 (Pink Palasol + 30 cm × 30 cm) was better in parameters like 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 T_3 (Royal Princess + 30 cm × 15 cm).

Keywords: *Chrysanthemum, Royal Princess, Snowball, Pink Palasol, Starlin Queen, spacing, varieties*

Introduction.

Floriculture is a fast emerging industry with a higher potential for returns than most of the field and other horticultural crops. Chrysanthemum belongs to the Asteraceae family. The name "chrysanthemum" comes from the Greek word "chryos" (gold) and "anthemon" (flower). Chrysanthemum have a diploid chromosome number of 2n=18 and are 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.

The world produced 10.4 million tonnes of chrysanthemums 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 chrysanthemums 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.

Chrysanthemum as cut flowers or long-stem are used for bouquets, vases, etc. (Prakash *et al.,* 2018). 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 whichcan 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 presentstudywas to identify suitable variety and planting density of chrysanthemum for improved growth, flower quality, and yield under high density planting inthe Prayagraj region.

Materials and Methods

The field experiment entitled “Performance of north Indian chrysanthemum (*Dendranthemagrandiflora*) varieties under high density planting in Prayagrajagro-climatic conditions” was carried out at the Department of Horticulture, SamHigginbottom 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.

2.1Geographical location and climatic conditions

Geographically, Prayagraj is situated in the South-Eastern part of Uttar Pradesh. It lies between the parallels of 24º 77‟ and 25º 47‟ north latitudes and 81º 19‟ and 82º 21‟ east longitudes. 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 43º - 47ºC which may go as high as 48ºC during peak summers (May-June). The minimum average temperature is 2-4ºC, which may fall as low as 1ºC 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 Experimental details:

The trail was laid out in FactorialRandomized block design with twelve treatments replicated thrice. Using 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). 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 ($CD_{0.05}$).

Chart 1 :Details of the treatment combinations.

Notations	Treatments combinations
T_1	V_1S_0(Royal Princess + 30cm ×30cm)
T_2	V_1S_1 (Royal Princess + 30cm× 20cm)
T_3	V_1S_2 (Royal Princess + 30cm× 15cm)
T_4	V_2S_0 (Snowball + 30cm× 30cm)
T_5	V_2S_1 (Snowball + 30cm× 20cm)
T_6	V_2S_2 (Snowball + 30cm× 15cm)

T_7	V_3S_0 (Pink Palasol + 30cm× 30cm)
T_8	V_3S_1 (Pink Palasol+ 30cm ×20cm)
T_9	V_3S_2 (Pink Palasol + 30cm ×15cm)
T_{10}	V_4S_0 (Starlin Queen + 30cm× 30cm)
T_{11}	V_4S_1 (Starlin Queen+ 30cm ×20cm)
T_{12}	V_4S_2 (Starlin Queen + 30cm× 15cm)

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

Vegetative parameters

Plant height - Plant height varied from 31.6cm to 47.4cm. Significantly taller plants (47.4 cm) were recorded in treatment T_9 (Pink Palasol+30cm x 15cm) followed by treatment T_{12} (Starlin Queen+30 cm x 15 cm, 45.2cm) whereas, shorter plants were recorded in treatment T_4 (Snowball +30 cm x 30 cm, 31.6cm). Similar findings have been reported by **Dorajeerao and Mokashi (2013) and Mali *et al.* (2016)** 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 - Plant spread varied from 16.7 cm to 25.1 cm. Significantly wider plants (25.1 cm) were recorded in treatment T_7(Pink Palasol + 30 cm x 30 cm) followed by treatment T_1 (Royal Princess + 30cm x 30 cm) and T_4 (Snowball + 30 cm x 30cm, 24.4cm) whereas,skinnier plants were recorded in treatment T_{12} (Starlin Queen+ 30 cm x 15 cm, 16.7cm). 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.* (2016)** in annual chrysanthemum and **Pratibha *et al.* (2018)** in French marigold.

Number of primary branches - Primary branches 30 days after pinching, varied from 3.3 to 6.2.More number of primary branches (6.2) were recorded in treatment T_7 (Pink Palasol+30 cm x 30 cm) followed by treatment T_8 (Pink Palasol +30 cm x 20 cm, 5.6) whereas,least number of primary branches were recorded in treatment T_6 (Snowball+ 30 cm x 15cm, 3.3). According to **Harper(1977)** 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.

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_1S_0(Royal Princess + 30 cm x 30 cm)	35.3	24.4	5.4
T_2	V_1S_1(Royal Princess + 30 cm x 20 cm)	40.7	21	5.2
T_3	V_1S_2(Royal Princess + 30 cm x 15 cm)	40.5	18.5	4.6
T_4	V_2S_0(Snowball + 30 cm x 30 cm)	31.6	24.4	5.1
T_5	V_2S_1(Snowball + 30 cm x 20 cm)	34.3	21.7	4.8
T_6	V_2S_2(Snowball + 30 cm x 15 cm)	35.1	18.7	3.3
T_7	V_3S_0(Pink Palasol + 30 cm x 30 cm)	39	25.1	6.2
T_8	V_3S_1(Pink Palasol + 30 cm x 20 cm)	44.5	22.5	5.6
T_9	V_3S_2(Pink Palasol + 30 cm x 15 cm)	47.4	19.6	5.2
T_{10}	V_4S_0(Starlin Queen + 30 cm x 30 cm)	40.5	23	5.2
T_{11}	V_4S_1(Starlin Queen + 30 cm x 20 cm)	44.6	21.8	5
T_{12}	V_4S_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

Floral parameter

Days taken to first bud initiation - Significantlyminimum (37 days) taken to first bud initiation were recorded in treatment T_3 (Royal Princess + 30 cm x 15 cm) followed by treatment T_2 (Royal Princess + 30 cm x 20 cm, 38.3 days) whereas, maximum were recorded in T_4 (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 which 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 (1991)** in chrysanthemum cv. kasturi and **Kale (2007)and Kour (2009)** in chrysanthemum.

Quality parameters

Duration of flowering - Duration of flowering varied significantly among different treatments. Significantly shorter duration of flowering was recorded in treatment T_6 (Snowball + 30 cm x 15 cm, 47 days) followed by treatment T_3(Royal Princess + 30 cm x 15 cm, 48 days) whereas,longer duration of flowering was recorded in treatment T_7 (Pink Palasol + 30 cm x 30 cm, 57.7 days). Plants spaced widely, remained in vegetative phase for 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 agro climatic conditions, leading to increase assimilation and subsequently increasing duration of flowering.These results are in line with the findings of**Kour (2009)** in marigold, **Waded (2015)** and **Taksande*et al.* (2017)** in chrysanthemum.

Vase life of chrysanthemum flowers–significantly longer period of vase life (10 days)was recorded in treatment T_7 (Pink Palasol + 30 cm x 30 cm) followed by treatments T_1 (Royal Princess + 30 cm x 30 cm), T_4 (Snowball + 30 cm x 30 cm), T_8 (Pink Palasol + 30 cm x 20 cm) and T_{10} (Starlin Queen + 30cm x 30 cm, 9 days) whereas,shorter period of vase life (6 days) was recorded in the treatment T_6 (Snowball +30 cm x 15cm). 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 (2015)** and **Aashutosh *etal.* (2019).**

Yield parameter

Number of flowers per plant – Significantly more number of flowers per plant (11.9) were registered in treatment T_7 (Pink Palasol + 30 cm x 30 cm) whereas, less number of flowers per

plant were registered in treatment T_6 (Snowball + 30 cm x 15 cm, 1.2).Plants grew more luxuriantly under wider spacing due to more availability of nutrients and space and resulted in production of more vegetative growth which might be responsible for better mobilization of biomass from source to sink i.e. flowers. **Dorajeerao*et al.* (2012)** reported in garland chrysanthemum. As a result of this, the widely spaced plants had comparatively higher levels of organic reserves, conductive for better floral development which thereby increased the number of flowers per plant. **Nagdeve*et al.* (2021)** reported in annual chrysanthemum.

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_1S_0(Royal Princess + 30 cm x 30 cm)	40	53	9	7.5
T_2	V_1S_1(Royal Princess + 30 cm x 20 cm)	38.3	50.3	8	7.3
T_3	V_1S_2(Royal Princess + 30 cm x 15 cm)	37	48	7	6
T_4	V_2S_0(Snowball + 30 cm x 30 cm)	57	50.3	9	2.6
T_5	V_2S_1(Snowball + 30 cm x 20 cm)	54.3	48.7	8	2.4
T_6	V_2S_2(Snowball + 30 cm x 15 cm)	53.3	47	6	1.2
T_7	V_3S_0(Pink Palasol + 30 cm x 30 cm)	44.3	57.7	10	11.9
T_8	V_3S_1(Pink Palasol + 30 cm x 20 cm)	42.3	56.3	9	11.2
T_9	V_3S_2(Pink Palasol + 30 cm x 15 cm)	40.3	55	8	7.5
T_{10}	V_4S_0(Starlin Queen + 30 cm x 30 cm)	48.3	52.3	9	7
T_{11}	V_4S_1(Starlin Queen + 30 cm x 20 cm)	46.3	50.7	8	6.6
T_{12}	V_4S_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

Conclusion

It is concluded that treatment T_9 (Pink Palasol + 30 cm × 15 cm) was found to be better in terms of plant height, T_7 (Pink Palasol + 30 cm × 30 cm) 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 T_3 (Royal Princess + 30 cm × 15 cm).

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