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Devendra Kumar
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Rubee Lata
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

HL Atal
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Harvindra Pal
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Corresponding Author
Devendra Kumar
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Effect of bio-regulators on vegetative growth attributes and shelf life of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

Devendra Kumar, Rubee Lata, HL Atal and Harvindra Pal

Abstract
The field experiment was conducted at the Horticulture Research Farm-I of the Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya- Vihar, Rae Bareli Road, Lucknow-226025 (UP), during the Rabi season of 2020-21 from the last week December to mid March. The experimental design was laid down in Randomized Block Design and replicated thrice having 10 (ten) treatments in each replication. The maximum height of marigold plant (29.13 cm and 27.72 cm) at 30 DAP, (60.34 cm and 55.32 cm) at 60 DAP, (75.24 cm and 71.46 cm) at 90 DAP, The highest number of branches per plant (7.65 and 7.55) at 30 DAP, (11.57 and 11.44) at 60 DAP, (45.28 and 43.36) at 90 DAP, The maximum spread marigold plant (49.4 and 46.73). The maximum shelf life of flower in LDPE (11.15 and 10.62 days), in silver foil (9.95 and 9. 88 days), in small trays (9.38 and 9.25 days), in white paper begs (9.15 and 9.08 days), whereas, the treatment T_3 was showed the best results on vegetative growth characters of marigold.

Keywords: marigold, vegetative growth, shelf life, bio-regulators

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 has attractive range of colors 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 Estrucsch 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 excitements in the field of agriculture. Gibberellic acid and Cycocel are very important plant growth regulators and are widely used in agriculture and horticulture. GA_3 regulates the growth and involve in both cell division and cell enlargements (Haberand and Leopold, 1960). The GA_3 has manifold effects, it affects the seed dormancy, seed germination, stem growth, root growth, flowering etc. (Rappaport and Singh, 1960). Sachs *et al*. (1960) reported that application of CCC retarded stem elongation by preventing cell division in the sub-apical meristem, usually without similarly affecting the apical meristem. Cycocel treatments have been found effective in the direction of earliness in flowering and fruiting. The application of Ethrel retards plant height, number of nodes and internodal length in marigold. It increased branching, delayed flowering, more number of leaves formed below the terminal flower, increased number of flower per plant. Ethrel is growth retardant check cell division in apical meristem only resulting in vascular synthesis below the apical meristem but the cambial and vascular cell continue to divide over a larger period and this result increase in

thickness of stem (Sachs, 1961).
Marigold responds to application of Maleic hydrazide in, axillary bud controller, growth retardant, increase number of branches, increase in weight and number of flower, more number of leaves and increase number of seed per flower in marigold. Pawar *et al.* (2011)

2. Materials and Methods
The field experiment was conducted at Horticultural Research Farm-I in front of Gautam Buddha Central Library, Department of Horticulture, School of Agricultural Sciences and Technology (SAST), Babasaheb Bhimrao Ambedkar University (A central university), Vidya-vihar, Rae Bareli Road, Lucknow-226 025 (UP), India. was undertaken during the Rabi season of 2020-21 from the last week December to mid March. Geographically, Lucknow is situated at 26^0 '76' N latitude, 80^0 '92' E longitude and an altitude of (123) meter above mean sea level (MSL). The climate of the experimental site is subtropical with maximum temperature ranging from 19 ^{0}C to 40 ^{0}C in summer and 5.5 ^{0}C to 19 ^{0}C in winter and relative humidity ranging from 60-90% in different seasons of the year. Lucknow has a sub-tropical climate with hot, dry summers and cold winters, with an average annual rainfall of 800 to 1000 mm and 85 percent of rain fall during the monsoon season. The layout of experimental design was laid down in Randomized Block Design and replicated thrice having ten treatments in each replication. The planting of seedlings took place on 27th 2020. Planting of seedlings were done in the evening at a spacing 40×40 cm (row to row and plant to plant) consisting of 20 plants per plot after Planting light irrigation were applied in the field. The treatments were T_1 (GA_3 50 ppm), T_2 (GA_3 100 ppm), T_3 (GA_3 200 ppm), T_4 (NAA 100 ppm), T_5 (NAA 200 ppm), T_6 (NAA 300 ppm), T_7 (Ethrel 200 ppm), T_8 (Ethrel 300 ppm), T_9 (Ethrel 400 ppm), T_{10} (Control), Appropriate management practices were adopted. Randomly Five plants were selected randomly and data were recorded each tagged plot in different characters viz.- Height of the plant, Number of branches, Spread of plant and Shelf life of flowers. at the appropriate stage.

2.2 Statistical Analysis
Observations on vegetative growth and Shelf- life parameters were recorded and statistically analyzed Gomez and Gomez, 1984. Data were subjected to one way ANOVA and means were separated at 5% level of Critical difference were obtained. All parameters were analyzed form the help of OPSTAT.

3. Results and Discussion
3.1 Height of plant (cm)
The plant height was recorded at 30, 60, and 90 days after planting the seedlings of marigold cv. Pusa Narangi Gainda
The experimental findings advocated that height of plant was significantly maximum with the application of GA_3 200 ppm (T_3) which was followed by Ethral 200 ppm (T_7), NAA 100 ppm (T_4) and GA_3 100 ppm (T_2). It is clear from the Table-1 and Fig. - 1. The promotive effect of Gibberellins on growth may be due to increasing auxin level of tissues or enhance the conversion of Tryptophane to IAA which causes the cell-division and cell elongation. Mohariya *et al.* (2003) studied the effect of GA_3 at 100-150 ppm on different varieties of chrysanthemum and observed that 150 ppm GA_3 increased plant height. Similar results to were also reported by Kumar *et al*. (2003) in tuberose using GA_3 200 ppm and Tyagi and Kumar (2006) in African marigold using GA_3 200 ppm Pal *et al.* (1986) in calendula using Ethrel 100 ppm.

3.2 Number of branches
The data presented in Table-1 maximum numbers of branches were recorded with NAA 300 ppm (T_6) which was found at par with Ethrel 400 ppm (T_9) and Ethral 300 ppm (T_8). Maximum number of branches and basal diameter of stem was reported with NAA 400 ppm. The results are conformity with Sunitha *et al*. (2007) [1] reported the effect of foliar application of Ethrel (750 and 1000 ppm) on African marigold (*Tagetes erecta* L.) cv. Orange Double recorded increased number of main branches, Kumar *et al.* (2010) reported regulation of growth and flowering in African marigold with Ethrel (100, 200, 300 and 400 ppm) treatment and reported increased number of main branches. Pawar *et al*. (2011) reported increased branches in African marigold with MH 500 ppm. And Singh (2004) also reported that MH (200 and 400 ppm) increased number of branches per plant in African marigold.

3.3 Plant spread
It is clear from the data presented in Table-2 spread of plant was recorded significantly maximum with the foliar application of GA_3 200 ppm (T_3) which was found at par with Ethral 200 ppm (T_7), NAA 100 ppm (T_4), GA_3 100 ppm (T_2) and GA_3 50 ppm (T_1), while lowest plant spread was recorded in Ethrel 400 ppm (T_9). GA_3 resulted hyper elongation of internodal length caused extension in plant height while increase in total count of main axis consequently increased number of dormant buds from where primary branches originated which results optimum spread of plant Gautam *et al*. (2006). These findings are in close conformity with result of Mehar *et al.* (1990) in chrysanthemum with GA_3 150 ppm**,** Dutta *et al*. (1998) in chrysanthemum with GA_3 150 ppm.

3.4 Shelf-life of marigold flowers (Days)
The data observed on shelf life of flowers are presented in Table No. 3

3.4.1 Shelf-life of marigold flowers in white paper package
It is clear from investigation that treatment T_3 (GA_3 at 200 ppm) is recorded maximum shelf life of flower (9.15 days) followed by treatment T_2 (GA_3at 100 ppm) having shelf life of flower (9.08 days). Minimum shelf life of flower (7.88 days) was observed in treatment T_{10}(control condition) on white paper.

3.4.2 Shelf-life of marigold flowers in small trays
It is obvious from the investigation that treatment T_3 (GA_3 at 200 ppm) is recorded maximum shelf life of flower (9.38 days) followed by treatment T_4 (NAA at 100 ppm) having shelf life of flower (9.25 days). Minimum shelf life of flower (7.5 days) was observed in treatment T_{10} (control condition) on small trays.

3.4.3 Shelf-life of marigold flowers in silver foil
It is evident from the Table that treatment T_3 (GA_3 at 200 ppm) is recorded maximum shelf life of flower (9.95 days) followed by treatment T_2 (GA_3at 100 ppm) having shelf life of flower T_{10} (9.88 days). Minimum shelf life of flower (8.15 days) was observed in treatment (control condition) on silver foil.

3.4.4 Shelf-life of marigold flowers in LDPE

It is clear from investigation that treatment T_3 (GA_3at 200 ppm) is recorded maximum shelf life of flower (11.15 days) followed by treatment T_9(ethral at 400 ppm) having shelf life of flower (10.48 days). Minimum shelf life of flower (8.43 days) was observed in treatment T_{10} (control condition) on LDPE.

Table 1: Effect of Bio-regulators on height of plant (cm) and Number of branches in Marigold

Treatments	Height of plant (cm)			Number of branches		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1 GA_3 50 ppm	26.06	51.95	69.12	6.2	11.38	32.1
T_2 GA_3 100 ppm	27.73	55.05	69.22	6.7	11.39	32.5
T_3 GA_3 200 ppm	29.13	60.34	75.24	6.81	11.57	34.94
T_4 NAA 100 ppm	23.8	42.51	71.41	6.1	7.3	29.75
T_5 NAA 200 ppm	25.4	42.11	61.41	7.55	11.4	37.25
T_6 NAA 300 ppm	24.43	40.76	56.11	5.81	8.02	45.28
T_7 Ethrel 200 ppm	25.46	55.32	71.46	6.3	7.41	28.95
T_8 Ethrel 300 ppm	27.16	46.71	61.56	7.65	11.44	37.4
T_9 Ethrel 400 ppm	27.4	42.12	56.1	5.86	8.08	43.36
T_{10} Control	25.46	51.08	66.62	6.58	7.19	25.31
SE(m)±	0.85	1.53	2.46	0.30	0.48	1.51
CD at 5%	2.57	4.60	7.38	0.91	1.46	4.53

Table 2: Effect of Bio-regulators on Spread Marigold plant

Treatments	Spread of plant (cm) at 90 DAT
T_1 GA_3 50 ppm	43.16
T_2 GA_3 100 ppm	46.36
T_3 GA_3 200 ppm	49.4
T_4 NAA 100 ppm	46.68
aT_5 NAA 200 ppm	41.3
T_6 NAA 300 ppm	35.61
T_7 Ethrel 200 ppm	46.73
T_8 Ethrel 300 ppm	41.5
T_9 Ethrel 400 ppm	34.61
T_{10} Control	39.68
SE(m)±	1.46
CD at 5%	4.39

Table 3: Effect of Bio-regulators on shelf-life of marigold

Treatments	Shelf life (days)			
	White paper	Small trays	Silver foil	LDPE
T_1 GA_3 50 ppm	9.02	9.05	9.65	10.62
T_2 GA_3 100 ppm	9.08	9.13	9. 88	10.44
T_3 GA_3 200 ppm	9.15	9.38	9.95	11.15
T_4 NAA 100 ppm	7.95	9.25	8.05	9.83
T_5 NAA 200 ppm	8.2	8.85	8.1	9.76
T_6 NAA 300 ppm	8.4	9.19	9.2	9.73
T_7 Ethrel 200 ppm	8.65	9.16	9.38	10.34
T_8 Ethrel 300 ppm	8.7	9.2	9.4	10.25
T_9 Ethrel 400 ppm	8.95	8.96	9.45	10.48
T_{10} Control	7.88	7.5	8.15	8.43
SE(m)±	0.35	0.28	0.42	0.40
CD at 5%	1.05	0.85	1.26	1.20

4. Conclusion

On the basis of results obtained from the present investigation, it might be concluded that the application of Bio-regulators were applied 40 days after transplanting and found most effective doses for vegetative growth parameters in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

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