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Effect of Pinching on Growth, Flowering and Yield attributes in Marigold (*Tagetes erecta* L.) in Vaishali district of Bihar

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ABSTRACT

Marigold (Tagetes erecta L.) is one of the most important commercial flower crops which is widely cultivated for its loose flower purpose all over India. Although it occupies 1st position in loose flower cultivation in India as well as in Bihar, but still no technologies or procedures have yet been standardized for increasing its productivity. Hence, the present investigation was carried out to evaluate the effect of pinching technology on growth and flower yield in marigold (Tagetes erecta L.) var. Ladoo Genda for two consecutive years at Krishi Vigyan Kendra, Vaishali. Three levels of pinching were done viz., Farmers Practice- no pinching, TO_1- early and double pinching at 30 and 40 DAT, and TO_2- late and double pinching at 40 and 60 DAT and it was laid out using RBD with three replications. Pinching means removing the terminal growing portion of stem to break the apical dominance which increases the production of more side branches and ultimately enhances the flower yield. A plant generally grows straight up due to apical dominance. No such type of research has been carried out in the state to standardize the horticultural practices for flower farmers' and commercial growth of this flower crop. Therefore, an effort was made to standardize one of such practice in Vaishali district of Bihar. The results revealed significant variations among all the treatments. Early and double pinching at 30 and 40 DAT increases the flower yield per plant (516.49 g) as well as per hectare (33.70 t/ha) as compared to non-pinched plants (383.07 g) per plant and (24.45 t/ha). Therefore, early and double pinching at 30 and 40 DAT can be recommended for the farmers of Vaishali district of Bihar.

Keywords: *Bihar, Commercial production, Double pinching, Farmers, Marigold, Yield, Vaishali*

INTRODUCTION

Indian culture has always placed a lot of importance on flowers. Globally, the socio-economic status of individuals is rising quickly day by day, and there is a favorable association between this and per capita flower consumption. The industry is still in the early stages and has tremendous potential because soil, climate, labor, transport, and the market are important factors that determine the scale of commercial floriculture.The demand for fresh flowers has steadily increased not only for decoration but also for many other purposes like essential oils, cosmetics, aroma therapy, dry flowers, potpourris, natural dyes, medicines, etc. As demand for flowers has gradually increased, floriculture has emerged as a significant agricultural industry in the commercial sector [1].Yet floriculture has not gained recognition as it deserves as a business opportunity. The tradition of cultivation of flowers is observed throughout the country, however, states of Andhra Pradesh, Tamil Nadu, Karnataka, West Bengal, Maharashtra, and Gujarat are still leading in commercial cultivation of flowers. Still today, more than two-thirds of the area under floriculture is devoted to production of traditional flowers like marigold, jasmine, roses, chrysanthemum, tuberose, etc. The total area under floriculture in 2019-2020 was 305 thousand ha with the total production of 2301 thousand tons of loose flowers and 762 thousand tons of cut flowers and total export of floriculture products during the year 2020-2021 was Rs. 575.98 crores or 77.84 USD Million [2]. In Bihar, the total area under floriculture is reported to be 1.21 thousand hectares with loose flower production of 10.95 thousand metric tons and 0.19 thousand metric tons of cut flowers.

In modern era, marigold is an important commercial flower of India that belongs to family 'Asteraceae' or 'Compositae' which originated in Central and South America especially Mexico [3]. It is one of the most commonly grown loose and cut flower crops in India which is extensively used in religious and social functions and also contains medicinal and nematicidal properties. Its wider adaptability due to easy cultural practices, larger blooming period, short juvenile period, profuse flowering, relatively problem free nature, attractive colors, shape, size, and good keeping quality have all contributed to its popularity [4]. Marigolds are one of the most widely used loose flowers for making garlands during religious festivals and cultural functions, wreaths, floral decoration, flower baskets, cut flowers, bedding and potting, and for making different products [5].Therefore, due to its several uses, marigold farming for commercial purposes is expanding in India. It is widely grown in Vaishali district of Bihar owing to the ease of its transportation and marketing.

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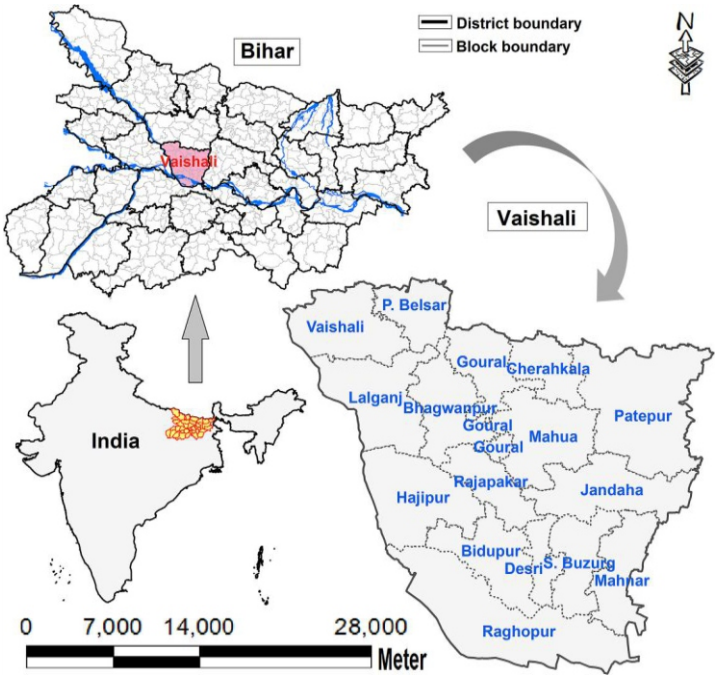
Among numerous crop management techniques, cultural manipulation of growth and flowering through proper pinching has significant importance to boost yield and quality of various annual flowers, including marigolds. In most of the flower crops, the number of blooms depends upon the bearing branches for flowering and yield, which can be controlled by restricting plant vertical development and promoting side shoots through apical bud pinching.Pinching is the act of removing or nipping off the new growth on a plant to force branching so that eventually the number of flowers is increased. It might be because by removing the apical section, more energy may have been directed into promoting the number of side branches. In most plant species, the axillary buds remain dormant due to inhibitory effect of growth of the primary shoot apex, a phenomenon called Apical Dominance [6]. Apical bud pinching breaks apical dominance and induces the development of lateral branches, thereby altering the plant architecture for increased potential yield When cytokinin concentration increases inaxillary buds, it breaks their dormancy [7] but auxins exported from apical meristem may limit cytokinin concentration in these lateral buds and maintain apical control through hormonal interaction [8]. So, by applying pinching we can regulate the plant architecture and also improve the quality of flowers

So far, no study has been conducted in the state to standardize the horticultural procedures for commercial cultivation of this flower crop by the flower growers. Although the state's agro-climate is relatively favorable, and this crop has a lot of promise but the lack of production technology for farmers prevents its commercial cultivation in larger areas.



Marigold is cultivated in approx. 400 ha of area in Vaishali district of Bihar (District Agriculture Office, 2022) but it was observed that one of the important factors for the low productivity of marigold was attributed to the fact that there was less production of flowers. Survey of different blocks, interaction and field visits of marigold growers were done to know the problem faced by the farmers. Thus, keeping in view current problem an attempt was made to conduct an On-Farm Trial with two different levels of pinching on various growth and flowering parametersfor exploring the possibilities to enhance the yield potential of marigold flowers.

MATERIALS AND METHODS

The present investigation was carried outby Krishi Vigyan Kendra, Vaishali in ten different villages of four different blocks i.e., Hajipur, Bhagwanpur, Rajapakar and Lalganj for two consecutive years i.e., 2020-21 and 2021-22 with an aim to enhance the yield potential of marigold flowers. Ten marigold growing farmers from all villages were selected for conducting this trial to ensure their active participation. The demonstration of improved technology was taken in the area of 0.25 ha of each farmer. The experimental sites were situated along the latitude of 25°68"N andlongitude 85°35" E with an altitude of 51 m above mean sea level.The climate of the district is semi-arid to sub-tropical and annual precipitation on an average is 1168 mm although most of the rain is received during rainy season. Summers and winters are also not complete dry. The temperature of the district varies from 7°C to 45° C and the soil texture is sandy loam with adequate drainage and optimum water holding capacity.

The land was brought to a fine tilth by ploughing it three times followed by levelling. Well decomposed farm yard manure was applied before the land preparation at the rate of 20 tons per hectare and mixed well into the soil. Besides this, a recommended dose of fertilizers @ 125 kg N, 100 kg P_2O_5, and 100 kg K_2O per ha were also incorporated into the field, out of which half dose of N and the entire dose of P_2O_5 and K_2O were applied as basal dose at the time of planting whereas, the remaining N was applied in two split doses at 30 and 60 days after planting. The field was lightly irrigated before transplanting to optimize moisture. Seeds of African marigold (*Tagetes erecta L.*) cv. Ladoo Genda was sown in the raised nursery bed during December. Healthy seedlings with uniform growth having 3-4 true leaves and of 8 to 10 cm height were transplanted at spacing of 40 cm × 40 cm in an area of around 0.2 ha. The seedlings before transplanting were treated with Captan @ 3 g or Carbendazim @ 2.5 g for half an hour to prevent seed and soil-borne fungal diseases. After transplanting light irrigation was given in the field. Throughout the crop growing period, uniform cultural operations and crop management practices were adopted. Depending upon the prevailing weather conditions subsequent irrigation was given to the crop by flooding.

The experiment was planned out in Randomized Block Design. The treatments included three levels of pinching as depicted in Table 1. The technique of random sampling was adopted for recording the data for various parameters of marigold. The data were subjected to Statistical analysis using randomized block design (RBD) as given by [9].

Table 1: Treatments and different pinching combinations.

Farmers practice (FP)	No pinching
Technology option 1 (TO_1)	Double pinching at 30 and 40 days after transplanting
Technology option 2 (TO_2)	Double pinching at 40 and 60 days after transplanting

RESULT AND DISCUSSIONS

The 1st year, 2nd year and pooled mean data of all the different treatments were observed for different characters and are presented in Tables 2, 3, and 4. Analysis of variance revealed significant differences among the different treatments in terms of various morphological traits.

I. Effect of pinching on Growth attributes

An inquisition of data presented in Table 2 indicated that all the treatments varied significantly concerning various growth attributes. Significant variation was observed among the various vegetative parameters.

Observations on plant height of marigold as influenced by different levels of pinching were recorded two times, i.e.,at 30 and 40 DAT and 40 and 60 DAT (Table 1). Significant influence of various pinching treatments was observed on plant height during both the observations. The maximum height of plants (68.55 cm) was observed in plants with no pinching i.e., Farmers practice which was followed by pinching at 40 and 60 DAT (57.65 cm) whereas plant with minimum height (37.16 cm) was recorded in double pinching at 30 and 40 DAT. It was found that plant height was reduced gradually with an increase in pinching levels.This was due to the repetitive removal of the apical portion of the main branch thereby, liberating the axillary buds to become free from correlative inhibition of apical dominance and hence, started growing. [10] found that the when the terminal bud was removed during the process of pinching from the plants a stress condition was created and plant needed times to recover as a result of which growth was hampered. Moreover, the natural auxin concentration in the tip of the plant causes the plants to grow tall while, in case of without pinching plant exhibits it normal vegetative growth These results were also experimentally supported by the findings of [11], [12], [13] in marigold and [14] in chrysanthemum flower crop. The maximum numbers of secondary branches (41.84) were reported when plants were pinched at 30 and 40 DAT which was followed by pinching at 40 and 60 DAT while least number of secondary branches (26.11) were recorded when no pinching was done. Pinching in marigolds enhances the maximum number of secondary branches because of the breaking of apical dominance and sprouting of auxiliary buds which divert energy to the other parts of the plant besides the apical part [15]. [16] noticed while working on an African marigold cv. Pusa Narangi Gainda found that the maximum number of branches per plant, was recorded with single pinching at 35 DAT as compared to no pinching and double pinching at 39 DAT.

The increase in number of leaves is directly proportional to number of branches. The highest number of leaves (209.83) was recorded in pinching at 30 and 40 DAT followed by pinching at 40 and 60 DAT (206.47) whereas, the least number of leaves per plant (188.11) when plants were not pinched. Adequate number of leaves is essential for normal growth and production. An increase in the number of leaves causes the accumulation of greater photosynthesis leading to better growth parameters [17]. The present finding is in close conformity with the views of [18] in marigold and [19] in China aster.

Plant spread maintains air circulation and sunlight inside plant bush and protects plant from insect and disease infestation. Maximum plant spread (44.85 cm) was recorded in double pinching at 30 and 40 DAT which was followed by double pinching (37.37 cm) at 40 and 60 DAT while minimum (26.55 cm) was observed in plants with no pinching. Similar findings were also given by [20].

The stem diameter plays an important role in the marigold cultivation. Wider branching and more blooms per plant may result in lodging and stem breaking, which could result in significant economic loss for farmers. Pinching was found to have significant positive effectson stem diameter.

It was found that plants with double pinching at 30 and 40 DAT had wider stem diameter (1.31 cm) as compared to plants with double pinching at 40 and 60 DAT (1.19 cm) and plants with no pinching (0.88). [21] reported maximum stem diameter in the pinched plant than non-pinched plant.

II. Effect of pinching on Floral attributes

The data about floral characters are furnished in the Table 3. All the treatments varied significantly concerning various floral attributes.

The pooled data over both the years recorded on floral characters (Table 3) indicated that earliest bud initiation (43.72 days) and maximum duration of flowering (77.15 days) were obtained from treatment with no pinching whereas, double pinching at 30 and 40 DAT takes maximum days to bud initiation (71.76 days) and shortest duration of flowering (63.60 days). This might be because pinching of apical bud suppresses the bud initiation process by inhibiting cell division in the lateral meristem resulting in prevention of flower primordial development. Pinching temporarily reduces auxin which takes away the apical dominance. This enables the side buds to start growing. Similar results were reported by [22], [23], [13] and [24] in marigold while [25] and [26] and in carnation.

It is evident from the Table 1 that the increased number of pinching resulted into significant delay in the days to 1st flowering as well as days to 50 % flowering of Marigold.

Days to flowering (32.29 days) and days to 50 % flowering (66.11 days) were found to be earliest in the plants where no pinching was followed whereas maximum number of days taken for flowering (73.85 days) and days to 50 % flowering (98.70 days) was observed in plants with double pinching at 30 and 40 DAT. The delay in flowering by pinching was due to removal of physiological mature portion and the new shoots which emerged from the pinched plants took more time to become physiological inductive to produce flowers than non-pinched plants [17]. External factors such as environmental conditions prevailing in the area, genetic makeup of the plant, and soil type etc. also plays an important role in the days to first flowering in marigold. These results are in conformation with the findings of [21] and [13] in Marigold and [27] in Chrysanthemum

The data for fresh and dry weight of the flowers revealed that plants with no pinching had morefresh (5.23 g) and dry weight (0.86 g) of flowers followed by double pinching at 40 and 60 DAT (5.03 g and 0.84 g) whereas minimum fresh (4.61 g) and dry weight (0.80 g) in plants with double pinching at 30 and 40 DAT. The reason of increased fresh and dry weight of flowers with no pinching may be due to availability of more food material and better allocation of energy of lesser number of flowers [24]. [28] also reported that the fresh weight of flower is decreased with the pinching, which may be since when a plant is pinched it increase its branches and more flower is produced because of which comparatively less nutrient & bio-regulators is supplied in each flower compared to un-pinched plants. These results were also experimentally supported by the findings of [29] in marigold, [30] and [31] in China aster.

Table 2: Effect of pinching on growth attributing characters in African marigold (Tagetes erecta L.) var Ladoo Genda

	Plant height at maturity (cm)			No. of leaves per plant			No. of Secondary branches			Plant Spread (cm)			Stem diameter (cm)		
	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data
Farmers practice - No pinching	68.30	68.80	68.55	187.27	188.95	188.11	25.66	26.55	26.11	26.32	26.78	26.55	0.86	0.89	0.88
TO_1- Double pinching at 30 and 40 days	36.42	37.90	37.16	208.81	210.85	209.83	41.52	42.17	41.84	43.98	45.71	44.85	1.23	1.39	1.31
TO_2- Double pinching at 40 and 60 days	57.53	57.76	57.65	205.84	207.10	206.47	38.01	38.24	38.13	36.96	37.79	37.37	1.14	1.24	1.19
C.D at 5 %	**2.513**	**4.281**	**2.156**	**10.265**	**8.125**	**1.378**	**2.151**	**3.696**	**1.095**	**1.286**	**4.809**	**2.142**	**0.103**	**0.276**	**0.213**
SE± (m)	**0.623**	**1.062**	**0.329**	**2.546**	**2.015**	**0.21**	**0.534**	**0.917**	**0.167**	**0.319**	**1.193**	**0.327**	**0.025**	**0.068**	**0.033**

Table 3: Effect of pinching on flowering and yield attributing characters in African marigold (Tagetes erecta L.) var Ladoo Genda

	Days to bud initiation (days)			Days to 1st flowering (days)			Days to 50 % flowering (days)			Duration of flowering (days)			Fresh weight of flower (g)		
	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data
Farmers practice - No pinching	42.86	44.57	43.72	32.05	32.53	32.29	65.16	67.06	66.11	75.90	78.41	77.15	5.10	5.35	5.23
TO_1- Double pinching at 30 and 40 days	70.86	72.67	71.76	73.40	74.31	73.85	98.27	99.12	98.70	62.86	64.33	63.60	4.46	4.77	4.61
TO_2- Double pinching at 40 and 60 days	65.89	66.60	66.25	59.30	59.60	59.45	83.47	85.0467	84.26	66.85	68.15	67.50	4.99	5.06	5.03
C.D at 5 %	**4.755**	**4.358**	**2.001**	**0.734**	**4.763**	**1.034**	**3.904**	**3.865**	**1.747**	**3.419**	**2.226**	**2.149**	**0.336**	**N/A**	**0.409**
SE± (m)	**1.179**	**1.081**	**0.305**	**0.182**	**1.181**	**0.158**	**0.968**	**0.959**	**0.267**	**0.848**	**0.552**	**0.328**	**0.083**	**0.15**	**0.062**

III. Effect of pinching on Yield attributes

The yield per plant is an important parameter to determine the production and yield of marigold flowers. Significant difference was observed among all the genotypes for flower yield as depicted in Table 3 and Table 4.

The increase in the yield of flowers per plant (516.49 g) and yield of flowers per hectare (33.70 t/ha) was reported when pinched at 30 and 40 DAT which was statistically at par with flower pinched at 40 and 60 DAT (492.90 g and 31.72 t/ha) and minimum yield of flowers per plant (383.07 g) and yield of flowers per hectare (24.45 t/ha) in plants with no pinching. It might be since production of more branches per plant in pinched plants resulted in production of more number of flowers as compared to plants with no pinching treatment [32]. This increase in flower yield per plant under pinching treatment might also be due to the gain of extra energy in the production of more flowers per plant and ultimately surge in flower yield. The present finding is in agreement with the observation made by [23], [18] in Marigold, and [26] in carnation.Similarly, [29] reported that pinching increases flower yield per plant when pinched reaching maximum (334.70 g) compared to no pinching (226.91 g) while [31] also found that pinching increases the flower yield (96.78 q/ha) compared to non-pinching (68.78 q/ha).

Table 4: Effect of pinching on yield attributing characters in African marigold (Tagetes erecta L.) var Ladoo Genda

	Dry weight of flower (g)			Yield of flowers per plant (g)			Yield of flowers per hectare (t/ha)		
	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data	1st Year	2nd Year	Pooled data
Farmers practice - No pinching	0.84	0.87	0.86	381.60	384.55	383.07	23.88	25.01	24.45
TO_1- Double pinching at 30 and 40 days	0.79	0.80	0.80	512.73	520.26	516.49	32.06	35.33	33.70
TO_2- Double pinching at 40 and 60 days	0.83	0.85	0.84	488.81	497.00	492.90	30.56	32.87	31.72
C.D at 5 %	**0.027**	**N/A**	**0.033**	**10.745**	**11.077**	**9.269**	**3.567**	**4.024**	**3.511**
SE± (m)	**0.007**	**0.02**	**0.005**	**2.665**	**2.748**	**1.415**	**0.885**	**0.998**	**0.536**

CONCLUSION

The observations recorded from the present investigation revealed that, pinching not only helps to increase flower production in marigolds but also helps in maintaining trade, balance, and self-sufficiency. From the above discussion we can conclude that pinching significantly increase the flower production along with branching per plant, flower per plant, and plant spread as well. Among all the three treatments, the use of early and double pinching at 30 and 40 days after transplanting is beneficial for the flower-growing farmers helping them to increase their production and benefits with large economic returns.

FUTURE SCOPE OF STUDY

Since marigold is a very important and commercial flower crop for the farmers of Bihar as well as India therefore pinching in conjunction with optimum spacing, planting season, and variety will be is advantageous to flower-growing farmers, allowing them to increase their output also benefiting large economic returns.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest for the publication of the manuscript.

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