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Effect of different months of planting and pinching on flowering and yield of annual chrysanthemum (*Glebionis coronaria* L.) under Southern Telangana conditions

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Abstract
The study evaluated flowering and yield parameters and the results revealed that January planting recorded less number of days to flower bud initiation (35.18 days), full bloom (57.11 days), flower yield per plant (586.69 g) and per hectare (19.82 t). However, December planting resulted in producing larger flower diameter (5.75 cm), maximum fresh weight of flower (5.27 g) and dry weight of flower (0.55 g). Among the pinching treatments, no pinching led to the earliest flower bud initiation (30.88 days). Nevertheless, double pinching resulted in the maximum number of flowers per plant (116.37), flower yield per plant (486.51 g) and per hectare (16.43 t). The interaction effect of planting month and pinching showed that January planting with no pinching resulted early flower bud initiation (26.97 days), while January planting with double pinching produced the maximum number of flowers per plant (137.85), flower yield per plant (638.74 g) and per hectare (21.57 t). This study concludes that January planting is ideal for annual chrysanthemum cultivation in Southern Telangana conditions, delivering superior flowering and yield outcomes.

Keywords: Annual chrysanthemum, different planting months, pinching, yield

Introduction

Annual chrysanthemum (*Glebionis coronaria* L.) formerly called as *Chrysanthemum coronarium* (2n=4x=34), which is an aromatic annual herbaceous plant native to the Mediterranean region in the daisy family Asteraceae. It produces attractive flowers in shades of yellow and white and is slowly becoming as commercial flower crop in India for loose flower production and garland-making. It is a branching annual, about 61-90 cm tall, with very finely cut foliage and single or double yellow cream and white flowers, about 2.5-3.8 cm, across with cream white zone at the centre (Vishnu Swarup, 1967) [13] and it is a fast-growing winter blooming annual (Nagdeve *et al*., 2021) [8].

In North India, it is one of the cheapest sources of floral material for worship and garland particularly in early summer months when flowers are inadequate in supply. It is more popular among the flowers because of its hardy nature and ease of cultivation. Inaddition it is a photo insensitive and short duration flower crop with attractive yellow and white flowers with good keeping quality (Kedar *et al*., 2022) [6].

As annual chrysanthemum is gaining popularity in the Telangana state substituting chrysanthemum as off-season flower crop in summer, farmers are showing much interest in cultivation but finding difficult in identifying the appropriate time to plant and gain more yield and profits, due to non-availability of research findings on this crop in Southern Telangana zone till now. As planting the crop at a right time favours the growth of the plant providing all the environmental factors suitable for the development of crop. Investigating the right time of planting not only favours the growth and development of the crop in a particular location and aids in adjusting the harvest to fetch premium price in the market.

In addition, pinching is the general cultural operation used to control apical dominance by nipping or cutting the new growth of the plant to induce more branching and eventually more flowers as photosynthates are diverted to lateral buds.

This crop management practice will alter the growth architecture of the plant and leads to higher yields in many commercial crops. Annual chrysanthemum responds well to pinching and put forth excellent growth. However, method of pinching certainly influences the growth and flowering traits eventually on yields. Investigating on appropriate method of pinching that suits the right time of planting should be done.

Thus, to findout suitable month of planting and method of pinching, the present investigation titled, Effect of different months of planting and pinching on flowering and yield of annual chrysanthemum (*Glebionis coronaria* L.) under Southern Telangana conditions" was conducted.

Materials and Methods

The experiment was conducted during the *Rabi* season of December 2023 to April 2024 at the Floricultural Research Station, ARI, Rajendranagar, Hyderabad, the experimental site is located at a Latitude of 17.90˚ N and Longitude 78.23˚ S and at an altitude of about 542.3 m above mean sea level (MSL). The experimental field was laid out in factorial randomized block design with two factors were replicated thrice. The first factor included different months of panting: M1- December, M2- January and M3- February and the second factor pinching: P0- No pinching, P1- Single pinching and P2- Double pinching. Data on days to flower bud initiation, days to 50% flowering, days taken to full bloom, number of flowers per plant, flower diameter (cm), fresh weight of flower (g), dry weight of flower (g), flower longevity on the plant, number of flower pickings, flower yield per plant, per plot and per hectare were recorded and subjected to statistical analysis, Analysis of variance was worked out using standard statistical procedures as described by Panse and Sukhatme (1985) [9]. Standard Error of Mean (S.Em ±), Critical Difference (CD) at 5% probability and Co-efficient of Variance (CV%) was worked out for the interpretation of the results.

Results and Discussion Flowering parameters

Days to flower bud initiation

The data in respect of number of days required for the appearance of flower bud after transplanting was found significant. Significantly minimum (35.18 days) days taken for first flower bud initiation was recorded in M2- January, followed by M1-December (36.92 days) and was at par with M3-February (37.89 days). Among pinching, P0- No pinching recorded minimum days (30.88 days) for first flower bud initiation followed by P1- Single pinching (36.00 days) while maximum (43.11 days) number of days was recorded in P2- Double pinching. The interaction effect of different months of planting and pinching had significant variation. The minimum (26.97 days) days taken to flower bud initiation was noticed in M2P0- January + No pinching, followed by (32.00 days) in M1P0- December + No pinching, (33.67 days) in M3P0- February + No Pinching. While the maximum days (43.33 days) was recorded in M3P2- February + Double Pinching.

Days to 50% flowering

Significant variations were observed in the number of days required for 50% of flowering after transplanting. The minimum duration was recorded in M2- January (50.93 days), followed by M1- December (52.62 days) and the maximum duration was observed in M3 -February (53.61 days). The pinching showed significant variations in the number of days required for 50% of flowering. The minimum duration was recorded in the P0- No pinching (49.48 days), followed by P1- Single pinching (50.93 days), while the maximum duration was observed in the P2- Double pinching (56.76 days). The interaction between different months of planting and pinching showed significant variation. The minimum days to 50% flowering (47.53 days) were observed in the M2P0- January + No pinching which was at par with M2P1- January + Single pinching (47.87 days) followed by M1P0- December + No pinching (50.00 days). In contrast, the maximum days (57.60 days) to 50% flowering were recorded in the M3P2- February + Double pinching.

Days taken to full bloom

The planting months had a significant effect on the number of days required for full bloom after transplanting. The minimum duration (57.11 days) was observed in M2- January planting, significantly followed by M1- December planting (60.68 days) and the maximum duration was recorded in M3- February (60.82 days). The pinching had a significant impact on the number of days needed for full bloom. The minimum days required was recorded in P0- No pinching (55.61 days) which was at par with P1- Single pinching (57.48 days). However, the P2- Double pinching recorded maximum days (65.52 days). A significant difference was observed in interaction effect between planting month and pinching on days to full bloom. The minimum duration to full bloom was recorded in the M2P0- January + No pinching (54.47 days), which was at par with M3P0- February + No pinching (54.77 days) and M2P1 - January + Single pinching (55.00 days). Meanwhile, the maximum duration to full bloom was observed in the M3P2- February + Double pinching (70.27 days).

It was found that, January planting had a profound impact on days taken to flower bud initiation, 50% flowering and full bloom, which might be due to optimum day length conditions and temperatures during January and December planting conditions resulted in flowering in lesser duration of time period. Similar findings were also obtained by Rao and Reddy (2002) [10] with significant delay in flowering (55 days) was noticed in February planted crop which might be due to the fact that short day effect was reduced during the flower production period which was between mid-February to April. Mohanty *et al*. (2023) [7] in annual chrysanthemum. The pinching treatments effectively prolonged the vegetative phase, resulting in a delayed transition to the reproductive phase. In contrast, plants that received no pinching exhibited a shorter duration to full bloom, indicating that pinching treatments prolonged the vegetative phase and subsequently delayed flowering. Similar results have been obtained by Dobariya *et al*. (2023) [2] in annual chrysanthemum, Ehsanullah *et al*. (2021) [3] in chrysanthemum, Jyothi *et al*. (2018) [5] in marigold.

Number of flowers per plant

The month of planting had a significant impact on the total number of flowers per plant. M2- January planting resulted in the maximum (113.96) number of flowers per plant, significantly followed by M1- December (101.54). In contrast, M3- February planting recorded the minimum (69.67) number of flowers per plant. P2- Double pinching resulted in the maximum number of flowers per plant (116.37), followed by P1- Single pinching (94.16). Whereas, P0- No pinching recorded the minimum (74.64) number of flowers per plant. The interaction between different months of planting and pinching had a significant impact on the number of flowers per plant. The maximum number of flowers per plant was recorded in the M2P2 - January + Double pinching (137.85), followed by M1P2 - December + Double pinching (123.40), M2P1 -January +

Single pinching (121.43) and lowest in M3P0 - February + Single pinching (57.88).

The January planting exhibited the maximum number of flowers per plant, likely attributed to the increased branching, which inturn supported a higher flower count. The results are similar to the findings of Mohanty *et al*. (2023) [7] in annual chrysanthemum. In double pinching recorded maximum number of flowers per plant which might be attributed to due to removal of apical dominance resulted in more number of branches per plant were produced which inturn resulted in more number of flowers per plant. Similar findings are also recorded by Ehsanullah *et al*. (2021) [3], Chaudhary *et al*. (2023) [1] in chrysanthemum, Jena *et al*. (2021) [4] and Dobariya *et al*. (2023) [2]

Flower diameter (cm)

A significant variation in flower diameter was observed among the different months of planting. The maximum (5.75 cm) diameter was recorded in M1- December planting which was at par with M2- January (5.55 cm), while the minimum flower diameter was observed in M3- February (3.24 cm). The pinching had a significant impact on flower diameter. The maximum (5.07 cm) diameter was recorded in P0- No pinching treatment which was at par with P1- Single pinching (4.94 cm) while the minimum (4.54 cm) diameter was observed in the P2- Double pinching treatment. Flower diameter varied significantly due to the interaction effect of different months of planting and pinching. The maximum (6.08 cm) flower diameter was found in M1P0- December + No pinching which was at par with M1P1- December + Single pinching (5.87 cm), followed by M2P1- January + Single pinching (5.84 cm).

The flower diameter was significantly larger in the December planting, likely due to the increased accumulation of photosynthates and optimal climatic conditions during the crop growth period. Similar results were reported by Thakur (2022) [12] and Mohanty *et al*. (2023) [7] in annual chrysanthemum. In the absence of pinching, the maximum flower diameter was due to the allocation of assimilates to a lesser number of flowers. These results are in line with those of Jyothi *et al*. (2018) [5] in marigold, Jena *et al*. (2021) [4] and Dobariya *et al*. (2023) [2] in annual chrysanthemum.

Fresh weight of flower (g)

Fresh weight of flower varied significantly by different months of planting, the maximum weight of flower (5.27 g) was recorded in M1- December which was at par with M2- January (5.26 g) and lowest was recorded in M3- February (3.05 g). Among pinching, fresh weight of flower varied significantly. Maximum fresh weight of flower (5.09 g) was recorded in P0- No pinching, followed by P1- Single pinching (4.49 g) and lowest in P2- Double pinching (4.01 g). The interaction effect of different months of planting and pinching recorded significant variation on fresh weight of flower. The maximum fresh weight of flower (5.99 g) was found in M2P0- January + No pinching, followed by M1P0- December + No pinching (5.84 g), M2P1 - January + Single pinching (5.16 g). While minimum fresh weight of flower was recorded in M3P2- February + Double pinching (2.55 g).

Plants exhibiting greater vigour, characterized by a higher number of flowers with larger diameters, likely contributed to the maximum weight of flowers produced under the December planting. Similar findings were recorded by Mohanty *et al*. (2023) [7]. Maximum fresh weight of flower was recorded under no pinching this might be due to accumulation of photosynthates were limited in no pinching. Similar findings are in the line of Jyothi *et al*. (2018) [5] in marigold, Srivastava *et al*. (2023) [11] in French marigold and Dobariya *et al*. (2023) [2] in annual chrysanthemum.

Table 1: Effect of different months of planting and pinching on flowering and yield parameters of annual chrysanthemum (*Glebionis coronaria* L.)

Treatments	Days to flower bud initiation	Days to 50% flowering	Days taken to full bloom	Number of flowers per plant	Flower diameter (cm)	Fresh weight of flower (g)	Dry weight of flower (g)	Flower longevity on the plant (days)	Number of flower pickings	Flower yield per plant (g)	Flower yield per plot (kg)	Flower yield per hectare (t)
Months of planting (M)												
M1	36.92	52.62	60.68	101.54	5.75	5.27	0.55	6.37	3.82	528.75	8.46	17.86
M2	35.18	50.93	57.11	113.96	5.55	5.26	0.54	6.39	3.91	586.69	9.39	19.82
M3	37.89	53.61	60.82	69.67	3.24	3.05	0.27	5.87	3.24	207.78	3.32	7.02
S.Em ±	0.50	0.46	0.45	0.58	0.06	0.02	0.00	0.14	0.17	1.94	0.03	0.07
CD @ 5%	1.51	1.39	1.36	1.24	0.19	0.06	0.01	0.42	0.50	5.87	0.09	0.20
Pinching (P)												
P0	30.88	49.48	55.61	74.64	5.07	5.09	0.48	6.43	3.36	393.47	6.30	13.29
P1	36.00	50.93	57.48	94.16	4.94	4.49	0.45	6.17	3.57	443.25	7.09	14.97
P2	43.11	56.76	65.52	116.37	4.54	4.01	0.43	6.02	4.06	486.51	7.78	16.43
S.Em ±	0.50	0.46	0.45	0.58	0.06	0.02	0.00	0.14	0.17	1.94	0.03	0.07
CD @ 5%	1.51	1.39	1.36	1.24	0.19	0.06	0.01	NS	0.50	5.87	0.09	0.20
Interactions												
M1P0	32.00	50.00	57.60	83.44	6.08	5.84	0.57	6.67	3.43	487.01	7.79	16.45
M1P1	35.77	52.60	60.00	97.77	5.87	5.14	0.54	6.27	3.70	502.85	8.04	16.99
M1P2	43.00	55.27	64.43	123.40	5.31	4.83	0.52	6.17	4.33	596.39	9.54	20.14
M2P0	26.97	47.53	54.47	82.60	5.55	5.99	0.56	6.73	3.63	494.74	7.92	16.71
M2P1	35.57	47.87	55.00	121.43	5.84	5.16	0.53	6.37	3.87	626.59	10.02	21.17
M2P2	43.00	57.40	61.87	137.85	5.28	4.63	0.52	6.07	4.23	638.74	10.22	21.57
M3P0	33.67	50.90	54.77	57.88	3.59	3.43	0.29	5.90	3.00	198.67	3.18	6.71
M3P1	36.67	52.33	57.44	63.27	3.11	3.17	0.26	5.87	3.13	200.29	3.20	6.77
M3P2	43.33	57.60	70.27	87.87	3.02	2.55	0.24	5.83	3.60	224.38	3.59	7.58
S.Em ±	0.86	0.80	0.78	1.00	0.11	0.03	0.00	0.24	0.29	3.36	0.05	0.11
CD @ 5%	2.61	2.40	2.35	2.15	0.33	0.10	NS	NS	NS	10.17	0.16	0.34

M1- December, M2- January, M3- February

P0- No Pinching, P1- Single Pinching, P2- Double Pinching

Dry weight of flower (g)

Different months of planting significantly influenced on dry weight of flowers. Maximum dry weight of flower (0.55 g) was noted in M1- December planting which was at par with M2- January (0.54 g) and minimum dry weight of flower was found in M3- February (0.27 g). The results showed that pinching had a significant impact on dry weight of flower.

Maximum dry weight of flower was recorded in P0- No pinching (0.48 g), followed by P1- Single pinching (0.45 g) and minimum dry weight of flower was recorded in P2- Double pinching (0.43g). There was no significant interaction effect between different months of planting and pinching on dry weight of flower.

The December planting exhibited a significantly higher dry weight of flower which was likely a direct consequence of the increased fresh weight recorded in the same month. The no pinching treatment exhibited a maximum dry weight of flowers, likely due to the increased storage of photosynthates, which was also reflected in the higher fresh weight under no pinching. Similar results are obtained by Srivastava *et al*. (2023) [11] in French marigold.

Flower longevity on the plant (days)

Flower longevity on the plant differed significantly by different months of planting. Maximum flower longevity on the plant was recorded in M2- January (6.39 days) which was at par with M1- December planting (6.37 days). In contrast, lowest flower longevity was found in M3- February planting (5.83 days). The pinching and interaction effect had no significant variation in flower longevity on the plant. However, the maximum days of flower longevity (6.41 days) was found in P2- Double pinching. The results indicated that flower longevity on the plant varied significantly in the January planting. The favorable environmental conditions in January planting might have contributed to a longer duration of flower freshness on the plant, resulting in enhanced flower longevity on plant.

Yield parameters

Number of flowering pickings

The effect of different months of planting was found to be significant. The highest number of flower pickings (3.91) was noted in M2- January which was at par with (3.82) in M1- December and the least number of flower pickings (3.24) was recorded in M3- February planting. Among different pinching, P2- Double pinching recorded significantly highest (4.06) number of flower pickings, followed by P1- Single pinching (3.57) and least number of flower pickings was found in P0- No pinching (3.36). The interaction between different months of planting and pinching had no significant difference among number of flower pickings per month.

The increased flower production in January resulted in a higher number of pickings, indicating a positive effect of this planting time on flower yield might be attributed to the maximum flower yield per plant and plot. The double pinching treatment promoted a greater number of branches and flowers, leading to a higher flower yield per plant. Consequently, this resulted in an increase in the number of flower pickings.

Flower yield per plant (g)

The effect of different months of planting on flower yield per plant was found significant. Maximum flower yield per plant (586.69 g) was observed in M2- January planting, followed by M1- December (528.75 g). Whereas, the minimum flower yield per plant (207.78 g) was noticed in M3- February. The effect of pinching was found to be significant. Significantly maximum flower yield per plant was observed in P2- Double pinching (486.51 g), followed by in P1- Single pinching (443.25 g) and minimum flower yield per plant (393.47 g) was found in P0- No pinching. The interaction effect of different months of planting and pinching was significant. The highest (638.74 g) yield per plant was recorded in the treatment combination M2P2- January + Double pinching followed by M2P1- January + Single pinching (626.59 g), M1P2- December + Double pinching (596.39 g) and lowest flower yield per plant M3P0- February + No pinching (198.67 g).

Flower yield per plot (kg)

The different months of planting recorded significant difference for flower yield per plot. Significantly maximum flower yield per plot (9.39 kg) was observed in M2- January planting, followed by M1- December (8.46 kg). Whereas, the minimum flower yield per plot was noted in M3- February (3.32 kg). A significant effect of pinching on flower yield was observed, the maximum yield per plot (7.78 kg) was recorded in P2- Double pinching, followed by in P1- Single pinching (7.09 kg) and minimum flower yield per plot was found in P0- No pinching (6.30 kg). The interaction between planting month and pinching had a significant impact on flower yield per plot. The highest (10.22 kg) yield per plot was recorded in the M2P2- January + Double pinching treatment combination followed by M2P1- January + Single pinching (10.02 kg) and in M1P2- December + Double pinching (9.54 kg). In contrast, the lowest yield was observed in the M3P0- February + No pinching (3.18 kg).

Flower yield per hectare (t)

Flower yield per hectare differed significantly, the highest flower yield per hectare (19.82 t) was observed in M2- January, followed by M1- December (17.86 t). Whereas, the minimum flower yield per hectare (7.02 t) was noted in M3- February. A significant effect of pinching on flower yield per hectare was observed. The maximum yield per hectare was recorded P2- double pinching (16.43 kg), followed by in P1- single pinching (14.97 kg) and minimum flower yield per hectare was found in P0- no pinching (13.29 kg). The interaction between planting month and pinching significantly affected flower yield per hectare. The highest (21.57 t) yield per hectare was recorded in the M2P2- January + Double pinching treatment combination followed by (21.17 t) in M2P1- January + Single pinching and (20.14 t) in December + Double pinching. However, the lowest (6.71 t) yield was observed in the M3P0- February + No pinching treatment combination.

The results indicated that the January planting exhibited the maximum number of branches and flowers per plant, leading to an increased yield per plant, plot and hectare. This is likely attributed to the favorable and optimal climatic conditions during the growth period, which created an ideal environment for plant growth and development. The pinching treatment resulted in a significant increase in flower yield per plant, plot and hectare. By eliminating apical dominance, pinching enabled the plant to redirect its energy towards lateral growth, promoting the development of more side shoots and flowers and ultimately increased flower yield per plant, plot and hectare. Similar kind of observations on variation in flower yield per plant are reported by Jyothi *et al.* (2018) [5] in marigold, Jena *et al.* (2021) [4], Nagdeve *et al*. (2021) [8], Dobariya *et al.* (2023) [2] in annual chrysanthemum and Srivastava *et al*. (2023) [11] in French marigold.

Conclusions

The present investigation revealed that M2- January planting is optimal for annual chrysanthemum cultivation under Southern Telangana conditions, resulting in optimal, flowering and yield attributes. In contrast, M1- December planting excelled in producing larger flowers with maximum flower diameter, fresh weight and dry weight. Among the different pinching, P2- Double pinching significantly enhanced yield, with a maximum of 16.43 t ha-1. The treatment combination of M2P2- January planting with double pinching proved to be the most beneficial, resulting in maximum yield of 21.57 t ha-1 in annual chrysanthemum (*Glebionis coronaria* L.) under Southern Telangana condition.

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