Madras Agric. J., 100 (1-3): 45-47, March 2013
https://doi.org/10.29321/MAJ.10.001235

Effect of Plant Growth Regulators on Growth and Yield of African Marigold (*Tagetes erecta* Linn.)

Jyoti Kanwar* and S.K. Khandelwal
Department of Horticulture, S.K.N. College of Agriculture, Jobner, SKRAU, Bikaner Rajasthan- 303 329

A field experiment was conducted at Experimental Farm, Department of Horticulture, S. K. N. College of Agriculture, Jobner, SKRAU, Bikaner (Rajasthan) to find out the effect of plant growth regulators on growth and yield of marigold. Treatments consist of two levels of spray i.e. single spray (S_1) and double spray (S_2) and four levels of each Plant Growth Regulator *viz.*, GA_3 (GA_{50}, GA_{100}, GA_{150} and GA_{200} ppm) and NAA (N_{50}, N_{100}, N_{150} and N_{200} ppm) in African marigold (*Tagetes erecta* Linn.) cv. Pusa Narangi Gainda. The results revealed that single spray of GA_3 @ 150 ppm recorded significantly higher plant height (83.30 cm), leaf area (1188.58 cm_2), number of flowers per plant (78.49), average weight of flower (4.85 g) and yield of flowers per plant (365.23 g) as well as per hectare (132.27 q/ha). Application of NAA 150 ppm as a single foliar spray significantly increased plant height (72.22 cm), chlorophyll content in leaves (2.89 mg g_{-1}), duration of flowering (69.14 days), yield of flowers per plant (360.09 g) as well as per hectare (13.04 tonnes/ha).

Key words : Plant growth regulators, GA_3, NAA, marigold, spray.

African marigold (*Tagetes erecta* Linn.) a member of family compositeae, is one of the commercially exploited ornamental crops, grown for loose flowers, xanthophyll content, aromatic oil, cut flowers etc. It occupies special importance due to its hardiness, easy culture, wide adaptability to different soil and climatic conditions and easy transportation attracts the attention of flower growers. It is suitable for potted plant, bedding, edging, garland making, religious offering and also for making different products. It is gaining industrial importance due to its huge potential in value addition. Hence, to fulfill the demand of industrialists, it is necessary to increase its production through improved production technologies. Gibberellic acid (GA_3) has been found beneficial in enhancement of plant growth and flower production in marigold (Girwani *et al*., 1990). It has been reported that GA_3 regulate the plant growth through both cell division and cell enlargement (Sachs, 1965). NAA is another important PGR, which stimulate cell division, cell enlargement and cell elongation in apical region of plant. It increase osmotic pressure and permeability of cytoplasm to water and nutrients and decrease in cell pressure or increase cell wall permeability (Pandey and Sinha, 1986). It has been observed that fresh weight of single flower, number of seeds per flower, flower yield per plant with NAA @ 300 ppm was found significantly higher over control in African Marigold (Swaroop *et al.* 2007).

Materials and Methods

A field experiment was conducted at Experimental Farm, Department of Horticulture, S.K.N College of Agriculture, Jobner during *rabi* season, 2008-09 to study the response of different levels of PGR with their single and double sprays on growth and flowering in African marigold cv. Pusa Narangi Gainda. The total number of treatments tried was 17 comprising four levels of GA $_3$ and NAA namely 50, 100, 150 and 200 ppm and one control with their single and double sprays. The experiments were laid out in RBD with three replications having plot size of 3.0 x 2.25 sq. m. Thirty days old seedlings were transplanted at 60 x 45 cm apart. The first foliar spray of GA_3 and NAA was done at 30 DAT and second spray was done at 45 DAT. In physiological parameters, Leaf area was measured directly with the help of Li -3100 Areameter. Chlorophyll was determined by using the method of Arnon (1949). The observations on different growth and flower yield were recorded time to time in each treatment and data were analyzed statistically.

Results and Discussion

Growth Parameters

Foliar application of GA_3 and NAA significantly enhanced vegetative growth of marigold (Table 1). Application of GA_3 proved better for plant height as compared to NAA, whereas NAA showed better result in respect to leaf area and chlorophyll content in leaves as compared to GA_3. The effect of GA_3 and NAA on number of primary branches per plant did not differ significantly. Application of GA_3 significantly increased all the growth characters as its levels and number of sprays increased. The plant height and leaf area were recorded maximum at higher

*Corresponding author email: Jyotikhangarot@gmail.com

Table 1. Effect of GA_3 and NAA on growth and flowering of African marigold.

Treatment	Plant height (cm)	Number of primary branches plant^{-1}	Leaf area (cm^2)	Leaf chlorophyll content (mg g^{-1})	Duration of flowering (days)
Control	60.82	7.53	850.12	2.66	58.20
PGRs					
GA_3	78.82	10.10	1173.07	2.54	68.42
NAA	71.43	10.40	1261.80	2.89	70.34
SEm±	1.76	0.24	27.29	0.05	1.60
C.D. (P = 0.05)	5.06	NS	79.81	0.14	NS
GA_3 levels					
S_1G_{50}	65.12	8.50	963.72	2.65	59.11
S_1G_{100}	75.02	9.33	1091.06	2.61	68.05
S_1G_{150}	83.30	9.90	1188.58	2.57	69.25
S_1G_{200}	85.91	10.12	1218.40	2.55	70.15
S_2G_{50}	69.64	9.02	1114.20	2.59	60.35
S_2G_{100}	78.14	10.51	1192.15	2.50	70.12
S_2G_{150}	84.36	11.52	1296.42	2.44	75.10
S_2G_{200}	89.14	11.97	1320.10	2.41	75.25
SEm±	4.07	0.55	64.18	0.11	3.70
C.D. (P = 0.05)	11.69	1.57	184.32	NS	10.61
NAA levels					
S_1N_{50}	62.39	8.73	1050.42	2.68	61.12
S_1N_{100}	68.14	9.72	1153.99	2.80	66.43
S_1N_{150}	72.22	10.27	1230.22	2.89	69.14
S_1N_{200}	74.60	10.65	1300.24	2.92	75.23
S_2N_{50}	64.19	9.12	1192.46	2.72	65.82
S_2N_{100}	72.14	10.56	1304.88	2.88	71.12
S_2N_{150}	77.72	11.95	1412.12	3.11	76.15
S_2N_{200}	80.09	12.25	1450.12	3.15	77.16
SEm±	4.07	0.55	64.18	0.11	3.70
C.D. (P = 0.05)	11.69	1.57	184.32	0.31	10.61

level of GA_3 @ 200 ppm applied as double spray followed by double spray of GA_3 @ 150 and 100 ppm and single spray of GA_3 @ 200 ppm and 150 ppm. Numbers of branches per plant were recorded maximum with the application of GA_3 @ 200 ppm as double spray and it was statistically at par with GA_3 @ 150 and 100 ppm as double spray. The enhancement in plant height as a result of application of GA_3 might be due to the fact that GA_3 induced the active cell division and cell elongation (Greulach and Haesloop, 1958). Growth might also be increased due to osmotic uptake of water and nutrients under the influence of GA_3, which maintain swelling force against the softening of cell wall and thereby increasing the plant height (Lockhart, 1960). Increased leaf area per plant as a result of GA_3 application might be due to the fact that GA_3 interacts with auxin thus reduces the apical dominance and thereby results in enhancement of leaf area. These results are in also agreement with observations of Swaroop *et al.* (2007) in African marigold. Chlorophyll content in leaves did not significantly affected with the application of GA_3 at different levels and number of sprays. However, the chlorophyll content in leaves decreased as the levels and number of sprays of GA_3 increased.

Data (Table 1) further reveal that growth parameters were significantly increased as increasing NAA levels and their number of sprays. The plant height, leaf area and chlorophyll content in leaves were recorded maximum with double spray of NAA @ 200 ppm followed by double spray of NAA @ 150 ppm and 100 ppm, single spray of NAA @ 200 ppm and 150 ppm. The number of branches per plant was also recorded highest with the application of NAA @ 200 ppm as double spray but it was at par with double spray of NAA @ 150 ppm. This increase in plant growth might be due to fact that NAA, being a member of auxin group, promotes vegetative growth by active cell division, cell enlargement and cell elongation. These results are in consonance with Mankar *et al*. (2006) in China Aster. The increase in leaf area was due to the fact that the primary physiological effect of auxin is to stimulate the elongation of cells due to increased amylase activity, permeability of cell wall and formation of energy rich phosphate (ATP) which would have been utilized by plants for cellular expansion and tissue growth resulting in more vegetative growth of the plant (Pandey and Sinha, 1986).

Floral and Yield Parameters

Significant enhancement was recorded in floral and yield characters with the application of plant growth regulators as compared to control. However, both the plant growth regulators; GA_3 and NAA did not differ significantly in respect to all floral and yield characters (Tables 1& 2). Floral and yield parameters depicted in tables 1 and 2 show that duration of flowering, number of flowers per plant, average weight and diameter of flower and yield of flowers significantly increased with increasing levels of GA_3 and their number of sprays. Duration of flowering and average diameter of flower significantly increased with double spray of GA_3 @

Table 2. Effect of GA_3 and NAA on flower characters and flower yield of African marigold.

Treatment	Number of flowers plant^{-1}	Average weight of flower (g)	Average diameter of flower (cm)	Yield of flowers per plant (g)	Yield of flowers (ton/ha)
Control	69.48	4.15	4.75	288.20	10.66
PGRs					
GA_3	78.17	4.77	6.57	353.02	12.91
NAA	76.38	4.86	6.67	344.68	12.65
SEm±	1.51	0.11	0.15	8.16	0.20
C.D. (P = 0.05)	NS	NS	NS	NS	NS
GA_3 levels					
S_1G_{50}	69.90	4.22	5.62	295.54	10.94
S_1G_{100}	74.14	4.60	6.39	320.04	11.85
S_1G_{150}	78.49	4.85	6.88	365.23	13.22
S_1G_{200}	83.14	5.01	7.19	380.53	14.04
S_2G_{50}	70.62	4.24	5.75	300.54	11.13
S_2G_{100}	78.24	4.81	6.48	345.33	12.77
S_2G_{150}	82.92	5.20	6.99	400.23	14.42
S_2G_{200}	87.97	5.28	7.28	416.72	14.89
SEm±	3.50	0.26	0.35	18.84	0.60
C.D. (P = 0.05)	10.05	0.74	1.01	54.10	1.97
NAA levels					
S_1N_{50}	69.50	4.26	5.73	290.07	10.79
S_1N_{100}	73.26	4.78	6.42	325.18	12.02
S_1N_{150}	78.45	5.10	6.92	360.09	13.03
S_1N_{200}	81.78	5.22	7.23	375.89	13.56
S_2N_{50}	69.55	4.28	5.96	295.67	10.98
S_2N_{100}	75.12	4.82	6.62	350.07	12.87
S_2N_{150}	80.15	5.12	7.07	370.36	13.60
S_2N_{200}	83.25	5.30	7.42	390.12	14.25
SEm±	3.50	0.26	0.35	18.84	0.60
C.D. (P = 0.05)	10.05	0.74	1.01	54.10	1.97

200 ppm, 150 ppm and 100 ppm and single spray of GA_3 @ 200 ppm, 150 ppm and 100 ppm. Whereas, number of flowers per plant and weight of flowers were found significantly higher with double spray of GA_3 @ 200 ppm followed by double spray of GA_3 @ 150 ppm and 100 ppm, single spray of GA_3 @ 200 ppm and 150 ppm. The yield of flowers per plant as well as per hectare recorded maximum with double spray of GA_3 @ 200 ppm followed by GA_3 @ 150 ppm and single spray of GA_3 @ 200 and 150 ppm. The changes in floral and yield parameters by the application of GA_3 can be explained in light of the fact that GA_3 was quite effective in reducing the juvenile period of plants because of its higher capacity of cell division and cell elongation which cause early maturity in plants (Lockhart, 1960). These parameters might also have increased due to increased over all vegetative growth of the plants facilitating more photosynthetic area and metabolic activities resulting in more transport and utilization of the photosynthetic product resulting in higher flower yield. These results were also in inconsonance with the reports of Singh *et al*. (1991) in African marigold and Leena *et al*. (1992) in gladiolus.

Similarly, flower and yield parameters also responded significantly to increasing levels of NAA as single or double foliar spray. The number of flowers per plant, average weight and diameter of flower were recorded maximum with the application of double spray of NAA @ 200 ppm which was found statistically at par with double spray of NAA @ 150 ppm and 100 ppm, single spray of NAA @ 200, 150 ppm and 100 ppm. Double spray of NAA @ 200 ppm also recorded maximum duration of flowering and yield of flowers per plant as well as per hectare followed by double spray of NAA @ 150 ppm and 100 ppm, single spray of NAA @ 200 ppm and 150 ppm. The increase in these floral and yield characters might be due to the fact that NAA enhanced cell division and rate of respiration, resulting in production of metabolic energy which would have been utilized by plants for cellular expansion and tissue growth resulting in the improvement on numbers of flowers, diameter and weight of flowers. More number of flowers per plant and yield of flowers might also be due to the reasons that NAA, being an auxin, stimulates vegetative growth, regulate flowering and also prevent abscission of leaves and premature flower buds. Improved vegetative growth due to foliar spray of NAA coupled with increased photosynthesis on one hand and greater mobilization of photosynthate towards reproduction sites on the other hand might have helped for increased number of flowers per plant and flower yield. The reports of Swaroop *et al*. (2007) and Sunitha *et al*. (2007) in African marigold were also found in corroboration with the present study.

Conclusion

On the basis of the results obtained in present investigation it may be concluded that application of GA_3 and NAA enhanced the vegetative growth and yield character of marigold over control. A comparison of various treatment taken for study revealed that application of NAA @ 150 ppm applied as a single foliar spray (30 DAT) registered significantly higher values of growth and yield attributes.

References

Girwani, A., Srihari, R. and Chandrashekar, R. 1990. Response of marigold to growth regulators and zinc. *Indian J. Agric. Sci*, **60**: 220-222.

Greulach, V.A. and Haeshloop, J.C. 1958. The influence of GA_3 on cell division and cell elongation is *Phaseolus vulgaris*. *American J. Botany*, **45**: 568-570.

Leena, R., Rajeevan, P.K., Valsalakumari, P.K. and Ravidas, L. 1992. Effect of foliar application of growth regulators on the growth, flowering and corm yield of gladiolus cv. Friendship. *South Indian Horticulture*, **40**: 329-335.

Lockhart, J.A., 1960. Inter-cellular mechanism growth inhibitor of radian energy. *Plant Physiology*, **35**: 129-135.

Mankar, S.S., Holdankar, P.N., Rangwala, A.D., Joshi, D.D. 2006. Effect of growth regulators and organic compounds on growth, flowering and yield of China aster var. Ostrich Plune mixed. *South Indian Horticulture*, **43**: 311-317.

Pandey, S.S. and Sinha, B.K. 1986. Plant Physiology. III$_{rd}$ Edition Vikas Publication, New Delhi, pp. 425-430.

Sachs, R.M. 1965. Stem elongation. *Annual Review of Plant Physiology*, **26** : 73-93.

Singh, M.P., Singh, R.P. and Singh, G.N., 1991. Effect of GA_3 and ethrel on the growth and flowering of African Marigold. *Haryana J.Hort. Sci*, **20**: 81-84.

Sunitha, H.M., Hunja, R., Vyakaranahal, B.S., Bablad, H.B. 2007. Effect of pinching and growth regulators on plant growth, flowering and seed yield in African Marigold. *J. Ornamental Hort.*, **10**: 91-95.

Swaroop, K., Singh, P. and Kanwar, D.V.S. 2007. Vegetative growth, flowering and seed characters of African marigold as influenced different growth substances during mild off season. *J.Ornamental Hort.*, **10**: 268-270.

Received: August 02, 2012; Accepted: January 11, 2013