Effect of bio-regulators on flowering behavior and yield attributes of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

Harvindra Pal, Sunil Malik, Anuj Pal, Bhagchand Shivran and Vikram Singh

**DOI:** [https://doi.org/10.22271/chemi.2021.v9.i1q.11382](https://doi.org/10.22271/chemi.2021.v9.i1q.11382)

**Abstract**

The present investigation entitled “Effect of bio-regulators on flowering behavior and yield attributes of African Marigold (*Tagetes erecta* L.)” was carried out at Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology Modipuram, Meerut, Uttar Pradesh during the year 2016-2017. The layout of experimental field was laid down in Randomized Block Design in which ten treatments along with 3 replications. The Maximum days taken to first bud initiation were recorded application of Ethrel 400 ppm (T3), days taken to opening of first flower was recorded with MH 400 ppm (T2), duration of flowering (50.76 days) was recorded with GA3 300 ppm (T1), length of flower stalk was recorded with application of GA3 300 ppm (T1), Maximum number of flowers per plant was recorded with the application of GA3 300 ppm (T1), flowers diameter was recorded with the application of GA3 300 ppm (T1), number of flowers per plant was recorded with the application of GA3 300 ppm (T1), weight of flower was recorded with the application of GA3 300 ppm (T1), Maximum flower yield per plant was recorded with the application of GA3 300 ppm (T1), maximum flower yield per hectare was recorded with the application of GA3 300 ppm (T1), it is recommended to farmers for commercial cultivation of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda.

**Keywords:** African marigold (*Tagetes erecta* L.), flowering behavior, flower yield, GA3, MH and ethrel

**Introduction**

African Marigold (*Tagetes erecta* L.) is a native of Central and South America especially Mexico, and belongs to family Asteraceae is one of the most commonly grown loose flower and use extensively on religious and social functions in different forms. African Marigold flowers have attractive range of colours for a considerably prolonged period and the flowers can be kept remarkably well when cut. Sometimes, the whole plant can be used for decorations. They can be planted in beds for mass display, in mixed borders and can also be grown in pots. The generic name *Tagetes* is derived from, “Tages”, the name of Estruschi God, known for his beauty. French was the first to apply the name Tagetes, which was later adopted by others. Marigold were domesticated and used as an ornamental plant during pre-Columbian period before they were introduced in Europe and South Asia including India. Marigold is one of the oldest cultivated ornamental plants, being very popular in tropical and sub-tropical countries as a garden plant for beautification. Marigold is grown as landscape plants due to its variable height and various colours of flowers. It is highly suitable as a bedding plant, in herbaceous border and is also ideal for newly planted shrubbery to provide colour and fill spaces. French Marigold is ideal for rockeries, edging, hanging baskets and window boxes the use of plant growth substances has been found to be of great significance in the commercial cultivation of many ornamental crops. In our country, their use is very limited but in many Western countries they are creating many excitement in the field of agriculture. Gibberellic acid and cycoceal are very important plant growth regulators and are widely used in agriculture and horticulture. GA3 regulates the growth and involve in both cell division and cell enlargements (Haber and Leopold, 1960) [5]. The GA3 has manifold effects, it affects the seed dormancy, seed germination, stem growth, root growth, flowering etc. (Rappaport and Singh, 1960) [12] Sachs et al. (1960) [13] reported that application of CCC retarded stem elongation by...
Materials and Methods

The present investigation entitled “Effect of bio-regulators on flowering behavior and yield attributes of African marigold (Tagetes erecta L.) cv. Pusa Narangi Gainda.” was undertaken during November - March in 2016-17 at Horticultural Research Centre (HRC), Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology Meerut, (UP). The layout of experimental field was laid down in Randomized Block Design in which ten treatments along with 3 replications. The treatments are T1 (Control), T2 (GA3 100 ppm), T3 (GA3 200 ppm), T4 (GA3 300 ppm), T5 (MH 200 ppm), T6 (MH 300 ppm), T7 (MH 400 ppm), T8 (Ethrel 200 ppm), T9 (Ethrel 300 ppm), T10 (Ethrel 400 ppm). Seeds of Pusa Narangi Gainda were procured from GBPUIAT, Pantnagar, (UK). The seeds of marigold were sown in well prepared nursery beds, mixture of 10 kg FYM and leaf mould per square meter was thoroughly mixed at the time of soil preparation. Seeds were sown in line and a thin layer of mixture of sand, soil and FYM was applied over the seed mulching was also employed to avoid the disturbance during watering and to conserve moisture. The sowing was done on 21 Oct 2017. The healthy seedlings were transplanted 25-30 days after seed sowing in the evening at a spacing 45x45 cm consisting of 20 plants per plot. After transplanting light irrigation was applied in the field. After establishment of seedlings uniform cultural operations were performed regularly in each plot to maintain the plants in proper health. The control measure for insect pest and disease were also taken from time to time. The observations on days taken to first bud initiation, days taken to opening of first flower, duration of flowering (days), length of flower stalk (cm), diameter of flower (cm), number of flowers per plant, weight of flower (g), yield of flower per plant (g) and flower yield per hectare (g). The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984) [4]. The weed count data were analyzed after subjecting the original data to (√x + 0.5) transformation. The treatment means were compared by using the transformed values.

Results and Discussion

Days taken to first bud initiation: The earliest bud initiation was observed with the application of GA3 200 ppm (T3) followed by GA3 300 ppm (T4), while maximum days taken to bud initiation was noted with the application of Ethrel 400 ppm (T10). By Gibberellins reduces juvenile period and termination of juvenile phase, the shoot apical meristem instead of producing leaves and branches start producing flower buds. Dahiya and Rana (2001) and Kumar et al. (2001) reported that GA3 200 ppm induced early flowering in carnation. Similar finding were also reported by Tiwari (1992) in tuberose.

Days taken to opening of first flower: The minimum number of days taken to opening of first flower was observed with application of GA3 300 ppm (T4) followed by GA3 100 ppm (T2) and GA3 200 ppm (T5) while late flower opening was recorded noted T7 (MH 400 ppm). The present finding confirms the reports made by Dutta et al. (1993) in chrysanthemum. Early flowering owing to GA3 may be due to Gibberellins reduces juvenile period and termination of juvenile phase the shoot apical meristem instead of producing vegetative growth start producing flower (Krishnamurthy 1981). The results are in line with findings of Dahiya and Rana (2001) reported earlier flowering in chrysanthemum with GA3 150 ppm and Mohriya et al. (2003) [12] observed earlier flowering in chrysanthemum with GA3 150 ppm.

Duration of flowering (days): GA3 was found most effective in extending the flowering duration especially with GA3 300 ppm (T4) followed by GA3 200 ppm (T3) and GA3 100 ppm (T2) and it might be due to advanced stage of flowering in marigold. Dutta et al. (1993) and Gautam et al. (2006) [6] observed maximum flower duration in chrysanthemum with GA3 200 ppm, Dahiya and Rana (2001) reported maximum flowering duration in chrysanthemum cv. Vasantika with GA3 150 ppm. Kumar et al. (2010) [10] studied effect of growth regulators on flowering in African marigold with GA3 (25, 50, 100 and 200 ppm) and longest duration of flowering with GA3 200 ppm.

Length of flower stalk (cm): The maximum length with foliar application of GA3 300 ppm (T4). The increment in stalk length with application of GA3 might be due to enhanced cell-division and cell enlargement, promotion of protein synthesis coupled with higher dry matter of apical dominance (Dalal et al. 2009) [4]. Similar results were also reported by Dahiya and Rana (2001) observed maximum flower stalk length in chrysanthemum with GA3 150 ppm. Tiwari (1992) concluded that treatments of GA3 200 ppm increased the length of spike in tuberose and Gautam et al. (2006) [6] reported maximum length of flower stalk with GA3 200 ppm in chrysanthemum.

Diameter of flower (cm): The diameter of flower was found significantly maximum with GA3 300 ppm (T4) followed by Ethrel 300 ppm (T9) whereas minimum flower diameter was recorded under control (T1) GA3 and Ethrel both increases flower diameter at 300 ppm concentrations. Patel et al. (2010) [15] told that maximum diameter of flower was found with GA3 150 ppm in chrysanthemum. Similar result was also reported by Dalal et al. (2009) [4] with Gibberellic acid and Maleic hydrazide spray at 30th and 60th days after transplanting on growth flowering and yield of chrysanthemum under net house conditions. The results...
revealed that foliar application of gibberellic acid at 200 ppm concentration resulted maximum flowering, increased diameter of flower, length of flower stalk and flower yield in chrysanthemum. Tyagi and Kumar (2006) [21] found that the beneficial effect of GA\textsubscript{3} on African marigold (Tagetes erecta L.). Maximum flower diameter was recorded with GA\textsubscript{3} spray at 200 ppm. Nagarjuna et al. (1988) [13] apply foliar spray of GA\textsubscript{3} 100 and 200 ppm. 70 days after planting, flowering was hastened by 17 days and diameter (5.92 – 5.99 cm) was greatest with GA\textsubscript{3} at 200 ppm.

**Number of flowers per plant:** The maximum numbers of flower per plant were recorded with foliar application of GA\textsubscript{3} 300 ppm (T\textsubscript{4}) followed by GA\textsubscript{3} 200 ppm (T\textsubscript{3}). The enhancement in number of flower per plant might be due to the production of large number of laterals at early stage of growth which had sufficient time to accumulate carbohydrate for proper flower bud differentiation due to enhanced reproductive efficiency and photosynthesis restricted plant type. The result was in close conformity with Sunitha et al. (2007) [20] studied foliar application of GA\textsubscript{3} (100 and 200 ppm) in African marigold cv. Orange Double increase the number of flowers per plant, Gautam et al. (2006) [8] observed that GA\textsubscript{3} 200 ppm increased flowering and yield of chrysanthemum flower. Mohriya et al. (2003) [12] observed that 150 ppm GA\textsubscript{3} hastened flowering and highest number of flower per plant in chrysanthemum. Patel et al. (2010) [15] observed maximum number of flower per plant with GA\textsubscript{3} 150 ppm in chrysanthemum and Tanimwar et al. (2011) [22] in chrysanthemum.

**Weight of flower (g):** The weight of flower was reported significantly maximum with foliar application of GA\textsubscript{3} 300 ppm (T\textsubscript{4}). Tyagi and Kumar (2006) [21] evaluated the effect of GA\textsubscript{3} on African marigold (Tagetes erecta L.) and observed maximum fresh weight of flower with GA\textsubscript{3} spray at 200 ppm Gautam et al. (2006) [8] studied the effect of foliar application of GA\textsubscript{3}, NAA, Ethrel on chrysanthemum and observed that GA\textsubscript{3} 200 ppm and NAA 100 ppm increased growth, flowering and yield of chrysanthemum flower. Sunita et al. (2007) [20] in African marigold (Tagetes erecta L.) and reported maximum flower weight. Patel et al. (2010) [15] studied the effect of GA\textsubscript{3} (50, 100 and 150 ppm). Significantly maximum flower diameter (8.76 cm), flower weight (5.93 g) and shelf life of flowers (8.00 days) were obtained in the treatment GA\textsubscript{3} 150 ppm. Number of flowers per plant (48.30), flower yield per plant (170.77 g) and flower yield per hectare (12.65 t) were found maximum in the same treatment in case of chrysanthemum. Varma and Arha (2004) [23] also observed maximum flower yield with GA\textsubscript{3} 200 ppm as compared to control in marigold.

**Yield of flower per plant (g):** The yield of flower per plant differs significantly. Maximum flower yield per plant was recorded with foliar application of GA\textsubscript{3} 300 ppm (T\textsubscript{4}) followed by GA\textsubscript{3} 200 ppm (T\textsubscript{3}) and Ethrel 400 ppm (T\textsubscript{5}). Tyagi and Kumar (2006) [21] evaluated the effect of GA\textsubscript{3} on flower weight per plant of African marigold (Tagetes erecta L.) were maximum with GA\textsubscript{3} spray at 200 ppm, Mohriya et al. (2003) [12] also reported that the effect of GA\textsubscript{3} at 100, 150 ppm and TIBA at 100 ppm on different varieties of chrysanthemum and observed that 150 ppm GA\textsubscript{3} hastened flowering and highest number of flower per plant.

**Flower yield per hectare (q):** The yield of flower per hectare differs significantly. The maximum flower yield per hectare was recorded with application of GA\textsubscript{3} 300 ppm (T\textsubscript{4}) followed by GA\textsubscript{3} 200 ppm (T\textsubscript{3}). Patel et al. (2010) [15] studied the effect of GA\textsubscript{3} (50, 100 and 150 ppm). Significantly maximum flower diameter (8.76 cm), flower weight (5.93 g) and shelf life of flowers (8.00 days) were obtained in the treatment GA\textsubscript{3} 150 ppm. Number of flowers per plant (48.30), flower yield per plant (170.77 g) and flower yield per hectare (12.65 t) were found significantly maximum in the same treatment in chrysanthemum, Varma and Arha (2004) [23] reported maximum flower yield with GA\textsubscript{3} 200 ppm as compared to control in marigold. Devadanam et al. (2007) GA\textsubscript{3} at 150 ppm resulted maximum flower yield per hectare in tuberose.

**Table 1:** Effect of Bio-regulators on flowering behavior and yield attributes of marigold

| Treatments   | Days taken to first flower bud initiation | Days taken to opening of first flower | Duration of flowering (Days) | Length of flower stalk (cm) | Number of flowers per plant | Diameter of flower (cm) | Weight of flower (g) | Yield of flower per plant (g) | Yield of flower per hectare (q) |
|--------------|------------------------------------------|--------------------------------------|------------------------------|-----------------------------|-----------------------------|------------------------|------------------------|-------------------------------|------------------------------|
| T\textsubscript{1} Control | 57.65 | 99.45 | 36.39 | 7.73 | 21.00 | 6.73 | 10.02 | 210.42 | 103.90 |
| T\textsubscript{2} GA\textsubscript{3} 100 ppm | 52.21 | 91.13 | 46.34 | 8.11 | 27.31 | 7.91 | 11.98 | 327.17 | 161.56 |
| T\textsubscript{3} GA\textsubscript{3} 200 ppm | 48.77 | 91.25 | 48.7 | 7.88 | 28.25 | 7.81 | 12.25 | 346.07 | 170.89 |
| T\textsubscript{4} GA\textsubscript{3} 300 ppm | 50.76 | 89.76 | 50.76 | 9.1 | 29.01 | 9.49 | 13.05 | 378.50 | 186.95 |
| T\textsubscript{5} MH 200 ppm | 62.01 | 101.35 | 38.84 | 9.01 | 23.23 | 7.02 | 11.12 | 256.28 | 127.56 |
| T\textsubscript{6} MH 300 ppm | 62.01 | 104.07 | 41.19 | 7.34 | 24.02 | 7.31 | 11.50 | 276.23 | 136.41 |
| T\textsubscript{7} MH 400 ppm | 65.64 | 114.52 | 41.15 | 7.1 | 23.15 | 6.98 | 11.23 | 259.97 | 128.37 |
| T\textsubscript{8} Ethrel 200 ppm | 58.67 | 101.15 | 43.21 | 7.93 | 24.95 | 7.41 | 11.75 | 233.16 | 144.76 |
| T\textsubscript{9} Ethrel 300 ppm | 63.18 | 104.57 | 44.91 | 7.62 | 26.12 | 8.37 | 11.89 | 310.36 | 153.36 |
| T\textsubscript{10} Ethrel 400 ppm | 72.69 | 112.14 | 43.61 | 7.36 | 27.39 | 6.95 | 12.17 | 333.34 | 164.60 |
| SE(m)± | 2.14 | 3.6 | 1.59 | 0.28 | 0.94 | 0.28 | 0.43 | 11.11 | 5.59 |
| CD at 5% | 6.19 | 10.41 | 4.61 | 0.81 | 2.71 | 0.81 | 1.23 | 32.13 | 16.16 |

**Conclusion**

On the basis of result obtained from the present investigation it can be concluded that foliar application of GA\textsubscript{3} 300 ppm one month after transplanting was found most effective with respect to flowering behavior, and maximum flower yield and of African marigold (Tagetes erecta L.) and can be recommended to farmers for commercial cultivation of African marigold (Tagetes erecta L.) cv. Pusa Narangi Gainda.

**Acknowledgement**

The authors are thankful to the Head, Department of Horticulture, GBPUAT, Pantnagar, (UK) for encouragement and providing seed material of African marigold.

**References**

1. Anonymous. Office of the District Horticulture Officer, Meerut, UP 2016.
2. Dutta JP, Seamanthini R, Ramdas S. Growth and flowering response of chrysanthemum to growth regulators treatments. Orissa J Hort 1998;26(1):70-75.

3. Dahiy DS, Rana GS. Regulation of flowering in chrysanthemum as influenced by GA and shade house of different intensities. South Ind. Horti 2010;49:313-314.

4. Dalal SR, Karale GD, Momin KC. Effect of growth regulators on growth, yield and quality of chrysanthemum under net house conditions. Asian J Hort 2009;4(1):161-163.

5. Devedanam A, Shinde BN, Sable PB, Vedpathak SG. Effect of foliar spray of plant growth regulators on flowering and vase life of tuberose (Polianthes tuberosa Linn.) J Soils and Crops 2007;17(1):86-88.

6. Gautam SK, Sen NL, Jain MC, Dashora LK. Effect of plant growth regulators on growth, flowering and yield of chrysanthemum cv. Nilima. Orissa J of Hort 2006;34(1):36-40.

7. Gomez AA, Gomez KA. Statistical procedures for Agricultural Research, John Willey and Sons, Inc., New York 1984, 680.

8. Haber AH, Leopold HJ. Effects of gibberellins and gama irradiated wheat, Amer. J Bot 1960;47:140-144.

9. Kumar J, Singh P, Pal K. Effect of growth substances on flowering and bulb production in tuberose (Polianthes tuberosa L.) cv. Pearl Double. J of Orna. Hort 2003;9(3):227-228.

10. Kumar R, Ram M, Gaur GS. Effect of GA3 and ethrel on growth and flowering of African marigold cv. Pusa Narangi Gainda. Ind. J Hort 2010;67:362-366.

11. Mehar SP, Jiotode DJ, Turkhede A, Darange SO, Ghatol PV, Dhwad CS. Effect of planting time and growth regulator treatments on flowering and yield of chrysanthemum. Crop Res. Hisar 1990;18(3):345-348.

12. Mohariya AD, Patil BN, Wankhede SG, Band PE, Kartikeyan R. Effect of GA3 and TIBA on growth, flowering and yield of different varieties of Chrysanthemum. Adv. Plant Sci 2003;16(1):143-146.

13. Nagarjuna P, Reddy BV, Rao MR, Reddy EN. Effect of growth regulators and potassium nitrate on growth, flowering and yield of chrysanthemum. South Indian Hort 1998;36:136-140.

14. Pal P, Hore J, Poi AK. Effect of growth regulating chemical on growth and yield of flower of Calendula officinalis. Environ and Eco 1986;4(4):541-543.

15. Patel SR, Parekh NS, Parmar AB, Patel HC. Effect of growth regulators on growth, flowering and yield of chrysanthemum cv. IIHR-6 under middle Gujarat conditions. Int. J of Agri. Sci 2010;6(1):243-245.

16. Pawar RD, Patil PV, Magar SD, Chavan SK. Effect of maleic hydrazide, cycoceil and SADH (alar) on growth and flower quality in marigold (Tagetes erecta L.). J of Maharashatra Agri. Uni 2011;36(1):170-172.

17. Rappaort L, Singh JJ. Gibberellins and vegetable crops, Crops J Hort 1960;18:03-09.

18. Sachs RM. Gibberellin, Auxin and growth retardant affect cell division and shoot histogenesis. Advanced chemistry 1961;28:49-58.

19. Singh AK. Studies on effect of growth retardant on growth and flowering in African marigold. Hort. J 2004;17(1):79-82.

20. Sunita HM, Ravi Hanje, Vyakaranahal BS, Bablad HB. Effect of pinching and growth regulators on plant growth, flowering and seed yield in African marigold (Tagetes erecta L.) J of Orna. Hort 2007;10(2):91-95.

21. Tyagi AK, Kumar V. Effect of gibberellic acid and vermi compost on vegetative growth and flowering in African marigold (Tagetes erecta Linn.) J Orna. Hort 2006;9(2):150-151.

22. Tannirwar AV, Dange NR, Brahmankar SB. Effect of growth regulators and nutrients on growth and flowering of chrysanthemum cv. ZIPRI. Asian. J Hort 2011;6(1):269-270.

23. Verma LR, Arha. Studies on regulation of flowering in African marigold (Tagetes erecta L.) by the application of GA3, ethrel and MH. J Orna Hort 2004;7(3-4):168-170.