Society of Krishi Vigyan
www.iskv.in

J Krishi Vigyan 2026, 14(1) : 27-31

DOI: 10.5958/2349-4433.2026.00005.6

ISSN 2319-6432 (Print)
ISSN 2349-4433 (Online)

Effect of Bio-Inoculant and Gibberellic Acid on Flowering Parameters of African Marigold

Abhinav Kumar
Department of Horticulture, Faculty of Agriculture Sciences
Shree Khushal Das University, Hanumangarh, Rajasthan

www.IndianJournals.com
Not for Commercial Use
Downloaded From IP - 216.73.217.22 on dated 23-Nov-2026

ABSTRACT

The study was carried out during the year 2024–2025 at the Main Experiment Station, Department of Horticulture, Faculty of Agriculture Sciences, Shree Khushal Das University, Hanumangarh, Rajasthan. In order to assess the individual and combined impacts of bio-inoculants (Azotobacter) and Gibberellic acid (GA_3) on flowering characteristics of African marigold, the experiment was set up in a Factorial Randomized Block Design with 12 treatment combinations and three replications. The use of Azotobacter through soil treatment greatly improved early blossoming and overall flower quality. The earliest bud initiation, first flowering, 50% blooming, maximum flowering duration, flower stalk length, flower quantity, and fresh and dried flower weight were all noted in this treatment. By encouraging early bud formation, boosting cell division and elongation and increasing dry matter accumulation, foliar treatment of GA_3 at 200 ppm (G_4) at 30 DAT observed to be the most beneficial among the GA_3 levels in improving flowering metrics. The combination A_3G_4 (Azotobacter soil treatment + GA_3 200 ppm) consistently produced the most favorable trends for all flowering attributes, including flower diameter and overall floral yield, even though both bio-inoculants and GA_3 individually showed significant improvements and their interaction effect was statistically non-significant. While GA_3 administration successfully shortened the juvenile phase and accelerated the transition to reproductive development. In order to achieve superior blooming, greater quality, and higher output in African marigold, a combination of soil-applied Azotobacter (4 L/ha) and foliar GA_3 spray (200 ppm at 30 DAT) were found to be the most effective treatment.

Keywords: Bio fertilizer, GA_3, Flowering, Growth, Marigold, Plant Growth Regulator

INTRODUCTION

The African marigold (*Tagetes erecta* L.) is a popular annual flower that is prized for its beauty and extended blooming period. Marigold can be grown in all seasons, including rainy, winter, and summer, with rainy and winter crops being the most common in eastern Uttar Pradesh. African marigold (*Tagetes erecta*), French marigold (*Tagetes patula*), Signet marigold (*Tagetes tenuifolia*), and tiny marigold (*Tagetes tenuifolia*) are the most commonly cultivated Tagetes species (*Tagetes minuta*). Marigold loose flowers are used to make garlands, baskets, and *veni*, among other things. The petals are frequently used to create unique greeting cards, stationary, envelopes, and corporate gifts by embedding them in handmade paper. It's also utilized as a flavouring agent in a variety of bread goods, dairy products, yoghurt, and ice cream, and its powder and extracts have been allowed for use as sole colourants in chicken feed. Marigolds have also been identified as a food plant for some Lepidoptera caterpillars, such as the dot moth, as well as a nectar source for other butterflies. Marigold is a highly successful nematode control crop when used as a trap crop for nematode (*Helicoverpa armigera*) management in tomato fields.

Microbial inoculants of specific microorganisms, such as azotobacter, a free-living nitrogen-fixing bacteria, aid in improving soil fertility by accelerating biological nitrogen fixation from the atmosphere (approximately 25 to 30 l nitrogen per hectare), solubilizing insoluble nutrients in soil, generating small amounts of PGRs decomposing plant residues, improve flower quality by producing Phyto hormones, and enhancing plant nut uptake. Gibberellic acid is vital for stalk elongation, flower induction, flower and seed development, and storage reserve mobilisation. Gibberellic acid has been discovered to be particularly effective in controlling chrysanthemum growth and flowering (Gautam *et al*, 2006). Hence, a

Corresponding Author's Email - abhinavkumar188@gmail.com

Table 1: Effect of Bio-Inoculants and GA3 on Flowering Parameters of African Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

Treatment	Days to first bud initiation	Days taken to first flowering	Days taken to 50 % Flowering	Duration of Flowering (Days)	Length of flower stalk (cm)	Number of flowers per plant	Fresh weight of per flower (g)	Dry weight of per flower. (g)	Flower diameter (cm)
A_1	51.83	61.67	70.08	40.92	6.42	32.92	7.61	0.76	5.39
A_2	45.33	58.83	66.67	43.58	6.92	37.08	8.19	0.83	6.11
A_3	42.25	55.75	65.33	51.67	7.67	44.83	9.16	0.92	7.39
SEm±	1.007	1.359	1.201	0.841	0.233	0.852	0.158	0.019	0.178
C.D.(P=0.05)	2.954	3.986	3.524	2.465	0.683	2.499	0.463	0.057	0.521
G_1	48.44	66.33	71.89	42.00	6.11	29.11	7.26	0.75	5.70
G_2	46.56	57.67	67.56	44.22	6.67	36.89	8.11	0.83	6.26
G_3	45.78	56.11	65.44	46.44	7.44	41.11	8.41	0.85	6.48
G_4	45.11	54.89	64.56	48.89	7.78	46.00	9.52	0.91	6.74
SEm±	1.163	1.569	1.387	0.971	0.269	0.984	0.182	0.022	0.205
C.D.(P=0.05)	NS	4.603	4.069	2.847	0.789	2.886	0.535	0.066	0.602
A_1 G_1	53.67	66.67	76.67	38.00	5.67	25.67	6.67	0.69	4.89
A_1 G_2	52.33	62.00	70.00	39.67	6.33	30.67	7.33	0.73	5.33
A_1 G_3	51.00	59.67	67.33	42.33	6.67	36.33	7.67	0.77	5.55
A_1 G_4	50.33	58.33	66.33	43.67	7.00	39.00	8.78	0.86	5.77
A_2 G_1	46.33	66.33	71.00	39.33	6.00	28.33	7.11	0.73	5.44
A_2 G_2	45.67	57.00	66.33	41.33	6.67	36.00	8.33	0.84	6.11
A_2 G_3	45.00	56.33	65.00	44.67	7.33	40.33	8.44	0.85	6.33
A_2 G_4	44.33	55.67	64.33	49.00	7.67	43.67	8.89	0.89	6.55
A_3 G_1	45.33	66.00	68.00	48.67	6.67	33.33	8.00	0.82	6.77
A_3 G_2	41.67	54.00	66.33	51.67	7.00	44.00	8.66	0.92	7.33
A_3 G_3	41.33	52.33	64.00	52.33	8.33	46.67	9.11	0.95	7.55
A_3 G_4	40.67	50.67	63.00	54.00	8.67	55.33	10.89	0.98	7.89
SEm±	2.015	2.718	2.403	1.681	0.466	1.704	0.316	0.039	0.355
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

www.IndianJournals.com
Not for Commercial Use
Downloaded From IP - 216.73.217.22 on dated 23-Nov-2026

study was conducted to note down the effect of bio-inoculant and gibberellic acid on flowering parameters of african marigold.

MATERIALS AND METHODS

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications and twelve treatments at main experimental station, Department of Horticulture, Faculty of Agriculture Sciences, Shree Khushal Das University, Hanumangarh, Rajasthan during the year 2024-25. The treatments were A_1(Control), A_2 (Azotobacter by root treatment 0.25g/15 plants), A_3(Azotobacter by soil treatment 4L/ha), G_1(Control) G_2 (Gibberellic acid 100 ppm spray at 30 DAT), G_3 (Gibberellic acid 150 ppm spray at 30 DAT), G_4 (Gibberellic acid 200 ppm spray at 30 DAT), A_1G_1(Control), A_1G_2 (Gibberellic acid 100 ppm spray at 30 DAT), A_1G_3 (Gibberellic acid 150 ppm spray at 30 DAT), A_1G_4(Gibberellic acid 200 ppm spray at 30 DAT), A_2G_1 (Azotobacter by root treatment @ 0.25%), A_2G_2 (Azotobacter by root treatment 0.25% +100ppm gibberellic acid at 30DAT) A_2G_3 (Azotobacter by root treatment 0.25% +150ppm gibberellic acid at 30DAT) A_2G_4 (Azotobacter by root treatment@0.25% + 200ppm gibberellic acid at 30DAT) A_3G_1 (Azotobacter by soil treatment @4l/ha), A_3G_2 (Azotobacter by soil treatment @ 4l/ha +100ppm gibberellic acid at 30DAT), A_3G_3 (Azotobacter by soil treatment @ 4l/ha +150ppm gibberellic acid at 30DAT), A_3G_4 (Azotobacter by soil treatment @ 4l/ha +200ppm gibberellic acid at 30DAT).

The marigold seeds were sown in raised beds measuring 120×60×10cm. during the last week of September 2024-25. A mixture of garden soil and

www.IndianJournals.com
Not for Commercial Use
Downloaded From IP - 216.73.217.22 on dated 23-Nov-2026

coarse sand was used to enclose the seed beds. Seeds were sown in a clean line with a 4-5cm gap. After seeding, the nursery beds were covered by paddy straw as a mulch. Light irrigation provided at regular interval. Within 4-5 days of seeding, the seeds germinated, and the mulch layer was removed. The seedlings were hardened by withholding water for two to three days before being lifted. Watering was done in the morning, however, to help seedlings be lifted smoothly. Twenty-five days old seedlings were planted in the evening for their better survival. The plants of marigold were maintained healthy by using appropriate culture practice during the course of investigation and five plants were randomly selected from each plot and were tagged for recording various observations on days to first bud initiation, days to first flowering, days taken 50% flowering, duration of flowering, length of flower stalk, number of flowers per plant, fresh weight of flower, dry weight of flower and flower diameter. The data were analysed statistically as given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The data (Table 1) revealed that the earliest first bud initiation (42.25), first flowering (55.75) and 50% flowering (65.33 d) was recorded in the plants treated with the treatment A_3 (Azotobacter by Soil Treatment 4L/ha), whereas the maximum period taken for days to first bud initiation, days to first flowering and 50% flowering was recorded with A_1 (control) 51.83. Early bud initiation and First flowering in azotobacter-inoculated plants may be due to simple nutrient uptake and simultaneous transportation of growth-promoting compounds like cytokinin to axillary buds, resulting in apical dominance breaking. As a result, the plant has a better sink for rapid mobilization of photosynthates and an earlier transition from vegetative to the reproductive phase the present findings are in close agreement with Yadav *et al* (2018); Kumar and Kumar (2018) in marigold and Chaupoo *et al* (2020) reported hastened flower bud initiation in plants of marigold cv. Pusa Narangi Gainda treated with azotobacter.

The application of gibberellic acid has no significant effect on days to first bud initiation in the year 2019-20. The least number of days required for first bud initiation (45.11 d), first flowering (54.89 d) and 50% flowering (64.56 d) whereas the maximum days to first bud initiation, first flowering and 50% flowering with the treatment G_1 (Control). The foliar application of GA_3 significantly induced early bud and flowering which might be attributed to an increase in endogenous gibberellins levels in the plants. GA_3 was also quite successful in shortening the juvenile period of plants due to its powerful ability of cell division and cell elongation, which induces early maturity in plants. Similar results were also reported by Salem *et al* (2016) reported a positive significant effect of application of gibberellic acid on flowers of gerbera (*Gerbera jamesonii*) cv Dennis treated with GA_3 150 ppm; Mishra *et al* (2017) concluded early flower bud initiation through the application of GA_3 300 ppm one month after transplanting in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda.

The interaction of the application of the interaction of azotobacter with gibberellic acid was found statistically non-significant. The longest duration of flowers (51.67 d), Longest length of flower stalk (7.67), maximum number of flowers per plant (44.83), Fresh Weight of per flower (9.16), Dry Weight of per flower (0.92) and Flower diameter (7.39) was observed under the Treatment A_3 (Azotobacter by Soil Treatment 4 l/ha) and shortest duration of flowering (40.92), flower stalk (6.42 cm), number if flowers per plant (32.92), Fresh Weight of per flower (7.61g), Dry Weight of per flower (0.76g) and Flower diameter (5.39cm) observed under A_1 (Control). The application of azotobacter increased the availability of nitrogen and other nutrients as well as the secretion of growth-promoting hormones, which stimulates vegetative growth toward the development of superior flowering parameters. The present findings were in conformity with Mittal *et al* (2010), Kumawat *et al* (2017) described the positive response of marigolds to the inoculation of azotobacter. Kumar and Kumar (2018) in marigold, Gawade *et al* (2019) explained the beneficial impact of azotobacter on the chrysanthemum cv. Ratlam Selection.

Similarly, the longest duration of flowers (48.89d), Longest length of flower stalk (7.78), maximum number of flowers per plant (46.00), Fresh Weight of per flower (9.52g), Dry Weight of per flower (0.91) and Flower diameter (6.74 cm) was observed under the Treatment G_4 (GA_3 200 ppm at 30 DAT) and shortest duration of flowering (42.00), flower stalk (6.11cm), number of flowers per plant (29.11), Fresh Weight of per flower (7.26 g), Dry Weight of per flower (0.75) and Flower diameter (5.70) observed under A_1 (Control). The superior results of flower quality were obtained through the application of GA_3. The increased bloom diameter mediated by GA_3 administration could be due to increased cell division and cell enlargement as well as enhanced protein synthesis and dry matter accumulation. In case of duration of flowering with

GA_3 was most likely to be attributed to a reduction in the juvenile period in the interphase of the cell cycle, as a reduction in the S-phase encourages the shoot apical meristem to commence producing buds instead of leaves and branches. (Khangjarakpam *et al,* 2019). Kumar *et al* (2010) and Nair *et al* (2002) found similar results in gerbera. Number of flowers per plant in marigold attributed to gibberellic acid treatment could be due to the production of a large number of laterals at an early stage of growth, which had sufficient time to accumulate carbohydrates for optimal flower bud differentiation leading to enhanced reproductive efficiency and photosynthesis in the restructured plant type, which subsequently boosted the number of flowers per plant. Similar results were also reported by Sarkar *et al*. (2019) in marigold, Salem *et al*. (2016) in Gerbera. Ardalani *et al* (2014) reported a beneficial effect of GA_3 on marigolds in improving flower quality parameters. Floral weight may result from GA_3-mediated growth, biomass production, and carbohydrate content in crop plants. The GA_3 application encouraged corella growth, pollen germination, and pollen tube growth, resulting in an increase in flower weight. The results were in agreement with Shinde *et al* (2010) in chrysanthemum, Manimaran *et al* (2017) in gladiolus and Imandi *et al* (2017) in marigold cv. Siracole, Syngkrem *et al* (2018) in white marigold and Pangrahi *et al* (2020) in gladiolus cv. Malaviya Kundan. The interaction of azotobacter and gibberellic acid was found non-significant.

www.IndianJournals.com
Not for Commercial Use
Downloaded From IP - 216.73.217.22 on dated 23-Nov-2026

CONCLUSION

It may be concluded that the application of Azotobacter and GA_3 (Soil treatment with Azotobacter + spray of GA_3 200 ppm after 30 days of transplanting) may significantly improve the flowering and quality (Days to first bud initiation, Days taken to first flowering, Days taken to 50 % Flowering, Duration of Flowering (Days), Length of flower stalk (cm), Number of flowers per plant, Fresh weight of per flower (g), Dry weight of per flower. (g) and Flower diameter) of the marigold plants.

REFERENCES

Anburani A, Ajith D and Naik B P K (2025). Effect of foliar application of micronutrients on growth and yield of Marigold (*Tagetes erecta* L.). *J Krishi Vigyan* **13**(2): 282-287. DOI: 10.5958/2349-4433.2025.00051.9.

Shaikh A J, Yadlod S S and Kadari I A (2018). Effect of liquid bio-inoculants and fertilizer levels on growth and yield of African marigold (*Tagetes erecta* L.) cv. Calcutta. *Int J Chem Stu* **6**(6): 1968-1970.

Ardalani H, Hadipanah A and Pourrezvani S M (2014). Foliar Application Gibberellic acid and ethanol on flower yield and phenolic compositions in marigold (*Callendula officinalis* L.). *Elect J Biology* **10**(3): 73-78.

Chaupoo A S and Kumar S (2020). Integrated nutrient management in Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. *Int J Curr Microbiol App Sci* **9**(5): 2927-2939. https://doi.org/10.20546/ijcmas.2020.905.336

Gautam S K, Sen N L, Jain M C and Dashora L K (2006). Effect of plant growth regulators on growth, flowering and yield of chrysanthemum cv. Nilima. *Orrisa J of Hort* **34**(1): 36-40.

Gawade N V, Varu D K and Devdhara U (2019). Response of Biostimulants and Biofertilizers on Yield and Quality of Chrysanthemum cv. Ratlam Selection. *Int J Curr Microbiol App Sci* **8**(9): 2732-2742. https://doi.org/10.20546/ijcmas.2019.809.314

Imandi S and Reddy G V S (2017). Studies on the Effect of plant growth regulators on vegetative growth, flowering, yield and shelf life of the Marigold cv. Siracole. *Int J Agri Sci and Res* **4**(7): 65-70.

Kaplan L (1960). Historical and ethnobotanical aspects of domestication in Tagetes. *Econ Bot* **14**: 200-202.

Kaur R, Badyal S, Kumar R, Choudhary P and Kumar P (2020). Impact of frontline demonstrations on yield, economics and adoption of Marigold Cultivation. *J Krishi Vigyan* **8** (2): 178-181; DOI : 10.5958/2349-4433.2020.00037.9

Khangjarakpam G, Singh L J, Maitra S, and Mandal S (2019). Influence of foliar application of Gibberellic acid on growth, development, yield and biochemical constituents of African marigold cv. Pusa Narangi Gainda. *J Pharma and Phytochem* **8**(4): 1581-1585.

Kumar A and Kumar A (2018). Effect of bio-fertilizers and nutrients on growth and flower yield of

summer season african marigold (*Tagetes erecta* L.). *Pl Arch* 17(2): 1090-1092.

Kumar R, Ram M, and Gaur G S (2010). Effect of GA_3 and ethrel on growth and flowering of African marigold cv. Pusa Narangi Gainda. *Indian J Hort* **67**: 362-366.

Kumawat M, Khandelwal S K, Choudhary M R, Kumawat P K, Sharma G and Panwar P (2017). Effect of Integrated Nutrient Management on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.). *Int J Curr Microbiol App Sci* **6**(8): 60-65. https://doi.org/10.20546/ijcmas.2017.608.009

Manimaran P, Ghosh S and Priyanka R (2017). Bulb Size and Growth Regulators on the Growth and Performance of Bulbous Ornamental Crops. *Chem Sci Rev Let* **6**(22): 1277-1284.

Mishra P (2017) Effect of plant growth regulators on vegetative growth and flowering characters of African Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. *Int J Agri Sci and Res* **7**(1): 173-178.

Mittal R, Patel H C, D D N and Sitapara H H (2010) effect of integrated nutrient management on flowering, yield and vase life of African marigold cv. Local under middle Gujarat Agroclimatic conditions. *Asian Sci* **5** (1): 22-24.

Nair S, Singh V, and Sharma T (2002). Effect of plant growth regulators on yield and quality of gerbera under Bay Island conditions. *Indian J Hort* 59(1): 100-105.

Panigrahi S, Sisodia A and Singh A K (2020). Studied on Effect of growth regulators and corm size on growth and corm parameters in gladiolus cv. malaviya kundan. *The Bioscan* **15**(2): 247-251.

Panse V G and Sukhatme B V (1985). *Statistical Method for Agricultural Workers*. IInd. Ed., Indian Council of Agricultural Research, New Delhi.

Salem R A A, Saravanan D S and Prasad V M (2016). Effect of gibberellic acid spraying on yield and flowers of Gerbera (*Gerbera jamesonii*) cv Dennis. *Int J Sci Res* **5**(3): 376-377.

Sarkar D, Saud B K, Mahanta P, Kalita P, Neog B and Talukdar M C (2018). Response of pinching and gibberellic acid on growth and physiological characteristics of African Marigold. *Int J Curr Microbiol App Sci* **7**(3): 1666-1672. https://doi.org/10.20546/ijcmas.2018.703.199

Shinde K H, Parekh N S, Upadhyay N V and Patel H C (2010) Investigation of different levels of gibberellic acid (GA_3) and pinching treatments on growth, flowering and yield of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. 'IIHR-6' under middle Gujarat conditions. *Asian Hort* **12** (2): 416-419.

Yadav K S, Pal A K, Singh A K, Yadav D and Mauriya S K (2018). Effect of different bio-fertilizers on growth and flowering of marigold. J *Pharm and Phytochem* **7**(1): 1548-1550.

Received on 15/03/2026 Accepted on 30/03/2026

www.IndianJournals.com
Not for Commercial Use
Downloaded From IP - 216.73.217.22 on dated 23-Nov-2026