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Response of humic acid and gibberellic acid application on flowering and yield of summer African marigold

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Abstract
The objective of the investigation was to evaluate the impact of foliar application of gibberellic acid and humic acid on the growth and flowering parameters of summer African marigold (*Tagetes erecta* L.) at the Horticulture Section, College of Agriculture, Nagpur, between 2020–21 and 2021–22. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications with two factors *viz*., Factor A consist of four levels of humic acid (i.e., Control, 0.2% humic acid, 0.4% humic acid and 0.6% humic acid) and factor B consist of five levels of gibberellic acid (i.e., 100 ppm, 200 ppm, 300 ppm, 400 ppm and control). Flowering attributes were determined as flower diameter (mm), flower stalk length (cm), single flower weight (g) and number of flowers plant^{-1}. Yield characters i.e., flower yield plant^{-1}, flower yield plot^{-1} and flower yield t ha^{-1}. The results indicated that gibberellic acid and humic acid produced the best results of all the studied characters. In contrast, the control treatment produced the lowest mean values in African marigold, while humic acid at 0.2% and gibberellic acid at 100 ppm achieved the highest mean values in all flowering and yield attributes.

Keywords: Humic acid, gibberellic acid, foliar application, African marigold, flowering attributes, yield characters

Introduction

African marigold (*Tagetes erecta*) an annual herbaceous plant belongs to the Compositae subfamily of the Asteraceae. There is great scope to increase the area under this crop due to its wider adoptability, suitability under varied agro-climatic condition and huge demand in the market. Due to its chemical makeup, which includes terpenes, flavonoids, tannins, coumarins, and basic oils, it has various distinct uses in addition to being created for decorative purposes (Ashwlayan *et al*., 2018) [4]. The remedial, dietary, and pharmaceutical industries may thus find marigold to be a lucrative plant. Due to its cultural and religious significance, marigold may be a prospective undertaking bloom with growing demand in the environment (Adhikari *et al.*, 2020) [1]. Marigolds are famous among gardeners and flower dealers due to their ease of cultivation, extensive adaptation to varied soil and climatic conditions, long flower duration, short duration to produce marketable blooms, a wide range of beautiful colours, form, size, and high maintaining quality of flowers with elegant and pretty foliage.

Apical dominance, stretch in blooming (Sharma *et al.*, 2006) [33], and promotion of long and inclined stems (Gawle *et al.*, 2012) [15] are a few of the significant drawbacks associated with the development of this modification. These, in turn, result in poor yields or economic returns. However, setting up the surrounding climatic conditions through location selection, and adjusted dietary and physiological controls through pressing or the use of plant growth regulators can help to improve the plant growth. It is the taller species, growing reaching a height of 80- 100 cm.

Humic acid, an organic polymer produced naturally by the breakdown of peat, lignin, and organic waste, can be used to increase the quality and output of a product. With an increase in chlorophyll content, an acceleration of respiration, hormonal responses to growth, an increase in penetration in plant membranes, or a combination of these mechanisms, humic acid directly affects plant development.

Additionally, humic acid increases nutrient absorption through chelation and regeneration actions, as well as root and shoot growth, which affects plant growth indirectly (Atiyeh *et al.* 2002) [5]. Gibberellic acid advances the blossom's top quality and is used to go around the factors that restrict growth to maximize benefit. Additionally, it affects plant development by increasing the variety of both primary and secondary branches, which are combined to improve bloom quality and maintain consistency in bloom size and variety, which in the long run ensures better bloom generation. Gibberellic acid that is exogenously connected limits the vegetative, blooming, and exceptional parameters in both greater and lesser concentrations even though it worked to the fullest extent possible up to the greatest possible recognition and comments hindrance surpassed off past such concentrations. In view of the above the present investigation have been planned to assess effect of foliar application of humic acid and gibberellic acid on growth and flowering parameters of summer African marigold.

Materials and Methods

Field experiment was conducted during summer season of the year 2020-21 and 2021-22 at Horticulture Section, College of Agriculture, Nagpur, with an objective to study the effect of foliar application of humic acid and gibberellic acid on flowering and yield in summer African marigold.

The experiment was laid out in factorial randomized block design with twenty treatments combinations replicated thrice. Treatments comprising of factor A with four concentrations of humic acid *viz*., H_1 - control, H_2 – 0.2% HA, H_3 - 0.4% HA and H_4 - 0.6% HA and factor B with four concentrations of gibberellic acid *viz*., G_1 - control, G_2 - 100 ppm, G_3 - 200 ppm, G_4 - 300 ppm and G_5 - 400 ppm.

Seeds of African marigold var. African Double Orange were procured from horticulture section. The raised beds were prepared after mixing the well rotten FYM. The seeds were sown on bed at a distance of 10 cm between the row and 2 to 3 cm within the row at 1-1.5 cm depth. Four weeks old healthy, stocky seedlings were used for transplanting. Transplanting was done in the month of January at the spacing of 45 cm x 30 cm. The recommended dose of fertilizers (N: P_20_5: K_20 @ 100:50:25 kg ha^{-1}) were applied in the form of urea, single supper phosphate and muriate of potash. Full dose of single supper phosphate and muriate of potash and ½ dose of urea was applied at the time of transplanting and remaining ½ dose of urea was applied one month after transplanting.

The foliar application of humic acid and gibberellic acid was done twice at 15 DAT and 30 DAT as per treatment concentration. The observations *viz*., flower diameter (mm), flower stalk length (cm), single flower weight (g) and number of flowers $plant^{-1}$. Similarly yield characters i.e., flower yield $plant^{-1}$, flower yield $plot^{-1}$ and flower yield t ha^{-1} were recorded. The appropriate standard error of mean S.E., (m) and the critical difference (C.D.) were calculated at 5% level of probability.

Results and Discussion

The results obtained from present investigation are presented below on the basis of pooled mean of two years experimentation (2020-21 and 2021-22).

Effect of humic acid

The data regarding flowering parameters as influenced due to the foliar application of humic acid and gibberellic acid treatments during the years 2020-21 and 2021-22 are presented in Table 1.

Flower diameter (mm)

The pooled data presented in Table 1 indicated that, the diameter of fully opened flower was significantly influenced due to the foliar application of humic acid. Significantly maximum diameter of fully opened flower (7.24 cm) was recorded under the foliar application of humic acid, 0.2% and it was followed by the foliar application of humic acid, 0.4% (6.40 cm) and foliar application of humic acid, 0.6% (6.11 cm). However, the control treatment had recorded significantly minimum diameter of fully opened flower (5.52 cm). The increase in diameter of fully opened flower might be due to foliar application of humic acid helps to chelate or bind to nutrients in the soil, which helps to more available of nutrient uptake, when assess to sufficient nutrient they increase the diameter of flower and more vibrant flower. Similar finding was observed from Ahsan *et al*. (2012) [2] in tuberose, Ameena (2018) [3] in calendula, Gawade *et al*. (2019) [14] in chrysanthemum and Muhammad *et al*. (2017) [26], Sendhilnathan *et al*. (2019) [32] and Ghosh *et al*. (2022) [16] in marigold.

Flower stalk length (cm)

The pooled data furnished in Table 1 indicated that, significantly maximum stalk length of flower (6.05 cm) was recorded in the treatment 0.2% humic acid, and it was followed by the foliar application of humic acid, 0.4% (5.59 cm) and foliar application of humic acid, 0.6% (5.49 cm). However, significantly minimum stalk length of flower (5.33 cm) was recorded under foliar control treatment. When applied as a foliar spray, it may be taken up by the plant and transported to the roots where it can enhance nutrient uptake and promote overall plant growth. This increased nutrient uptake could lead to a greater supply of resources to the plant, resulting in longer stalks in African marigold. Similar results were observed from Keisam *et al.* (2014) [21], Sendhilnathan *et al*. (2019) [32] and Das *et al*. (2020) [10] in marigold.

Single flower weight (g)

The pooled results indicated that, weight of flower was significantly influenced due to the different concentration of humic acid. Significantly maximum weight of flower (8.54 g) was recorded with the foliar application of humic acid, 0.2% which was followed by the foliar application of humic acid 0.4% (8.14 g) and foliar application of humic acid, 0.6% (7.31 g). However, the control treatment had recorded significantly minimum weight of flower (6.85 g). Humic acid has been shown to enhance the activity of enzymes involved in plant growth and development, such as peroxidases, catalases, and polyphenol oxidases. These enzymes play important roles in cell division, elongation, and differentiation, which can ultimately lead to increased single flower weight. Similar results were obtained by Sendhilnathan *et al*. (2019) [32], Murugan *et al*. (2019) [27] and Das *et al*. (2020) [10] in marigold.

Number of flowers plant^{-1}

The pooled results indicated that, number of flowers plant^{-1} was significantly influenced due to the different concentration of humic acid. Significantly maximum number of flowers plant-1 (37.35) was recorded with the foliar application of humic acid, 0.2% which was found at par with the foliar application of humic acid 0.4% (36.52). However, the control treatment recorded significantly minimum number of flowers plant-1 (33.77 g). This might be due to humic acid which contains organic compounds that can improve soil fertility and nutrient availability. When foliar applied, humic acid can be taken up by the plant and transported to the roots where it can enhance nutrient uptake and promote overall plant growth. This increased nutrient uptake can result in greater plant biomass and lead to the production of more flowers per plant. Similar results were obtained by Mohammadipour *et al*. (2012) [29] and Ehsan *et al*. (2012) [12] in calendula. Babar Ali *et al*. (2015) [6] in gladiolus. Jawaharlal *et al*. (2013) [19], Khobragade *et al*. (2017) [23], Muhammad *et al*. (2017) [26], Gawade *et al*. (2019) [14], Sendhilnathan *et al*. (2019) [32], Murugan *et al*. (2019) [27]. Das *et al*. (2020) [10] and Ghosh *et al*. (2022) [16] in marigold.

Effect of Gibberellic acid:

Flower diameter (mm)

The pooled data presented in Table 1 indicated that, the diameter of fully opened flower was also significantly influenced due to the foliar application of gibberellic acid. Significantly maximum diameter of fully opened flower (8.18 cm) was recorded under the foliar application of GA^3, 100 ppm and it was followed by the foliar application of GA^3 200 ppm (6.08 cm), control, (6.06 cm) and foliar application of GA^3, 300 ppm (5.94 cm). However, the foliar application of GA^3 400 ppm had recorded significantly minimum diameter of fully opened flower (5.33 cm). An increase in diameter of flower might be caused by driving by photosynthates to flower as a consequence of intensification of the sink also increase cell division and cell elongation due to the foliar application of GA^3 which might have been utilized for the production of the better quality flower in African marigold in respect of diameter of fully open flower. Similar finding was observed from Dutta *et al*. (1995) [11], Shivaprakash *et al*. (2011) [35], Badge *et al*. (2015) [7], Kumar *et al*. (2016) [24], Khangiarakgam *et al*. (2019) [22] in marigold.

Flower stalk length (cm)

The pooled data furnished in Table 1 indicated that, significantly maximum stalk length of flower of African marigold (6.37 cm) was recorded with foliar application of gibberellic acid 400 ppm, it was followed by the foliar application of gibberellic acid 300 ppm (5.76 cm), foliar application of gibberellic acid 200 ppm (5.69 cm) and foliar application gibberellic acid 100 ppm (5.50 cm). However, significantly minimum stalk length of flower was recorded control (4.98 cm) treatment. This might be due to the enhanced growth rate of vegetative plant parts due to the enhanced physiological activities influenced by GA^3. GA^3 also increases the photosynthetic and metabolic activities causing more transportation and utilization of photosynthetic products. This might have resulted into the better stalk length of African marigold flower. Similar results were observed from Girwani *et al*. (1988) [17], Mithileshkumar *et al.* (2014) [25], Badge *et al.* (2015) [7] and Meshram *et al.* (2015) [28] in marigold.

Single flower weight (g)

The pooled results indicated that, weight of flower was significantly influenced due to the different concentration of gibberellic acid. Significantly maximum weight of flower (9.60 g) was recorded with the foliar application of GA^3, 100 ppm which was followed by the foliar application of GA^3 200 ppm (7.92 g) and foliar application of GA^3, 300 ppm (7.55 g). However, the foliar application of GA^3 400 ppm had recorded significantly minimum weight of flower (6.24 g). Maximum flower weight with the foliar application of gibberellic acid might be due to diversification of photosynthates towards the flowers as a consequence of intensification of sink and more accumulation of metabolites in the flower which may tend to increase the weight of flowers. Similar results were observed from Kanwar *et al*. (2013) [20], Gopichand *et al*. (2014) [18], Badge *et al*. (2015) [7], Kumar *et al*. (2016) [24] in marigold.

Number of flowers plant^{-1}

The pooled results indicated that, number of flowers plant^{-1} was significantly influenced due to the different concentration of gibberellic acid. Significantly maximum number of flowers^{-1} (40.32) was recorded with the foliar application of GA^3, 100 ppm which was followed by the foliar application of GA^3 200 ppm (36.19) and foliar application of GA^3, 300 ppm (35.88). However, the foliar application of GA^3 400 ppm had recorded significantly minimum number of flowers plant^{-1} (32.55). An increase in number of flower plant was owing to the increase in vigour of the plant due to an application of GA^3, 100 ppm as foliar spray which might have helped to enhance the uptake of nitrogen, phosphorus and potassium by the plants and this better uptake of nutrients might have supported the vegetative growth *viz*., plant height, number of branches and finally might have increased the number of flower plant-^{1}. Similar finding was observed from Banker *et al*. (1988) [9], El- Shafie *et al*. (1995) [13] in carnation, Shivaprakash *et al*. (2011) [35], Badge *et al*. (2015) [7], Kumar *et al*. (2016) [24], Khangiarakgam *et al*. (2019) [22] in marigold.

Interaction effect

The data presented in Table 1(a) revealed that, interaction effect due to foliar application of humic acid and gibberellic acid on flowering parameters of African marigold was found significant at all stages during both the year of experimentation (2020-21 and 2021-22).

Flower diameter (mm): The pooled data revealed that, the diameter of fully opened flower was also significantly influenced due to the interaction effect of the foliar application of humic acid and foliar application of gibberellic acid treatments. Significantly maximum diameter of fully opened flower (9.75 cm) was recorded under the treatment combinations H_2G_2 and it was followed by the treatment combinations H_3G_2 (8.63 cm) and H_4G_2 (8.16 cm). However, treatment combination H_1G_5 had recorded significantly minimum diameter of flower (4.51 cm).

Flower stalk length (cm)

The pooled data revealed that, the stalk length of flower was also significantly influenced due to the interaction effect of the foliar application of humic acid and foliar application of gibberellic acid treatments. Significantly maximum stalk length of flower (6.85 cm) was recorded under the treatment combinations H_1G_4 and it was followed by the treatment combinations H_1G_3 (6.54 cm), H_1G_5 (6.47 cm), H_1G_3 (6.36 cm) and H_3G_5 (6.36 cm). However, treatment combination H_2G_1 had recorded significantly minimum stalk length of flower (4.56 cm).

Yield parameters

The data regarding Yield parameters as influenced due to the foliar application of humic acid and gibberellic acid treatments during the years 2020-21 and 2021-22 are presented in Table 2.

Effect of humic acid

Flowers yield plant^{-1}

The pooled results indicated that, flowers yield plant^{-1} was significantly influenced due to the different concentration of humic acid. Significantly maximum flowers yield plant^{-1} (195.43 g) was recorded with the treatment foliar application of humic acid, 0.2% which was found at par with the treatment foliar application of humic acid 0.4% (192.12 g). However, the control treatment was recorded significantly minimum flowers yield plant^{-1} (167.73 g). Application of humic acid improves over all development of plant growth and allied increase in root biomass resulting in higher water and nutrient uptake and also transpiration might have lowered, causing more carbon dioxide availability through stomatal opening and hence, the net increase in photosynthetic rate. A cumulative effect of all these factors might have resulted in total yield enhancement. Similar results were obtained by Ravindra (2016) [31] Murugan *et al*. (2019) [27] in marigold, Ehsan *et al*. (2012) [12] in calendula, Balasankar *et al*. (2013) [8] in okra and Gawade *et al*. (2019) [14] chrysanthemum.

Flowers yield plot^{-1}

The pooled results indicated that, flowers yield plot^{-1} was significantly influenced due to the different concentration of humic acid. Significantly maximum flowers yield plot^{-1} (5.19 kg) was recorded with the foliar application of humic acid, 0.2% which was followed by the foliar application of humic acid 0.4% (4.70 kg) and foliar application of humic acid, 0.6% (4.54 kg). However, the control treatment had recorded significantly minimum flowers yield plot^{-1} (3.68 kg). Application of humic acid improves over all development of plant growth and allied increase in root biomass resulting in higher water and nutrient uptake and also transpiration might have lowered, causing more carbon dioxide availability through stomatal opening and hence, the net increase in photosynthetic rate. A cumulative effect of all these factors might have resulted in total yield enhancement. Similar results were obtained by Ravindra (2016) [31] and Murugan *et al*. (2019) [27] in marigold. Ehsan *et al*. (2012) [12] in calendula, Balasankar *et al*. (2013) [8] in okra, Gawade *et al*. (2019) [14] in chrysanthemum.

Flowers yield t ha^{-1}

The pooled results indicated that, flowers yield hectare^{-1} was significantly influenced due to the different concentration of humic acid. Significantly maximum flowers yield hectare^{-1} (12.02 t ha-1) was recorded with the foliar application of humic acid, 0.2% which was followed by the foliar application of humic acid 0.4% (10.82 t ha^{-1}) and foliar application of humic acid, 0.6% (10.45 t ha^{-1}). However, the control treatment was recorded significantly minimum flowers yield hectare^{-1} (8.51 t ha^{-1}). Application of humic acid improves over all development of plant growth and allied increase in root biomass resulting in higher water and nutrient uptake and also transpiration might have lowered, causing more carbon dioxide availability through stomatal opening and hence, the net increase in photosynthetic rate. A cumulative effect of all these factors might have resulted in total yield enhancement. Similar results were obtained by Ravindra (2016) [31], Murugan *et al*. (2019) [27], Das *et al*. (2020) [10].

Effect of Gibberellic acid

Flowers yield plant^{-1}

The pooled results indicated that, flowers yield plant^{-1} was significantly influenced due to the different concentration of gibberellic acid. Significantly maximum flowers yield plant^{-1} (206.18 g) was recorded with the foliar application of GA^3, 100 ppm which was followed by the foliar application of GA^3 200 ppm (186.68 g), foliar application of GA^3, 300 ppm (183.78 g) and control (181.67 g). However, the foliar application of GA^3 400 ppm was recorded significantly minimum flowers yield plant^{-1} (89.86). An increase in the yield of flower plant might be due to the fact that, gibberellic acid treated plants might have produced more vegetative growth in terms of plant height and leaf area. This might have resulted into production and accumulation of more photosynthates which would have diverted to the sink resulting into the more flower yield in African marigold. Similar finding was observed from Moond and Gehlot (2006), Kanwar *et al*. (2013) [20] Shivaprakash *et al*. (2011) [35], Badge *et al*. (2015) [7], Kumar *et al*. (2016) [24], Khangiarakgam *et al*. (2019) [22] in marigold.

Flowers yield plot^{-1}

The pooled results indicated that, flowers yield plot^{-1} was significantly influenced due to the different concentration of gibberellic acid. Significantly maximum flowers yield plot^{-1} (5.48 kg) was recorded with the foliar application of GA^3, 100 ppm which was followed by the foliar application of GA^3 200 ppm (4.57 kg), foliar application of GA^3, 300 ppm (4.44 kg) and control (4.31 kg). However, the foliar application of GA^3 400 ppm had recorded significantly minimum flowers yield plot^{-1} (3.85 kg). An increase in the yield of flower plot^{-1} might be due to the fact that, gibberellic acid treated plants might have produced more vegetative growth in terms of plant height and leaf area. This might have resulted into production and accumulation of more photosynthates which would have diverted to the sink resulting into the more flower yield in African marigold. The results were with conformity with shinde *et al*. (2010) [34] in chrysanthemum, Badge *et al*. (2015) [7], Shivaprakash (2011) [35] in marigold.

Flowers yield t ha^{-1}

The pooled results indicated that, flowers yield hectare^{-1} was significantly influenced due to the different concentration of gibberellic acid. Significantly maximum flowers yield hectare^{-1} (12.66 t) was recorded with the treatment foliar application of GA^3, 100 ppm which was followed by the foliar application of GA^3 200 ppm (10.57 t), foliar application of GA^3, 300 ppm (10.28 t) and control (9.82 t).

However, the foliar application of GA^3 400 ppm had recorded significantly minimum flowers yield $hectare^{-1}$ (8.91 t). An increase in the yield of flower ha^{-1} might be due to the fact that, gibberellic acid treated plants might have produced more vegetative growth in terms of plant height and leaf area. This might have resulted into production and accumulation of more photosynthates which would have diverted to the sink resulting into the more flower yield in African marigold. Similar finding was observed from the results were with conformity with shinde *et al*. (2010) [34] in chrysanthemum, Badge *et al*. (2015) [7], Shivaprakash (2011) [35] in marigold.

Interaction effect: The data presented in Table 2 revealed that, interaction effect due to foliar application of humic acid and gibberellic acid on yield parameters of African marigold was found non-significant at all stages during both the year of experimentation (2020-21 and 2021-22).

Table 1: Effect of foliar application of humic acid and gibberellic acid on flowering parameters in African marigold (mean pooled data over two year)

Factors	Growth parameters			
	Flower diameter (mm)	Stalk length (cm)	Single flower weight (g)	Number of flowers $plant^{-1}$
	Pooled	Pooled	Pooled	Pooled
A) Humic acid (H)				
H_1- Control	5.52	5.33	6.85	33.77
H_2- 0.2%	7.24	6.05	8.54	37.35
H_3- 0.4%	6.40	5.59	8.14	36.52
H_4- 0.6%	6.11	5.49	7.53	35.87
'F' test	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.07	0.06	0.14	0.41
CD at 5%	0.21	0.18	0.40	1.16
B) Gibberellic acid (G)				
G_1- Control	6.06	4.98	7.51	34.45
G_2- 100 ppm	8.18	5.50	9.60	40.32
G_3- 200 ppm	6.08	5.69	7.92	36.19
G_4- 300 ppm	5.94	5.76	7.55	35.88
G_5- 400 ppm	5.33	6.37	6.24	32.55
'F' test	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.08	0.07	0.16	0.45
CD at 5%	0.24	0.20	0.45	1.30
C) Interaction effect (AxB)				
'F' test	Sig.	Sig.	NS	NS
SE (m) ±	0.17	0.14	1.15	1.15
CD at 5%	0.47	0.41	-	-

Table 1(a): Interaction effect on flowering parameters as influenced by humic acid and gibberellic acid

Treatment combinations	Flowering parameters	
	Flower diameter (mm)	Stalk length (cm)
	Pooled	Pooled
H_1G_1	5.47	4.56
H_1G_2	6.18	5.14
H_1G_3	5.88	5.23
H_1G_4	5.57	5.53
H_1G_5	4.51	6.19
H_2G_1	6.68	5.12
H_2G_2	9.75	5.83
H_2G_3	6.75	6.23
H_2G_4	6.84	6.59
H_2G_5	6.17	6.48
H_3G_1	6.05	5.42
H_3G_2	8.63	5.42
H_3G_3	5.86	5.57
H_3G_4	5.86	5.17
H_3G_5	5.60	6.36
H_4G_1	6.05	5.05
H_4G_2	8.16	5.47
H_4G_3	5.83	5.41
H_4G_4	5.48	5.48
H_4G_5	5.06	6.02
F test	Sig.	Sig.
SE (m) ±	0.17	0.14
CD at 5%	0.47	0.41

Table 2: Effect of foliar application of humic acid and gibberellic acid on yield parameters in African marigold (mean pooled data over two year)

Factors	Flowering parameters		
	Flowers yield plant^{-1}	Flowers yield plot^{-1}	Flowers yield hectare^{-1}
	Pooled	Pooled	Pooled
A) Humic acid (H)			
H_1- Control	167.73	3.68	8.51
H_2- 0.2%	195.43	5.19	12.02
H_3- 0.4%	192.12	4.70	10.82
H_4- 0.6%	187.25	4.54	10.45
'F' test	Sig.	Sig.	Sig.
SE (m) ±	1.20	0.06	0.13
CD at 5%	3.42	0.16	0.36
B) Gibberellic acid (G)			
G_1- Control	181.67	4.31	9.82
G_2- 100 ppm	206.18	5.48	12.66
G_3- 200 ppm	186.68	4.57	10.57
G_4- 300 ppm	183.78	4.44	10.28
G_5- 400 ppm	169.86	3.85	8.91
'F' test	Sig.	Sig.	Sig.
SE (m) ±	1.34	0.06	0.14
CD at 5%	3.83	0.18	0.41

Conclusion

The experiment conducted on African marigold showed that the foliar application of humic acid at a concentration of 0.2% and gibberellic acid at 100 ppm at 15 and 30 days after transplanting resulted in the best outcome in terms of flowering and yield parameters. Both treatments showed significant improvements, indicating their potential for enhancing African marigold production.

Therefore, it can be concluded that foliar application of humic acid and gibberellic acid at 15 DAT and 30 DAT is an effective approach to promote the flowering and yield of African marigold during summer season.

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