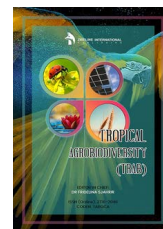


ZIBELINE INTERNATIONAL
PUBLISHING

ISSN: 2716-7046 (Online)

CODEN: TARGCA



REVIEW ARTICLE

EFFECT OF PINCHING ON YIELD AND YIELD ATTRIBUTING CHARACTERISTICS OF MARIGOLD (*TAGETES ERECTA* L.): A REVIEWLalit B.C.^{a*}, Poonam Belbase^b, Naren Shahu^c, Kamal Pahari Magar^c^a Institute of agriculture and animal science (IAAS), Paklihawa Campus.^b Midwest Academy & Research institute, Campus of live science, Dang.^c Gokuleshwar agriculture & animal science campus.* Correspondence author email: laltiaas@gmail.com

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ARTICLE DETAILS

Article History:

Received 28 May 2020

Accepted 15 June 2020

Available online 18 June 2020

ABSTRACT

Marigold species are famous around the world and grown for its different purpose like beautification, to extract pharmaceuticals products, loose flowers, and cut as well. Among the many species of marigold *Tagetes erecta* L. is one of the famous species grown in Nepal. Pinching in marigold is a process of increase in flower yield through the diversion of energy through breaking apical dominance in plants. Pinching increases the flower yield (96.78 q/ha) compared to non-pinching (68.78 q/ha) (Rathore et al., 2011) in marigold.

KEYWORDS

Marigold, Pinching, Flower, Yield

1. INTRODUCTION

Marigold (*Tagetes erecta* L.) is one of the most important commercial flowers belong to family Compositae / Asteraceae grown all over the world, which accounts for more than half of the nation in loose flower production (Jyothi et al., 2018). It is native to south and Central America especially Mexico (Singh et al., 2019). Marigold is one of the oldest cultivated flowering plants, being very popular in tropical and sub-tropical countries as a garden plant, pots plant and herbaceous border for beautification (Singh et al., 2017).

Marigold is also known as "Sayapatri" in Nepali and "Gainda" in Hindi. Among the 33 genes of *Tagetes*, *T. erecta* L. and *T. patula* L. are the most common species grown for the ornamental values (Rayberg, 1915). Two types of marigold i.e. African marigold (*Tagetes erecta* L., 2n=24) and French marigold (*Tagetes patula* L., 2n=48) are more popular in the Nepal and Indian vicinity (Singh et al., 2019). The crosses between African and French marigolds have resulted in triploid cultivars. Thus, the three major horticultural types are African, French and Triploid (Dhakal, 2016). Another species *Tagetes minuta* L. is famous for its high content of essential oil.

The plants of *Tagetes erecta* are tall in nature and depending on species it varies from 0.1 to 2.2 m and are erect consist of many branching, flower size is large and various in colors depending on varieties (Khan et al., 2018). Flower colors are yellow and orange in various shades such as light yellow, golden yellow, bright yellow, deep orange and bright orange (Singh et al., 2019). Although *Tagetes* species grow well in almost any type of soil but prefer soil with proper drainage. Marigold is most popular due to its easy cultural practices, wide adaptability, short juvenility, profuse flowering, and large blooming period, relatively problem free nature, attractive colors, shape, size and good keeping quality (Jyothi et al., 2018). 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 also for making different products (Swaroop et al., 2007). Marigold is also a potential source for the production of natural products used in pharmaceutical components like suitable for meal production, natural colorant preparation, oil extraction, pigment extraction mainly xanthophylls etc (Jyothi et al., 2017). Nowadays many industries are interested in marigold cultivation owing to its potential in value addition. In most of the flower crops, the flowering and yield is mainly dependent on the number of flowers bearing branches which can be manipulated by checking vertical growth of plants and encouraging side shoot by means of apical bud pinching (Sasikumar et al., 2015). Such side shoot would provide more scope to bear flowers and in turn contribute for higher flower yield (Sunitha et al., 2007).

Pinching is the process of removal of apical bud along with few leaves. It might be due to the fact that by removal of the apical portion more energy might have been to promote the number of side branches. The number of side branches directly positively correlated the yield of flower in African marigold (Singh et al., 2019). Pinching delays the flowering but increases the number of flowers. The main purpose of pinching is to encourage branching to produce a bushy growth and or to enhance the production of more flowers and seed yield. For pinching, use your thumb and forefinger to pinch out the top growth of the plants. For cutting, use a sharp knife. A group researchers obtained the maximum number of branches and flowering yield with delayed pinching (40 DAT) in marigold (Sehrawat et al., 2003). For maximizing yield in a limited cultivable area, the present investigation was carried out to standardize the pinching technique in African marigold cv. Pusa Narangi Gainda.

2. EFFECT OF PINCHING IN GROWTH

2.1 Plant height at maturity

The non-pinched plant of marigold attains maximum height at its maturity due to apical dominance (Sunitha et al., 2007; Rajyalakshmi and

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DOI:

[10.26480/trab.02.2020.57.60](https://doi.org/10.26480/trab.02.2020.57.60)

Rajashekhar, 2014; Gnyandev et al., 2014). A single pinched plant after 20 and 30 DAT reduces height whereas producing the maximum number of side branches (Singh et al., 2014). Pinching significantly reduces the plant height but increases the plant spread and number of branches where at three levels of pinching the maximum plant height was gained at pinching of marigold at 30 DAT compared to pinching at 40 & 50 DAT (Kumar et al., 2012; Rathore et al., 2011; Maharnor et al., 2011). Bhat and Shepherd also reported that single pinching after 35 DAT reduces plant height as compared to double pinching and no pinching in African marigold (Bhat and Shepherd, 2007). Some researchers also reported that pinching at 20 DAT cause a reduction of plant height (72.82 cm) in marigold (Khandelwal et al., 2003). Field research conducted by reported that maximum increase in plant height was found in the plants pinched at 15 DAT and minimum increase in non-pinched plants in African marigold (Badge et al., 2014).

2.2 Number of branches per plant

Pinching in marigold enhance the maximum number of branches because of the breaking of apical dominance and sprouting of auxiliary buds which divert energy to the other parts of the plant beside the apical part (Sasikumar et al., 2015). In the China aster cv. Phule Ganesh, it was reported the maximum number of branches per plant was seen when pinched at 15 DAT than non-pinched (Gnyandev et al., 2014). In another research, it was found that maximum numbers of branches (40.55 branches/plants) were found when pinched at 40 DAT (Sarkar et al., 2018). Research by shows that the maximum number of primary branches and the maximum number of leaves per the plant was produced when pinching at 40 DAT; similar findings were reported in African marigold (Singh et al., 2019; Kumar et al., 2012).

The maximum numbers of secondary branches were reported when pinched at 20 DAT (Sharma et al., 2006). Another finding reported that the maximum number of secondary branches were found when single pinched at 30 DAT compared to 40 DAT and no pinched in African marigold cv. Pusa Basanti Gaiinda (Rajbeer et al., 2009). Research in African marigold cv. Pusa Narangi Gaiinda, observed that with 3% nitrogen foliar spray with single pinched increase the number of primary branches while double pinching with 2% nitrogen increases the number of secondary branches and plant height (Singh et al., 2015).

2.3 Stem diameter

Wider branching and the higher number of flowers per plant may cause lodging and breaking of the stem which may lead to heavy economic loss for farmers. The stem diameter plays an important role in the marigold growing. Pinching was found to have significant positive effects on stem diameter in African marigold cv. Sirakole where stem diameter was found to be maximum (0.76cm) in the pinched plant than non-pinched plant (0.60cm) (Khan et al., 2018). Stem diameter was found maximum in pinching at 30 DAT than non-pinching and pinching at 60 DAT in African marigolds (Meena et al., 2015). A group researchers also reported that stem diameter is maximum in the pinched plant (1.30cm) than non-pinched (1.24cm) in African marigold (Parhi et al., 2016).

2.4 Plan spread

Pinching at the visible bud stage is found to improve the plant spread (37.73 cm) (Wani et al., 2018). Plant spread maintains air circulation & sunlight inside plant bush and protects plant from insect and disease infestation. A study reported that the pinching of a shoot at 30 DAT improves the plant spread in marigold (Mohanty et al., 2015). Whereas maximum plant spread is seen at pinching of the shoot after 20 DAT contradicts findings (Kumar et al., 2012). The plant spread was found maximum at a single pinched of African marigold cv. Pusa Narangi Gaiinda, when pinched after 35 DAT than double pinched after 39 DAT, (Bhat and shepherd, 2007).

2.5 Stalk length

Stalk length is a very important characteristic of marigold when it is sold as a cut flower. The quality of marigold depends on the stalk length (Shrinivas and Rajashekhar, 2020). Despite its varieties, the stalk length also depends on the pinching of plants. A studied the effects of pinching on stalk length and finds that stalk length of flower increases significantly with pinching (Sheena et al., 2017). The maximum stalk length found in pinching at 28 DAT was 4.90 cm and minimum stalk length was 4.66 cm in the non-pinched plant in marigold. Stalk length is increased in flower when pinched at 20 DAT (Pusar and Singh, 2012).

3. EFFECT OF PINCHING IN FLOWER

3.1 Days to first flowering

Pinching affects days to first flowering. An experiment carried with three-level of pinching (single pinch at 30, double pinch at 30 & 60 and no pinched) shows that double pinching at 30 and 60 DAT delayed the flowering (94.85 days) followed by single pinching and no pinching at 77.12 days and 71.35 days respectively in African marigold cv (Meena et al., 2015). Pusa Narangi Gaiinda supports the finding (Pushkar and Singh, 2012). Similar research carried out with three-level of pinching i.e. no pinching, 30 DAT single pinch and double pinch at 30 & 45 days find that double pinching delayed flowering (59.50 days) followed by single pinching and no pinching at all, 52.50 days and 48.33 days respectively in African marigold cv. Sirakole (Parhi et al., 2016). External factors like environment, species, time of planting nutrient management and soil type etc. plays an important role in the days to first flowering in marigold. A group researchers carried a similar research on first flowering of marigold and finds that planting at 15 September takes minimum time for the first flowering of marigold (66.70 days) whereas planting at 15 November takes maximum time for the days to first flowering (97.71 days) maybe due to the unwavering environmental condition (Meena et al., 2015).

3.2 Days to 50% flowering

The findings of suggest that there are no effects of pinching in 50% flowering in marigold but due to the pinching, the emergence of new branches takes time to enter reproductive phase which affects the maximum number of days to take 50% flowering was in pinched plants (54.99 days) while it was minimum in un-pinched plants (50.56 days) (Khan et al., 2018; Sehrawat et al., 2003).

3.3 Number of flowers per plant

The number of flowers per plant is an important parameter to determine the production and yield of flowers. In marigold cv. Orange double, the increase in the number of flowers per plant was reported when pinched (61.9) than non-pinched (50.6) by reported that double pinching increase flower per plant three times than non-pinching in marigold (Sunitha et al., 2007; Rajyalakshim and Rajashikhar, 2014; Prakash et al., 2016; Khan et al., 2018). A reported in African marigold cv (Meena et al., 2015). Pusa Narangi Gaiinda, the maximum number of flowers per plant was when double pinch at 30 DAT (34.91) followed by a single pinch at 30 DAT and no pinch (31.97 & 28.90) respectively. A similar result was reported double pinching maximized the number of flowers per plant (63.81) as compared to single pinching in African marigold cv (Bhat and Shepherd, 2007). Pusa Narangi Gaiinda. Similarly, reported that the maximum number of flowers per plant was obtained in double pinched (48.34) compared to the single pinched and no pinched (32.86 & 17.63) respectively in African marigold (Tomar et al., 2004).

The slightly different finding was reported in the African marigold cv (Parhi et al., 2016). Sirakole that the maximum number of flowers per plant was observed in the plant which was single pinched at 30 DAT (39.34) followed by double pinching at 30 and 45 DAT and no pinching 38.16 & 34.50 respectively. Whereas reported that pinching at 40 DAT gives the maximum number of flowers per plant (62.78) (Sarkar et al., 2018). And the similar result was reported in African marigold cv (Rajbeer et al., 2009; Shrivastava et al., 2005). Pusa Basanti Gaiinda with two levels of pinching at 30 & 40 DAT. A study recorded that the maximum number of flowers per plant (34.10) when pinched at 15 DAT compared to the non-pinched (25.01) (Badge et al., 2005).

3.4 Flower diameter

The notable effects of pinching can be seen in the flower size and flower diameter (Patade et al., 2020). The genetic makeup of varieties and their interaction with the prevailing environment bring variation in the flower size and its diameter. Sailaja et al., (2013) reported that no-pinching increased the flower diameter (5.61 cm) as compared to single pinching (5.21cm) and double pinching (4.38 cm) in China aster. Similar findings were given by Bhat and Shephard in African marigold cv. Pusa Narangi Gaiinda. The pinching effects on increasing flower size and ultimately flower diameter. A group researchers observed that among the pinched, flower diameter is maximum when pinched at 5 weeks of transplanting (Patade et al., 2020). However, some researchers explain that the flower diameter of the pinched plant is small compared to non-pinched, due to the distribution of nutrients and other minerals promoting the vegetative growth in marigold (Cicevan et al., 2016).

3.5 Duration of flowering

The pinching of flower doesn't affect or increase flower duration or production rather it delays production of the flower by 10-12 days in the condition of Ludhiana India. This could be useful for regulating production and avoiding the surplus in the flower market (Arora and Khanna, 1986). But the maximum duration of flowering is recorded when pinching is done at 30 DAT (Singh and Puskar, 2012). Two varieties of African marigold (Pusa Narangi gairda & Pusa Basanti gairda) shows the maximum duration of flowering in no pinching compared to pinched (Prakash et al., 2016). A similar result was demonstrated in African marigold (Sehrawat et al., 2003).

4. EFFECT OF PINCHING IN FLOWERING YIELD

4.1 Fresh weight of flower

The pinching has a positive impact on increasing the fresh weight (7.64 g) of flowers in marigold and other similar flowers (Rathore et al., 2011). The fresh weight of flowers contributes to the total yield of flowers hence it is one of the important parameters for yield determination. The fresh weight of flower is decreased with the pinching, it may be due to the reason that 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. In a research, it was found that in un-pinched plant fresh flower weight maximum (8.93 g) and minimum (7.36 g) in pinched at 28 DAT. A similar result was reported in African marigold cv (Rathore et al., 2011). Pusa Basanti Gairda. Spacing plays an important role in increasing the yield & weight of a flower may be due to less competition between plants for nutrient and moisture. With an increase in spacing, the fresh flower weight is increased with a maximum of (9.30 g) at the spacing of 40*40 cm and a minimum of (7.28g) in the spacing of 30*30 cm. (Sheena et al., 2017). A group researchers also observed a similar result in African marigold (Ahirwar et al., 2012). A result in the fresh weight of flower (6.59g) was maximum in case of no pinching as compare to pinched one (6.02g) (Khobragade et al., 2012). A research conducted in the effect of late pinching no pinching, pinching at 20 & 30 DAT shows that there are no significant effects of no pinching on increasing fresh as well as dry weight of flower in African marigold cv. "Crackerjack" (Joshi et al., 2002).

4.2 Flower yield per plant & Total yield

Yield per plant is a very important parameter to determine the total production of flowers. Pinching significantly increase the flower yield per plant when done in 15 DAT and gives net monetary returns with higher B/C ratio in African marigold (Badge & Panchbhai, 2018; Prakash et al., 2006). Similarly, reported that pinching increases flower yield per plant when pinched reaching maximum (334.70 g) compared to no pinching (226.91 g) Pinching increases the flower yield (96.78 q/ha) compared to non-pinching (68.78 q/ha) (Rathore et al., 2011; Kobragade et al., 2012). Some researchers also recorded maximum flower yield (30.99 tones/ha) due to pinching at 40 days after transplanting compared to no pinching (42.80 and 22.40 tones/ha, respectively) in African marigold cv (Srivastava et al., 2002). Pusa Narangi Gairda. Similarly, conducted a field experiment on the effect of pinching on African marigold revealed that plants pinched 20 days after planting resulted in the highest flower yield (167.80 q/ha) as compared to no pinching (Khandelwal et al., 2003).

Whereas pinching of marigolds after 40 DAT gives maximum flower yield (16.44 tones/ha) than un-pinched similar result was reported in African marigold cv. Pusa Basanti Gairda gives maximum yield per plant pinched after 40 DAT (Naik et al., 2004; Shrivastava et al., 2005). Likewise, reported that pinching at 30 days after transplanting gives maximum flower yield (1700.78 g/m²) as compared to non-pinching (1120.53 g/m²) in African marigold cv (Chauhan et al., 2005). Pusa Narangi Gairda supported (224.10 q/ha) by Singh et al, 2018. The highest flower yield (203.00 q/ha) was obtained with pinching of terminal shoots at 30 days after transplanting in African marigold as compared to no pinching (Sharma et al., 2012). While a study reported that the maximum yield of a flower was found in the plant pinched after 5 week of transplanting, a similar result was reported in research paper where the weight of flowers 30DAT per plot (3745.95 g) and yield of flowers per hectare (13873.0 kg) (Patade et al., 2020; Mohanty et al., 2015).

5. CONCLUSION

Marigold is an economic flowering plant that contributes to a large sector of the Nepalese flower economy. Every year millions of loose flowers of marigold are imported for the festivals like Tihar from India. Pinching not only helps to increase flower production but also helps in maintain trade

balance and self-sufficiency. It is also one of the best ways to increase the livelihood standard and per capita income of farmers in Nepal. From the above discussion we can conclude that pinching significantly increase the flower production along with branching per plant, flower per plant and flower diameter as well. The use of pinching along with the appropriate spacing, planting season and variety is beneficial for the flower growing farmers helping them to increase their production and getting benefited with large returns of the economy.

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