Effect of Pinching on Growth, Yield, and Quality of African Marigold (*Tageteserecta* L.) cv. PusaNarangiGainda

ABSTRACT

Marigold is a very common and a hardy flower crop cultivated throughout the world. Pinching is an important intercultural practice commonly followed in cultivation of marigold however, this needs to be standardized for getting higher yields in commercial cultivation. Hence, the present investigation was conducted at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Division of Horticulture, during 2020-21 and 2021-22 to standardize the commercial pinching practice for getting higher productivity.Three levels of pinching (no pinching, single at 20 daysand double at 20 and 40 days after transplanting) were used in the course of the researcharranged using a factorial randomized block layout with three replications applied to African marigold variety PusaNarangiGainda. The results revealed that treatment P_0 (No pinching) was discovered to be the finest in increment in height of plant, early flower bud initiation flower opening and treatment P_2 (Double pinching) in boosting spread of plant, primary branches,length of leaf, leaf width, leaf area, plant fresh weight, plant dry weight, total biomass, root- shoot ratio, 50% flowering, flower diameter, stalk and ray floret length, fresh and dry flower weight, mass and number of flower per plant, flower yield additionallyimproved quality characteristics like chlorophyll and xanthophyll contentin marigold. Hence, it might be concluded that application of double pinching can be helpful and recommended in improving yield as well as quality characteristics in commercial cultivation of marigold.

Keywords: Growthcharacteristics, Flowers,Marigold,Pinchingand Quality attributes.

Introduction

Marigold is a homegrown plant in South and Central America, particularly Mexico. It is a member of the Tagetes genus in the Asteraceae family(Kumar *et al.,* 2014). Tages, a demigod and highly revered god in ancient Egypt, was the inspiration for the name Tagetes. (Girwani*et al.,* 1990). About 33 reported species of this genus, the three species most frequently cultivated are *Tageteserecta* L. (African marigold), *Tagetespatula* L. (French marigold), and *Tagetestenuifolia* L. (Striped marigold). (Joshi *et al.,* 2002; Kumar *et al.,* 2013). African marigoldis a diploid species of marigold (2n=24)predominantly purpose of used as a gardening plant, both in urban and rural areas for bedding and for growing in pots.The stem is cylindrical, oblong, herbaceous to moderately woody, striated, occasionally ridged, smooth or somewhat with villi, and has resin channels in the bark that release a fragrant gas when squeezed(Girwani*et al.,* 1990; Mithilesh*et al.,* 2014; Singh and Sisodia, 2018).This is a major flower crop grown widely in North India. Xanthophyll extracted from flowers are used for medicinal and poultry feeding purpose. Lutein is another carotenoid pigment found in mainly in marigold flowers. About 90 per cent carotenoid are present in dry petals of marigold (Mithilesh*et al.,* 2014; Kumar and Sharma, 2013).Pinching is the process of snipping or chopping off a plant's new growth to force branching and eventually boost the number of blooms(Singh *et al.,* 2018;Sikarwar et al., 2021; Chaudhary et al., 2023). Apical dominance causes a plant to typically grow vertically. Assimilates are redirected into lateral buds if the growth tips are pinched off, which causes plentiful branching(Ravneet*et al.,* 2018). Therefore, the goal of the current investigation was to standardize the standard pinching practice in the marigold flower crop in order to get higher yields and economic returns per unit area.

Materials and Methods

The current study was carried out in the Division of Horticulture, Rajasthan Agricultural Research Institute, located in Durgapura, Jaipurduring October to January seasons of 2020-21 and 2021-22, respectively. The research study comprised three levels of pinching (no pinching, single at 20 daysand double at 20 and 40 days after transplanting). It was set up in a factorial randomized block design with three replications.This location is geographically positioned at 750 47' East longitudes, 260 51' North latitude, and has an altitude of 390 m over the mean sea level which issituated in the state Rajasthan's Jaipur district.This area is in Rajasthan's semi-arid Eastern Plain Zone, or Agroclimatic Zone IIIa. This area usually experiences extremes in temperature during the summer and winter due to its semi-arid environment. Temperatures can go as high as 49^0C in the summer and as low as 0^0C in the winter.Frost is a common wintertime phenomenon. 52 to 92% relative humidity is the range throughout which it shifts. Summers and winters are almost entirely dry.The 120 x 60 x 10 cm raised beds were used to spread the marigold seeds. The seedlings, which were put in lines with a 40 x 40 cm spacing, were 30 days old, uniform in height, robust, and strong with 5–6 leaves. According to the treatment, pinching was done once (20 DAT) or twice (20 DAT and 40 DAT). Five randomly chosen and labelled plants per plot were used to collect the data. In order to evaluate the importance of variance in data derived from different growth, yield, and quality characteristics, the Fisher (1950) factorial randomized block design technique was utilized to apply analysis of variance.

Results and Discussion

Impact of pinching on plant vegetative growth characteristics

The results collected from the present experimental designregarding plant vegetative growth characteristics is displayed in Table 1, which clearly demonstrated that the appositeness of pinching in different combinations had produced pronounced effect on growth attributes of marigold flower. The maximum plant height was acquired in treatment P_0(No pinching) (70.2 cm, 73.6 cm and 71.9) and least was observed in P_2(Double pinching) (48.2cm, 51.6cm and 49.9cm) in 2020-21, 2021-22 and pooled data respectively. There was an increase of 44.80% in plant height in treatment P_0as compared to P_2. The remarkable plant height observed in the absence of pinching (P0) treatment was mostly caused by the fact that the expansion was hindered during the pinching process once the extreme bud was removed off the plants that experienced a stress. Plants that have a natural amount of auxin in their tips grow taller. Auxin is momentarily reduced by pinching, which removes the apical dominance. This permits the side buds to begin developing(Ravneet*et al.*,2018).The plant (N-S) spread (46.6cm, 49.4cmand 48.0cm)was recorded maximum with application of treatment P_2 and minimum in the treatment P_0 (33.2cm, 35.9 cm and 34.5 cm) correspondingly for the years 2020–2021, 2021–2022and pooled data.There was an increase of 38.97% in plant spread in treatment P_2 as compared to P_0.A reasonable explanation for the increased plant spread under various pinching treatments could be attributed to stem cell expansion and reduced apical development, ultimately leading to an excess of main branches per plant. Pinching may have caused a plant's principal branches to multiply more frequently, which may have increased stem cell size through cell enlargement and cell division(Pathania*et al.*,2000).Treatment P_2recorded highest number of primary branches per plant (14.46, 17.33 and 15.90) while, lowest number of primary branches were recordedin the treatment P_0 (9.25, 11.79 and 10.52) correspondingly for the years 2020–2021, 2021–2022and pooled data.There was an increase of 51.14% in number of primary branches per plant in treatment P_2 as compared to P_0.This sufficiency in primary branches is the consequence of higher photosynthetic activity brought on by improved cell division, larger cells, and increasing leaf area (Joshi *et al.*, 2002).The longest leaf length (13.4 cm, 13.9 cm and 13.7 cm) was acquired in treatment P_2 whereas, the smallest leaf length (7.5 cm, 7.9 cm and 7.7 cm) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Application of treatment P_2resulted in an increase of 77.92% increment in plant leaf length as compared to P_0.The widest leaves (6.68 cm, 8.08 cm and 7.38 cm) were obtained in treatment $P_2$and narrowest leaves (3.86 cm, 4.58 cm and 4.22 cm) were found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Application of treatment P_2lead to 74.85 %expansionleaf width as compared to P_0.The mean best plant leaf area (49.2, 50.4 and 49.8 cm^2) was obtained in treatment P_2 andmerest mean plant leaf area (39.5, 39.8 and 39.7 cm^2) was found in treatment $P_0$for the year 2020-21, 2021-22 and pooled data respectively. The 25.44%increment in plant leaf area under treatment $P_2$was observed as compared to P_0.Pinching produced longer and wider leaves per plant, which may have been caused by the breakdown of apical dominance and the final redirection of energy towards the growth of more side branches (Kumar *et al.,* 2002).

The highest meanplant fresh weight (299.03, 301.00 and300.2g) was obtained in treatment $P_2$and least mean plant fresh weight (179.34, 180.46 and179.90g) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The increment in plant fresh weight under treatment $P_2$was registered 66.77% highest than P_0.One possible explanation for the observed increase in fresh weight of plants in pinching treatments could be the consolidation of vegetative growth, leading to a higher overall fresh plant weight(Khandelwal *et al.,*2003). The highest mean top plant dry weight (96.23, 99.69 and97.96 g) was obtained in treatment P_2 and lowest mean plant dry weight (53.53, 56.15 and54.84g) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The increase in plant dry weight under treatment $P_2$was registered 78.02% higher than P_0.This could be linked to the plants' improved vegetative development, which in pinching treatments produced a rise in the dry weight per plant (Grawal*et al.,*2004).The maximum plant biomass (80.63, 83.80 and 82.22 q/ha) was obtained in treatment P_2 and minimum plant biomass (42.93, 45.26 and 44.10 q/ha) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The increment in plant biomass under treatment $P_2$was 86.44%higher than P_0.The mean highest root-shoot ratio (0.226, 0.219 and 0.222) was obtained in treatment $P_2$and lowest mean plant root-shoot ratio (0.129, 0.124 and 0.126) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data. The increase in plant root-shoot ratio under treatment $P_2$was 76.19%higher than P_0.When comparing pinching treatments to control P_0 (no pinching), marigold plants that are extensively pinched produce larger branches and eventually spare leaves per plant. When compared to unpinched plants, P_2 (double pinching) produced greater leaf length, width, and area along with a higher number of side shoots, leaves, and dry plant weight. This boosted total biomass and the root-shoot ratio in marigold plants(Mirza, 1995). These findings are in intently conformity with those of Srivastava *et al.*2002, Kumar *et al*. 2003, Dalal*et al.*2006, Dorajeerao and Mokashi 2012 and Anuradha *et al.*2017.

Impact of pinching on plant floral growth characteristics

The data in Table 2 further demonstrate how varied levels of pinching had a substantial impact on the marigold plant's floral growth characteristics. The mean minimal days to first flower bud initiation(28.0, 29.0 and 28.0) was obtained in treatment P_0 (No Pinching) and maximal mean first flower bud initiation (35.0, 36.0 and 35.0) was found in treatment P_2 (Double Pinching) correspondingly for the years 2020–2021, 2021–2022and pooled data. However, earliest bud initiation under P_0 was 25.0%lower than treatment P_2.The mean lowest days to first flower opening (34.0, 35.0 and 34.0) was obtained in treatment P_0while, highest days tofirst flower opening (45.0, 46.0 and 45.0) was found in treatment P_2correspondingly for the years 2020–2021, 2021–2022and pooled data.However, earliest first flower opening noted under $P_0$was 32.35% lesser than treatment P_2.The mean earliest days to 50% flowering (45.0, 46.0 and 45.0) was obtained in treatment$P_0$and highest mean days to 50% flowering (54.0, 55.0 and 54.0) was found in treatment P_2correspondingly for the years 2020–2021, 2021–2022and pooled data.Here, earliest 50% flowering was noted under P_0 which was 20.0% earlier than treatment

P_2.The maximal flower diameter 7.9, 7.7 and 7.8 cm was obtained in treatment $P_0$and minimal mean plant flower diameter 4.6, 5.2 and4.9 cmwas similarly found in treatment P_2correspondingly for the years 2020–2021, 2021–2022and pooled data.Application of P_0 treatment enhanced the flower diameter to the extent of 59.13% over P_2 treatment in pooled analysis.The pinching delayed the commencement of the reproductive phase by prolonging abundant growth, which may have produced in an altered vegetative growth pattern. This could explain why the pinching took longer for the first bud to initiate. When comparing the number of days required for 50% flowering, pinched plants required more time than non-pinched plants. Pinching may be useful in changing the source-sink conjunction in order to promote the reproductive phase. Due to the freshly arriving shoot's prolonged physiological maturation period, flowers showed up later and thus was delayed 50% flowering(Jangra, 1993).The reason why flower diameter varies among the various pinching treatments may be because the plant enters the vegetative phase after the acute portion is removed, and the new shoots took longer to reach physiological maturity. As a result, treatment P_0 (no pinching) produced the largest flower diameter(Grawal*et al.,*2004).

The maximum flower stalk length 8.11, 9.08 and8.60cm was obtained in treatment $P_2$and minimum mean plant flower stalk length 5.37, 5.54 and 5.46cmwas found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Here, application of treatment P_2enhanced the flower stalk length up to 59.25% over P_0.The mean maximum length of ray floret 2.15, 2.86 and 2.50cmwas obtained under the treatment P_2 and minimal mean plant length of ray floret 1.50, 2.00 and 1.78cmwas found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Application of treatment P_2 enhanced the length of ray florets to the extent of 40.44%over P_0.The apical section created a high stalk length per plant as a result of twofold pinching, which would have destroyed the apical dominance and caused the increased flower stalk length(Sunitha *et al.,* 2007). The extra food material that is available to fewer flowers may be the cause of the increased length of the ray florets of flowers that have undergone twice pinching(Tomar*et al.,*2004).The maximum fresh flower weight 7.88, 8.87 and8.83gwas obtained in treatment $P_2$and minimum mean plant fresh flower weight 4.19, 5.03 and 4.61gwas found in the treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Treatment P_2 registered 81.77% more fresh flower weight over P_0.The rise in fresh flower weight through pinching intervention may be the result of extra energy being directed towards producing more blooms per plant(Singh and Baboo, 2003).The mean maximal dry flower weight 1.57, 1.61 and1.59g was obtained in treatment $P_2$and minimal mean dry flower weight 0.85, 1.10 and0.97gwas found in treatment $P_0$for the year 2020-21, 2021-22 and pooled data respectively.The increase in dry flower weight under treatment P_2 was registered to the tune of 63.91%over treatment P_0.The maximal number of ray florets per flower 212.0, 215.0 and 214.0 was obtained in treatment P_2 and minimal number of ray florets per flower 122.0, 125.0 and 123.0 was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Application of treatment P_2increased the number of ray florets per flower to the extent of 73.98%over P_0.Thehighest weight of flowers per plant (553.31, 558.44 and 555.87 gwas obtained in treatment P_2 and lowest weight of flowers per plant (253.62, 258.59 and256.11g)was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Pinching led to a rise in the flowers weight per plant and yield-attributing measurements. This increase was primarily driven by the growth of more leaves and active branches (Srivastava *et al.,* 2002).

Effect of pinching on plant yield characteristics

The largestnumber of flowers per plant(70.0, 71.0 and 70.0) was obtained in treatment P_2 and lowestnumber of flowers per plant(49.0, 52.0 and 51.0) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The treatment P_2registered 37.25%higher number of flowers per plant over P_0.The highest number of flowers per plot(848.0, 853.0 and 851.0) was obtained in treatment P_2 and minimum number of flowers per plot (596.0, 629.0 and 612.0) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data. The increase in number of flowers per plot with treatment P_2 was up to the extent of 39.05%over P_0.Increases in photosynthetic area may result in higher photosynthetic rates, better absorption, and building up excess photosynthates, which would produce the maximum number of blooms per plant and plot parameters recorded with pinching treatments(Yassin and Pappaiah, 1990).The mean maximum flower yield per hectare (189.71, 191.46 and 190.59 q/ha) was obtained in the treatment P_2 and minimum mean flower yield per hectare (121.24, 122.95 and 122.09 q/ha) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The increases in flower yield under application of pinching P_2 was registered to the tune of 56.10% over treatment P_0.The highest net return (254396, 257903 and 256149Rs./ha) was obtained in treatment $P_2$and least net return (121619, 125028 and 123324Rs./ha) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.Pinching is known to speed up the creation of more photosynthates, which are then used to produce more flowers with branches and seeds per bloom. Pinching probed apical dominance and redirected more metabolites towards the formation of more flowers per plant and hectare, which may have contributed to the increase in floral yield under pinching treatments(Tomar*et al.*,2004).

Effect of pinching on flower quality characteristics

The information presented in Table 3 led to the conclusion that the oppositeness of various pinching levels, treatment P_2 (double pinching) significantly increased the shelf life of flower,vase life of flower, chlorophyll content and xanthophyll content (mg/gm) compared to treatment P_0 (no pinching) here, treatment P_1 (single pinching) statically at par with treatment P_2 (double pinching).The mean outsideshelf life of flower (6.0, 7.0 and 7.0) was obtained in treatment P_2 andleast meanshelf life of flower (4.0, 4.0 and 4.0) was similarly found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The treatment P_2 showed increased shelf life to the extent of 42.42%over P_0.The best vase life of flower(14.0, 16.0 and 15.0) was obtained in treatment P_2 and merest meanvase life of flower (8.0, 10.0 and 9.0) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The application of P_2 significantly registered highest vase life of flower withan extent of 68.68% over P_0.The effect of pinching, which helped to improve the lustrous and keeping quality of flowers, may be the cause of the notable improvement in shelf and vase life of flowers. The majority of the physiological characteristic is accelerated by pinching, leading to cell elongation and cell enlargement. The cell wall's flexibility is what causes the expansion of the cell. This increases the vase life and shelf life of flowers by lowering the wall pressure across the cell wall and the turgor pressure brought on by osmotic forces in the vascular sap, which direct water entry into the cell and produce cell expansion(Joshi *et al.*,2002).The mean maximum chlorophyll content in plant (1.810, 1.854 and 1.832mg/gm) was obtained in treatment $P_2$and minimum meanchlorophyll content in plant (1.150, 1.125 and 1.137mg/gm) was found in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The chlorophyll content in treatment P_2which was found 61.12% higher over P_0.The maximum xanthophyll contentin plant (5.47, 5.70 and 5.59mg/gm) was obtained in treatment P_2 and minimum meanxanthophyll content in plant (3.07, 3.07 and 3.07mg/gm) wasfound in treatment P_0correspondingly for the years 2020–2021, 2021–2022and pooled data.The marigold flower treated with P2 exhibited an

82.08% increase in xanthophyll content compared to P0. The prime development of chlorophyll and xanthophyll content in African marigold may have resulted from the positive interaction of higher photo oxidation rates and carboxylation efficiency; treatment P2 (double pinching) increased the amount of anthocyanin in the petal; expansion with pinching increased the chlorophyll and xanthophyll content in the marigold leaf and flowers, respectively(Garde *et al.*, 2013). The above conclusions are in accordance with the findings of Tomar*et al.*2004, Kour*et al*. 2012, Badge *et al*. 2015, Baskaran and Abirami 2017 and Singh *et al*. 2018.

Conclusion

From the present investigation the final results revealed that the treatment P_0 (No pinching) was discovered to be ideal for increment in height of plant, early flower bud initiation andearly flower opening while, treatment P_2 (Double pinching) was found to be best in boostingspreading of plant, primary branches'numbers per plant, length of leaf, width of leaf, area of leaf, plant fresh weight, plant dry weight, total biomass, root- shoot ratio, 50% flowering, flower diameter, stalk and ray floret length, fresh and dry flower weight, quantity and mass of flowers on each plant, flower yield additionally improved quality characteristics like chlorophyll and xanthophyll content in marigold. Therefore, it might be concluded and can be recommended to the farmers growing African marigold crop, that the application of double pinching can be helpful in enhancing yield as well as quality characteristics in commercial cultivation of African marigold.

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Table: 1 Effect of pinching on plant vegetative growth characteristics of African marigold

Treatments	Plant height (cm)			Plant spread (cm)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
P_0-No Pinching (Control)	70.2	73.6	71.9	33.2	35.9	34.5
P_1-Single Pinching (at 20 DAT)	59.2	62.6	60.9	38.4	41.3	39.8
P_2-Double Pinching (at 20 DAT and 40 DAT)	48.2	51.6	49.9	46.6	49.4	48.0

SEm±	0.76	0.81	0.39	0.42	0.45	0.21
CD (P=0.05)	2.15	2.28	1.08	1.19	1.28	0.60
Treatments	**Number of primary branches per plant**			**Leaf length (cm)**		
P_0-No Pinching (Control)	9.25	11.79	10.52	7.5	7.9	7.7
P_1-Single Pinching (at 20 DAT)	13.49	16.23	14.86	13.2	13.8	13.5
P_2-Double Pinching (at 20 DAT and 40 DAT)	14.46	17.33	15.90	13.4	13.9	13.7
SEm±	0.76	0.81	0.38	0.12	0.14	0.06
CD (P=0.05)	2.15	2.28	1.04	0.33	0.38	0.18
Treatments	**Leaf width (cm)**			**Leaf area (cm^2)**		
P_0-No Pinching (Control)	3.86	4.58	4.22	39.5	39.8	39.7
P_1-Single Pinching (at 20 DAT)	6.65	8.04	7.34	44.4	45.3	44.8
P_2-Double Pinching (at 20 DAT and 40 DAT)	6.68	8.08	7.38	49.2	50.4	49.8
SEm±	0.03	0.05	0.02	0.39	0.45	0.19
CD (P=0.05)	0.09	0.13	0.05	1.10	1.27	0.54
Treatments	**Plant fresh weight (g)**			**Plant dry weight (g)**		
P_0-No Pinching (Control)	179.34	180.46	179.90	53.53	56.15	54.84
P_1-Single Pinching (at 20 DAT)	254.23	255.90	255.07	67.43	70.59	69.01
P_2-Double Pinching (at 20 DAT and 40 DAT)	299.03	301.00	300.02	96.23	99.69	97.96
SEm±	2.80	2.80	1.58	0.88	0.88	0.54
CD (P=0.05)	7.91	7.91	4.42	2.48	2.49	1.52
Treatments	**Plant total biomass (q/ha)**			**Plant root-shoot ratio**		
P_0-No Pinching (Control)	42.93	45.26	44.10	0.129	0.124	0.126
P_1-Single Pinching (at 20 DAT)	58.83	61.70	60.27	0.139	0.170	0.155
P_2-Double Pinching (at 20 DAT and 40 DAT)	80.63	83.80	82.22	0.226	0.219	0.222
SEm±	0.88	0.88	0.46	0.014	0.014	0.007
CD (P=0.05)	2.48	2.49	1.27	0.040	0.040	0.020

Table: 2 Effect of pinching on plant floral growth characteristics of African marigold

Treatments	**First flower bud initiation (DAT)**			**First flower opening (DAT)**		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
P_0-No Pinching (Control)	28.0	29.0	28.0	34.0	35.0	34.0
P_1-Single Pinching (at 20 DAT)	33.0	34.0	33.0	41.0	42.0	41.0
P_2-Double Pinching (at 20 DAT and 40 DAT)	35.0	36.0	35.0	45.0	46.0	45.0
SEm±	0.28	0.31	0.14	0.28	0.31	0.15
CD (P=0.05)	0.80	0.87	0.40	0.80	0.87	0.41
Treatments	**50 % flowering (DAT)**			**Flower diameter (cm)**		
P_0-No Pinching (Control)	45.0	46.0	45.0	7.9	7.7	7.8

P_1-Single Pinching (at 20 DAT)	48.0	49.0	48.0	5.8	6.1	6.0
P_2-Double Pinching (at 20 DAT and 40 DAT)	54.0	55.0	54.0	4.6	5.2	4.9
SEm±	0.50	0.55	0.2	0.07	0.09	0.05
CD (P=0.05)	1.40	1.56	0.69	0.19	0.26	0.13
Treatments	**Flower stalk length (cm)**			**Length of ray floret (cm)**		
P_0-No Pinching (Control)	5.37	5.54	5.46	1.50	2.00	1.78
P_1-Single Pinching (at 20 DAT)	7.99	8.98	8.49	2.10	2.83	2.46
P_2-Double Pinching (at 20 DAT and 40 DAT)	8.11	9.08	8.60	2.15	2.86	2.50
SEm±	0.07	0.09	0.04	0.03	0.03	0.02
CD (P=0.05)	0.19	0.26	0.12	0.09	0.10	0.05
Treatments	**Fresh flower weight (g)**			**Dry flower weight (g)**		
P_0-No Pinching (Control)	4.19	5.03	4.61	0.85	1.10	0.97
P_1-Single Pinching (at 20 DAT)	5.60	6.16	5.88	1.07	1.09	1.08
P_2-Double Pinching (at 20 DAT and 40 DAT)	7.88	8.87	8.38	1.57	1.61	1.59
SEm±	0.07	0.09	0.05	0.02	0.02	0.02
CD (P=0.05)	0.20	0.25	0.14	0.04	0.05	0.06
Treatments	**Number of ray florets per flower**			**Weight of flowers per plant (g)**		
P_0-No Pinching (Control)	122.0	125.0	123.0	253.62	258.59	256.11
P_1-Single Pinching (at 20 DAT)	168.0	170.0	169.0	442.51	447.23	444.87
P_2-Double Pinching (at 20 DAT and 40 DAT)	212.0	215.0	214.0	553.31	558.44	555.87
SEm±	1.62	1.62	0.87	1.99	1.99	1.41
CD (P=0.05)	4.58	4.58	2.43	5.62	5.62	4.25

Table: 3 Effect of pinching on flowerquality characteristics of African marigold

Treatments	**Number of flowers per plant**			**Number of flowers per plot**		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
P_0-No Pinching (Control)	49.0	52.0	51.0	596.0	629.0	612.0
P_1-Single Pinching (at 20 DAT)	57.0	60.0	59.0	692.0	724.0	708.0
P_2-Double Pinching (at 20 DAT and 40 DAT)	70.0	71.0	70.0	848.0	853.0	851.0
SEm±	1.15	1.15	0.58	4.91	5.38	2.64
CD (P=0.05)	3.25	3.24	1.62	13.86	15.19	7.39
Treatments	**Flower yield (q/ha)**			**Net return (Rs/ha)**		
P_0-No Pinching (Control)	121.24	122.95	122.09	121619	125028	123324
P_1-Single Pinching (at 20 DAT)	151.72	153.33	152.53	180499	183724	182111
P_2-Double Pinching (at 20 DAT and 40 DAT)	189.71	191.46	190.59	254396	257903	256149
SEm±	2.42	2.42	1.25	2402	2661	1382
CD (P=0.05)	6.84	6.84	3.50	6776	7507	3863
Treatments	**Shelf life of flower (days)**			**Vase life of flower (days)**		

P_0-No Pinching (Control)	4.0	4.0	4.0	8.0	10.0	9.0
P_1-Single Pinching (at 20 DAT)	4.0	6.0	5.0	11.0	13.0	12.0
P_2-Double Pinching (at 20 DAT and 40 DAT)	6.0	7.0	7.0	14.0	16.0	15.0
SEm±	0.09	0.11	0.05	0.09	0.11	0.05
CD (P=0.05)	0.24	0.31	0.13	0.24	0.31	0.15
Treatments	**Chlorophyll content (mg/gm)**			**Xanthophyll content (mg/gm)**		
P_0-No Pinching (Control)	1.150	1.125	1.137	3.07	3.07	3.07
P_1-Single Pinching (at 20 DAT)	1.790	1.834	1.812	3.67	3.79	3.73
P_2-Double Pinching (at 20 DAT and 40 DAT)	1.810	1.854	1.832	5.47	5.70	5.59
SEm±	0.009	0.009	0.011	0.01	0.02	0.03
CD (P=0.05)	0.025	0.025	0.031	0.04	0.04	0.08