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Effect of pinching and nitrogen on flowering and flower quality of annual chrysanthemum

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Abstract
This research was conducted to investigate the "Effect of pinching and nitrogen on flowering and flower quality 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 flowering parameters in terms of days to first flower bud initiation is recorded the minimum days in no pinching and no fertilizer treatment whrere as the maximum days to fully opened flower from bud initiation, days to 50 % flowering, days required for harvest and flowering span of plant was recorded maximum in pinching at 20 DAT and 150 kg N ha^{-1}. In respect of flower quality parameters the maximum weight of fully opened flower, diameter of fully opened flower, number of petals $flower^{-1}$, flower longevity and shelf life of flower were recorded in pinching at 20 DAT and 150 kg N ha^{-1}.

Keywords: Annual chrysanthemum, pinching, nitrogen, flowering, quality

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 flowering and flower quality. Fertilizer application has a pronounced effect on the flowering and of flowers quality. 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 flowering and flower quality of annual chrysanthemum" was undertaken at Horticulture Section, College of Agriculture, Nagpur.

Material and Methods
The investigation entitled, "Effect of pinching and nitrogen on flowering and flower quality 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 flowering parameter

The data in respect of early first flower bud initiation (40.82 days) was recorded in treatment P_0 *i.e.* no pinching and which was followed by the treatment P_1 (46.14) *i.e.* Pinching at 20 days after transplanting. Whereas, pinching at 30 days after transplanting recorded significantly maximum days for first flower bud initiation (48.82 days). From above finding, it was shown that, minimum days for first flower bud initiation was recorded under the treatment of no pinching. This might be due to reason that, the delay in bud appearance due to the pinching treatments might be due to removal of physiological mature portion of the plant and thus new shoots, which emerged out from the pinched plants took more time to become physiological inductive to produce flower buds than non-pinched plants. Similar results were reported by Bhat and Shephered (2007) [3] in African marigold, Rao *et al.* (2008) [5] in carnation and Kumar *et al.* (2013) [9] in chrysanthemum.

Significantly minimum days (12.86 days) required to fully open flower from bud initiation was recorded with no pinching which was followed by the treatment P_1 *i.e.* pinching at 20 days after transplanting (16.75 days). However, maximum days required to fully open flower from bud initiation (20.14 days) was recorded in pinching at 30 days after transplanting. From above finding, it was shown that, minimum days required to fully open flower from bud initiation recorded under the treatment of no pinching. From above results, it is shown that, pinching delayed flowering. The delayed in flowering by pinching was due to removal of mature portion and new shoots which emerged out from pinched plants took more time to become physiological inductive to produced flowers than non-pinched plant. Similar results were reported by Bhat and Shephered (2007) [3] in African marigold and Kumar *et al.* (2013) in chrysanthemum.

Minimum days to 50 per cent flowering P_0 (73.85 days) was recorded in treatment of no pinching which was found to be followed by treatment P_1 *i.e.* Pinching at 20 days after transplanting (81.51 days). However, delay flowering at 50 per cent (84.11 days) was recorded in pinching at 30 days after transplanting. From the above findings, it was shown that, minimum days for first flower bud initiation was recorded with no pinching treatment. The delay in 50 per cent flowering might be due to blooming due to late pinching attributed to the fact that during the process of pinching the physiologically mature portion of the shoot was removed and the new shoots, which emerged on pinched plants, took more time for initiation of reproductive phase and to be physiologically mature. The similar results were also obtained with the finding of Sailaja *et al.* (2014) [13] in China aster.

Significantly, minimum days to harvest (78.38 days) was recorded with P_0 *i.e.* no pinching treatment which was followed by treatment P_1 pinching at 20 days after transplanting (87.15 days). Whereas, days required to harvest was found maximum (96.99 days) with P_2 pinching at 30 days after transplanting treatment. From the above results, it is shown that, the maximum days required to harvest was recorded with pinching at 30 days after transplanting. The delayed in flowering by pinching might be due to removal of mature portion and new shoots, which emerged out from pinched plants took more time to become physiological inductive to produce flowers than non-pinched plants. The similar results were also obtained with the finding of Chauhan *et al.* (2016) [5] in African marigold and Khobragade *et al.* (2012) [8] in China aster.

Significantly, maximum flowering span (44.23 days) was recorded with pinching at 30 days after transplanting which was followed by treatment P_1 pinching at 20 DAT treatment (37.81 days). Whereas, total flowering span was found minimum (33.11 days) with no pinching treatment. From above results, it is shown that, the maximum flowering span was recorded with pinching at 30 days after transplanting. The possible reason for long period of bloom under different pinching treatments may be due to the fact that after removal of apical portion of the plant, the plant enters into the vegetative phase and the new shoots took longer time to get physiological maturity, there by resulting longest duration of flowering. Similar results were recorded by Khandelwal *et al.* (2003) [7], Arora and Khanna (1980) [2] in marigold.

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

Treatments	Days to first flower bud initiation (days)	Days to fully opened flower from bud initiation (days)	Days to 50 % flowering (days)	Days required for harvest (days)	Flowering span (days)
Pinching (P)					
P0	40.82	12.86	73.85	78.38	33.11
P1	46.14	16.75	81.51	87.15	37.81
P2	48.82	20.14	84.11	96.99	44.23
F Test	Sig.	Sig..	Sig.	Sig.	Sig.
S.E. (m) ±	0.61	0.32	0.33	1.32	0.19
C D at 5%	1.81	0.96	0.98	3.89	0.58
Nitrogen (N)					
N_0 – Control	43.92	15.31	77.22	82.80	37.10
N_1 - 50 kg N /ha	44.43	16.15	79.20	88..18	37.91
N_2 - 100 kg N /ha	46.24	17.30	80.96	88.29	38.53
N_3 - 150 kg N /ha	46.46	17.57	81.91	90.77	39.99
F test	Sig.	Sig.	Sig.	Sig.	Sig.

S.E. (m) ±	0.71	0.37	0.38	1.53	0.23
CD at 5%	2.09	1.11	1.13	4.50	0.67
Interaction P X N					
F test	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. (m) ±	1.51	0.80	0.81	3.25	0.48
CD at 5%	-	-	-	-	-

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

Treatments	Weight of fully opened flowers (g)	Diameter of fully opened Flower (cm)	Number of petals Flower^{-1}	Flower longevity (days)	Shelf life (days)
Pinching (P)					
P0	3.25	4.56	183.04	10.18	1.44
P1	4.40	5.45	186.94	10.81	2.0
P2	3.57	5.14	184.98	10.71	1.97
F Test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.17	0.08	1.03	0.01	0.03
C D at 5%	0.49	0.26	3.50	0.03	0.09
Nitrogen (N)					
N_0 – Control	3.0	4.66	178.90	10.35	1.72
N_1 - 50 kg N /ha	3.81	5.04	183.29	10.53	1.76
N_2 - 100 kg N /ha	3.98	5.1	185.11	10.65	1.79
N_3 - 150 kg N /ha	4.17	5.40	192.64	10.73	1.87
F test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.19	0.10	1.19	0.02	0.03
CD at 5%	0.57	0.30	3.50	0.06	0.10
Interaction P X N					
F test	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. (m) ±	0.41	0.21	2.53	0.04	0.07
CD at 5%	-	-	-	-	-

Effect of pinching on flower quality parameter

The weight of flower was maximum (4.40 g) in P_1 pinching at 20 days after transplanting which was followed by P_2 pinching at 30 days after transplanting (3.57 g). Whereas, minimum weight of flower (3.25 g) was recorded in P_0 *i.e.* no pinching. From above results, it was shown that weight of flower was recorded maximum with pinching at 20 days after transplanting. This might be due to fact that pinching increase the lateral branches thus pinched plant produce more number of flowers then un-pinched plants, hence the developing flower received comparatively more food material resulting in increase of flower weight. The similar results were also recorded by Rakesh Kumar *et al.* (2001) [12] in chrysanthemum.

The diameter of flower was maximum (5.45 cm) in P_1 pinching at 20 days after transplanting which was followed by treatment P_2 *i.e.* pinching at 30 days after transplanting (5.14 cm). Whereas, minimum diameter of flower (4.56 cm) was recorded in P_0 *i.e.* no pinching treatment. From above results, it was shown that, pinching increased the diameter of flower. The maximum diameter of fully opened flowers observed in P_1 *i.e.* Pinching at 20 days after transplanting was due to pinching at earlier stage induced vigorous branching, favoured to develop larger flowers. Similar results were also recorded by Kohle (1970) in carnation, who noticed that, the flower size of carnation increased by 15 percent by de shooting done at 20 days after transplanting. Hendriks and Lemper (1983) and Bholane (1998) [6, 4] in chrysanthemum.

The number of petals flower^{-1} was maximum (186.94) in P_1 *i.e.* pinching at 20 DAT which was at par with the treatment P_2 *i.e.* pinching at 30 days after transplanting (184.98). Whereas, minimum number of petals flower^{-1} (183.04) was recorded in P_0 *i.e.* no pinching treatment. From above results, it was shown that the number of petals per flower observed in no pinching treatment. Similar variation in number of petals per flower was noticed by Palekar *et al.* (2018) [11] in marigold.

Significantly, maximum longevity of flower (10.81days) were found in P_1 pinching at 20 days after transplanting of which was followed by treatment with pinching at 30 days after transplanting (10.71 days). Whereas, minimum longevity of flower was recorded in no pinching treatment (10.18 days). From the above results, the maximum longevity of flower was recorded with P_1 pinching at 20 days after transplanting. Similar results were also reported by Khandelwal *et al.* (2003) [7] in marigold.

Significantly, maximum shelf life of flower (2.0 days) were found in P_1 pinching at 20 days after transplanting which was at par with P_2 *i.e.* pinching at 30 DAT (1.97 days). Whereas, minimum shelf life was recorded in P_0 *i.e.* no pinching (1.44 days). From the above results, the maximum shelf life of flower was recorded with P_1 pinching at 20 days after transplanting. These might be due to more accumulation of carbohydrates in un-pinched plants. These results are in close agreement with findings of Singh *et al.* (2005) and Chauhan *et al.* (2016) [15, 5] in African marigold.

Effect of nitrogen on flowering parameter

Significantly, an early flower bud initiation was observed (43.92 days) in N_0 (0 kg N ha^{-1}) which was at par with treatment N_1 (50 kg N ha^{-1}) (44.43 days). However, late flower bud initiation (46.46 days) was recorded in the treatment N_3 (150 kg N ha^{-1}). From above results, it was shown that, the late induction of flower buds were observed in higher dose of nitrogen. This may be due to increased vegetative growth of the plant at higher level of nitrogen which might have decreased C: N ratio and there by delay in flower bud initiation. Similar results were reported by Satar *et al.* (2012) [14] in annual chrysanthemum, Vedavathi *et al.* (2014) [17] in Asiatic lily and Mali *et al.* (2016) in annual chrysanthemum.

The treatment N_0 recorded significantly the minimum days (15.31) for opening of flowers from bud emergence, which was at par with the treatment N_1 (16.15). Whereas, the treatment N_3 took maximum days (17.57) for flower bud opening. Days required to fully opened flower from bud emergence were significantly less with the increasing nitrogen level. High nitrogen appears to favour for development of flower, might have taken less number of days required to fully opened flower. These results are in close conformity with the findings of Naik (2014) in African marigold.

Significantly, minimum days to 50 per cent flowering was recorded (77.22 days) in N_0 (0 kg N ha^{-1}) which was followed by the treatment N_1 (50 kg N ha-1) (79.20 days). However, maximum days (81.91 days) to fully opened flower from flower bud emergence was recorded in the treatment N_3 (150 kg N ha^{-1}). From the above results, it was shown that nitrogen application of N_3 (150 kg N ha^{-1}) recorded maximum days to 50 per cent flowering. Increase in nitrogen levels favoured the proper development of plant and this could be attributed to promoted vegetative growth of the plant resulting in delayed reproductive phase which ultimately might have taken less number of days required for 50 per cent flowering from transplanting. These results were in close conformity with the findings of Vedavathi *et al.* (2014) [17] in Asiatic lily, Tembhare *et al.* (2016) in annual chrysanthemum.

Significantly, minimum days to first harvesting from transplanting was recorded (82.8 days) in N_0 (0 kg N ha^{-1}) which was followed by the treatment N_1 (50 kg N ha^{-1}) (88.18 days). However, maximum days (90.77 days) to first harvesting was observed in the treatment N_3 (150 kg N ha^{-1}). From the above results, it was shown that nitrogen application of N_3 (150 kg N ha^{-1}) recorded maximum days to first harvesting. This delay might be due to higher dose of nitrogen which encouraged vegetative growth of the plants and prolonged the time required by the plant to enter into reproductive phase from vegetative phase and thereby delayed the days to first harvesting. These results were in close conformity with the findings of Vedavathi *et al.* (2014) [17] in Asiatic lily.

Significantly, maximum flowering span was recorded with treatment N_3 (150 kg N ha^{-1}) (39.99 days) which was found to be followed by the treatment N_2 (100 kg N ha^{-1}) (38.53 days). Whereas, total flowering span was found minimum (37.10 days) with treatment N_0 (0 kg N ha^{-1}). From above results, it is shown that, the maximum flowering span was recorded in the treatment N_3 (150 kg N ha^{-1}). With increased application of nitrogen crop produced maximum vegetative growth as well as longevity of intact flower due to which total flowering span would have been increased. Above findings can be correlated with Maheta *et al.* (2016) [10] in China aster.

Effect of nitrogen on flower quality parameter:

An application of 150 kg nitrogen ha^{-1} had recorded maximum weight of flower (4.17 g) which was found to be at par with100 kg nitrogen ha^{-1} (3.98 g). However, significantly minimum weight of flower (3.0 g) was recorded in control treatment. From above results, it was shown that, nitrogen at 150 kg ha^{-1} recorded maximum weight of flower. This might be due to nitrogen being a synthesis of protein as supposed to be reason for increase of flower weight. Similar result is close conformity with the results obtained by Acharya and Dashora (2004), Yadav *et al*. (2001) [18] in marigold.

An application of 150 kg nitrogen ha^{-1} was recorded maximum diameter of flower (5.40 cm) which was found to be at par with 100 kg nitrogen ha^{-1} (5.1 cm). However, significantly minimum diameter of flower (4.66 cm) was recorded in control treatment. From above results, it was shown that, nitrogen at 100 kg ha^{-1} recorded maximum diameter of flower. This might be due to nitrogen being a constituent of protoplasm, basic reaction of photosynthesis providing total biomass production. These findings results reported by Sheena *et al.* and Ahmed *et al*. (2017) [1] in marigold.

An application of 150 kg nitrogen ha^{-1} was significantly recorded maximum number of petals flower^{-1} (192.64) which was followed by treatment N_2 *i.e.* 100 kg nitrogen ha^{-1} (185.11). However, significantly minimum number of petals flower^{-1} (178.90) was recorded in control treatment. From above results, it was shown that nitrogen at 150 kg ha^{-1} had recorded maximum number of petals flower^{-1}. This might be due to nitrogen increased photosynthetic activity for better development of flower. Similar results were obtained by Palekar *et al*. (2018) [11] in marigold.

Significantly maximum longevity of flower was recorded with an application of 150 kg nitrogen ha^{-1} (10.73 days) which was followed by treatment with 100 kg nitrogen ha^{-1} (10.65 days). Whereas, the control treatment recorded minimum longevity of flower (10.35 days). From the above results, the maximum longevity of flower was recorded with nitrogen 150 kg ha^{-1}. The results are in conformity with the finding of Sonawane *et al.* (2008) [16] in China aster.

Significantly maximum shelf life of flower was recorded with an application of 150 kg nitrogen ha^{-1} (1.87 days) which was at par with 100 kg nitrogen ha^{-1} (1.79 days). Whereas, the control treatment recorded minimum shelf life of flower (1.72 days). From the above results, the maximum shelf life of flower was recorded with nitrogen 150 kg ha^{-1}. The results are in conformity with the finding of Sonawane *et al.* (2008) [16] in China aster.

Conclusion

In respect of flowering characters, among the different levels of pinching and nitrogen levels, the minimum days to first flower bud initiation from transplanting, fully opened flower from first bud initiation, 50 per cent flowering and first harvesting from transplanting were recorded in no pinching *i.e.* control condition whereas pinching at 30 after transplanting had recorded maximum duration of flowering span. Among the different nitrogen levels, maximum flowering span was recorded with 150 kg N ha^{-1}. However, earliest first flower bud initiation from transplanting, fully opened flower from first bud initiation, 50 per cent flowering and days to first harvesting from transplanting were recorded in control condition *i.e.* 0 kg N ha^{-1}.

In respect of quality characters, among the different levels of pinching and nitrogen, weight of single flower, diameter of flower, number of petals per flower, shelf life and longevity of flower were noted in P_1 *i.e.* pinching at 20 DAT. Among the different nitrogen levels, maximum weight of single flower, diameter of flower, number of petals flower per flower, flower longevity and shelf life were recorded in 150 kg N ha^{-1}.

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