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Effect of pinching and nitrogen on growth and flower yield of annual chrysanthemum

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Abstract
This research was conducted to investigate the "Effect of pinching and nitrogen on growth and flower yield of annual chrysanthemum" was carried out during *rabi* season of the year 2019- 2020 at the farm of Horticulture Section, College of Agriculture, Nagpur. The experiment was laid out in factorial Randomized Block Design with 12 treatment replicated thrice. The treatments comprised of the three pinching treatments *viz*., no pinching, 20 DAT and 30 DAT and four nitrogen levels *viz*., 0 kg N ha^{-1}, 50 kg N ha^{-1}, 100 kg N ha^{-1} and 150 kg N ha^{-1}. The results obtained in the present investigation indicated that, the growth parameters in terms of height of plant was recorded maximum in 150 kg N ha^{-1} and no pinching, whereas, the maximum stem diameter, number of branches, spread of plant and leaf area were recorded with pinching at 20 DAT and 150 kg N ha^{-1}. As regards yield parameters, the maximum flower yield $plant^{-1}$ and $hectare^{-1}$ were recorded with pinching at 20 DAT and 150 kg N ha^{-1}.

Keywords: Annual chrysanthemum, pinching, nitrogen, growth, flower yield

Introduction
Annual chrysanthemum (*Chrysanthemum coronarium* L.) is one of the most important commercially cultivated flower crops grown in India, though it is originated in South Europe. It is a winter annual crop and belongs to the family *Asteraceae*. It is also known as 'Crown Daisy' or 'Garland chrysanthemum'. Because of variation in size, shape and colour of flowers, it is propagated by seeds producing daisy like, golden yellow to white flowers. It is different from florist chrysanthemum in many aspects. The crop is relatively short durated and less photosensitive thus capable of coming up throughout the year. It is hardier, vigorous and grows taller. Its flowers are various shades of yellow white, having single or double forms. The cultural practices *viz*., the suitable pinching and nitrogen application play an important role in influencing the growth and flower yield. Fertilizer application has a pronounced effect on the vegetative growth and yield of flowers. Pinching is one of the important horticultural practices, which is being practiced in annual chrysanthemum to reduce the plant height and to encourage more number of branches on plant and thereby more flower yield per plant can be obtained. In Vidarbha region of Maharashtra state annual chrysanthemum is cultivated in large scale but productivity is low and there is no proper recommendation based on latest technology to increase the yield potential. The growers get attracted towards annual chrysanthemum due to its short duration to produce marketable attractive yellow and white colour flowers with good keeping quality. Non availability of high quality seeds of known variety of annual chrysanthemum is one of the major constraints to its cultivation. Hence, keeping of this view in mind an experiment entitled "Effect of pinching and nitrogen on growth and flower yield of annual chrysanthemum" was undertaken at Horticulture Section, College of Agriculture, Nagpur.

Material and Methods
The investigation entitled, "Effect of pinching and nitrogen on growth and flower yield of annual chrysanthemum" was carried out at the field of college garden, Horticulture Section, College of Agriculture, Nagpur during rabi season of the year 2019-20. An experiment was conducted in Factorial Randomized Block Design with 12 treatment combinations which were replicated for three times. The allotment of treatments to the various plots were done randomly in each replication. The experimental plot was ploughed and subsequent harrowing was done. After clod crushing the soil was brought to fine tilth. At the time of land preparation, well-rotten FYM @ 20 t ha^{-1} was mixed uniformly in the soil before last harrowing. The field was laid out into plots with flat beds of 2.25m x 2.40m =5.4m^2 size. The treatment wise nitrogen levels 0 kg N, 50 kg N, 100 kg N, and 150 kg N ha^{-1} were calculated according to plot size and subsequently applied in the form of urea. The recommended dose of fertilizer 100 kg N, 50 kg P, 50 kg K ha^{-1} was applied to all the plots in the form of urea, single super phosphate and

murate of potash according to plot size Full dose of P_2O_5 and K_2O along with ½ dose of N was applied at the time of transplanting. Remaining ½ dose of N was given at 30 days and 45 days after transplanting.

Results and Discussion

Effect of pinching on growth parameter

The data in respect of plant height was recorded at 90 DAT, significantly maximum plant height (110.33 cm) was recorded in the treatment P_0 *i.e.* in control. Which was followed by P_1 (106.52 cm) *i.e.* pinching at 20 days after transplanting. However, minimum plant height (103.93 cm) was recorded in P_2 (Pinching at 30 days after transplanting). The similar results were also obtained with the finding of Habiba *et al.* (2012) [9] in Chrysanthemum, Sailaja *et al.* (2014) [15] in China aster.

As regards stem girth of plant at 50 per cent flowering was significantly influenced by different levels of pinching. The maximum stem girth (2.03 cm) of plants observed in treatment P_1 (at 20 DAT) which was followed by the treatment P_2 (1.71 cm) *i.e.* pinching at 30 days after transplanting. Minimum stem girth of plants observed in P_0 (No pinching) (1.44 cm). This might be, due to the fact that, an early pinching reduced the plant height with corresponding increase in branches per plant tending to more plant spread and automatically accumulated the carbohydrates in branches resulted in to thicker stem. The above findings bear resemblance with the observations of Badge *et al.* (2014) [3] in African marigold.

The data in respect of number of branches plant^{-1} was recorded at 45 days after transplanting, treatment P_1 (pinching at 20 DAT) obtained significantly maximum branches plant^{-1} (14.09) which was followed by P_2 (12.14) *i.e.* pinching at 30 days after transplanting. However, minimum branches plant^{-1} (10.92) was recorded in P_0 (no pinching). In pinching, the apical portion of main stem was pinched and therefore, more side branches were formed below pinched portion. This might be due to the diversion of carbohydrates or food material towards the auxiliary vegetative buds below pinched portion. The similar results were also obtained with the finding of Dalal *et al.* (2006) [7] in carnation, Bhat and Shephered (2007) [4] in African marigold, Kumar *et al.* (2014) in China aster.

The data in respect of spread of plant at 50 per cent flowering stage was significantly influenced by different levels of pinching. Significantly maximum plant spread (61.26 cm) was recorded in P_1 (pinching at 20 DAT) which was followed by P_2 (52.40 cm) *i.e.* pinching at 30 days after transplanting. Whereas, minimum plant spread (47.11 cm) P_0 (no pinching). Significant increase in plant spread was observed with pinching at 20 DAT.

The data in respect of leaf area of plant at 50 per cent flowering was significantly influenced by different levels of pinching. The maximum leaf area (24.71 cm^2) of plants observed in treatment P_1 (at 20 DAT) which was followed by P_2 (21.16 cm^2) *i.e.* pinching at 30 days after transplanting. Minimum leaf area of plants observed in P_0 (No pinching) (18.64 cm^2). From the above findings, leaf area (24.71cm^2) was found maximum in P_1 *i.e.* pinching at 20 days after transplanting. This might be due to reduction in vertical growth by removal of apical dominance which causes for cell division and cell elongation. Similar results were also observed by Dorajeerao and Mokashi (2012) [8] in garland chrysanthemum (*Chrysanthemum coronarium* L.).

Table 1: Effect of pinching and nitrogen on growth parameters of annual chrysanthemum

Treatments	Plant height (cm)	Stem girth (cm)	Number of branches	Plant Spread	Leaf area (cm)
Pinching (P)					
P0	110.33	1.44	10.92	47.11	18.64
P1	106.52	2.03	14.09	61.26	24.71
P2	103.93	1.71	12.14	52.40	21.16
F Test	Sig	N.S.	Sig.	Sig.	Sig.
S.E. (m) ±	0.23	0.02	0.21	1.89	0.58
C D at 5%	0.69	0.07	0.62	5.56	1.72
Nitrogen (N)					
N_0 – Control	105.78	1.45	10.94	45.59	18.82
N_1 - 50 kg N /ha	106.46	1.61	11.74	51.78	20.99
N_2 - 100 kg N /ha	107.35	1.84	13.10	56.19	21.80
N_3 - 150 kg N /ha	108.11	2.02	13.77	60.80	24.39
F test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.27	0.02	0.24	2.19	0.67
CD at 5%	0.79	0.08	0.71	6.42	1.98
Interaction P X N					
F test	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. (m) ±	0.57	0.05	0.51	4.64	1.43
CD at 5%	-	-	-	-	-

Table 2: Effect of pinching and nitrogen on flower yield parameters of annual chrysanthemum

Treatments	Number of flowers plant^{-1}	Flower yield plant^{-1} (g)	Flower yield plot^{-1} (kg)	Flower yield ha^{-1} (q)
Pinching (P)				
P0	71.67	131.87	4.81	131.79
P1	111.74	190.50	7.03	203.47
P2	91.66	170.29	6.12	188.52
F Test	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.82	5.05	0.07	1.32
C D at 5%	2.43	14.83	0.20	3.87
Nitrogen (N)				
N_0 – Control	79.70	138.65	4.79	167.83

N_1 - 50 kg N /ha	89.91	159.57	5.92	171.90
N_2 - 100 kg N /ha	96.50	170.77	6.45	175.81
N_3 - 150 kg N /ha	100.65	187.88	6.79	182.84
F test	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.95	5.84	0.08	1.52
CD at 5%	2.81	17.13	0.24	4.47
Interaction P X N				
F test	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	2.03	12.38	0.17	3.23
CD at 5%	5.96	36.33	0.51	9.50

Effect of pinching on flower yield parameter

Maximum number of flowers plant^{-1} (111.74) was recorded with pinching at 20 days after transplanting which was followed by treatment pinching at 30 days after transplanting (91.66). Whereas, total number of flowers plant^{-1} was found minimum (71.67) with no pinching treatment. From above results, it is shown that, the maximum number of flowers plant^{-1} was recorded with the pinching at 20 days after transplanting. The increase in number of flowers due to the pinching treatment may be correlated with vegetative growth characters like number of branches. Due to the pinching treatment more side branches were formed below the pinched portion of the main stem of plant. These more vegetative growth obtained in pinched plants resulted in production of maximum number of flower plant^{-1}. Similar results were also recorded Maharnor *et al.* (2011) [12] in African marigold.

Maximum flower yield plant^{-1} (190.50 g) was recorded with the treatment of pinching at 20 days after transplanting which was followed by P_2 (170.29 g). Whereas, minimum flower yield plant^{-1} (131.87 g) was observed in no pinching treatment. From above finding, it was shown that maximum flower yield plant^{-1} was observed under the treatment pinching at 20 days after transplanting. The increase in flower yield due to pinching treatment might be due to the reason that the pinched plants obtained superior vegetative growth and it was responsible for the production of more number of flowers per plant and consequently, yield of flower per plant was increased in pinched plant as compared to un-pinched plant. Pinching produce more number of branches and more vegetative growth resulted in the production of maximum number of flowers per plant. These results are in conformity with the results obtained by Chauhan *et al.* (2016) [6], Maharnor *et al.* (2011) [12] in African marigold.

The flower yield plot^{-1} was maximum (7.03 kg) in pinching at 20 days after transplanting which was followed by treatment P_2 (pinching at 30 days after transplanting) (6.12 kg). Whereas, minimum flower yield plot^{-1} (4.81 kg) was recorded in no pinching treatment. From above finding, it was shown that maximum flower yield plot^{-1} was recorded under the treatment pinching at 20 days after transplanting increase the flower yield plot^{-1}. The increase in yield of flowers (per plot and per hectare) in P_1 treatment in comparison of other pinching treatments was due to the lower weight of individual flower than other treatments. The present results are supported by Maharnor *et al.* (2001) [12] and Chauhan *et al.* (2016) [6] in African marigold.

Maximum flower yield ha^{-1} was recorded in pinching at 20 days after transplanting (203.47 q) which was followed by treatment P_2 *i.e.* Pinching at 30 days after transplanting (188.52 q). Whereas, the minimum flower yield ha^{-1} (131.79 q) was recorded in no pinching treatment. From above finding, it was shown that, maximum flower yield ha^{-1} was recorded under the treatment pinching at 20 days after transplanting. The early pinching after transplanting was produced maximum yield per hectare might be due to pinching removes the apical dominance and produced the maximum lateral branches and flowers. The above results are similar to the findings of Khandelwal *et al.* (2003) [10] in marigold.

Effect of nitrogen on growth parameter

At 90 days after transplanting, an application of N_3 (150 kg N ha^{-1}) obtained significantly maximum plant height (108.11 cm) which was found to be at par with N_2 (100 kg N ha^{-1}) (107.35 cm). However, minimum plant height (105.78 cm) was recorded in N_0 (0 kg N ha^{-1}). From the above results, it is shown that nitrogen at 150 kg ha^{-1} observed maximum plant height in all growth stages of annual chrysanthemum. The increase in plant height by increasing the dose of nitrogen might be due to the fact that, nitrogen plays a vital role in the plants and affects physiological activities in various ways. It is a constituent of protoplasm, chlorophyll and nucleic acid. One of the main function of nitrogen is the initiation of meristematic activity of plant. Thus the growth of plant largely depend upon the nitrogen. Thus similar results were obtained by Patel *et al.* (2010) [13] in Golden rod, Vedavathi *et al.* (2014) [19] in Asiatic lily and Satar *et al.* (2016) [16] in annual chrysanthemum.

Maximum stem girth (0.02 cm) of plant was observed in N_3 (150 kg N ha^{-1}) which was found to be followed by the treatment N_2 (1.84 cm) *i.e.* 100 kg N ha^{-1}. Whereas, minimum stem girth of plant was recorded in control treatment N_0 (1.45 cm). From above results, it is shown that stem girth of plant was found maximum with dose of 150 kg N ha^{-1}. It is shown that maximum stem girth of plant in all growth stages were significantly influenced with higher level of nitrogen. Being nitrogen is a contributed to cell multiplication and enlargement resulting in increased photosynthesis. The finding bears resemblance with the observations with the observations of Kumar *et al.* (2009) [11] in marigold, Shinde *et al.* (2014) [7] in African marigold and Satar *et al.* (2016) [16] in annual chrysanthemum.

At 45 days after transplanting, significantly maximum number of branches plant^{-1} was observed in N_3 (150 kg N ha^{-1}) (13.77) which was found to be at par with the treatment N_2 (100 kg N ha^{-1}) (13.10). However, minimum branches plant^{-1}(10.94) was recorded in N_0 (0 kg N ha^{-1}). From the above results, it is shown that, significantly more number of branches plant^{-1} was observed in treatment N_3 (150 kg N ha^{-1}) in all plant growth stages. There was significant increase in number of branches by applying higher dose of nitrogen. This might due to nitrogen being a growth promoting nutrient helps in synthesis of protein and increases cell division and cell enlargement which results in the increased number of branches plant^{-1}. Similar results were also recorded by Pushkar *et al.* (2008) [14] in marigold and Kumar *et al*. (2009) [11] African marigold.

Maximum plant spread was recorded in N_3 (150 kg N ha^{-1}) (60.80 cm) which was at par with the treatment N_2 (100 kg N ha^{-1}) (56.19 cm). Whereas, minimum plant spread was observed in N_0 (45.59 cm). From above findings, plant spread

was found maximum with increasing dose of nitrogen *i.e.* N_3 (150 kg N ha^{-1}). Nitrogen is implicated in all enzyme reactions taking place in the cell thus plays an active role in energy metabolism. Thus it is responsible for cell multiplication, enlargement and cell differentiation resulting in, increase photosynthesis and translocation. Similar results were also observed by Pushkar *et al.* (2008) [14] in African marigold and Singh and Nigam (2015) [17] in chrysanthemum.

Maximum leaf area of plant was observed in N_3 (150 kg N ha^{-1}) (24.39 cm^2) which was followed by N_2 (100 kg N ha^{-1}) (21.80 cm^2). Whereas, minimum leaf area of plant was observed in N_0 (18.82 cm^2). From above finding leaf area of plant was found maximum with increasing dose of nitrogen *i.e.* N_3 (150 kg N ha^{-1}). The increase in leaf area is due to the increased Synthesis of protein and protoplasm. Better availability of nitrogen leading to the quick and better vegetative growth of plant. Similar results were also observed by Kumar *et al.* (2009) [11] in African marigold and Patel *et al.* (2010) [13] in golden rod.

Effect of nitrogen on flower yield parameter

Significantly maximum number of flowers $plant^{-1}$ was recorded in N_3 (150 kg N ha^{-1}) (100.65) which was followed by the treatment N_2 (100 kg N ha^{-1}) (96.50). Whereas, minimum number of flowers $plant^{-1}$ was observed in N_0 (0 kg N ha^{-1}) (79.70). From above findings, it is shown that, the maximum flowers $plant^{-1}$ was recorded with the treatment N_3 (150 kg N ha^{-1}). This might be due to nitrogen increased photosynthetic activity for better vegetative growth of the plant. Nitrogen was the main driving force behind the life processes which led to enhanced flower production. Acharya and Dashora (2004) recorded the maximum number of flowers per plant in marigold with the application of 150 kg N ha^{-1}. Similar results were also reported by Arulmozhian and Poppaiah (1989) in marigold.

Maximum flower yield was observed in N_3 (150 kg N ha^{-1}) (187.88 g) which was at par with the treatment N_2 (100 kg N ha^{-1}) (170.77 g). Whereas, minimum flower yield $plant^{-1}$ was observed in N_0 (138.65 g) From above finding, it was noticed that, an application of nitrogen 150 kg ha^{-1} recorded maximum flower yield $plant^{-1}$. This might be due to nitrogen increased photosynthetic activity for better vegetative growth of the plant. Nitrogen was the main driving force behind the life processes which led to enhanced flower production and ultimately in flower yield $plant^{-1}$. These results are conformity with the findings of Chauhan and Kumar (2007) [5] in calendula and Sonwane *et al.* (2013) in China aster.

An application of 150 kg nitrogen ha^{-1} had recorded significantly maximum flower yield $plot^{-1}$ (6.79 kg) which was followed by treatment N_2 (100 kg N ha^{-1}) (6.45 kg). However, significantly minimum flower yield $plot^{-1}$ (4.79 kg) was recorded in control treatment. From above finding, it was noticed that, an application of nitrogen 150 kg ha^{-1} recorded maximum flower yield $plot^{-1}$. This might be due to nitrogen increased photosynthetic activity for better vegetative growth of the plant. These results are conformity with the findings of Chauhan and Kumar (2007) [5] in calendula and Sonwane *et al.* (2013) in China aster.

An application of 150 kg nitrogen ha^{-1} had recorded significantly maximum flower yield ha^{-1} (182.84 q) which was followed by 100 kg N ha^{-1} (175.81 q). However, significantly minimum flower yield ha^{-1}(167.83 q) was recorded in control treatment. From above finding, it was noticed that an application of nitrogen 150 kg ha^{-1} recorded maximum flower yield ha^{-1}. This might be due to nitrogen increased photosynthetic activity for better vegetative growth of the plant. These results are conformity with the findings of Arora and Khanna (1980) [1] in African marigold.

Conclusion

The maximum height of plant was recorded with P_0 *i.e.* No pinching and 150 kg N ha^{-1}. Whereas, maximum stem girth, number of branches, plant spread and leaf area were recorded with P_1 *i.e.* pinching at 20 DAT and 150 kg N ha^{-1}.

In respect of yield characters, among the different levels of pinching and nitrogen, number of flowers, flower yield per plant and flower yield per plot were found to be pinching at 20 after transplanting as compared to other levels of pinching. Among different nitrogen levels, number of flower, flower yield per plant and flower yield per plot were noticed in 150 kg N ha^{-1}.

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