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

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Abstract
The Present investigation to study effect of pinching on growth and flowering of Annual Chrysanthemum (*Chrysanthemum coronarium*) cv. Local was carried out in form of a field trial at the Agricultural Research Station, Binjhagiri, Chhatabar, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2019-20. Among three different levels of pinching tried, parameters like plant height and flower diameter were observed to be maximum under no pinching (P_0) treatment. Besides, plants took minimum time for appearance of first flower bud under this treatment. On the other hand plants with shortest height was recorded under double pinching (ie. pinching after 30 and 45 days of planting) treatment (P_2) However, several growth and flowering parameters were improved under this pinching treatment. Parameters like number of leaves and primary branches, number of flowers per plant(248.82 nos), number of flowers per plot (13,046.20 nos) as well as per hectare (15,099768.52 nos)were observed to be maximum under this double pinching treatment. Different levels of pinching could not influence the plant spread significantly. Since the ultimate aim of any crop production programme is to maximize the yield through an ideal crop management practices, double pinching, once after 30 days and again after 45 days of planting was most suitable practice for maximizing flower yield in annual chrysanthemum cv. Local which may be recommended to the flower growers for its commercial cultivation.

Keywords: Plant height, plant spread, number of leaves, appearance of flower bud, flower diameter, number of flowers per plant, number of flowers per plot

Introduction
Annual chrysanthemum, botanically known as *Chrysanthemum coronarium* L., is an annual herbaceous plant with aromatic flavor which is popularly known as garland chrysanthemum or edible chrysanthemum belonging to the daisy family Asteraceae. It is native to the Mediterranean region. It is cultivated and naturalized in East Asia in scattered locations in North America. It is a hardy, vigorous and relatively short duration plant which produces attractive flowers in various shades of yellow and white having single or double forms (Desai, 1962).In India it is commercially grown for production of loose flowers in certain pockets of Maharashtra, Karnataka, Bihar, Punjab, Haryana Uttar Pradesh, Madhya Pradesh and West Bengal supplementing the production of florist chrysanthemum. In Odisha it is mostly grown as a garden plant in beds and borders. However, as a commercial flower its popularity is next to marigold which is extensively used as loose flower. It is popularly known as cherry gold in West Bengal and Odisha. Annual chrysanthemum is used alone or in combination with marigold and other flowers for preparation of garland and also for religious offering. However, the entire requirement of the state is met from West Bengal since its commercial cultivation has not yet been started in the state of Odisha. So far no research work has been initiated in the state to standardize the horticultural practices for commercial cultivation of this flower crop by the flower growers. Although the agro- climatic condition of the state is more or less similar to that of West Bengal and is quite favorable and there is lot of potential of this crop, unavailability of production technology to the farmers comes in the way for its commercial cultivation.

Among different crop management practices to increase production and quality of various annual flowers including annual chrysanthemum, cultural manipulation of growth and flowering through proper pinching assumes greater significance. Pinching is the act of cutting or nipping off the new growth on a plant in order to force branching so that the eventual number of flowers is increased. A plant generally grows straight up due to apical dominance. If the growing tips are pinched out, the assimilates are diverted in to the lateral buds and

branching occurs thus arresting vertical growth which ultimately improves flower yield of plants.

In the present trial an attempt was made to investigate the effect of three levels of pinching on various growth and flowering parameters for exploring the possibilities of improving yield of flowers through pinching.

Materials and methods

The Present investigation to study effect of pinching on growth and flowering of Annual Chrysanthemum (*Chrysanthemum coronarium*) cv. Local was carried out in form of a field trial at the Agricultural Research Station, Binjhagiri, Chhatabar, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2019-20. The experiment was conducted following Factorial Randomized Block Design consisting of two factors *viz*., spacing and pinching as treatments. In the present investigation four levels of spacing *viz*., S_1 (30cmX30cm), S_2 (40cmX30cm), S_3 (60cmX40cm) & S_4 (60cmX60cm) as main plot treatments and three levels of pinching *viz*., P_0 (No pinching), P_1 (Single pinching i.e 30 days after transplanting) & P_2 (Double pinching i.e 30 and 45 days after transplanting) as sub plot treatments under each main plot treatment were included which were replicated thrice. Growth parameters like plant height, plant spread (East-West) & number of leaves per plant and flowering parameter like flower diameter were recorded twice i.e. after two and three months of planting. Flowering parameters like days to appearance of first flower bud, number of flowers per plant and yield of flowers per plot in terms of number were also recorded. Flower yield per hectare was computed from per plot (8.64 m^2 area) yield data. All the data concerning various growth parameters, flowering components and flower characters were analyzed statistically. The analysis of variance table was prepared. 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.

Results and Discussion

Plant height

Observations on plant height of annual chrysanthemum as influenced by different levels of pinching were recorded two times, i.e. after two and three months of planting (Table 1). Significant influence of various pinching treatments was observed on plant height during both the observations. The maximum height was observed in plants receiving no pinching (P_0) treatment which was followed by and at par with single pinching (P_1) done after 30 days of planting. The minimum was observed in double pinched plants (P_2) done after 30 and 45 days after transplanting. However, it was at par with single pinching. The same trend was observed during both the observations. The plant height of 96.86 cm, 92.11cm and 85.26 cm were recorded in plants receiving P_0, P_1 and P_2 treatments respectively after two months of planting while it was 101.96 cm (P_0), 95.96 cm(P_1) and 89.66 cm (P_2) during the second observation recorded after three months of planting. It was noticed that plant height was reduced gradually with increase in pinching levels. The result of the present study is in conformity with the findings with Ona *et al.* (2015) [8] who observed tallest plant from P_0 (no pinching) and the shortest plant in P_2(twice pinching) in Snow ball chrysanthemum. Reduction in plant height in pinched plants is mainly due to elimination of apical dominance. Working with chrysanthemum Habiba *et al.* (2012) [3] reported that in the process of pinching when terminal bud was removed from the plants that attained a stress and the plant required time to overcome this condition and the growth was hampered. Natural auxin concentration at the tip of the plant causes to grow tall. Pinching temporarily reduces auxin which takes away the apical dominance. On the other hand, in case of without pinching of terminal bud (no pinching), the plants exhibit normal vegetative growth. For that the pinched plants could not accomplish vegetative growth and the ultimate results were the shortest plant compared to without pinching of terminal bud (no pinching).

Plant spread (East-West)

It was observed that maximum spread of 57.01cm and 63.31 cm were recorded during first and second observations respectively under double pinching (P_2) done at 30 and 45 days after planting while the minimum spread of 55.98 cm and 60.87 cm were recorded under single pinching(P_1) and no pinching (P_0) treatments after two and three months of planting respectively (Table 1). Minimum plant spread recorded in no pinching treatment(P_0) at three months of planting might be due to diversion of carbohydrates or food material towards the auxiliary bud below the pinched portion and neutralized the effect of apical dominance which caused reduction in plant height, increase in number of primary branches as well as plant spread. The result was supported by Gaidhani *et al.* (2020) [2] who ascribed the aforementioned reason while experimenting with China aster. However, no significant difference was observed in plant spread in the present study due to various pinching treatments during any of the observations.

Number of leaves per plant

It was found that plants receiving double pinching(P_2) i.e. pinched after 30 and 45 days after planting recorded the maximum number of leaves which differed significantly from other pinching treatments. It was followed by single pinching (P_1) i.e. after 30 days of planting and the lowest number was recorded in plants receiving no pinching treatment(P_0). The same trend was noticed during both the observations. The average leaf number per plant were 1189.15, 1032.88 and 878.25 under double pinching (P_2), single pinching (P_1) and no pinching(P_0) treatments respectively after two months of planting while the plant receiving double pinching (P_2), single pinching (P_1) and no pinching (P_0) treatments recorded 1655.82, 1518.08 and 1288.58 leaves per plant respectively after three months of planting(Table 1). The result of this study corroborates the findings of Khobragade *et al.* (2012) [4] who found a positive effect of pinching on china aster plants and the pinched plants showed maximum number of leaves in comparison to un pinched plants. This was due to lateral dominance in the plants, producing more number of branches and thus more leaves.

Days taken for appearance of first flower bud

Significant difference in appearance of first flower bud in plants was also noticed due to various pinching treatments (Table 1). It was the earliest in plants receiving no pinching (P_0) treatment which took 25.35 days for the same and it was at par with single pinching (P_1) which took 25.80 days. In the present investigation gradual delay in appearance of first flower bud was noticed with increase in pinching levels. Plants receiving double pinching (P_2) took maximum time (26.12 days) for the same which was followed by and at par with single pinching (P_1).The result of the present study is in agreement with Gaidhani *et al.* (2020) [2] who observed that

pinching delayed flower bud formation in china aster compared to the plants where no pinching was performed. This delay might be due to removal of apical portion, as a result of which phenomenon of apical dominance got broken in pinched shoots and thus took longer time to become physiologically mature for initiation of flower bud.

Table 1: Effect of various levels of pinching on plant height, plant spread, number of leaves and days to appearance of flower bud in annual chrysanthemum cv. Local

Treatments	Plant height(cm)		Plant spread(E-W) (cm)		No. of leaves per plant		Days to appearance of first flower bud
	After 2 months	After 3 months	After 2 months	After 3 months	After 2 months	After 3 months	
Pinching(P)							
P_0 (No pinching)	96.86	101.96	56.49	60.87	878.25	1288.58	25.35
P_1 (Single pinching)	92.11	95.96	55.98	61.36	1032.88	1518.08	25.80
P_2 (Double pinching)	85.26	89.66	57.01	63.31	1189.15	1655.82	26.12
SE(m) ±	1.82	1.61	0.89	0.92	41.19	37.44	0.09
CD at 5%	8.90	7.83	NS	NS	200.59	182.32	0.47

Flower size/Flower diameter

Various levels of pinching also influenced the diameter of flowers significantly (Table 2). It was observed that flowers with maximum diameter were produced in plants receiving no pinching (P_0) treatment which decreased with increase in pinching levels and flowers with minimum diameter were recorded in double pinched plants (P_2). The same trend was observed during both the observations. Average flower diameter of 5.30 cm,4.73 cm and 4.39 cm were recorded under P_0(no pinching),P_1(single pinching) and P_2(double pinching) treatments respectively after two months of planting while the same recorded under P_0, P_1 and P_2 treatments were 4.68 cm,3.77 cm and 3.19 cm respectively after three months of planting. Similar findings have been reported by Nain *et al.* (2017) [7] in marigold and Khobragade *et al.* (2012) [4] in china aster who concluded that decrease in flower diameter in pinched plants might be attributed to the fact that in pinched plant energy was shared by the developing side branches, while in case of un pinched plants, the energy sharing was limited to the flower developing in main branch only. It was further noticed that flower size in general was reduced under different treatments with increase in age of plants.

Number of flowers per plant

Significant difference in number of flowers per plant was also observed due to various levels of pinching treatments(Table 2). It was significantly higher (248.82) in plants receiving double pinching (P_2) and was followed by single pinching (P_1) and no pinching (P_0) treatments which recorded 195.67and 170.55 flowers per plant respectively. Increase in number of flowers might be due to the fact that pinched plants induced more number of auxiliary shoots resulting in well shaped bushy plants bearing more number of flowers. Nain *et al.* (2017) [7] and Meena *et al.* (2015) [5] also reported similar findings in African marigold.

Number of flowers per plot

Various levels of pinching also had significant influence on number of flowers per plot(8.64m^2) as observed in the present investigation(Table 2). It was maximum (13046.20) under double pinching (P_2) which decreased with decrease in the pinching levels and 10152.60 number of flowers were recorded under single pinching (i.e. P_1) On the other hand the minimum (8738.50) was recorded under no pinching treatment (P_0.).It might be due to the factthat production of more number of branches per plant resulted in production of more number of flowers in pinched plants as compared to plants receiving no pinching treatment. Hence, more number of flowers per plot would be obviously expected. Similar findings have also been reported by Khobragade *et al.* (2012) [4] in china aster and Mohanty *et al.* (2015) [6] in marigold.

Number of flowers per hectare

Various levels of pinching influenced the total yield (number) of flowers per hectare significantly (Table 2). Maximum number (1,50,99,768.52) was produced under double pinching (P_2) treatment which showed a decreasing trend with reduction in pinching level and the number was 1,17,50,694.44 under single pinching(P_1). On the other hand minimum number of flowers per hectare (1,01,14,004.63) were recorded under no pinching(P_0) treatment. It was found that all the pinching treatments were significantly different from each other with respect to this parameter.

Table 2: Effect of various levels of pinching on flower diameter, number of flowers per plant, number of flowers per plot and per hectare in annual chrysanthemum cv. Local

Treatments	Flower diameter(cm)		No. of flowers per plant	No. of flowers per plot	No. of flowers per hectare
	After 2 months	After 3 months			
Pinching(P)					
P_0 (No pinching)	5.30	4.68	170.55	8738.50	10114004.63
P_1 (Single pinching)	4.73	3.77	195.67	10152.60	11750694.44
P_2 (Double pinching)	4.39	3.19	248.82	13046.20	15099768.52
SE(m) ±	0.04	0.01	2.49	130.62	151188.64
CD at 5%	0.22	0.08	12.16	636.01	736123.38

Conclusion

Among three different levels of pinching tried, parameters like plant height, and flower diameter were observed to be maximum under no pinching (P_0) treatment. Besides, plants took minimum time for appearance of first flower. However, plants receiving no pinching treatment exhibited poor performances with respect to several growth and flowering parameters. Number of leaves per plant, number of flowers per plant, number and flowers per plot as well as per hectare were found to be lowest under this treatment (P_0). On the

other hand plants with shortest height was recorded under double pinching (i.e. pinching after 30 and 45 days of planting) treatment. However, several growth and flowering parameters were improved under this pinching treatment. Parameters like plant spread (East-West), number of leaves, number of flowers per plant, number of flowers per plot as well as per hectare were observed to be maximum under this double pinching treatment. Besides, flowering parameters like days to appearance of first flower bud was maximum delayed under this pinching treatment. However, Different levels of pinching could not influence the plant spread significantly.

Since the ultimate aim of any crop production programme is to maximize the yield through an ideal crop management practices, double pinching, once after 30 days and again after 45 days of planting was most suitable practice for maximizing flower yield in annual chrysanthemum cv. Local which may be recommended to the flower growers for its commercial cultivation.

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