International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 3614-3617

Received: 15-10-2020
Accepted: 27-11-2020

Shivani P Tandel
Department of Floriculture and Landscape Architecture, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Mehsana, Gujarat, India

Kiran Kumari
Department of Floriculture and Landscape Architecture, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Mehsana, Gujarat, India

Corresponding Author:
Shivani P Tandel
Department of Floriculture and Landscape Architecture, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Mehsana, Gujarat, India

Influence of different levels of fertilizers and plant growth regulators on growth and yield characters of African marigold (*Tagetes erecta* L.)

Shivani P Tandel and Kiran Kumari

DOI: https://doi.org/10.22271/chemi.2021.v9.i1ay.11792

Abstract
A field experiment was conducted during 2019-20 to study the effect of different levels of fertilizers and plant growth regulators on growth and yield characters of African marigold cv. 'Pusa Narangi Gainda'. Three levels of fertilizers (100% RDF, 80% RDF and 60% RDF) and five different concentrations of plant growth regulators (water spray, 25 ppm GA_3, 50 ppm GA_3, 1 ppm Triacontanol and 2 ppm Triacontanol) were tested individually and in combinations in a Randomized Block Design with factorial concept (FRBD) and replicated thrice. The results revealed that among different fertilizer levels 100% RDF (NPK 250:100:100 kg/ha) resulted in maximum plant height at 25, 50, 75 DAT and at last picking (35.43, 55.92, 69.82 and 77.24 cm, respectively), number of primary and secondary branches (14.06 and 21.30, respectively) as well as plant spread (42.81 cm). Along with these, the yield attributes such as number of flowers per plant (64.86), flower yield per plant (318.26 g), per plot (2.79 kg) and per hectare (114.76 q) were found maximum with the same treatment. Among plant growth regulators, two times application (30 and 60 DAT) of 50 ppm GA_3 resulted in maximum plant height at 50, 75 DAT and at last picking (58.43, 71.24 and 79.96 cm, respectively), maximum number of primary and secondary branches (14.92 and 23.00, respectively) as well as plant spread (45.49 cm). The yield attributes *viz.*, number of flowers per plant (67.62), flower yield per plant (314.90 g), per plot (2.78 kg) and per hectare (114.49 q) were recorded maximum in the same treatment. The interaction between 100% RDF and 50 ppm GA_3 was found best as it resulted in maximum plant height at 75 days after transplanting (74.87 cm) and at last picking (84.93 cm) as well as maximum number of primary and secondary branches (17.36 and 26.16, respectively), number of flowers per plant (73.23), flower yield per plant (377.30 g), per plot (3.31 kg) and per hectare (136.35 q). Thus, it can be concluded from the findings that application of 100% RDF with two times foliar application (30 and 60 DAT) of 50 ppm GA_3 can significantly improve the overall plant growth and flower yield of African marigold.

Keywords: African marigold, fertilizers, plant growth regulators

Introduction
Marigold (*Tagetes erecta* L.) belongs to family Asteraceae and two most popular commercially cultivated species are African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.) which have their origin in Mexico and South Africa, respectively. In India, marigold is thought to be introduced by Portuguese between 1502. Its easy cultivation, early flowering and bright shade of colours has made it most important commercial loose flower crop in India.

The growth and yield of plant are mainly influenced by two major factors *viz*., genetic and management, however regulating plant growth by the application of PGR's constitute the third most important advances in agro technology for improving growth, flowering and quality parameters in flower crops (Navale *et al.,* 2010) [8]. Amongst management factors, nutrition plays an important role in growth and yield of flowers. There is great demand of marigold throughout the year, especially during festive season. To fulfill the ever-increasing demand, it is necessary to increase its production through improved production technologies. Nitrogen is an essential element required by the plants for growth and development. An adequate supply of nitrogen is associated with vigorous vegetative growth and deep green colour of leaves. Nitrogen plays vital role in the synthesis of chlorophyll as well as amino acids, which contribute to the building units of protein and thereby, growth of plants. A good supply of phosphorus is associated with increased root growth and early maturity of crop besides disease

resistance in plants. Application of phosphorus not only increases the crop yield but also improves the quality (Sharma, 2018) [10]. Potassium enhances the translocation of photosynthates and regulate the opening and closing of stomatas so, it is also major essential elements for plant growth and flower yield of marigold.

The influence of numerous growth substances has been commercially exploited, both in green house as well as field crops. Gibberellins (GA_3) play an important role in growth and flowering of ornamental plants. Foliar application of gibberellic acid enhances vegetative attributes along with flower initiation (Kumar *et al.*, 2003) [4]. Triacontanol (TRIA) is a natural plant growth regulator found in epicuticular waxes (Naeem *et al*., 2012) [7]. Triacontanol increase cell division rates, which produces large root and shoot mass, improve protein synthesis, promote flowering and earlier crop maturity. Both GA_3 and Triacontanol outstandingly claim to promote growth and yield of certain crops. The supply of nutrition may be enhanced when its application is supplemented by using growth regulators like Gibberellic acid (Singh *et al.*, 2018) [12]. Thus, determining to the large scale cultivation and demand of marigold, this study was conducted to find out the crop response to fertilizers levels and varied concentration of growth regulators.

Materials and Methods

The present investigation was conducted during 2019-20 at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Mehsana, Gujarat. The sandy loam soil of the experimental area was fairly leveled and had uniform fertility status. Seeds of African marigold cv. 'Pusa Narangi Gainda' were sown on the raised beds and healthy and uniform seedlings were transplanted at a spacing of 60 cm x 45 cm on flat beds of 3.0 m × 2.25 m size after one month of sowing. The seedlings were transplanted in the main field on 16th September. There were fifteen treatment combinations with three levels of RDF *i.e.* 100%, 80% and 60% and five PGRs treatments *i.e.* water spray, 25 ppm GA_3, 50 ppm GA_3, 1 ppm triacontanol and 2 ppm triacontanol. The well decomposed FYM (15 t/ha) and recommended dose of chemical fertilizers at the rate of 250 kg N, 100 kg P_2O_5 and 100 kg K_2O per hectare were applied as per the treatment. Among these full doses of phosphorous and potassium was applied before transplanting according to the treatments whereas, nitrogen through urea was given in the two split doses *i.e.* at the time of transplanting and one month after transplanting. Foliar application of plant growth regulators was done at 30 and 60 days after transplanting. The experiment was laid out in a Randomized Block Design with factorial concept and replicated thrice in open field condition. Observations on different growth and yield parameters were recorded and analyzed statistically.

Results and Discussion

Growth characters

Growth characters of African marigold was significantly influenced by the various treatments (Table 1-3). Among the different fertilizer treatments, maximum plant height at 25, 50, 75 days after transplanting and at last picking (35.43 cm, 55.92 cm, 69.82 cm and 77.24 cm, respectively), number of primary and secondary branches (14.06 and 21.30, respectively) as well as plant spread (42.81 cm) was recorded under the treatment 100% RDF. Among the plant growth regulators, significantly maximum plant height at 50, 75 days after transplanting and at last picking (58.43 cm, 71.24 cm and 79.96 cm, respectively), number of primary and secondary branches (14.92 and 23.00, respectively) as well as plant spread (45.49 cm) was recorded with 50 ppm GA_3. The interaction between different levels of fertilizers and plant growth regulators also exhibited significant effect on the plant height and number of branches, whereas interaction effect for plant spread character was non-significant. Among the interaction effects, maximum plant height at 75 days after transplanting and last picking (74.87 cm and 84.93 cm, respectively) and primary branches and secondary branches (17.36 and 26.16, respectively) were recorded in the plants supplied with 100% RDF and two foliar spray of 50 ppm GA_3. It is evident from the data that plant height at 25 DAT was not significantly influenced by plant growth regulators and interaction of fertilizers and plant growth regulators. It is due to the fact that observation was taken before the 1st spray of plant growth regulators. The plant height increased continuously from 25 days after transplanting to last picking in all the treatments and differed significantly at all the stages. At early growth stages *i.e.* 50 and 75 days after transplanting, there was consistently more increase in plant height and steady increase after 75 days. The increase in plant height with 100% RDF and 50 ppm GA_3 might be due to the reason that GA_3 helps in increasing the photosynthetic activity in plants and also promote vegetative growth and also the supply of nutrients through balanced dose of RDF has positive effect on vegetative growth *i.e.* plant height could be attributed to effectiveness in providing a balanced nutritional requirement which is favorable to plant system. Nitrogen is the component of protein and nucleic acids and chlorophyll. Phosphorus being an essential component of protoplasm and chlorophyll cause conversion of photosynthates into phospholipids resulting in adequate vegetative growth, thus increased plant height (Monish *et al.*, 2008) [6]. These results are also in close conformity with the earlier work of Kumar (2019) [5] in African marigold. Similar results with GA_3 were also reported by Imandi and Reddy (2017) [1] in marigold. Nitrogen supply to the roots, stimulates the production and export of cytokinin to the shoots. The increased levels of cytokinin in plants might have caused the lateral buds to sprout giving a greater number of lateral branches and photosynthates transportation which used in synthesis of nucleic acid and protein that enhances the cell expansion leading to maximum spreading of plant (Wagner and Michael, 1971) [14]. These results are also in close conformity with the earlier work of Sharma *et al.* (2006) [9] in African marigold. The increase in number of branches and plant spread with GA_3 might be due to hyper elongation of internode. Similar results were also reported by Singh *et al.* (2017) [11] in African marigold.

Yield characters

The yield characteristics of African marigold *viz.* number of flowers per plant, flower yield per plant, per plot and per hectare were significantly influenced by various treatments (Table 4 and 5). Among the various fertilizer treatments, maximum number of flowers per plant (64.86), flower yield per plant (318.26 g), per plot (2.79 kg) and per hectare (114.76 q) was recorded in 100% RDF. Among the plant growth regulators, significantly maximum number of flowers per plant (67.62), flower yield per plant (314.90 g), per plot (2.78 kg) and per hectare (114.49 q) was recorded with application of 50 ppm GA_3. The interaction effect between fertilizers and plant growth regulators was also found significant for yield characters. The maximum number of flowers per plant (73.23), flower yield per plant (377.30 g),

per plot (3.31 kg) and per hectare (136.35 q) was recorded with interaction of 100% RDF and two times foliar application of 50 ppm GA_3. The possible reason for more yield with 100% RDF and two times foliar application of 50 ppm GA_3 might be that increased content of available nitrogen, phosphorous and potassium promoted better vegetative growth, resulting in more number of flowers per plant and per hectare. Nitrogen is an important constituent of chlorophyll and stimulates photosynthesis in plant, therefore flower yield increased. These results corroborate with the findings of Singh and Vikram (2016) [13] and Kumar (2019) [5] in African marigold. Foliar application of GA_3 has produced 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 which ultimately increased number of flowers and flower yield. These results corroborate the earlier findings of Kumar *et al.* (2016) [3] and Khangjarakpam *et al.* (2019) [2] in African marigold.

Table 1: Effect of different levels of fertilizers and plant growth regulators on plant height (cm) at 25 DAT and 50 DAT

Plant growth regulators (G) (ppm)	Plant height (cm) at 25 DAT				Plant height (cm) at 50 DAT			
	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean
	f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF	
g_0 - Water spray	35.91	32.29	28.73	32.31	47.48	45.07	39.86	44.14
g_1 - GA_3 25 ppm	34.81	33.00	29.49	32.43	55.33	54.45	50.15	53.31
g_2 - GA_3 50 ppm	35.54	32.29	27.57	31.80	62.50	59.64	53.16	58.43
g_3 - Triacontanol 1.0 ppm	36.27	32.30	30.23	32.93	54.00	52.59	42.64	49.74
g_4 - Triacontanol 2.0 ppm	34.64	31.65	27.34	31.21	60.31	58.74	48.00	55.68
Mean	35.43	32.31	28.67		55.92	54.10	46.76	
	F	G	Interaction (F x G)		F	G	Interaction (F x G)	
S.Em.±	0.56	0.73	1.26		0.70	0.90	1.56	
C.D. at 5%	1.63	NS	NS		2.02	2.61	NS	

* NS- Non significant

Table 2: Effect of different levels of fertilizers and plant growth regulators on plant height (cm) at 75 DAT and at last picking

Plant growth regulators (G) (ppm)	Plant height (cm) at 75 DAT				Plant height (cm) at last harvest			
	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean
	f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF	
g_0 - Water spray	61.59	57.84	49.19	56.21	65.13	62.33	57.17	61.54
g_1 - GA_3 25 ppm	70.89	68.68	64.06	67.88	78.20	77.01	70.18	75.13
g_2 - GA_3 50 ppm	74.87	73.72	65.13	71.24	84.93	82.83	72.11	79.96
g_3 - Triacontanol 1.0 ppm	69.04	66.62	51.31	62.33	76.30	73.39	58.49	69.39
g_4 - Triacontanol 2.0 ppm	72.70	68.15	52.46	64.44	81.62	75.15	60.89	72.55
Mean	69.82	67.00	56.43		77.24	74.14	63.77	
	F	G	Interaction (F x G)		F	G	Interaction (F x G)	
S.Em.±	0.85	1.10	1.91		0.90	1.16	2.02	
C.D. at 5%	2.47	3.19	5.52		2.61	3.37	5.84	

Table 3: Effect of different levels of fertilizers and plant growth regulators on number of primary and secondary branches and plant spread (cm)

Plant growth regulators (G) (ppm)	Number of primary branches				Number of secondary branches				Plant spread (cm)			
	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean
	f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF	
g_0 - Water spray	8.82	8.00	7.14	7.99	14.00	13.10	11.14	12.74	36.93	35.73	33.55	35.40
g_1 - GA_3 25 ppm	14.23	13.18	9.51	12.30	21.00	20.52	17.06	19.53	42.85	40.11	36.76	39.91
g_2 - GA_3 50 ppm	17.36	15.79	11.61	14.92	26.16	23.67	19.17	23.00	48.10	46.35	42.02	45.49
g_3 - Triacontanol 1.0 ppm	13.00	11.14	7.93	10.69	19.93	18.27	13.08	17.10	40.07	38.91	35.66	38.21
g_4 - Triacontanol 2.0 ppm	16.89	14.73	9.06	13.56	25.42	22.71	14.34	20.82	46.11	43.83	39.64	43.19
Mean	14.06	12.57	9.05		21.30	19.65	14.96		42.81	40.99	37.53	
	F	G	Interaction (F x G)		F	G	Interaction (F x G)		F	G	Interaction (F x G)	
S.Em.±	0.25	0.32	0.55		0.40	0.52	0.89		0.53	0.68	1.19	
C.D. at 5%	0.72	0.93	1.60		1.16	1.50	2.59		1.54	1.98	NS	

* NS- Non significant

Table 4: Effect of different levels of fertilizers and plant growth regulators on number of flowers per plant and flower yield per plant (g)

Plant growth regulators (G) (ppm)	Number of flowers per plant				Flower yield per plant (g)			
	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean
	f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF	
g_0 - Water spray	61.11	56.55	50.56	56.07	293.90	246.41	224.10	254.80
g_1 - GA_3 25 ppm	64.21	60.17	58.53	60.97	319.11	288.07	226.82	278.00
g_2 - GA_3 50 ppm	73.23	68.82	60.80	67.62	377.30	301.96	265.42	314.90
g_3 - Triacontanol 1.0 ppm	61.02	60.33	59.60	60.31	297.82	283.64	240.08	273.85
g_4 - Triacontanol 2.0 ppm	64.72	62.07	60.52	62.44	303.17	295.09	287.36	295.21

Mean	64.86	61.59	58.00	318.26	283.04	248.76	
	F	G	Interaction (F x G)	F	G	Interaction (F x G)	
S.Em.±	0.66	0.85	1.47	5.14	6.63	11.49	
C.D. at 5%	1.90	2.46	4.26	14.88	19.21	33.28	

* NS- Non significant

Table 5: Effect of different levels of fertilizers and plant growth regulators on flower yield per plot (kg) and per hectare (q)

Plant growth regulators (G) (ppm)	Flower yield per plot (kg)				Flower yield per hectare (q)			
	Levels of fertilizers (F)			Mean	Levels of fertilizers (F)			Mean
	f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF		f_1 - 100% RDF	f_2 - 80% RDF	f_3 - 60% RDF	
g_0 - Water spray	2.60	2.12	1.90	2.20	106.86	87.11	78.19	90.72
g_1 - GA_3 25 ppm	2.73	2.52	2.00	2.42	112.48	103.57	82.30	99.45
g_2 - GA_3 50 ppm	3.31	2.74	2.29	2.78	136.35	112.89	94.24	114.49
g_3 - Triacontanol 1.0 ppm	2.63	2.48	2.04	2.39	108.37	102.19	83.95	98.17
g_4 - Triacontanol 2.0 ppm	2.67	2.58	2.51	2.58	109.74	106.17	103.16	106.36
Mean	2.79	2.49	2.15		114.76	102.39	88.37	
	F	G	Interaction (F x G)		F	G	Interaction (F x G)	
S.Em.±	0.05	0.06	0.10		1.88	2.42	4.20	
C.D. at 5%	0.13	0.17	0.30		5.44	7.02	12.16	

Conclusion

On the basis of the results of the present investigation, it could be concluded that application of 100% RDF (NPK 250:100:100 kg/ha) along with two times foliar application (30 and 60 DAT) of 50 ppm GA_3 is beneficial for obtaining good plant growth and higher yield in African marigold.

References

1. Imandi S, Reddy SGV. Studies on the effect of plant growth regulators on vegetative growth, flowering, yield and shelf life of the marigold cv. Siracole. International Journal of Agricultural Science and Research 2017;7(4):65-70.
2. Khangjarakpam G, Singh LJ, Maitra S, Mandal S. Influence of foliar application of Gibberellic acid on growth, development, yield and biochemical constituents of African marigold cv. Pusa Narangi Gainda. Journal of Pharmacognosy and Phytochemistry 2019;8(4):1581-1585.
3. Kumar H, Kumar J, Dev P, Ram N, Kaviraj. Effect of nitrogen and GA_3 on growth and flowering behavior of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. International Journal of Agricultural Invention 2016;1(1):84-87.
4. Kumar P, Raghava SPS, Mishra RL, Singh KP. Effect of GA_3 on growth and yield of China aster. Journal of Ornamental Horticulture 2003;6:110-112.
5. Kumar R. Effect of different doses of nitrogen on growth, flowering and yield attribute on African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. M.Sc. *Thesis* submitted to Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 2019.
6. Monish M, Kumar V, Umrao, Tyagi AK, Meena PM. Effect of nitrogen and phosphorus levels on growth, flowering and yield of China aster. Agricultural Sciences Digest 2008;28(2):97-100.
7. Naeem M, Masroor M, Khan A, Moinuddin. Triacontanol: A potent plant growth regulator in agriculture. Journal of Plant Interactions 2012;7(2):129-142.
8. Navale MU, Aklade SA, Desai JR, Nannavare PV. Influence of plant growth regulators on growth, flowering and yield of chrysanthemum (*Dendrathema grandiflora* Tzvelev) cv. IIHR-6. International Journal of Pharma and Bio Sciences 2010;1(2):396-450.
9. Sharma DP, Patel M, Gupta N. Influence of nitrogen, phosphorus and pinching on vegetative growth and floral attributes in African marigold (*Tagetes erecta* Linn.). Journal of Ornamental Horticulture 2006;9:25-28.
10. Sharma G. Effect of NPK on growth and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. M.Sc. *Thesis* submitted to YSP University of Horticulture and Forestry, Nauni, Solan 2018.
11. Singh AK, Kumar P, Sisodia A, Pal AK, Singh HV, Padhi M. Effect of pinching, urea and GA_3 on growth, flowering and seed attributes in African marigold (*Tagetes erecta* L.). Journal of Ornamental Horticulture 2017;20(1,2):34-39.
12. Singh HN, Vishwakarma G, Singh J. Effect of Gibberellic acid and nitrogen on yield and marketability of cabbage (*Brassica oleracea* var. *capitata* L.) cv. pride of India. Journal of Pharmacognosy and Phytochemistry 2018;7(3):900-903.
13. Singh P, Vikram B. Influence of different dose of N, P and K on plant growth and flower yield on pinched seedling plants of African marigold (*Tagetes erecta* L.). Research in Environment and Life Sciences 2016;9(6):684-687.
14. Wagner H, Michael G. The influence of varied nitrogen supply on the production of cytokinins in sunflower roots. Biochem Physiol Pflanzen 1971;162:147-158.