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Mausumi Mohanty
Department of Horticulture, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Chitta Ranjan Mohanty
Department of Horticulture, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Subhendu Jena
Department of Horticulture, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Sukirti Mohanty
Department of Horticulture, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Corresponding Author:
Mausumi Mohanty
Department of Horticulture, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Effect of planting date on growth and flowering of annual chrysanthemum (*Chrysanthemum coronarium* L.)

Mausumi Mohanty, Chitta Ranjan Mohanty, Subhendu Jena and Sukirti Mohanty

Abstract
An investigation was undertaken in form of a field experiment at the Agricultural Research Station, Binjhagiri, Chhatabara, Institute of Agricultural sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2020-2021. The experiment was conducted on Factorial Randomized Block design consisting of factor *viz*, planting dates. The present investigation four dates of planting *viz*., D1 (24th December 2020), D2 (8th January 2021), D3 (23rd January 2021) & D4 (7th February 2021) are carried out. The result of the study revealed that among four different planting dates tried, plants grown under 24th December planting exhibited better performance with respect to several growth and flowering parameters. Plants with maximum height (66.50 cm), number of leaves (1274.22nos), spread in E-W (63.03 cm) & N-S (60.83 cm), number of primary branches (14.58 nos.) & basal stem diameter (1.20 cm), number (113.93) and weight of flowers 152.67 g) per plant and per plot (4101.60 nos and 5.50 kg), as well as per hectare (47,47222.22nos and 63.61q) with maximum size/diameter (2.66 cm) of flower were recorded under December planted crop. Performance of plants under 8th January planting with respect to plant height (61.26cm)., basal stem diameter (1.15 cm), flower size (2,21 cm), weight of flowers per plant (58.42 g), per plot (2.10 kg) and per hectare (24.34 q) was next to December planting. While several growth parameters like number of leaves, plant spread, number of primary branches per plant and floral parameters like earliest to 50% flowering and number of flowers per plant, per plot and per hectare showed improvement under 23rd January planting next to December planting. On the other hand, performance of plants with respect to almost all parameters was very poor under the 7th February planting date which recorded minimum height (43.40 cm),number of leaves (700.25nos), spread of E-W (36.61 cm) and N-S (34.18 cm), number of branches (9.91 nos.), number (51.76) & weight (49.23 g/plant) of flowers per plant, least diameter (1.79 cm), number and weight flowers per plot (1863.20nos and 1.77 kg) as well as number and weight flowers per hectare (21,56481.48nos and 20.51q).

Keywords: *Chrysanthemum coronarium*, *Annual chrysanthemum*, date of planting analysis

Introduction
Annual chrysanthemum is a member of family Asteraceae, commonly known as crown Daisy or Garland Chrysanthemum; scientifically designated as *Chrysanthemum coronaium* is a native to Mediterranean region, distributed throughout Europe, north Africa and Asia (Sharma *et al*, 2015) [9]. The plants are taller, growing to a height of 1.2 meter and more vigorous which produce flowers in singles or doubles with shades of yellow and white. *Chrysanthemum coronarium*, recently known as *Glebionis coronaria*is cultivated commercially for production of cut and loose flowers. Annual chrysanthemum is commercially cultivated in winter in India for production of loose flowers in certain pockets of Maharashtra, Karnataka, Bihar, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and west Bengal. It is popularly known as cherry gold in west Bengal and Odisha. In Odisha it is mostly grown as a garden plant in beds and borders. Field experiment comprised of five planting times *viz*., 15th September, 1st October, 15th October, 1st November and 15th November at Horticulture section, Rural Institute, Pipri-Wardha (Maharashtra) India, during the year 2010-11 and 2011-12 resulted in significantly maximum plant height, number of branches per plant and diameter of main stem at 60, 75 and 90 days after planting, spread of plant at 50% flowering and biomass of plant (fresh and dry) in the 15th October planting (Hawa *et al.*, 2021) [2]. Palai *et al*. (2018) [6] resulted out of an investigation on effect of planting dates and photoperiod on growth and flowering of chrysanthemum that early flowering (41.33 days) was obtained in 1st December (Natural photoperiod) planted crop.

It is used alone or in combination with marigold and other flowers for preparation of garland and also for religious offering. Apart from its ornamental value, it has got several medicinal uses. The leaves are expectorant and stomachic. In conjunction with black pepper it is used in the treatment of gonorrhoea. The flowers are aromatic, bitter and stomachic. Besides its medicinal values, annual chrysanthemum is also used for edible purpose. Garland chrysanthemum is a moderately nutritious crop. Young shoots and stems are eaten raw or cooked. Flowers raw or blanched briefly are added to salads.

Although it is quite popular as a loose flower in the state of Odisha from commercial point of view, its commercial cultivation has not yet been started here. Among various horticultural practices adopted for commercial cultivation of flowering annuals, planting time assume greater significance. Though yield and quality of flowers is primarily a genotypic trait, it is greatly influenced by the prevailing environment under local climatic condition during the growth period of the crop. Field experiment on the effect of planting time during the period between October 2017 to February, 2018 with four planting time on growth and quality in Chrysanthemum cv. Ratlam Selection was concluded that later planting on 3rd week of November took minimum days for flowering parameters and recorded maximum diameter of flower., while earlier planting on 1st week of October showed maximum duration of flowering span, length of flower stalk, vase life, shelf life, in situ longevity of flowers (Jindal *et al.*, 2018) [3]. Hence, keeping the above facts in view, the present research project was undertaken to assess the best time of time of planting in Odisha condition.

Materials and Methods

The present investigation was undertaken in form of a field experiment at the Agricultural Research Station, Binjhagiri, Chhatabara, institute of Agricultural sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2020-2021. The experiment was conducted to study the effect of date of planting on growth and flowering of annual chrysanthemum cv. Local following Randomized Block design. In the present investigation four dates of planting *viz*., D1 (24th December 2020), D2 (8th January 2021), D3 (23rd January 2021) & D4 (7th February 2021) were adopted which were replicated thrice. All the data concerning various growth parameters, flowering components and flower characters were analyzed statistically. The treatment effects were tested by 'F' test at 5% level of significance. The critical difference at 5% level was calculated for comparing treatment means.

Result and Discussion

Plant height: Observation on plant height of annual Chrysanthemum as influenced by different planting dates, was recorded after two months of transplanting and the analysed data are presented in Table 1. Significant difference in plant height was observed due to various planting dates under study. It was found maximum (66.50 cm) in 24th December, 2020 planted crop which differed significantly from other planting dates. It was followed by the same planted on 8 January 2021 (61.26 cm). On the other hand, plants with minimum height (43.40 cm) was recorded under 7 February 2021 planting. Increase in plant height in 24 December 2020 planted crop might be due to prevailing congenial environmental condition during the growth period of the crop. mild weather conditions with atmospheric temperature ranging from 26.8 °C to 31.6 °C and relative humidity ranging from 68% to 91% in the morning might have proved favourable for the increased plant height in annual chrysanthemum. Similar effect of mild weather condition favouring increase in plant height in annual chrysanthemum was also reported by Sharma *et al*. (2015) [9]. Prevalence of high temperature coupled with high rate of evaporation during the growth period (March-April) of February planted crop probably did not allow the plants to grow taller. Similar findings with respect to plant height in December, January and February planted crop in marigold was also reported by Mohanty *et al*. (2015) [5].

Number of leaves per plant: The data presented in Table 1 indicated that significant influence of planting dates on number of leaves per plant in annual chrysanthemum was noticed after two months of planting. It was maximum (1274.22nos) in 24 December 2020 planted crop and was followed by the same recorded under 23 January planting (1205.89nos) On the other hand significantly minimum number (700.25nos) of leaves was recorded under 7 February planting. Favourable growing condition with mild temperature and high relative humidity prevailing during the growth period of December and January planted crops might have resulted in better vegetative growth with more number of leaves as compared to February planted crop. Similar effect of planting dates was reported by Mohanty *et al*. (2015) [5] in marigold who observed more number of leaves per plant in December and January planted crop as compared to February planting.

Plant Spread: Observations on plant spread in East–West and North-South direction of annual chrysanthemum as influenced by various planting dates were recorded after two months of planting and the analysed data are presented in Table 1. It was found that significant variation in plant spread of annual chrysanthemum existed in both the directions. It was maximum in 24 December 2020 planted crop which recorded 63.03 cm and 60.83 cm spread in E-W and N-S directions respectively. It was followed by 23 January 2021 and 8 January 2021 planting which recorded 46.17 cm and 39.94 cm spread respectively in East-West direction while the values for same dates of planting were 42.95 cm and 40.51 cm respectively in North – South direction. On the other hand, significantly minimum spread of 36.61 cm and 34.18 cm was recorded under 7 February planting in East-West and North-South direction respectively. Maximum plant spread as observed under December planting might be due to the availability of congenial growth conditions with mild atmospheric temperature (26.8 °C to 31.6 °C) and moderate to high relative humidity (68-91%) in the morning prevailing during the growth period which favoured with more vegetative growth. Performance of January planted crop was same what better next to December planting whereas prevalence of high temperature (34.5 °C to 36.0 °C) coupled with high rate of evaporation during the growth period (March - April) resulted in low spread of plant in February planted crop. The result of the present study is conformity with Mohanty *et al*. (2015) [5] who observed higher plant spread in December and January planted crop in marigold as compared to February planting. This is also in line with the research of Thumar *et al*., 2020 [1].

Number of primary branches: As indicated in Table-1, significant difference in number of primary branches per plant was noticed due to different planting dates under study. it was maximum (14.58 nos.) in 24 December planted crop which was followed by 23 January and 8 January planting recording 12.93 and 10.07 branches per plant respectively. On the other hand, significantly minimum number of branches (9.91 nos.) as recorded at 7 February planting. However, it was at par with the same recorded under 8 January planting this might be due to the availability of congenial condition for growth of December planted crop followed by January planting. On the other hand, unfavourable growing condition during growth period with higher temperature and high evaporation might have resulted in reduced number of primary branches under February planting. The result of the present study is in closed agreement with Mohanty *et al*. (2015) [5] who also observed more number of primary branches per plant in marigold under December planting followed by January planting, while the lowest was recorded in February planted crop under Bhubaneswar condition.

Basal stem diameter: Data recorded in Table-1 revealed that significant influence of various planting dates was noticed with respect to basal stem diameter of plants. It was maximum (1.20cm) under 24 December planting which was followed by 8 January planting (1.15cm) without showing significant variation. On the other hand, minimum (1.03cm) was recorded under 23 January planting which was at par with the same recorded under 7 February planting (1.05cm). For the plants under 24 December and 8 January planting, the growing conditions were more or less similar and favourable which resulted in production of thicker stems under these planting dates. Similar results have also been reported in marigold by Parhi (2008) [8] who recorded thicker stems in 15 December and 15 January planted crops as compared to the same recorded under February planting.

Days taken for 50% flowering: The data presented in table 1 revealed that various planting dates had significant influence on days to 50% flowering in annual chrysanthemum. It was observed to be earliest under 23 January 2021 planting which took 49.67 days for the same. However, time taken for the same under 24 December 2020 and 8 January 2021 planting did not show any significant variation from it which took 50.33 and 51.67 days respectively. It might be due to the reason that during December and January planting there were short day conditions which resulted in formation of flower buds in lesser time period. Similar effect of short-day conditions on earlier bud formation and 50% flowering was reported by Lakshmi *et al*. (2014) [4] in African marigold. On the other hand, significant delay in production of 50% 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-March to April; this is in line with the findings of Rao *et al*., 2002 [8] in African Marigold.

Number of flowers per plant

It was noticed that different planting dates showed significant variation with respect to number of flowers produced per plant (table-2). Maximum number of flowers per plant (113.93) was recorded under 24 December planting which was followed by 23 January and 8 January planting with 103. 38 and 92.58 flowers per plant respectively. This might be due to the fact that production of more number of branches, greater plant spread with more number of leaves produced per plant under December 24 followed by January planting might have produced more photo synthases ultimately improving the flower number under these planting dates. On the other hand, plants under February planting exhibiting less vegetative growth in terms of number of branches, plants and number of leaves, produced minimum number of flowers (51.76) per plant. Similar results have also been reported by Parhi (2008) [7] in marigold who recorded more number of flowers under December planting followed by January planting while it was the minimum under February planting.

Flower size/diameter

As indicated in Table 1, maximum size/ diameter of flower (2.66 cm) was recorded under December planting which differed significantly from other planting dates with respect to this parameter. It was followed by 8 January and 23 January planting measuring 2, 21 cm and 2.09 cm respectively. On the other hand, flowers with least diameter (1.79 cm) were produced under 7 February planting. Better vegetative growth of plants in term of plant height, plant spread, increased number of leaves and primary branches per plant might have contributed for production of larger flowers under December planting followed by January planting. On the other hand, poor vegetative growth under February planting might have resulted in smaller flowers as observed in the present investigation. Effect of planting dates on flower size was reported by Mohanty *et al*. (2015) [5] who also observed similar effect of December, January and February planting in marigold under Bhubaneswar condition.

Weight of flowers per plant

The data revealed that significantly higher weight of flowers (152.67 g) per plant was recorded in 24 December planted crop and it was followed by the same recorded under 8 and 23 January planting which had 58.42 g and 53.71 g flower per plant respectively (table-2). On the other hand, significantly less weight (49.23 g/plant) of flowers was recorded under 7 February planting. Plants with greater vigour producing more number of flowers with greater diameter might have resulted in production of maximum weight of flowers under December planting while January planting was next in order. On the other hand, poor vegetative growth exhibited under February planting with production of least number of smaller flowers might have resulted in recording minimum weight of flowers under this planting date. The findings of the present study is in conformity with Parhi (2008) [7] who reported similar results in marigold.

Number of flowers per plot

The data pertaining number of flowers per plot as influenced by planting time, pinching levels and their interaction are presented in Table-2. A significant variation in number of flowers per plot was observed due to various planting dates. It was highest (4101.60nos) under 24 December planting followed by 23 January (3721.60nos) and 8th January (3332.80nos) planting whereas the lowest (1863.20nos) was recorded under 7 February planting. Highest number of flowers recorded under December planting followed by January planting might be due to greater plant vigor and favorable climatic condition including temperature prevailing

during the crop period. On the other hand, plant with less vigor and high temperature coinciding with flowering time in case of February planted crop might have resulted in reduction of number of flowers per plot. Similar findings have also been reported by Mohanty *et al*, (2015) [5] in marigold who observed higher flower number per plot under December planting followed by January planting while the lowest number was recorded under February planting.

Weight of flower per plot

Significantly higher weight of flowers (5.50 kg) per plot was recorded under 24 December planting and it was followed by 8 January and 23 January planting which recorded 2.10 kg and 1.93 kg of flower per plot respectively (table-2). Favourable climatic condition including temperature prevailing during the crop period might have resulted in production of higher weight of flower per plot under December planting followed by January planting. Between the two planting dates in the month of January, although number of flower per plot was higher under 23 January planting as compared to 8 January planting, higher weight of flowers per plot was recorded under 8 January planting as the size of flowers under this planting date was larger which might have larger weight and compensated the weight in spite of less number flower per plot. On the other hand, minimum weight (1.77 kg) per plot was recorded under 7 February planting. Plants with less vigor and high temperature coinciding with flowering time in case of February planted crop might have resulted in reduction of flower number and weight of flower per plant and ultimately per plot. Higher flower yield per plot on weight basis under December planting followed by January planting and minimum weight per plot under February planting was also reported by Mohanty *et al*, (2015) [5] in marigold.

Number of flowers per hectare

Data on total number of flowers per hectare in annual chrysanthemum as influenced by different planting dates were computed from per plot yield data which were statically analyzed and presented in Table 2. It indicates that a significant variation in number of flowers per hectare was observed due to various planting dates under study. It was the highest (47,47222.22nos) under 24 December planting followed by 23 January (43,07407.41nos) and 8 January (38,57407.41nos) planting whereas the lowest (21,56481.48nos) was recorded under February planting.

Weight of flower per hectare

Data on yield of flowers per hectare on weight basis in annual chrysanthemum as influenced by different planting dates, pinching treatments and their interaction were computed from per plot yield data and the same were statistically analyzed and presented in Table 2. Data pertaining to weight of flowers per hectare as influenced by various planting dates indicated that significantly higher weight of flowers (63.61 q) per hectare was recorded under 24 December planting and it was followed 8 January and 23January planting which recorded 24.34 and 22.38 quintals of flower respectively. On the other hand, the lowest yield of flowers per hectare (20.51q) was recorded under 7 February planting.

Table 1: Effect of Date of Planting on various flowering and vegetative parameters of annual chrysanthemum after 2 months of planting

Treatments Date of planting (D)	Plant height in (cm)	Number of leaves/plants	Plant spread (E-W) (cm)	Plant spread (N-W) (cm)	Number of primary branche s	Basal stem diameter (cm)	Days taken for 50% flowering	Flower size/flower Diameter (cm)
D1 (24th Dec 2020)	66.50	1274.22	63.03	60.83	14.58	1.20	50.33	2.66
D2 (08th Jan 2021)	61.26	968.16	39.94	40.51	10.07	1.15	51.67	2.21
D3 (23th Jan 2021)	55.35	1205.89	46.17	43.95	12.93	1.03	49.67	2.09
D4 (07th Feb 2021)	43.40	700.25	36.61	34.18	9.91	1.05	55.00	1.79
S.E(m) ±	0.51	20.05	0.34	0.33	0.31	0.01	0.73	0.03
CD at 5%	1.50	58.82	1.01	0.98	0.92	0.05	2.15	0.09

Table 2: Effect of Date of Planting on various yield parameters of annual chrysanthemum after 2 months of planting

Treatments date of planting (D)	Number of flowers per plant	Weight of flowers per plant (g)	Number of flowers per plot	Weight of flowers per plot (kg)	Number of flowers per hectare	Weight of flower per hectare (q)
D1 (24th Dec 2020)	113.93	152.67	4101.60	5.50	4747222.22	63.61
D2 (08th Jan 2021)	92.58	58.42	3332.80	2.10	3857407.41	24.34
D3 (23th Jan 2021)	103.38	53.71	3721.60	1.93	4307407.41	22.38
D4 (07th Feb 2021)	51.76	49.23	1863.20	1.77	2156481.48	20.51
S.E(m) ±	0.95	0.42	34.31	0.01	39720.00	0.17
CD at 5%	2.79	1.23	167.09	0.07	193392.98	0.85

Conclusion

Based on the result of the present study, it was concluded that among four different planting dates tried, plants grown under 24th December planting exhibited better performance with respect to several growth and flowering parameters. Plants with maximum height (66.50 cm), number of leaves (1274.22nos), spread (E-W and N-S) (63.03 cm and 60.83 cm), number of primary branches (14.58) & basal stem diameter (1.20c.), number and weight of flower per plant (113.93 and 152,67gm), per plot (4101.60nos and 5.50 kg), as well as per hectare (47,47222.22 nos and 63.61 q) with maximum size/diameter (2.66 cm) of flower were recorded under December planted crop. Performance of plant under 8th January planting with respect to plant height (61.26 cm), basal stem diameter (1.15cm), flower size (2.21 cm), weight of flowers per plant (58.42 gm), per plot (2.10 kg) and per hectare (24.34 q) was next to December planting. While several growth parameters like number of leaves, plant spread, number of primary branches per plant and floral parameters like earliest to 50% flowering and number of flowers per plant, per plot and per hectare showed improvement under 23rd January planting next to December

planting. On the other hand, performance of plants with respect to almost all parameters was very poor under the 7th February planting date which recorded minimum height (43.40Cm), number of leaves (700.25nos), spread E-W (36.61 cm) and N-S (34.18 cm), number of branches (9.91nos), number (51.76) and weight (49.23) gm/plant of flowers per plants, least diameters (1.79 cm), number and weight of flowers per plot (1863.20nos)and (1.77 kg) as well as number and weight of flowers per hectare (21,56481.48nos and 20.51q). Hence, it was concluded that planting of annual Chrysanthemum cv. Local between last week of December to last week of January with adoption of single pinching at 30 days after transplanting would be beneficial for improvement of yield and quality of flowers which may be recommended to the flower growers for its commercial cultivation.

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