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Influence of growth retardants on morphological characterization of African marigold (*Tagetes erecta* L.)

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Abstract
One of the most popular annual flower crops grown for commerce is the African marigold (*Tagetes erecta* L.), which has a 2n=24 genetic makeup and member of the Asteraceae family. It is an important crop for landscaping and is also grown commercially for loose flowers, cut blooms, oil and pigment extraction, fragrance, cosmetics, as well as for medical purposes. An experimental field test on morphological effects of African Marigold (Arka Bhanu F1 hybrid) was conducted at the Department of Horticulture, Killikulam, Agricultural College and Institute of Science from January 2023 to August 2023. The study was conducted in Randomized block design (RBD) with three replications. The treatments are Mepiquat chloride at 50, 100, 150 ppm (T_1, T_2, T_3), Chlormequat chloride at 50, 100, 150 ppm (T_1, T_2, T_3) and Uniconazole at 50, 100, 150 (T_1, T_2, T_3). In this all treatments Chlormequat chloride at 150 ppm was recorded significant difference to the plant morphology and recorded minimum plant height, maximum numbers of branches, Minimum numbers of leaves, shortest internodal length, heighest length, width, area of the leafs and maximum stem girth, dry matter content, fresh root weight, dry root weight followed by other treatments.

Keywords: Arka bhanu F1 hybrid, growth retardants, mepiquat chloride, Chlormequat chloride, Uniconazole

Introduction
African marigold (*Tagetes erecta* L.) possessing 2n=24 is one of the most widely used annual flower crops cultivated on a commercial scale. It belongs to Asteraceae family and it was acclaimed a crucial crop for landscaping and is also grown commercially for loose flowers, cut blooms, oil and pigment extraction, fragrance, cosmetics, as well as for medicinal uses.The hardy annual herb that could reach up to a height of 90 cm has upright growth habit and branches. The roots have a shallow and fibrous root structure. The stems are striated, herbaceous to woody stem. The leaves are opposite and pinnately split. Leaflets have a lance-shaped blade and serrations. Green foliage has a stem that is either green or light yellow in colour. Flowers are big, globular, solitary inflorescences that range in size from single to nearly double. Flowers might be lemon yellow, yellow, golden, yellow and orange. The marigold is indigenous to Mexico, but it is also grown in Belize, Colombia, Venezuela, China, India, Zambia, Zimbabwe, South Africa and Australia. In India, there are 255 thousand hectares of marigolds being grown, yielding 1754 thousand MT of flowers Kaur H (2021) [1]. It is commercially grown in Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, West Bengal, Chattisgarh, Orissa, Haryana, Sikkim etc. Plants naturally biosynthesized compounds has been called as plant growth regulators. It has an impact on physiological and metabolic functions. A numerous biotic and abiotic factors controlled seed germination, seedling growth, and plant development as a result of the changing climatic environment, which lowers biological and economic yields. Plant growth inhibitors (PGRs) are chemical substances that can prevent the manufacture of gibberellin, which in turn prevents the growth of plants. The inhibited stem elongation, reducing internodal length, increased lateral branching and enhanced flower production without any formative effectsis mainly regulated by different kinds of growth retardants such as Uniconazole, Mepiquat chloride, Chlormequat chloride. The impact of growth retardant on vegetative characters and yield attributes in marigold. Dwarfing effect upon plants, increasing flower diameter, reduced stem height and increased enzymatic activity has been enhanced by 1000 ppm of Cycocel and 10 ppm of Uniconazole with a positive impact on plants ability to withstand environmental challenges Karimi *et al.* (2019) [2].

The maximum flowering, fully opened flower weight flowers at Cycocel 1500 ppm was reported by Kedar *et al*. (2023) [3]. The reduced plant height, minimum leaf area and maximum average plant spread have been noticed by application of Cycocel at 1500-ppm, Mhatre (2023) [4]. The maximal vase life in Chrysanthemum was recorded with foliar spray of CCC at 100 ppm Jadhav S.K *et al.* (2015) [5]

Materials & Methods

The trial field experiment on effects of growth retardant on morphological characteristics in African Marigold (Arka bhanu F1 hybrid) was conducted from January 2023 to August 2023 at the Department of Horticulture, Agricultural College and Research Institute, Killikulam.The trial was laid out in Randomized block design (RBD) with a package of treatments consisting of Mepiquat chloride -50 ppm (T_1), Mepiquat chloride - 100 ppm (T_2), Mepiquat chloride - 150 ppm (T_3), Chlormequat chloride - 50 ppm (T_4), Chlormequat chloride - 100 ppm (T_5), Chlormequat chloride -150 ppm (T_6), Uniconazole-50 ppm (T_7), Uniconazole - 100 ppm (T_8), Uniconazole -150 ppm, Control (T_{10}) and numbers of replication was three.The well-decomposed farmyard manure(FYM) at 10 t/ha and recommended dose of inorganic fertilisers was 40 kg N, 30 kg P2O5, and 30 kg K2O/ha in the form of urea and single super phosphate. Following the preparation of the layout the entire amount of FYM was applied to each plot and thoroughly mixed with the soil.At the time of sowing the phosphorus (100%) and nitrogen (50%) were incorporated into trial field and remaining 50% of the nitrogen was added every 30 seconds. In the trial location was contain gross plot size of 3 x 2.6 m and net plot size of 1.8 x 2.5 m and the planting was done at a spacing of 90 x 60 cm. In this experiment the Statistical analysis was done as per the methods expressed by Panse and Sukhatme (1985) [17].

Results and Discussion

Morphological parameters

Plant height (cm)

All spraying treatments was given at 15 days and 22 days interval by using foliar application and it's indicated in (table 1). Treatment-T_6 (Chlormequat chloride -150 ppm) was recorded minimum plant height as followed respectively all other treatments. In this trial T_6 treatment was given plant height for 26.59 cm when compared to control (40.59 cm) and growth retardants of Chlormequat chloride was inhibit the Gibberllin bio-synthesis as well as affected cell devision, elongation and regulate plant height without any formative effects. Similar results was obtained by Majeed *et al*. (2017) [6] in African marigold and Soliman *et al*. (2022) [7] in cape jasmine.

Number of branches:

The information in (table 1) demonstrates that the various treatments under study had a substantial impact on the number of branches per plant and all of the treatments produced more branches than the control. In this below the (table 1) revealed that maximum numbers of branches (15.96 branches) at treatment (T_6) of Chlormequat chloride at 150 ppm subsequently, compared to other treatments and control (13 branches). The retardants was act as a lateral dominance with transportation of GA_3 through axillary branches. The study revealed by Majeed *et al.* (2017) [6] in African marigold and El-Deeb *et al.* (2018) [8] in Zigzag plant.

Number of leaves

The foliar spraying interval at 15 and 22 days of treatments was influenced number of leaves in the plant was noted (table 1). Lowest number of leaves (32.00) was established in the treatment are T_6 (Chlormequat chloride–150 ppm), T_7 (Uniconazole–50 ppm) followed by other treatments and control was noted down (49.15 leaves/plant). It has act as leaf senescence and this identical study was taken by Majeed *et al*. (2017) [6] in influence of growth retardant on African marigold and Nerium by Kumar *et al*. (2019) [9]

Internodal length (cm)

Significant findings were revealed by data on Internodal length in (table 1) for all the treatments dramatically decreased the Internodal length (1.27 cm) at treatments of Chlormequat chloride -150 ppm (T_6) followed by other treatments and control (2.76 cm). The above discussed (Plant height) way retardants was inhibited Gibberellins bio-synthesis and same study was undertaken by Kentelky *et al*. (2021) [10] in Chrysanthemum and Karagoz *et al*. (2022) [11] in Zinnia.

Leaf length (cm)

The information regarding the leaf length as affected by the application of various chemicals was shown in (Table 1). Among the all the treatments recorded maximum leaf length (3.41 cm) T_6-Chlormequat chloride – 150 ppm, subsequently all other treatments and control (2.69 cm).The chemicals was assimilated the nutrients, so it could be enhance the leaf length into the plant and morphological study was undertaken by (Maslanka *et al*. (2017) [18] in effects of Cycocel on African marigold, which ultimately resulted in leaf length.

Leaf width (cm)

Similarly (Table 1) indicated that the impact of given chemical treatments on the leaf width was significance but T_6 (Cholromequat chloride – 150 ppm) obtained maximum leaf width (1.03 cm) while minimum leaf width (0.71 cm) also was recorded under T_1 (Mepiquat chloride – 50 ppm) treatment.The above mentioned (leaf length) retardants are increased nutrition assimilation into plants, so leaf width could be increased and same investigation taken by Kedar *et al*. in 2023 [3] for morphological changes in annual chrysanthemum.

Leaf area (cm^2)

Leaf area (Table 1), given by significant difference with respect to foliar application of different growth retardants. Treatment T_6 (Chlormequat chloride – 150 ppm) recorded maximum leaf area (3.55 cm^2), at the same time lowest leaf area 1.66 cm^2 estimated under T_1 (Mepiquat chloride – 50 ppm) and respectively, all other treatments has significant level of increased leaf area by mentioning leaf length and width basis. This similar morphological study was revealed by Swetha *et al*. (2023) [13] in ornamentals.

Stem girth (cm)

A perusal of the data from table 1, reveals that the stem girth was found significant. However, application of (T_6) Chloromequat chloride at 150 ppm with resulted in highest stem girth (2.08 cm) followed by all other treatments and control (0.91 cm) was recorded lowest stem girth.This chemicals increased the lateral meristematic tissues, increased

plant diameter.In this study revealed by Karagoz *et al*. (2022) [11] for effects of growth retardant on morphology in Zinnia and significant different in African marigold by Maslanka *et al*. (2017) [18].

Dry matter content (g/plant)

The data on dry matter content as influenced by the application of growth retardants are given in Table 1. Among different plant growth retardants, significantly minimum dry matter content (54.73 g/plant) was observed at treatment of T_6 (Chlormequat chloride-150 ppm) as compared to other treatment except control which recorded the highest (71.33 g/plant) and the chemicals are minimize the vegetative characters and reduced the dry matter content. The present findings thus agreed with Swetha *et al*. (2023) [13] in ornamentals.

Fresh root weight (g/plant)

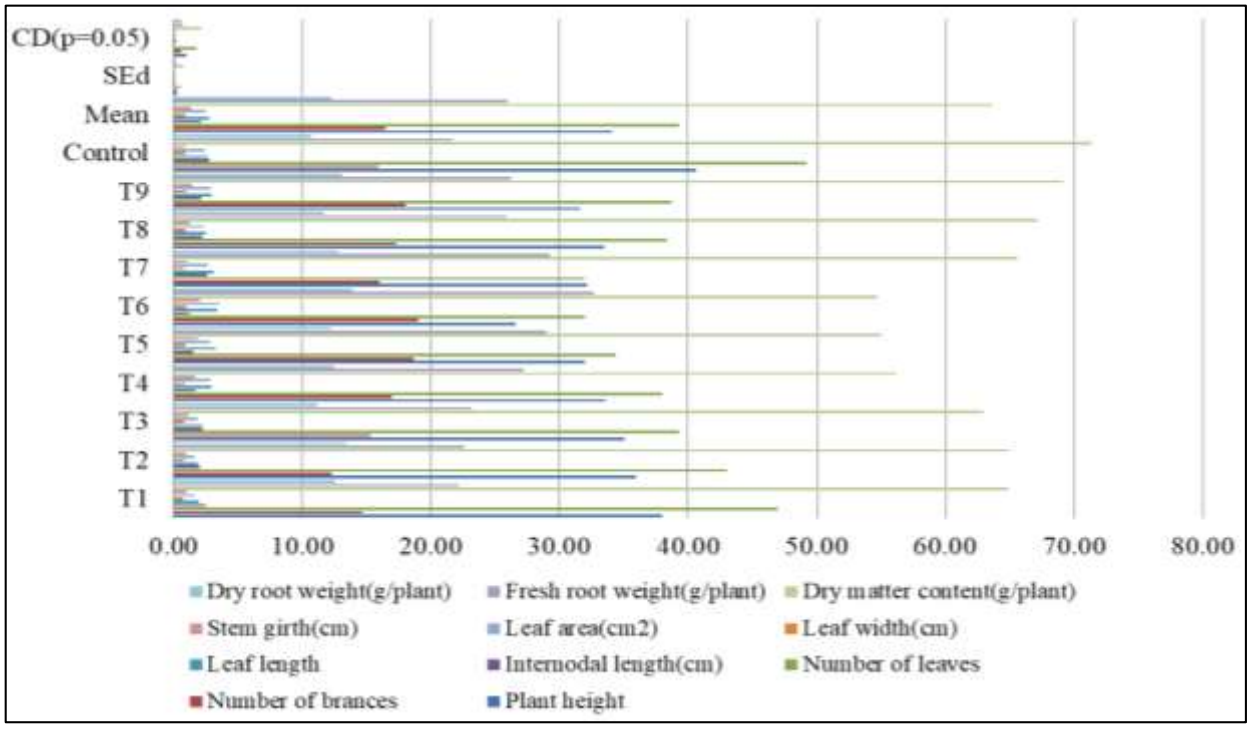
Data in Table (1) showed that fresh root weight was increased by using Chlormequat chloride and Uniconazole compared with the control. Weight (32.65 g/plant) was noticed that treated plants with Chlormequat chloride (T_6) at 150 ppm comparing with all other treatments, control (21.62 gram/plant). Chemicals was enhanced root microorganisms and increased xylem, phloem transportation. These results and interpretation were in agreement with Swetha *et al*. (2023) [13] and Shoa Kazemi *et al*. (2014) [14] in Pot Marigold.

Dry root weight (g/plant)

Data in Table (1) showed that dry root weight (g/plant) treating plants with growth retardants significantly increased the dry root weight when compared with the control plants. It was worth notice that the maximum dry root weight obtained resulted when plants were treated with Chlormequat chloride (T_6) at 150 ppm with recorded 13.92 g/plant, when compared to untreated plants and control (10.75 g/plant). Above mentioned (root fresh weight) based dry root weight was increased and growth retardants influence on dry root weight as agreed with Kumar *et al*. (2020) [15] in African Marigold and Negash *et al*. (2020) [16] in poinsettia.

Table 1: Effects of growth retardant on Morphological characteristics in African Marigold.

Treatment	Plant height (cm)	Number of branches	Number of leaves	Internodal length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm2)	Stem girth (cm)	Dry matter content (g/plant)	Fresh root weight (g/plant)	Dry root weight (g/plant)
T_1	38.00	14.67	47.00	2.50	2.01	0.71	1.66	1.05	64.87	22.22	12.58
T_2	35.96	12.33	43.00	2.07	1.87	0.82	1.59	0.99	64.90	22.59	13.41
T_3	35.08	15.33	39.33	2.27	2.21	0.84	1.91	1.16	62.94	23.13	11.13
T_4	33.58	17.00	38.00	1.72	2.97	0.96	2.87	1.64	56.18	27.26	12.45
T_5	32.00	18.67	34.33	1.55	3.33	0.89	2.90	1.87	55.02	29.01	12.22
T_6	26.59	19.00	32.00	1.27	3.41	1.03	3.55	2.08	54.73	32.65	13.92
T_7	32.13	16.00	32.00	2.60	3.14	0.87	2.72	1.13	65.58	29.26	12.80
T_8	33.51	17.33	38.33	2.27	2.52	0.89	2.34	1.31	67.09	25.86	11.66
T_9	31.66	18.00	38.67	2.13	2.93	0.97	2.84	1.49	69.17	26.26	13.11
Control	40.59	15.96	49.10	2.76	2.69	0.88	2.45	0.91	71.33	21.62	10.75
Mean	34.10	16.49	39.31	2.13	2.75	0.90	2.54	1.35	63.61	25.95	12.27
SEd	0.33	0.20	0.61	0.03	0.08	0.02	0.09	0.02	0.72	0.25	0.22
CD (p=0.05)	0.99	0.60	1.81	0.09	0.25	0.05	0.25	0.07	2.13	0.73	0.65



Morphological characterization of African Marigold

Conclusion

According to the study findings, In the treatment of Chlormequat chloride (T_6) @ 150 ppm for foliar application at 15,22 days intervals was the growth retardant that could be utilised to increased and some significant changes on morphological characteristics are Plant height, number of branches, number of leaves, Intermodal length, stem girth, leaf length, width, area of leaves, dry matter content, fresh root weight and dry root weight in African marigold (*Tagetes erecta* L.) as followed by except treatments.

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