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Effect of Plant Growth Regulators and Pinching on Growth and Yield of Marigold (*Tagetes erecta* L.) under Prayagraj Agro Climatic Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment has been conducted to determine the activity of plant growth regulators and pinching on the growth and flowering yield of African marigold (*Tagetes erecta* L.) in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (UP) during Rabi season 2021-2022, nine treatments were included in this trial viz..., T_0 Control, T_1 GA_3 100 PPM + Pinching, T_2 GA_3 200 PPM + Pinching, T_3 Triacontanol 20 ppm + Pinching, T_4 Triacontanol 30 ppm + Pinching, T_5 Lihocin 2000 ppm + Pinching, T_6 Lihocin 4000 ppm + Pinching, T_7 NAA 10 ppm + Pinching and T_8 NAA 20 ppm + Pinching, were tested in three replications. The experiment of this design was randomized block design. The results has revealed that GA_3 treatments and pinching had significant response on the plant height, number of branches per plant, number of leaves per plant, plant spread per plant, days from bud initiation to harvest, days required for flower appearance from transplanting, number of flowers per plant, flower diameter, fresh and dry flower weight, flower yield per plant, flower yield per plot, and flower yield per hectare. The maximum plant height (76.17cm), number of branches per plant (53.21), plant spread (90.22cm), number of leaves per plant (409.07), flower yield per plant (402.13g/plant), flower yield per plot (1.57kg), and flower yield per hectare (15.67) were recorded in the treatment T_2 GA_3 200 PPM + Pinching. This treatment showed the best results in vegetative growth and yield production.

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Keywords: Marigold; plant growth regulators; pinching; growth and yield.

1. INTRODUCTION

Marigold (*Tagetes spp.*) is one of the popular and commercial loose flower crop that is cultivated in India. The family of marigold is Asteraceae. Two of the most popularly cultivated species of marigold are African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.) which are originated in Mexico and South Africa, respectively. Marigold has gained its popularity because of its hardiness, easy culture, wide adaptability to different soil and climatic conditions and also easy transportation which will attract the attention of flower growers. It is also suited for potted plant, bedding, edging. garland making, religious offering and also to preparre various products [1-3]. Due to value edition it also has importance in industry.

The plant growth regulators (which are also called as plant bio regulators) are the compounds which are used to improve the growth of plants or plant parts. The use of growth regulators in horticultural crops to increase the productivity is not a new one. Several plant growth regulators are used in different kinds of horticulture crops to increase the quality and quantity of produce [4,5]. Gibberellic acid (GA_3) is an important PGR used for the regulating growth and yield in various horticultural crops (Taiz and Zieger, 2002). GA_3 regulate the plant growth through both cell division and cell enlargement. Use of GA_3 is a very crucial for increasing vegetative growth and simultaneously the yield of flower crops [6,7]. The growth regulator triacontanol (TRIA) has a good role to promote the growth, yield, photosynthesis, nitrogen fixation, enzymatic activities and the level of free amino acids, reducing sugars and soluble proteins. The TRIA application increases the plant growth, number of inflorescences and quality of flower. NAA is also another important PGR, which stimulates cell division, enlargement of cell and elongation of cell in the apical region. It also increases Osmotic pressure and permeability of cytoplasm to water and nutrients (Pandey and Sinha, 1986).

Pinching and application of plant growth regulators plays an important role in flower improvement and yield of the crop. In many flower crops, the flowering and yield mainly depends on the branches bearing number of flowers which can be manipulated by checking the vertical growth of plants and encouraging side shoots by means of apical bud pinching. But, the studies on influence of pinching of apical bud in African marigold and its effect on flowering and yield are meagre. The factors limiting the growth and yield to harness can be overcome by plant growth regulators.

2. MATERIALS AND METHODS

The experiment was carried out at the Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj (2021-22) which is situated in the agro climatic zone IV- middle Gangetic plains (sub-tropical belt) in the south-east part of Uttar Pradesh India. The site of experiment is located at 98 meters from sea level at 25.57º N latitude 81.51º E longitude has a typical subtropical climate with extremes of summer and winter. The maximum temperature of the location reaches up to 46ºC - 48ºC and seldom falls down as low as 4ºC-5ºC during winter season especially in the month of December and January the average rainfall in this area is around 1027 mm annually with maximum concentration during July to September with a little showers and drizzles in winter also.

The experiment was conducted out in Randomized Block Design (RBD) with three replications and nine treatments: T_0 Control, T_1 GA_3 100 PPM + Pinching, T_2 GA_3 200 PPM + Pinching, T_3 Triacontanol 20 ppm + Pinching, T_4 Triacontanol 30 ppm + Pinching, T_5 Lihocin 2000 ppm + Pinching, T_6 Lihocin 4000 ppm + Pinching, T_7 NAA 10 ppm + Pinching, T_8 NAA 20 ppm + Pinching in net plot area of 1m × 1m whereas Marigold seeds were sown in portrays filled with sterilized cocopeat and well decomposed fine compost in October, 2021. Data were recorded after 30,60,90 days after transplanting(DAT). The results and data were subjected to statistical analysis separately by using the analysis of variance (ANOVA) technique. The difference among treatments means has been compared by using least significant difference test at 5% probability levels.

3. RESULT AND DISCUSSION

3.1 Growth Parameters

“The growth parameters were measured in terms of plant height (cm), Plant spread, number of branches and number of leaves are given in table 1. At 90 DAT, maximum plant height (76.17 cm) was recorded with application of (GA_3 @ 200 ppm + Pinching), followed by (GA_3 @ 100 ppm + Pinching) with (75.14 cm) and lowest plant height (53.07 cm) was recorded in (Lihocin 4000 ppm + Pinching). The significant increase in the plant height with GA3, which may be influenced due to the action of gibberellins promotes vegetative growth by the way of cell division and elongation of cell and this maight be resulted in increase of height in the plant. GA3 helps to increase the photosynthetic activity in plants. This may have been increased the osmotic uptake of water and nutrients, by maintaining constant swelling force against softening of cell walls. These results are nearby with the findings" of Naidu (2011), Dobaria [8], Yadav (2013), Palei [9], Markam (2017) and Kumar (2017).

"At 90 DAT Maximum plant spread (E-W) was recorded in T_2 with application of (GA_3 @ 200 ppm + Pinching) (90.22 cm) followed by (GA_3 @ 100 ppm + Pinching) with (89.13 cm) and lowest (38.49 cm) was recorded in (Lihocin 4000 ppm + Pinching). Maximum plant spread (N-S) was recorded with application of (GA_3 @ 200 ppm + Pinching) (90.12 cm) followed by (GA_3 @ 100 ppm + Pinching) with (89.07 cm) and lowest (38.47 cm) was recorded in (Lihocin 4000 ppm + Pinching). Among the two concentrations of GA_3 the maximum average plant spread was recorded at 200 ppm. It shows that 200 ppm was the optimum dosage for maximum average spread of plant. GA_3 at optimum dose (200 ppm) might have been promoted the metabolic activities of the plant and influenced the uptake of water and nutrients. Therefore, the spread of the plant recorded the increased magnitude. Similar results were recorded" by Pandya (2000), Naidu (2011) and Dobaria [8].

"The maximum average number of branches per plant was recorded in (GA_3 @ 200 ppm + Pinching) (53.21) followed by (GA_3 @ 100 ppm + Pinching) with (52.98) and lowest (39.91) was recorded in (Lihocin 4000 ppm + Pinching). The difference of number of branches per plant may be due to the usage of different concentrations of various plant growth regulators and pinching. However, the experiment showed notable differences due to the use of various growth regulators. GA3 significantly showed the maximum highest average number of branches with 200 ppm spray. Followed by maximum average branches was noted by GA3 100 ppm. The results are in close conformity with the findings" of Pandya (2000), Patidar (2003), Dobaria [8], Yadav (2013), Palei et al. [9] in marigold.

"At 90 DAT The maximum number of leaves has been recorded with the application (GA_3 @ 200 ppm + Pinching) (409.07) followed by (GA_3 @ 100 ppm + Pinching) with (407.13) and lowest (274.53) was recorded in (Lihocin 4000 ppm + Pinching). The leaves which are the chief important functional unit for photosynthetic process, greatly influences the growth and yield of flower crop. The variation in number of leaves per plant in various treatments might be due to effect of various concentrations of different plant growth regulators. As mentioned earlier in the result that different plant growth regulators have significantly affected the number of branches per plant, there with all the leaves per plant were also significantly increased in GA3, the results were close to observation" of Patidar (2003), Sunitha (2007), Naidu (2011), Dobaria [8], Sherpa (2013), Palei et al. [9] and Kumar (2017) in marigold.

3.2 Yield Parameters

"The observation regarding yield attributes *viz.,* Number of flower per plant, Flower yield per plant (g/plant), Flower yield per plot (kg/plot), Flower yield per hectare (t/ha)are shown in table 2. The maximum average number of flowers per plant were recorded with application GA3 @ 200 ppm + Pinching (31.76) followed by GA3 @ 100 ppm + Pinching (31.26) and lowest was recorded in Lihocin 4000 ppm + Pinching (22.20). The more number of flowers is due to the production of branches with good number of developed flowers on the branches. The flower yield per plant may be dependent on individual flower weight and number of flowers per plant resulting to the variation in flower yield among the different PGR treatments and pinching. Similar results in flower yield were observed" by Patidar (2003), Sunitha (2007), Naidu (2011), Kumar et al. (2012), Dobaria [8], Yadav (2013), Kumar (2017) and Markam, (2017).

"Maximum average yield per plant was recorded at 90 DAT with application of GA3 @ 200 ppm + Pinching (402.13 g/plant) followed by GA3 @ 100 ppm + Pinching (395.07 g/plant) and minimum flower yield per plant was recorded in Lihocin @ 4000 ppm + Pinching (316.50 g/plant). The increase in yield may be due to direct growth promoting the action of GA3. The GA3 which is present might have been increased the growth promoting enzymes as a result manufacturing more nucleic acid, in the plants. These findings were in accordance with the results" of Naidu (2011), Kumar et al. (2012), Dobaria [8], Palei et al. [9], Wadgave (2016), Markam, (2017) and Kumar (2017).

"Maximum average yield per plot was recorded at 90 DAT with application of GA3 @ 200 ppm + Pinching (1.57 kg/plot) followed by GA3 @ 100 ppm + Pinching (1.44 kg/plot) and minimum yield per plot was noted in Lihocin @ 4000 ppm (0.96 kg/plot). These results might be due to the variation in the production of flower yield as different growth regulators promotes or decreases the metabolic activities in the plants. Data recorded for flower yield per plot might have varied due to the effect of plant growth regulators to yield flowers. There was visible increase in yield of flowers in the plots treated with GA3. Similar results were obtained" by Naidu (2011), Kumar et al., (2012), Dobaria (2012), Palei et al. [9], Wadgave (2016), Markam, (2017) and Kumar (2017).

"Maximum average yield per hectare was recorded at 90 DAT with application of GA3 @ 200 ppm + Pinching (15.67 t/ha) followed by GA3 @ 100 ppm (14.37 t/ha) and minimum yield per hectare was noted in Lihocin @ 4000 ppm (9.60 t/ha). The increase in yield of flower per ha might be due to increased weight of flower and number of flowers per plant . Similar difference in flower yield after treatment of various plant growth regulators with different concentrations was also reported earlier. The increase in flower yield per hectare with the treatment of GA3 was also supported with the results" of Naidu (2011), Kumar et al., (2012), Dobaria (2012), Palei et al. [9], Wadgave (2016), Markam, (2017) and Kumar (2017) in marigold plant.

Table 1. Effect of plant growth regulators and pinching on growth attributes of Marigold

Treatments	**Plant height (cm)**	**Plant spread (cm)**		**Number of branches**	**Number of leaves**
		(E-W)	**(N-S)**		
Control	59.95	70.44	70.28	44.40	370.80
GA_3 100 ppm + Pinching	75.14	89.13	89.07	52.98	407.13
GA_3 200 ppm + Pinching	76.17	90.22	90.12	53.21	409.07
TRIA 20 ppm + Pinching	71.89	85.21	85.17	52.13	328.47
TRIA 30 ppm + Pinching	72.02	88.59	88.52	52.83	330.07
Lihocin 2000 ppm + Pinching	55.06	41.88	41.84	40.03	277.93
Lihocin 4000 ppm + Pinching	53.07	38.49	38.47	39.91	274.53
NAA 10 ppm +Pinching	66.16	78.38	78.32	44.66	391.13
NAA 20 ppm +Pinching	67.54	81.00	80.87	44.79	393.27
F- test	S	S	S	S	S
SEm (±)	0.73	2.34	2.30	0.24	6.06
CD (5%)	2.18	7.02	6.89	0.72	18.17

Table 2. Effect of plant growth regulators and pinching on yield attributes of Marigold

Treatments	**Number of flower per plant**	**Flower yield per plant (g/plant)**	**Flower yield per plot (kg/plot)**	**Flower yield per hectare (t/ha)**
Control	23.72	325.73	0.98	9.80
GA_3 100 ppm + Pinching	31.26	395.07	1.44	14.37
GA_3 200 ppm + Pinching	31.76	402.13	1.57	15.67
TRIA 20 ppm + Pinching	29.71	369.00	1.08	10.80
TRIA 30 ppm + Pinching	30.09	375.11	1.09	10.90
Lihocin 2000 ppm + Pinching	22.86	318.67	0.97	9.70
Lihocin 4000 ppm + Pinching	22.20	316.50	0.96	9.60
NAA 10 ppm +Pinching	27.43	381.42	1.22	12.23
NAA 20 ppm +Pinching	27.92	387.17	1.18	11.77
F- test	S	S	S	S
SEm (±)	2.17	10.97	0.10	1.02
CD (5%)	6.50	32.89	0.31	3.06

4. CONCLUSION

From the above results, it has been concluded that the application of GA_3 200 ppm +Pinching was found to be the best treatment by obtaining highest growth and yield. It was found more productive when compared to other treatments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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