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Effect of NAA, BA and Kinetin on Yield of African Marigold (*Tagetes erecta* Linn.)

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A B S T R A C T

A field experiment was conducted to study the effect of NAA, BA and Kinetin on growth of African marigold during *rabi* season of 2009-10. The trial was conducted in a completely randomized block design with ten treatments in three replications. The treatments comprised of three level each of NAA (100, 200, 300 ppm), BA (25, 50, 75 ppm) and kinetin (50, 100, 150 ppm) thus, making 10 treatments including absolute control. The result of the present study indicated that application of NAA, BA and Kinetin significantly increased the growth and yield at different levels and among these. Among different treatment, application of NAA had more pronounced effect on growth and yield of African marigold as compared to BA and Kinetin. NAA @ 300 ppm recorded maximum plant height (77.26 cm), number of branches (14.53), plant spread (60.80x56.86 cm^2), number of flowers per plant (57.60), average weight of flowers (12.93g), average diameter of flowers (9.20 cm) and yield of flowers per plant (744.7 g), per plot (7.36 kg) and per hectare (170.37 q).

Introduction

Marigold (*Tagetes erecta* Linn.) is an annual flower to cultivate easily and have wide adaptability to different soil and climatic conditions. It belongs to family Compositeae and native of India. It has a great economic potential for loose flower trade. It is especially used for making garland, decoration and induced in landscape plans due to its variable height and colour. Marigolds have also great medicinal importance *i.e.* leaf extract is good remedy for ear-ache and flower extract is used as blood purifier and against bleeding piles. Besides, it is also found important in controlling nematodes because, it produce *thiophenes*, which are naturally occurring biocides. Application of NAA, BA and Kinetin showed tremendous potential in modulating growth and related processes in different crops. They are considered bio-soft wards, which elicit rapid as well as long term responses in crop plants (Yadav *et al.*, 1994 and Malik *et al.*, 1996). NAA is an important growth substance, which stimulates the cell division, cell enlargement and cell elongation in apical region. BA and kinetin are cytokinin which has been found essential for growth and development of plant organs, retention of

chlorophyll, translocation of nutrient (Pandey and Sinha, 1984). Considering the importance of NAA, BA and Kinetin to find out the best growth regulators and its concentration in response of yield of African marigold.

Materials and Methods

The experiment was undertaken on African marigold (*Tagetes erecta* Linn.) var. Cracker Jack" at Horticultural Farm, Department of Horticulture, SKN College of Agriculture (S.K.R.A.U., Bikaner) campus-Jobner. The soil of experimental plot was loamy sand with 8.10 pH and 1.20 dSm^{-1} EC at 25^0C. The experiment was laid out in a RBD (Randomized Block Design) with three replications. The randomization of the treatments was done with the help of random number table. Crop was raised during *rabi* season of 2009-10 and plot size was 2.4 x 1.8 m^2 maintaining 60 x 45 cm spacing, so single plot contains 16 plants. The treatments comprised of three level each of NAA (100, 200, 300 ppm), BA (25, 50, 75 ppm) and kinetin (50, 100, 150 ppm) thus, making 10 treatments including absolute control. For preparation of solution, Alchohol for NAA and 1N NaOH for BA and Kinetin with fresh water (Chawla, 2009) was used as sticking agent. Two successive spray of these growth substances was done at 30 and 45 DAT (days after transplanting) of seedlings. Apply recommended dose of Nitrogen, Phosphorus and Potassium (200: 100: 100 kg per hectare) and all essential cultural practices were followed to maintain optimum plant stand.

The growth attributes *i.e.* plant height, number of branches and plant spread at final picking and yield attributes *i.e.* number of flowers, flower weight, flower diameter and yield of flowers recorded on five randomly selected plants and duration of flowering recorded on the based on plot and average were calculated. Then parameters were subjected to statistical analysis (Panse and Sukhatme, 1995).

Results and Discussion

Growth attributes

The present investigation was shown that foliar application of plant growth regulators (rest) significantly increased vegetative growth *i.e.* plant height (71.51cm) number of branches per plant (13.02) plant spread (56.11x52.17 cm^2) over control (64.40 cm, 10.93, and 48.53x45.66 cm^2, respectively). Application of NAA had more pronounced effect on plant growth (73.95 cm), number of primary branches per plant (13.93) and plant spread (58.31x54.62 cm^2) as compared to BA (69.68 cm, 12.11 and 52.75x49.51 cm^2, respectively) and Kinetin (70.89 cm, 13.02, 57.26x52.40 cm^2, respectively) (Table 1).

Further, application of NAA @ 300 ppm recorded maximum plant height (77.26), number of branches per plant (14.53) and plant spread (60.80x56.86 cm^2) over NAA @ 100 ppm (70.00 cm, 13.20, 55.46x51.86 cm^2, respectively). NAA @ 300 ppm was statistically identical with NAA @ 200 ppm. This increased in plant height, number of branches per plant and plant spread with increasing levels of NAA, might be due to the fact of NAA, being a member of auxin group, promotes vegetate growth by active cell division, cell enlargement and cell elongation. Another probable reason to increased plant growth may be the osmotic uptake of water and nutrient under the influence of NAA. Primary physiological effect of auxin is to stimulate the elongation of cells due to increase 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, 1984). These

results are in close conformity with those of Kumar *et al.*, (2008) in gladiolus, Mukhopadhayay and Mukhopadhayay (1990) in Carnation. Therefore, application of BA and Kinetin increased the vegetative growth *i.e.* plant height, number of branches per plant and plant spread with increasing levels. Application of BA was found significantly variation in plant height, number of branches per plant and plant spread at but application of Kinetin was found non-significant in respect of vegetative growth of plant. This increased in vegetative growth might be due to the fact that BA and Kinetin are the member of cytokinin. Cytokinin enhanced the cell division as well as cell elongation. These results have also been inconsonance with Sonvir *et al.*, (2002), Kim *et al.*, (2003), Barman and Rajani (2004) and Kumar *et al.*, (2006) (Table 2).

Table.1 Effect of NAA, BA and Kinetin on growth of African marigold

Treatments	Plant height (cm)	Number of branches per plant	Plant spread (cm^2)	
			North-South	East-West
Control	64.40	10.93	48.53	45.66
Rest	71.51	13.02	56.11	52.17
SEm±	3.02	0.55	2.27	2.11
CD (p=0.05)	8.56	1.56	6.43	5.99
NAA	73.95	13.93	58.31	54.62
BA	69.68	12.11	52.75	49.51
Kinetin	70.89	13.02	57.26	52.40
SEm±	1.42	0.26	1.07	1.00
CD (p=0.05)	4.04	0.74	3.03	2.82

Table.2 Effect of different levels of NAA, BA and Kinetin on growth of African marigold

Treatments	Plant height (cm)	Number of branches per plant	Plant spread (cm^2)	
			North-South	East-West
NAA 100 ppm	70.00	13.20	55.46	51.86
NAA 200 ppm	74.60	14.06	58.66	55.13
NAA 300 ppm	77.26	14.53	60.80	56.86
SEm±	2.47	0.45	1.85	1.73
CD (p=0.05)	6.99	1.28	5.25	4.89
BA 25 ppm	65.06	10.66	50.00	46.80
BA 50 ppm	69.66	12.60	52.93	49.73
BA 75 ppm	74.33	13.06	55.33	52.00
SEm±	2.47	0.45	1.85	1.73
CD (p=0.05)	6.99	1.28	5.25	4.89
Kinetin 50 ppm	67.73	12.60	54.73	49.80
Kinetin 100 ppm	71.00	13.00	57.66	52.73
Kinetin 150 ppm	73.93	13.46	59.40	54.66
SEm±	2.47	0.45	1.85	1.73
CD (p=0.05)	NS	NS	NS	NS

NS=non-significant

Table.3 Effect of NAA, BA and Kinetin on yield of African marigold

Treatments	Number of flowers per plant	Average weight of flowers(g)	Average diameter of flowers(cm)	Yield of flowers per plant(g)	Yield of flowers per plot(kg)	Yield of flowers per hectare(q)
Control	41.93	10.60	6.20	444.45	4.42	102.31
Rest	51.81	12.20	7.78	633.97	6.31	146.03
SEm±	2.10	0.49	0.31	25.51	0.25	5.88
CD (p=0.05)	5.94	1.40	0.88	72.31	0.72	16.67
NAA	55.04	12.37	8.44	682.11	6.78	156.94
BA	45.37	12.01	7.15	545.92	5.44	125.85
Kinetin	55.02	12.23	7.75	673.89	6.71	155.32
SEm±	0.99	0.23	0.15	12.03	0.12	2.77
CD (p=0.05)	2.80	NS	0.42	34.09	0.34	7.86

NS=non-significant

Table.4 Effect of different levels of NAA, BA and Kinetin on yield of African marigold

Treatments	Number of flowers per plant	Average weight of flowers(g)	Average diameter of flowers(cm)	Yield of flowers per plant(g)	Yield of flowers per plot(kg)	Yield of flowers per hectare(q)
NAA 100 ppm	52.40	11.73	7.53	614.65	6.13	141.89
NAA 200 ppm	55.13	12.46	8.60	686.91	6.85	158.56
NAA 300 ppm	57.60	12.93	9.20	744.76	7.36	170.37
SEm±	1.71	0.40	0.25	20.83	0.21	4.80
CD (p=0.05)	4.85	1.14	0.72	59.04	0.59	13.61
BA 25 ppm	42.18	11.33	6.60	477.89	4.74	109.72
BA 50 ppm	45.76	12.16	7.26	556.44	5.55	128.47
BA 75 ppm	48.16	12.53	7.60	603.44	6.02	139.35
SEm±	1.71	0.40	0.25	20.83	0.21	4.80
CD (p=0.05)	4.85	1.14	0.72	59.04	0.59	13.61
Kinetin 50 ppm	51.97	11.52	6.86	598.69	5.98	138.42
Kinetin 100 ppm	55.86	12.26	7.93	684.84	6.80	157.40
Kinetin 150 ppm	57.22	12.90	8.46	738.13	7.35	170.13
SEm±	1.71	0.40	0.25	20.83	0.21	4.80
CD (p=0.05)	4.85	1.14	0.72	59.04	0.59	13.61

Yield attributes

The application of plant growth regulators (rest) brought perceptible variation in number of flowers (51.81), flower weight (12.20 g), flower diameter (7.78 cm) and yield of flowers per plant (633.97 g), per plot (6.31 kg) and per hectare (146.03 q) as compared to control (41.93, 10.60 g, 6.20 cm, 444.45 g 4.42 kg and 102.31 q, respectively). Among different PGRs, application NAA recorded maximum number of flower per plant (55.04), average flower weight (12.37 g) and diameter (8.44 cm), yield of flowers per plant (682.11

g), per plot (6.78 kg) and per hectare (156.94 q) (Table 3).

Application of NAA @ 300 ppm recorded significantly higher number of flower per plant (57.60), average flower weight (12.93 g) and diameter (9.20 cm), yield of flowers per plant (744.76 g), per plot (7.36 kg) and per hectare (170.37 q) over 100 ppm (52.40, 11.73 g 7.53 cm, 614.65 g, 6.13 kg and 141.89 q, respectively) and it was found statistically identical with 200 ppm. This increase in yield characters might be due to fact that NAA enhance cell division and rate of the plants for cellular expansion and tissue growth. NAA, being an auxin it stimulate vegetative growth, regulate flowering and also prevent abscission of leaves and pre mature flower buds. Similar results have also been obtained by Chodhaury and Khandelwal (2008) in gladiolus, Singh (2003) in French marigold. Sharma *et al.,* (1995) found increase in plant height of chrysanthemum with increasing levels of NAA from 25 to 100 ppm spray. Thus, application of BA @ 75 ppm and Kinetin @ 150 ppm significantly increased yield characters over their lower concentrations. BA and Kinetin being cytokinin, these induce the flowering might be due to ability to alter the osmotic distributions *i.e.* the theory of nutrient diversion (Sachs *et al.,* 1979). The above findings are in close agreement with finding of Sonvir *et al.,* (2002), Kim *et al.,* (2003), Barman and Rajni (2004) and Choudhary (2008) in gladiolus (Table 4).

The application of NAA, BA and Kinetin significantly increased growth and yield characters. Among these, application of NAA had more pronounced effect on growth and yield characters as compared to BA and Kinetin. Different concentration of NAA, BA and Kinetin was found significant difference on growth and yield. Among different concentrations of NAA, NAA @ 300 ppm recorded significantly higher plant height (77.26 cm), number of branches per plant (14.53), plant spread (60.80x56.86 cm^2) number of flower per plant (57.60), average flower diameter (9.20 cm) and weight (12.93 g) and yield of flowers per plant (744.76 g), per plot (7.36 kg) and per hectare (170.37 q)**.**

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