Journal of Crop and Weed, 12(2):47-49(2016)

Effect of plant growth regulators on growth, flowering and yield attributes of African marigold (T*agetes erecta* L.)

S. PALEI, [1]A.K. DAS AND D.K. DASH

Department of Fruit Science and Horticulture Technology, [1]Department of Vegetable Science, Orissa University of Agriculture and Technology, Bhubaneswar Odisha, India

Received:03-04-2016; Revised:14-08-2016; Accepted:25-08-2016

ABSTRACT

An experiment was carried out during winter season of 2014 in Department of Fruit Science and Horticulture Technology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. The experiment was conducted in randomized block design with ten treatments comprising of three levels each of gibberellic acid (25, 50, 100 ppm), ethrel (25, 50, 100ppm) and naphthalene acetic acid (25, 50, 100 ppm) replicated thrice to evaluate the effect of these plant growth regulators on growth, flowering and yield characters in African marigold. Among all the treatments gibberellic acid @100 ppm resulted in maximum plant height, numbers of branches per plant, number of leaves per plant and plant girth ,early flower bud initiation, opening of first flower and maximum duration of flowering, flower stalk length, number of flowers per plant, weight of flower, weight of flower per plant and flower yield per plant as compared to other treatments.

Keywords **:** Flowering attributes, flower yield, Marigold, plant growth regulator

Marigold (*Tagetes erecta* L.) is an important commercial flower in India belongs to family Asteraceae (Compositae). It is very popular due to easy to grow and wider adaptability. In India, African marigold flowers are sold in the market as loose for making garland. Flowers are traditionally used for offering in temple, churches and used in festival for beautification of landscape. It is highly suitable for making flower beds in herbaceous border and also found ideal for newly planted shrubberies to provide colour and fill the gap in landscape. Both leaves and flowers possesses medicinal values. Growth regulators find their extensive use in ornamental crops for modifying their developmental process. Plant growth regulators play an important role in flower production, which in small amount promotes or inhibits or quantitatively modifies growth and development. Gibberellic acid increased to be very effective in manipulating growth and flowering in marigold (Kumar *et al*., 2014). Ethrel retard plant height, number of nodes and internodal length, increase branching and delayed flowering (Sachs, 1961). Naphthalene acetic acid is reported to be a rooting promoter improve plant growth (Ullah *et al*, 2013). The experiment was carried out to asses the optimum concentration of various growth regulators to cause beneficial effect on growth and flowering behaviour of marigold.

MATERIALS AND METHODS

The experiment was conducted during winter season of 2014-2015 at the Department of Fruit Science and Horticulture Technology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India. Recommended doses of NPK and other inputs were applied at appropriate time. The treatments comprising of three doses each of GA_3 (25, 50 and 100 ppm), ethrel (25, 50 and 100ppm) and NAA(25,50 and 100ppm). Spraying of growth regulators were done 30 days after transplanting. In this experiment T_1 is taken as control , T_2 as GA_3 @ 25 ppm, T_3 as GA_3 @ 50 ppm, T_4 as GA_3 @ 100 ppm, T_5 as Ethrel @ 25 ppm, T_6 as Ethrel @ 50 ppm, T_7 as Ethrel @ 100 ppm, T_8 as NAA @ 25 ppm, T_9 as NAA @ 50 ppm, T_{10} as NAA @ 100 ppm. The experiment was laid out in a randomized block design with three replication. Twenty days old seedling of African marigold (*Tagetes erecta* L.) were planted. Different growth attributes like plant height , numbers of branches per plant, number of leaves per plant and plant girth were recorded to know the significant effect of different growth regulators. The important flowering characters *viz*. days taken to first flower bud initiation, days taken to opening of first flower, duration of flowering, length of flower stalk^{-1}, diameter of flower, number of flower plant^{-1} and yield characters such as weight of flower, flowers yield plant^{-1} were recorded in five randomly selected plants per replication in each treatment. The data were analyzed by method suggested by Fisher and Yates (1949).

RESULTS AND DISCUSSION

Growth regulators on growth attributes

Plants treated with 100 ppm GA_3 (T_4) showed the maximum plant height (36.55cm) followed by T_3(GA_3

Email:suvalaxmipalei@gmail.com

@ 50 ppm) and minimum plant height (24.32cm) was recorded from the plant sprayed with 100 ppm NAA. Maximum numbers of branches (35.22) were found from the plants sprayed with 100 ppm GA_3 and minimum of that recorded from the plants treated with 100 ppm NAA. From table 1 , It was revealed that plant treated with 100 ppm GA_3(T_4) produced maximum number of leaves (92.5) .Minimum number of leaves was at found at from the plant sprayed with normal water (control) . Maximum plant girth was obtained from the plant treated with 100 ppm GA_3 (2.6 cm), minimum plant girth was observed at control.

Table 1 : Effect of plant growth regulator on growth attributes of African marigold

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of leaves plant^{-1}	Plant girth (cm)
T1	27.800	23.400	46.500	1.367
T2	34.900	28.700	73.400	2.167
T3	35.667	30.100	76.500	2.133
T4	37.133	35.200	82.200	2.600
T5	24.300	28.800	61.500	1.733
T6	22.400	29.200	57.233	2.233
T7	21.700	29.100	55.200	1.467
T8	28.900	27.900	58.300	1.367
T9	29.500	27.500	59.100	1.500
T10	28.000	28.200	60.800	1.500
SEm(±)	**0.492**	**0.320**	**0.526**	**0.190**
LSD(0.05)	**1.460**	**0.950**	**1.564**	**0.565**

Foliar application of GA_3 (100 ppm) significantly increased the plant height (36.55 cm), Numbers of branches plant^{-1}, number of leaves plant^{-1} and plant girth compared to other growth regulator treatments and control (Table 1). This may be due to enhanced cell division and cell enlargement, promotion of protein synthesis by GA which might have resulted in enhanced vegetative growth. Similar results were reported by Sunitha *et al.* (2007) in African marigold and Verma *et al.* (2000) in carnation.

Earliest bud initiation and flowering was observed with the application of. GA_3 100 ppm Plants treated with GA_3 @ 100 ppm found to form first bud on 44.9 days after transplanting where as the plants sprayed with normal water produce first bud on 61.8 days. Gibberellins reduces juvenile period and with the termination of juvenile phase, the shoot apical meristem instead of producing leaves and branches start producing buds. Similar finding were also reported by Dahiya and Rana (2001).

Minimum number of days taken to opening of first flower was observed with the application of GA_3 100 ppm and maximum number of days (107. 97) taken to opening of first flower were found from the plant treated with NAA @ 100 ppm (T_{10}). GA_3 was found most effective in extending the flower duration (53.17 days) especially with GA3 100 ppm. It might be due to advanced stage of flowering in marigold. Dutta *et al*. (1998). But spray of NAA @ 100 ppm reduces the duration of flowering to 30.56 days.

Table 2 : Effect of plant growth regulators on flowring attributes of African marigold

Treat-ments	Days taken to first flower bud formation	Days taken to opening of first flower	Duration of flowering (days)	Length of flower stalk (cm)	Number of flowers plant^{-1}	Diameter of the flower (cm)
T1	61.867	99.667	35.900	6.233	41.433	6.133
T2	52.467	95.233	46.067	7.500	51.600	8.500
T3	45.933	98.667	46.767	8.367	56.633	9.200
T4	44.000	83.267	53.167	8.933	65.767	9.400
T5	59.467	103.733	41.967	7.300	46.900	8.000
T6	60.367	104.400	42.767	7.567	46.900	8.300
T7	68.800	108.467	42.100	7.333	50.967	7.467
T8	55.233	93.600	40.000	7.567	52.367	7.800
T9	55.400	97.200	38.167	8.267	55.567	8.267
T10	59.100	107.967	30.567	7.733	55.933	8.500
SEm(±)	**0.547**	**0.461**	**1.159**	**0.175**	**1.105**	**0.237**
LSD (0.05)	**1.625**	**1.370**	**3.444**	**0.519**	**3.281**	**0.705**

Significantly maximum flower stalk length (8.93 cm) and maximum flower diameter (9.4 cm) were recorded with foliar spray of GA_3 100 ppm. The increment in stalk length and flower diameter might be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter of apical dominance (Dalai *et al*., 2009). Similar result was also reported by Tyagi and Kumar (2006). Maximum number of flowers plant^{-1} were recorded with application of GA_3 100 ppm (65.76). The enhancement in number of flowers plant^{-1} 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 restrictive plant type. The result was in close conformity with Sunitha *et al*. (2007).

Table 3 : Effect of plant growth regulator on Yield Attributes of Africal Marigold

Treatments	Weight of Flowers (g)	Flower yield plant^{-1} (g)
T1	7.800	320.000
T2	10.400	557.700
T3	13.100	742.167
T4	15.400	987.167
T5	10.433	455.333
T6	11.333	530.533
T7	11.767	585.967
T8	11.167	532.033
T9	11.033	575.433
T10	11.967	622.500
SEm(±)	**0.236**	**7.127**
LSD(0.05)	**0.702**	**21.174**

Weight of flower was reported significantly maximum (15.4 g) with application of GA_3 100 ppm (Table 3). Significantly maximum yield of flower plant^{-1} (987.167 g) were recorded with foliar application of GA_3 100 ppm. Verma and Arha (2004) and Devadanam *et al*. (2007) also observed maximum flower yield per hectare with GA_3 treatment in African marigold.

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