Plant Archives Vol. 25, No. 1, 2025 pp. 451-456 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.067

GROWTH AND FLOWER PRODUCTION OF ANNUAL CHRYSANTHEMUM (*GLEBIONIS CORONARIA* L.) UNDER DIFFERENT PLANTING DATES AND SPACING

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(Date of Receiving-26-11-2024; Date of Acceptance- 12-02-2025)

ABSTRACT

The purpose of the study was to investigate the influence of different planting dates and spacing on the growth and flower production of annual chrysanthemum (*Glebionis coronaria* L.). The results showed that vegetative parameters like plant height, spread, branches, chlorophyll content and flower yield per plant increased under early planting of 15th November and planting pattern of 4 plants/m^2, whereas flowering was delayed. Although, flower and seed yield per m^2 was highest under 60x30 cm distance accommodating 9 plants/m^2. Hence, it was concluded that planting of annual chrysanthemum during 2nd week of November at 60×60 cm spacing accommodating 4 plants/m^2 would be beneficial for improvement of flower yield and quality under Punjab conditions. Although, if high density plantation is to be recommended plant spacing 60 × 30 cm accommodating 9 plants/m^2 can be seen as beneficial for obtaining higher flower and seed yield per plot.

Key words : Annual chrysanthemum, Planting dates, Spacing, Growth, Flower production.

Introduction

Annual chrysanthemum (*Glebionis coronaria* L.) belonging to the family Asteraceae is popularly known as garland chrysanthemum or crown daisy and used as loose flower for making garlands or as bedding plant in landscape (Lohia *et al.*, 2024). The species is also referred as *Leucanthemum coronarium* or *Chrysanthemum coronarium* (Jena *et al.*, 2021). In India, the crop has been naturalized in Maharashtra, Karnataka, Bihar, Punjab, Haryana, Uttar Pradesh and Madhya Pradesh (Dorajeerao *et al.*, 2012) and commonly known as 'Bijli', 'Baboona', 'Guldhak', 'Market' and 'Gendi'. It is known as companion plant for protection against nematodes and caterpillar (Mishra *et al.*, 2002).

Among different crop management practices, planting time plays greater significance in expanding production and quality of flowers. Annual chrysanthemum flowers at the specific time in March under Punjab conditions, but by regulating the planting time, growers can avoid crop flood in the market and can get quality flowers during off season with higher profit (Jindal *et al.*, 2018). Plant spacing by modifying the microclimate at the close vicinity of plants exerts the considerable influence on crop performance and thus, affects the plant growth and yield of flowers in terms of number, size and weight (Jena *et al.*, 2021). Too wider spacing may result in lower flower yield due to insufficient number of plants per unit area (Sharma *et al.*, 2018) whereas, closer planting result in greater competition among the plants and thus reduces flower yield or flower size. Dorajeerao *et al.* (2012) reported that in annual chrysanthemum the flower yield per ha was highest at 30×30 cm spacing, whereas number of flowers per plant were highest at 60×60 cm.

There is lack of scientific information with respect to aspects of planting date and spacing for growth and flower production of annual chrysanthemum. Therefore, keeping in view the aspects of crop scheduling, attempts were made to optimize the best planting date and spacing for enhancing the growth, flowering and seed production in annual chrysanthemum under Punjab conditions.

Materials and methods

The present investigation was carried out at Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana during 2021-22 and 2022-23 to investigate the effect of planting dates and spacing on the growth and flower production of annual chrysanthemum. The experiment was laid out in a factorial randomized block design with four treatments of planting dates i.e. 15th November, 30th November, 15th December and 30th December and three treatments of plant spacing comprising of 60×60 cm (4 plants/m^2), 60×45 cm (6 plants/m^2) and 60×30 cm (9 plants/m^2) with three replication each. Each plot was prepared with $1m^2$ area. The field was thoroughly prepared and healthy and uniform seedlings of annual chrysanthemum were transplanted on raised beds following different spacing levels and planting times as per treatments. The crop was raised by applying standard dose of NPK @ 100, 50, 50 kg/ha. The irrigation, weeding and other cultural operations were followed from time to time. The observations were recorded during the course of investigation for two years and subjected statistical software General R-based Analysis Platform Empowered by Statistics 1.0.0 (Gopinath *et al*., 2020).

Results and Discussion

Growth parameters

The data revealed that planting dates, spacing and their interaction significantly affected the plant height and spread at flowering stage as illustrated in Table 1. The maximum plant height (127.83 cm) was observed in 15th November planting at closer spacing of 60x30 cm, whereas minimum height (91.83 cm) in 30th December planting at 60×60 cm. The 15th December planting produced plants with maximum spread (85.00 cm) which was at par with 30th November planting (82.50 cm) at 60x60 cm. The early planting during 15th November planting favored vegetative growth for production of taller plants due to congenial climatic conditions (*i.e.* temperature), whereas short plants produced late planting of 15th December enhanced more plant spread. The reduced plant spacing increased the plant height due to heavy competition between plants for light, moisture, space and aeration which further enhanced stem elongation (Mladenoviæ *et al*., 2020) or may be due to shade avoidance response, where plant height tends to increase with higher planting densities (Smith, 1982). The wider spaced plants have enough space to spread their branches, so they might have increased lateral growth (plant spread) at the expense of apical growth (height).

The planting dates and spacing had significant effect on no. of branches/plant and leaf area/cm^2 whereas interaction between them was found to be non-significant (Table 2). The early planting of 15th November was superior with respect to number of branches per plant (23.00) and leaf area (17.67 cm^2), whereas late planting of 30th December marked the least branches per plant (16.28) and leaf area (12.44 cm^2). The highest number of branches per plant (22.67) and leaf area (15.63 cm^2) was observed under wider spacing (60×60 cm) and tend to decrease with closer spacing with least found under 60x30 cm (17.62 and 12.58 cm^2). The 15th November planting provided favorable temperature for vegetative growth, thus enhancing the number of branches and leaf area. At closer spacing, light interception is less which results in lower carbon fixation that reduces the plant ability in carbon assimilation and translocation towards new branch production and thus potentially reduces the number of branches per plant and thus, leaf area. However, increase in number of branches and leaves per plant at wider spacing might be attributed to sufficient amount of light, air and nutrients producing more photosynthates (Harper, 1977). Similar results were also reported by Aashutosh *et al*. (2019) in chrysanthemum.

Flowering parameters

The planting dates and spacing significantly affected the days to bud appearance whereas, their interaction

Table 1 : Effect of planting dates and spacing on plant height and spread in annual chrysanthemum.

T/S	Plant height (cm)				Plant spread (cm)			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	103.17	124.50	127.83	118.50	64.67	60.00	54.67	59.78
30 Nov	104.33	106.17	110.00	106.83	82.50	64.83	66.67	71.33
15 Dec	100.33	95.83	103.50	99.89	85.00	81.00	66.67	77.56
30 Dec	91.83	96.67	96.00	94.83	56.17	57.67	62.33	58.72
Mean S	99.92	105.79	109.25		72.08	65.87	62.58	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	2.52	2.18	4.36		2.05	1.78	3.56	

Table 2 : Effect of planting dates and spacing on number of branches/ plant and leaf area/ m^2 in annual chrysanthemum.

T/S	Number of branches per plant				Leaf area/m^2			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	28.00	21.33	19.67	23.00	20.17	17.17	15.67	17.67
30 Nov	20.83	20.00	18.67	19.83	14.33	13.92	12.83	13.69
15 Dec	23.17	19.67	18.50	20.44	14.33	12.83	10.67	12.61
30 Dec	18.67	16.50	13.67	16.28	13.67	12.50	11.17	12.44
Mean S	22.67	19.37	17.62		15.63	14.10	12.58	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	1.96	1.69	NS		1.48	1.28	NS	

Table 3 : Effect of planting dates and spacing on days to bud appearance and 50% flowering in annual chrysanthemum.

T/S	Days to bud appearance				Days to 50% flowering			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	81.33	84.00	85.50	83.61	113.00	115.33	117.50	114.06
30 Nov	75.67	76.50	77.83	76.67	102.33	106.00	103.33	104.11
15 Dec	63.50	63.17	63.17	63.28	89.67	89.33	87.33	87.89
30 Dec	45.33	45.50	52.50	47.78	72.67	75.67	72.83	73.61
Mean S	66.46	67.29	69.75		94.42	96.58	95.25	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	2.04	1.77	NS		2.04	1.77	NS	

was non-significant. The planting dates, spacing and their interaction significantly affected the days to 50% flowering and flowering duration (Table 3).

As planting time was delayed from 15th November to 30th December, the days to bud appearance was reduced from 83.61 to 47.78 days, therefore producing early flowers buds by 35 days in late planting. Whereas, when the plant spacing is decreased from 60x60 cm (66.46 days) to 60x30 cm (69.75 cm) the bud appearance is significantly delayed by 3.29 days. The 50% flowering was early when planting time was delayed from 15th November to 30th December and plants were spaced wider. The earliest 50% flowering was under 30th December planting at 60x60 cm (72.33 days) followed by 60x30 cm (72.83 days) which were at par with each other. The maximum days to 50% flowering were taken by 15th November planting under 60×30 cm (117.50 days) followed by 60×45 cm (115.33 days), which were at par. The maximum flowering duration was in 15th November planting (54.17 days), which was at par with 30th November planting (52.67 days) in wider spacing of 60×60 cm whereas, the minimum flowering duration was reported in 30th November planting (43.33 days), which was at par with all other planting times in spacing of 60×30 cm.

The study suggests that delayed planting resulted in early bud formation and flowering which might be due to short day length conditions prevailing in December planting. These results are supported by findings in annual chrysanthemum (Mohanty *et al.*, 2023), in lachenalia (Kapczyñska, 2013) and in alstroemeria (Kumar *et al.*, 2024). The extended flowering duration during November planting may be attributed to optimum temperature condition during the flowering time. The wider plant spacing kept the flowers representable for longer duration that might be due to sufficient amount of light, air and nutrients with lesser competition producing more photosynthates.

The planting time and spacing significantly affected flower diameter, whereas planting time and their interaction non-significantly affected flower diameter and SPAD content (Table 4). The largest flower were reported under 15th December planting (6.26 cm) which was at par with 30th November (6.20 cm) and 15th November (6.14 cm) plantings whereas, significantly smallest flowers (5.88 cm) was under 30th December planting. The flowers size decreased with decrease in plant spacing from 60×60cm (6.32 cm) to 60×45 cm (6.00 cm). The SPAD content was significantly increased with increasing the plant spacing from 60x30 cm (34.31) to 60×60 cm (38.33). The delayed planting of 30th December resulted in smaller flowers which might be due to poor vegetative growth under unfavorable climatic conditions. The widest spacing favored large flower size and SPAD

Table 4 : Effect of planting dates and spacing on number of flowers and flower yield per plant in annual chrysanthemum.

T/S	Number of flowers per plant				Flower yield per plant (g)			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	695.00	575.67	488.50	586.39	1146.83	750.00	688.00	861.61
30 Nov	546.67	445.00	398.33	463.33	855.50	660.17	658.33	724.67
15 Dec	464.50	354.67	325.17	381.45	789.00	689.00	543.83	673.95
30 Dec	314.67	300.00	254.83	289.83	578.83	464.33	439.67	494.28
Mean S	505.20	418.83	366.70		842.54	640.87	582.46	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	2.77	2.40	4.80		3.43	2.97	5.95	

Table 5 : Effect of planting dates and spacing on flower diameter and SPAD index in annual chrysanthemum.

T/S	Flower diameter (cm)				SPAD index			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	6.31	6.01	6.10	6.14	42.83	33.15	37.95	37.98
30 Nov	6.35	6.05	6.21	6.20	37.33	37.05	33.78	36.06
15 Dec	6.48	6.10	6.20	6.26	37.00	33.32	35.00	35.11
30 Dec	6.15	5.83	5.68	5.88	36.17	34.12	32.02	34.10
Mean S	6.32	6.00	6.05		38.33	34.41	34.68	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	0.13	0.11	NS		NS	2.82	NS	

content due to more availability of light and nutrients to the plants and increased photosynthetic activities by leaves. The present results are in close conformity to the findings of Bhargav *et al*. (2016), who found that as the spacing was decreased, the diameter of flower in China aster was also reduced.

Flower and seed yield

The planting dates, spacing and their interaction significantly affected the number of flowers per plant, flower yield per plant (g), flower yield per m^2 and seed yield per m^2 (Tables 5 and 6).

The number of flowers per plant was significantly reduced as planting time was delayed from November to December and plant spacing was decreased. Maximum number of flowers per plant (695.00) was recorded under 15th November planting at spacing of 60×60 cm followed by 60×45 cm spacing (575.67). Whereas, 30th December planting resulted in minimum number of flowers per plant (254.83) under 60×30 cm spacing. The flower yield per plant was maximum (1146.83 g) in 15th November planting followed by 30th November (855.50 g) and 15th December (789.00 g) planting under spacing of 60×60 cm. On the other hand, significantly minimum flower yield per plant (439.67 g/) was recorded under closest spacing (60x30 cm) in 30th December planting.

Significantly higher flower and seed yield per m^2 was recorded under closest spacing of 60×30 cm (3.90 kg and 536.00 g) followed by 60×45 cm (3.45 kg and 444.00 g) under 15th November planting, whereas 60×60 cm spacing resulted in lowest flower yield per plot in 30th December planting (1.25 kg and 161.33 g). The widest spacing recorded the highest yield per plant under all planting times, whereas 30th December planting recorded lowest flower yield per plant under all spacing.

This enhanced flower and seed production under November planting might be due to congenial climatic conditions resulting in production of taller plants with more number of branches and more leaf area which enhanced photosynthetic production ultimately improving the flower number. Under wider spacing there was more availability of nutrients and space which resulted in vigorous vegetative growth and mobilization of biomass from source (leaf) to sink *i.e.*; flowers. Whereas, low vegetative growth exhibited under December planting and closest spacing resulted in poor flower production. The results are in conformity with Dorajeerao *et al*. (2012) who observed increase in number of flowers per plot with a decrease in planting distance in garland chrysanthemum. The flowers yield per plant was higher under wider spacing, whereas flower yield per plot was more under closer spacing which is due to more plant population accommodated per plot area under close spacing that further compensated the flower yield per plot. Similar results were observed in snapdragon by

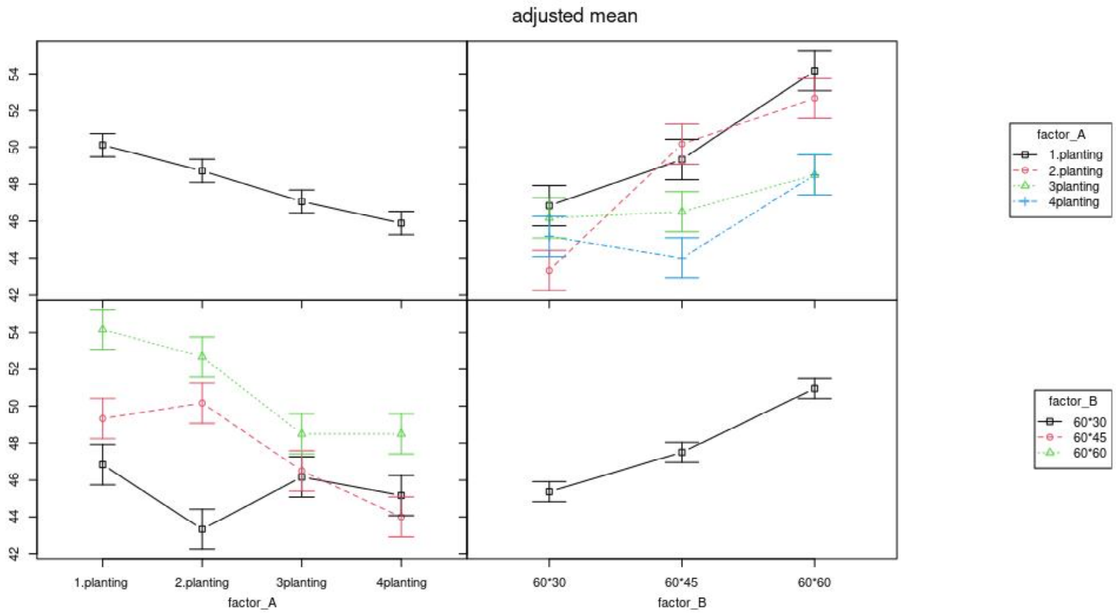

Fig. 1 : Effect of planting dates and pattern on flowering duration in annual chrysanthemum.

Table 6 : Effect of planting dates and spacing on flower and seed yield per m² in annual chrysanthemum.

T/S	Flower yield/ m²(kg)				Seed yield/m²(g)			
	60×60 cm	60×45 cm	60×30 cm	Mean T	60×60 cm	60×45 cm	60×30 cm	Mean T
15 Nov	2.78	3.45	3.90	3.38	411.33	444.00	536.00	463.78
30 Nov	2.18	3.33	3.18	2.90	210.00	288.00	330.67	276.22
15 Dec	1.85	2.12	2.60	2.19	185.33	257.00	309.33	250.56
30 Dec	1.25	1.80	2.03	1.69	161.33	201.00	209.33	190.56
Mean S	2.02	2.67	2.93			297.00	346.33	
CD (0.05)	T	S	T × S		T	S	T × S	
Mean	0.16	0.14	0.29		7.79	6.70	13.51	

Sharma *et al*. (2018) in larkspur by Dhatt *et al*. (2010) and in cosmos by Dubey *et al*. (2002).

Conclusion

Hence, it was concluded that planting of annual Chrysanthemum during 2nd week of November would be beneficial for improvement of flower yield and quality under Punjab conditions. Correlation between temperature, days to flowering and flower yield per plot (kg) reveals that as the temperature decreases along with delay in planting the flower yield and seed yield per plot also decrease. It was also observed that among three different plant spacing, wider spacing i.e. 60×60cm accommodating 4 plants/ m² obtained maximum better results in terms of vegetative and flowering parameters. Although, if high density plantation is to be recommended plant spacing 60×30 cm accommodating 9 plants/m² can be seen as beneficial for obtaining a greater number of flower heads and seed yield per plot.

Acknowledgement

The authors would like to thank the Department of Floriculture and Landscaping for providing necessary facilities.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Author contribution

All authors contributed to this research. Conceptualisation, material preparation and layout of work was planned by Dr. Tanya Thakur. Data collection was done by Mr. Urvind and analysis was done by Ms. Arushi Garg. Final approval was made by all the authors after proofreading.

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