



Effect of Plant Growth Regulators on Flower Yield and Shelf Life of Gaillardia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

To assess the impact of plant growth regulators (PGRs) on flower yield and quality of Gaillardia, an experiment was carried out at Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon (C.G.) during the 2022-2023. Thirteen treatments comprising different concentrations of GA₃ (100 ppm, 200 ppm, 250 ppm), NAA (100 ppm, 150 ppm, 200 ppm), CCC (500 ppm, 750 ppm, 1000 ppm), MH (50 ppm, 100 ppm, 150 ppm) and control (Distilled water) were laid out in a randomized block design with three replications. Application of different plant growth regulators was done at 30, 45 and 60 days after transplanting (DAT). Results revealed that foliar application of GA₃ 100 ppm significantly enhanced flower diameter (66.35 mm), number of flowers/plant (77.66), flower

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yield per plant (177.50 g), flower yield/plot (4.43 kg), flower yield/hectare (14.76 t/ha) and flowering duration (78.90 days) and shelf life (42 hrs). These findings suggest that GA₃ at 100 ppm is most effective in improving flowering, yield parameters and shelf life of *Gaillardia*.

Keywords: *Gaillardia*; plant growth regulators; GA₃; MH; CCC.

1. INTRODUCTION

Gaillardia pulchella L., commonly known as blanket flower, is an important ornamental species in the Asteraceae family, native to North and South America, with a chromosome number of $2n = 36$. It is appreciated for its vibrant, long-lasting flowers in shades of yellow, orange, red, and bronze, and for its spreading habit. The plant has alternately arranged leaves and typically reaches a height of around 30 cm. Among the 30 known species, *G. pulchella* (annual), *G. aristata* (biennial), and *G. grandiflora* (perennial) are of horticultural significance.

In India, and particularly in the state of Chhattisgarh, *Gaillardia* is cultivated both as a cut flower and for loose flower markets, with widespread use in garlands and religious offerings. The crop is extensively grown in districts such as Bilaspur, Mungeli, Dantewada, Raigarh, and Raipur, covering an estimated area of 184 hectares and yielding approximately 1,108 metric tonnes (Anonymous, 2018–19). *Gaillardia* is favoured for its adaptability to diverse climatic conditions, resistance to pests and diseases, and extended flowering period. Moreover, *Gaillardia pulchella* has been employed in erosion control and has shown nematicidal activity when incorporated as green manure. The successful cultivation of *Gaillardia* is influenced by a combination of genetic potential, environmental conditions, and cultural practices. Among modern horticultural tools, plant growth regulators (PGRs) have gained importance for managing plant architecture, enhancing flower yield, and improving quality. PGRs such as gibberellic acid (GA₃) and naphthalene acetic acid (NAA) promote vegetative growth by stimulating cell elongation, division, and photosynthetic activity. GA₃, in particular, enhances branching and ensures uniform flowering, contributing to higher flower yield (Acharya et al., 2021). Conversely, growth retardants such as maleic hydrazide and cycocel (CCC) are known to regulate plant height by inhibiting cell elongation, thereby enhancing flower compactness and improving market appeal (Garner, 2004). Given the increasing commercial importance of *Gaillardia* and the

potential of plant growth regulators (PGRs) to optimize its production, the present investigation was undertaken to evaluate the effects of various PGRs on growth, floral yield, and quality in *Gaillardia pulchella*.

2. MATERIALS AND METHODS

The present study was conducted during 2022–23 at the experimental farm of Pt. Kishori Lal Shukla College of Horticulture and Research Station, Pendri, Rajnandgaon. The site is geographically situated at 21.10° N latitude and 81.03° E longitude, with an average elevation of 307 meters above mean sea level. The climate of the region is tropical, characterized by hot summers, moderately cold winters, and a warm, humid monsoon season. During the experimental period, the maximum and minimum temperatures ranged from 26.4°C to 36.8°C and 9.2°C to 23.9°C, respectively, with a recorded rainfall of 70.5 mm. The soil of the experimental site was deep, moderately drained clay soil with a pH of 7.1, organic carbon 0.64g kg⁻¹, Available NPK 175 kg/ha, 3.18 kg/ha and 261 kg/ha, respectively. A field trial with three replicates was performed in RBD. Treatment consists of different concentrations of GA₃ (100 ppm, 200 ppm, 250 ppm), NAA (100 ppm, 150 ppm, 200 ppm), CCC (500 ppm, 750 ppm, 1000 ppm), MH (50 ppm, 100ppm, 150 ppm) and control (Distilled water). The genotype 'Miraj', a promising variety of *Gaillardia*, was used as the planting material for the experiment. This genotype was procured from the University of Horticultural Sciences, Bagalkot, Karnataka. The plants bear yellow flowers and are hardy, with good adaptability to a wide range of climatic conditions. The variety is characterized by spreading branches and thin, elongated, hairy leaves.

For seedling production, 98-celled prostrays were used, filled with a growing medium consisting of cocopeat and soil in a 1:1 ratio. One seed was sown per cell at a depth of 1 cm, using approximately 13–15 trays for seed germination. The trays were covered with a mulch sheet to facilitate rapid germination and placed under a protected structure. Regular watering was done

daily. After 30 days of sowing, healthy seedlings having 4–5 true leaves were selected for transplanting. Transplantation was carried out in the evening hours to avoid exposure to direct sunlight, and immediate light irrigation was provided. The seedlings were transplanted at a spacing of 40 × 30 cm. As per the recommending dose of manure for growth and development of plant FYM was applied @ 4.5 kg uniformly per plot into the soil before transplanting. Good cultural practices were followed during the entire crop period. Observations on vegetative (at 60 and 90 DAT) and yield parameters were observed and analyzed statistically using the analysis technique of variance with randomized block design (Panse and Sukhatme, 1995). The level of significance of t-test and F-test was kept at 5% (P=0.05).

3. RESULTS AND DISCUSSION

3.1 Flowering Parameters

Analysis of data showed in Table 1 that effect of plant growth regulators on flowering parameter of gaillardia viz., days taken to first flower bud appearance (DAT), days to flower open from bud stage, days required to first flowering (DAT), days required to 50% flowering (DAT), flowering duration (Days) and flower diameter (mm) was significant. The minimum days taken to first flower bud appearance (64.07 days), days to flower open from bud stage (7.06 days), days required for first flowering after transplanting (71.13 days), days required for 50 % flowering (85.66 days) and longest flowering duration (78.90 days) was registered with GA₃ 100 ppm) Whereas, maximum days taken to first flower bud appearance (72.54 days), number of days required for opening of flower from bud stage (11.86 days), days required for first flowering after transplanting (84.40 days), more number of days required for 50 % flowering after transplanting (101.33 days) and shortest flowering duration (69.30 days) was recorded in treatment T₁ (Control). Early flower bud appearance with GA₃ might be due to that GA₃ increased cell division and cell elongation. It also accumulates more carbohydrate in plant body which leads to early flower bud appearance. Early 50 % flowering with GA₃ might be due to early production of florigen, as GA₃ is component of florigen which is required for the formation of flowers in the plants. Comparable finding was registered by Singh *et al.* (2023) in African marigold and Salve *et al.* (2016) in chrysanthemum. The maximum flower diameter

(66.35 mm) was recorded in treatment T₂ (GA₃ 100 ppm) while, minimum flower diameter (45.29 mm) recorded in treatment T₁ (Control). The flower diameter increased significantly when plants were treated with GA₃ (Gibberellic acid) at 100 ppm. This might be because the flowers acted as strong sinks—they pulled more nutrients and food (photosynthates) from the plant, helping them grow larger. A similar increase in flower size was reported by Dutta *et al.* (1993) in chrysanthemum, where the flower size increased because the petals became longer and more numerous. Similar results were obtained by Patil (2002) in gaillardia and Chauhan *et al.* (2014) in gerbera.

3.2 Yield Parameters and Shelf Life

Analysis of data showed in Table 2 that effect of plant growth regulators on yield parameters and shelf life of gaillardia viz., number of flowers per plant, flower yield per plant (gm), flower yield per plot (kg), flower yield per ha (t/ha) and shelf life (hrs). The maximum number of flowers/plant (77.66), flower yield/plant (177.50 g), flower yield/plot (4.43 kg) and flower yield (14.76 t/ha) were noted with GA₃ 100 ppm whereas, minimum number of flowers per plant (59.46), flower yield per plant (123.71g), flower yield per plot (3.09 kg) and flower yield per ha (10.29 t/ha) was recorded with Control. After successful vegetative phase only, the plant could step into reproductive phase with better yield. Similar results were found by Ramdevputra *et al.* (2009) and Salem *et al.* (2016) in gerbera. Highest flower yield/plot with GA₃ might be due to a greater number of flowers per plant and improvement in weight of flowers per plant and production of large number of laterals at early stage of growth which had sufficient time to accumulate carbohydrate for proper flower bud differentiation due to enhanced reproductive efficiency and photosynthesis restrictive plant type. The results are in agreement with the findings of Sindhuja *et al.* (2018) and Kuri *et al.* (2018) in china aster. Highest flower yield/plot (4.43 kg) with GA₃ might be due to highest flower yield per plant. The results are in agreement with the findings of Sindhuja *et al.* (2018) and Kuri *et al.* (2018) in china aster. Significantly increase in flower yield with GA₃ might be due to a greater number of flowers per plant and improvement in weight of flowers per plant. Close parallelism between vegetative growth and flowering, and it is possible that promontory effect of GA₃ on vegetative growth, associated with efficient mobilization capacity. These results are in

Table 1. Effect of different plant growth regulators on flowering parameters of gaillardia

Treatment notation	Days taken to first flower bud appearance (DAT)	Days to flower open from bud stage	Days required to first flowering (DAT)	Days required to 50% flowering (DAT)	Flowering duration (Days)	Diameter of flower (mm)
T ₁ (Control)	72.50	11.86	84.40	101.33	69.30	45.20
T ₂ (GA ₃ 100 ppm)	64.07	7.06	71.13	85.66	78.90	66.35
T ₃ (GA ₃ 200 ppm)	65.00	7.46	72.46	88.66	77.50	63.12
T ₄ (GA ₃ 250 ppm)	66.10	7.60	73.73	89.00	76.30	61.23
T ₅ (NAA 100 ppm)	72.07	8.66	80.73	93.66	70.90	57.92
T ₆ (NAA 150 ppm)	70.16	8.43	78.60	92.33	71.40	58.66
T ₇ (NAA 200 ppm)	68.00	8.26	76.26	91.00	73.70	59.92
T ₈ (CCC 500 ppm)	69.54	9.86	79.40	98.33	70.60	53.15
T ₉ (CCC 750 ppm)	69.43	9.90	79.33	97.70	70.70	55.66
T ₁₀ (CCC 1000 ppm)	68.14	8.86	78.50	97.00	71.50	56.31
T ₁₁ (MH 50 ppm)	67.93	10.20	78.13	96.33	72.40	51.01
T ₁₂ (MH 100 ppm)	68.26	9.33	77.60	94.33	72.90	52.00
T ₁₃ (MH 150 ppm)	68.00	8.53	76.53	93.00	73.50	52.50
SE(m±)	1.61	0.38	2.07	2.68	1.94	2.46
CD(P=0.05)	4.73	1.11	6.10	7.88	5.70	7.22
CV	3.08	7.31	4.64	4.96	4.60	7.55

Table 2. Effect of different plant growth regulators on yield parameters and shelf life of gaillardia

Treatment notation	Number of flowers per plant	Flower yield per plant (gm)	Flower yield per plot (kg)	Flower yield per ha (t/ha)	Shelf life (hrs)
T ₁ (Control)	59.46	123.71	3.09	10.29	35.33
T ₂ (GA ₃ 100 ppm)	77.66	177.50	4.43	14.76	42.00
T ₃ (GA ₃ 200 ppm)	75.53	173.25	4.33	14.43	41.00
T ₄ (GA ₃ 250 ppm)	74.60	171.37	4.28	14.26	40.66
T ₅ (NAA 100 ppm)	65.86	150.26	3.75	12.49	36.33
T ₆ (NAA 150 ppm)	66.30	151.44	3.78	12.59	37.66
T ₇ (NAA 200 ppm)	68.66	152.95	3.82	12.73	38.03
T ₈ (CCC 500 ppm)	71.53	160.01	3.96	13.19	38.33
T ₉ (CCC 750 ppm)	72.93	163.09	4.07	13.56	38.66
T ₁₀ (CCC 1000 ppm)	74.23	164.51	4.11	13.69	39.00
T ₁₁ (MH 50 ppm)	65.33	153.62	3.83	12.76	39.40
T ₁₂ (MH 100 ppm)	65.53	154.88	3.86	12.86	39.66
T ₁₃ (MH 150 ppm)	69.00	162.19	4.04	13.46	40.33
SE(m±)	3.25	7.70	0.18	0.65	1.07
CD(P=0.05)	9.56	22.61	0.53	1.92	3.14
CV	8.08	8.42	8.01	8.58	4.76

harmony with outcome of Gupta and Dutta (2000) and Ramdevputra et al. (2009) in chrysanthemum. The maximum shelf life (42 hrs) of flowers was recorded in treatment T₂ (GA₃ 100 ppm) while, minimum shelf life (35.33 hrs) of flowers recorded in treatment T₁ (Control). This might be due to the increase activity of amylase enzyme by GA₃ which hydrolyzed the extensive starch reserves and released the reducing sugar. Reducing sugars being osmotically active cause an influence of water, resulting in increased shelf life of flowers. Similar result was observed by Navale et al. (2010) in chrysanthemum.

4. CONCLUSION

Among the various plant growth regulators evaluated, foliar application of GA₃ at 100 ppm proved to be the most effective in enhancing the growth, flower yield, and shelf life of *Gaillardia*. However, as these findings are based on a one-season study, further investigations across multiple seasons and locations are necessary to establish more robust and reliable recommendations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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