International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(10): 266-270
www.biochemjournal.com
Received: 16-07-2024
Accepted: 21-08-2024

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Studies on the impact of organic and inorganic stimulants on growth, flowering and corm production in gladiolus (*Gladiolus grandiflorus* L.)

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DOI: https://doi.org/10.33545/26174693.2024.v8.i10d.2445

Abstract

An experiment entitled "Studies on the impact of Organic and Inorganic Stimulants on growth, flowering and corm production in Gladiolus (*Gladiolus grandiflorus* L.)" was carried out at the Horticultural Research cum Instructional farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2023-24. The treatment contained GA_3 (100 and 200 ppm), Thiourea (2% and 3%), BA (50 and 100 ppm), KNO_3 (250 and 500 ppm), Cow urine (25 and 50%), Cow dung slurry (25 and 50%) and Water (Control). The experiment was performed in a Randomized Block Design with three replications. The application of GA_3 at 200 ppm proved to be the most effective in increasing days taken to sprouting (5.38 days), plant height (129.07 cm), number of days taken to spike initiation (59.00 days), spike length (76.13 cm), number of florets per spike (14.73), vase life of cut spike days (10.20), weight of corms per plant (63.30 g) and weight of cormels per plant (23.86 g). BA increased number of sprouts per corm (3.30), number of spike (3.30) and number of corms per plant (3.06). Whereas among the organic stimulants cow dung slurry at 50% performed best in improving spike length (72.80 cm).

Keywords: Gladiolus, GA_3, BA, thiourea, KNO_3, cow urine, cow dung slurry, randomized block design (RBD)

Introduction

Gladiolus is a prominent cut flower in India and globally valued for its striking spikes adorned with elegant delicate florets that bloom sequentially, offering excellent keeping quality. These flowers ranging from white to deep crimson are primarily used for garden and interior decoration as well as in bouquet. Belonging to the Iridaceae family, gladiolus is native to Africa and Asia Minor and was introduced to India by the British in the 16th and 17th centuries. Initially believed to thrive only in hilly regions, advancements in agricultural practices have demonstrated that gladiolus can also flourish in various climates and soil types including the plains of Chhattisgarh. This has led to increased cultivation as a cash crop, particularly in districts like Raipur, Durg and Bilaspur. Currently, around 500 to 1,000 hectares are dedicated to gladiolus cultivation in the State.

Plant Growth Regulators (PGRs) are bioactive compounds that modulate specific growth processes in plants including root and shoot development, flowering time and overall yield and quality. Key PGRs like auxins, gibberellins, and cytokinins regulate cell division, elongation and flowering. In gladiolus cultivation, thiourea enhances growth, stress resilience, flowering and yield making it a valuable bioactive tool in ornamental horticulture. Additionally, Potassium Nitrate (KNO_3) is essential for nutrient supply, flowering enhancement, root growth, stress tolerance and quality improvement. Organic inputs such as cow dung slurry and cow urine contribute to gladiolus cultivation by providing nutrients, improving soil health, boosting growth, increasing pest resistance, supporting sustainability, and enhancing flower quality and yield. Benzyl Aminopurine (BA) a growth regulator can enhance sprouting, boost the number of sprouts per plant and increase corm production.

Materials and Methods

A field experiment was conducted at the Horticultural Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the

2023-24 season to assess the effects of GA_3, thiourea, BA (benzyl adenine), KNO_3, cow urine, and cow dung slurry on sprouting, flowering, and corm production. Medium-sized gladiolus corms (4-6 cm in diameter) were soaked in a 0.2% Carbendazim fungicide solution for 30 minutes, then dried in the shade for 3 to 4 hours. The corms were subsequently soaked for 24 hours in the various treatments and a control (water), then dried for another 24 hours before planting. They were planted randomly in plots spaced 30×20 cm apart, with irrigation applied the day before to maintain moisture. Planting done on November 2023, using a Randomized Block Design (RBD).

Results and Discussion

Vegetative parameters

Number of days taken to sprouting (days)

GA_3 significantly promoted the sprouting of corms. The shortest time to sprouting (5.38 days) was observed in Treatment T_2 - GA_3 at 200 ppm, which was statistically similar to Treatment T_1 - GA_3 at 100 ppm (5.68 days). Among the organic stimulants, T_9 (cow urine) required the least time to sprout, taking 7.60 days. Conversely, the longest duration to sprouting (15.73 days) was recorded in T_0 (Control). The observed decrease in number of days taken to sprouting from applying GA_3 may be attributed to the promoting effects of gibberellic acid on the dormancy of gladiolus corms, leading to enhanced cell division in the shoot tip and cell elongation. These findings align with earlier studies on the sprouting of gladiolus corms on cormels. Additional support for these results comes from Suresh *et al.* (2009) [41], Khan *et al.* (2013) [20], Amin *et al.* (2013) [2], and Neetu *et al*. (2013) [31]. Similar outcomes were also reported by Kumar and Singh (2005) [24] and Baskaran *et al.* (2014) [9] in gladiolus.

Number of sprouts per corm

The highest sprouts count per corm (3.30) was noted in Treatment T_5 (BA at 50 ppm), which was statistically similar to Treatment T_6 - BA at 100 ppm (3.20). Relatively, cow urine (T_9) at 25% generated the maximum number of corms (1.33) among the organic stimulants. In comparison, Treatment T_0 (Control) had the minimum sprout count per corm (1.00). Axillary bud break and subsequent shoot growth have been reported to be stimulated by the external application of cytokinins to a number of plants. This may have been caused by BA breaking dormancy, which promoted sprouting. There are more shoots per corm as a result of BA's increase of cell expansion and shoot differentiation. This is in accordance with the results obtained by Abou-El-Ella (2007) [3], Anju Pal *et al*. (2003) [4] and Baskaran and Misra (2007) [7].

Plant Height (cm)

At 30 DAP, clearly showed that the maximum plant height (47.75 cm), was obtained in treatment T_1 (GA_3 at 100 ppm), which was also comparable to T_2 - GA_3 at 200 ppm (44.62 cm). Among the organic stimulants cow dung slurry at 25% (T_{11}) obtained maximum height (43.80). However, minimum plant height (35.28 cm) was obtained in T_0 (Control).

At 60 DAP (88.34 cm) is obtained in treatment T_2 (GA_3 at 200 ppm) which was statistically similar to treatment T_1 - GA_3 at 100 ppm (87.79 cm). In case of organic stimulants cow dung slurry at 50% (T_{12}) obtained maximum height (84.46 cm). However, minimum plant height (69.47 cm) was obtained in treatment T_0 (Control).

At 90 DAP the maximum plant height (129.07 cm) was obtained in treatment T_2 (GA_3 at 200 ppm), which was statistically similar to treatment T_1 - GA_3 at 100 ppm (125.73 cm). In Case of organic stimulants cow dung slurry at 50% (T_{12}) observed maximum height (123.47 cm). However, minimum plant height (103.8 cm) was obtained in T_0 (Control). GA_3 increases plant cell division and elongation, which results in an increase in the number of cells and lengthening of the cells, and both of which have an impact on plant growth. This is in accordance with the findings of Sharma *et al.* (2004) [39], Rana *et al.* (2005) [36], Bhalla and Kumar (2008) [10], Kumar *et al.* (2008) [23], Awasthi *et al.* (2012) [5], Chopde *et al.* (2012) [14], Dogra *et al*. (2012) [17] and Sudhakar and Kumar (2012) [40].

Floral and corms Parameters

Number of days to spike initiation

The minimum number of days (59.00 days) to spike initiation was obtained in treatment T_2 (GA_3 at 200 ppm) which was statistically similar to treatment T_1 (GA_3 at 100 ppm) that is 59.13 days. Among the organic stimulants cow urine at 25% (T_9) took minimum days (65.40) to spike initiation. However, Maximum number of days (73.06 days) to spike initiation was obtained in treatment T_5 (BA at 50 ppm). Early spike initiation (59 days) was recorded in GA_3 at 200 ppm, this may be the result of early corm emergence, early vegetative phase competition as seen by rapid cell division and elongation, and the fact that GA_3 is highly effective in shortening the plant juvenile phases (Wagh *et al.* 2012) [46].

Spike length (cm)

The maximum spike length (76.13 cm) was obtained with the treatment T_2 (GA_3 at 200 ppm) which was statistically similar to treatment T_1 - GA_3 at 100 ppm (73.26 cm). Among the organic stimulants cow dung slurry at 50% (T_{12}) obtained maximum spike length which is (72.80 cm). Whereas, minimum spike length (63.00 cm) was obtained in treatment T_0 (Control). The increased spike length with the application of GA_3 might be due to rapid internodal elongation, rapid cell division and cell elongation in the intercalary meristem (Ashwini *et al*. 2019) [6].

Number of spike/plant

The maximum number of spike (3.30) was obtained with the treatment T_5 (BA at 50 ppm) which was statistically similar to treatment T_6 - BA at 100 ppm (3.13). As an organic stimulants cow urine at 25% and cow dung slurry at 50% both obtained maximum number of spike per plant (2.06). Whereas, minimum number of spike per plant (1.53) was obtained in treatment T_0 (Control). A possible explanation for an increase in spike yield is that cytokinin promotes lateral bud growth and cell division, both of which result in multiple shooting. This report is in conformity with Murti and Upreti (1995) [30] and Baskaran and Misra (2007) [7].

Number of florets/spike

The maximum number of florets per spike (14.73) was obtained with the treatment T_2 (GA_3 at 200 ppm) which was statistically similar to treatment T_9 - Cow urine at 25% (13.80). Among the organic stimulants cow urine at 25% (T_9) obtained maximum number of florets per spike (13.80).

Whereas, minimum number of florets per spike (12.07) was obtained in treatment T_0 (Control). Gibberellic acid promotes the growth of auxiliary buds and their flowering. This might be resulted from the optimal amount of GA_3 being available, which enhanced the length of the rachis and spikes, both of which are positively linked with the number of florets per spike. These observations and findings in the present investigation are in conformity with earlier reports by Sarkar *et al*. (2009) [38] in tuberose.

Table 1: Effect of Organic and inorganic stimulants on growth and flowering parameters

Treatments	Number of days taken to sprouting	Number of sprouts per corm	Plant height (cm)			Number of days to spike initiation	Spike length (cm)	Number of spike
Control (T_0)	15.73^{a}	1.00^{e}	35.28^{e}	69.47^{g}	103.80^{d}	71.60^{b}	63.00^{e}	1.53^{b}
GA_3 100 ppm (T_1)	5.68^{i}	1.30^{cd}	47.75^{a}	87.79^{a}	125.73^{ab}	59.13^{i}	73.26^{ab}	1.66^{b}
GA_3 200 ppm (T_2)	5.38^{i}	1.60^{b}	44.62^{b}	88.34^{a}	129.07^{a}	59.00^{i}	76.13^{a}	2.00^{b}
Thiourea 2% (T_3)	7.80^{gh}	1.30^{cd}	37.00^{e}	72.01^{f}	114.80^{bcd}	61.13^{h}	63.70^{e}	1.80^{b}
Thiourea 3% (T_4)	9.00^{e}	1.50^{bc}	40.61^{cd}	71.99^{f}	113.60^{cd}	62.93^{fg}	63.20^{e}	2.13^{b}
BA 50 ppm (T_5)	13.40^{c}	3.30^{a}	40.16^{d}	77.79^{cd}	118.13^{abc}	73.06^{a}	67.53^{de}	3.30^{a}
BA 100 ppm (T_6)	14.13^{b}	3.20^{a}	36.64^{e}	78.86^{c}	119.80^{abc}	71.66^{b}	62.86^{e}	3.13^{a}
KNO_3 250 ppm (T_7)	11.86^{d}	1.30^{cd}	36.32^{e}	74.55^{e}	116.67^{bc}	63.26^{f}	66.60^{de}	1.60^{b}
KNO_3 500 ppm (T_8)	12.26^{d}	1.70^{b}	42.76^{bcd}	76.99^{d}	117.47^{bc}	62.46^{g}	66.267^{de}	1.73^{b}
Cowurine 25% (T_9)	7.60^{h}	1.33^{cd}	43.08^{bcd}	83.51^{b}	120.47^{abc}	65.40^{e}	69.80^{bcd}	2.06^{b}
Cowurine 50% (T_{10})	7.80^{gh}	1.26^{cde}	41.98^{bcd}	84.35^{b}	121.93^{abc}	66.73^{d}	71.13^{abcd}	2.00^{b}
Cow Dung slurry 25% (T_{11})	8.06^{g}	1.06^{de}	43.80^{bc}	83.28^{b}	119.47^{abc}	66.80^{d}	67.83^{cde}	2.06^{b}
Cow dung slurry 50% (T_{12})	8.53^{f}	1.20^{de}	41.08^{cd}	84.46^{b}	123.47^{abc}	67.53^{c}	72.80^{abc}	1.80^{b}
S.Em±	0.14	0.084	1.01	0.44	3.32	0.214	1.612	0.216
CD at 5%	0.41	0.247	2.96	1.29	9.71	0.627	4.707	0.631

Vase life of cut spike (days)

The maximum vase life of cut flower (10.2 days) was obtained with the treatment T_2 (GA_3 at 200 ppm) which was statistically similar to treatment T_1- GA_3 at 100 ppm (8.80 days). Among the organic stimulants cow dung slurry at 25% (T_{11}) obtained maximum vase life (7.86 days) of cut flower. Whereas, minimum vase life of cut flower (5.53 days) was obtained in treatment T_0 (Control). Maximum vase life of cut spike was obtained maybe due to the superior action of auxin, which has been shown to delay senescence and promote metabolite translocation and may be helpful in extending the vase life of cut spike, may be the cause of the greater efficiency of the optimal dose of GA_3. The findings are in agreement with Tawar *et al.* (2002) [43], Umrao *et al.* (2007) [45] and Chopde *et al.* (2013) [15] in gladiolus.

Table 2: Effect of Organic and inorganic stimulants on flowering and corm parameters

Treatment	Number of florets	Vase life of cut spike (days)	Number of corms per plant	Weight of corms per plant (g)	Weight of corms per plant (g)
Control (T_0)	12.07^{bc}	5.33^{g}	1.86^{c}	32.70^{f}	11.93^{g}
GA_3 100 ppm (T_1)	13.27^{abc}	8.80^{b}	2.6^{ab}	61.90^{a}	20.40^{b}
GA_3 200 ppm (T_2)	14.73^{a}	10.20^{a}	2^{c}	63.30^{a}	23.86^{a}
Thiourea 2% (T_3)	12.73^{bc}	8.20^{c}	2.26^{bc}	37.80^{e}	15.26^{f}
Thiourea 3% (T_4)	12.73^{bc}	8.66^{b}	2.13^{bc}	39.00^{e}	16.06^{def}
BA 50 ppm (T_5)	12.53^{bc}	7.40^{de}	3.06^{a}	52.60^{cd}	15.60^{ef}
BA 100 ppm (T_6)	11.87^{c}	7.53^{de}	2.8^{a}	51.10^{d}	17.93^{cd}
KNO_3 250 ppm (T_7)	12.20^{bc}	7.20^{e}	2.2^{bc}	39.20^{e}	12.93^{g}
KNO_3 500 ppm (T_8)	13.20^{abc}	6.20^{f}	2.06^{bc}	50.00^{d}	15.53^{f}
Cowurine 25% (T_9)	13.80^{ab}	7.60^{de}	2.13^{bc}	50.26^{d}	17.80^{cde}
Cowurine 50% (T_{10})	13.60^{abc}	7.73^{d}	1.90^{c}	57.10^{b}	17.20^{cdef}
Cow Dung slurry 25% (T_{11})	12.67^{bc}	7.86^{cd}	2.06^{bc}	54.70^{bc}	18.66^{bc}
Cow dung slurry 50% (T_{12})	13.40^{abc}	7.73^{d}	1.89^{c}	51.60^{d}	16.06^{def}
S.Em±	0.51	0.19	0.17	0.889	0.68
CD at 5%	1.50	0.14	0.51	2.594	1.99

Number of corms/plant

The maximum number of corms/plants (3.06) was obtained with that of treatment T_5 (BA at 50 ppm) which was statistically similar to treatment T_6 - BA at 100 ppm (2.80). Among the organic stimulants cow urine at 25% (T_9) obtained maximum number of corms per plant (2.13). Whereas, minimum number of corms per plant (1.86) was obtained in treatment T_0 (Control). Maximum number of corms per plant was obtained in BA at 50 ppm which might be due to, BA typically results in greater cell division and splitting than in gladiolus corm size growth. Khan *et al.* (2013) [20] found that the concentration of BA enhanced multiple shooting and accelerated corm production in gladiolus. The result is in conformity with Raju (2000) [34] in lillies and Rajaram *et al.* (2002) [35].

Weight of corms per plant (g)

The maximum weight of corms per plant (63.30 g) was obtained with the treatment T_2 (GA_3 at 200 ppm), which was statistically similar to treatment T_1 - GA_3 at 100 ppm (61.90). Among the organic stimulants treatment T_{10} (Cow urine at 50%) obtained maximum weight of corms per plant (57.10 g). Whereas, minimum weight of corms per plant (32.7 g) was obtained in treatment T_0 (Control). GA_3

obtained maximum weight of corms per plant maybe due to its ability to increase the number of leaves which in turn increased the photosynthesis and photosynthetic assimilates. These assimilates were transported to the daughter corms, thereby increasing size and weight. Supportively, lowest values for corm weight were recorded in control (Reddy *et al.*, 2013) [37].

Weight of cormels/Plant (g)

The maximum weight of cormels per plant (23.86 g) was obtained with the treatment T_2 (GA_3 200 ppm) which was statistically similar to treatment T_1 GA_3 100 ppm (20.40 g). As an organic stimulants T_{11} (cow dung slurry at 25%) obtained maximum weight of cormels (18.66 g).Whereas, minimum weight of cormels per plant was obtained with treatment T_0 (Control). Gladiolus plants treated with GA_3 have much higher cormel weights per plant. This may be because the GA_3 treated plants stay physiologically active longer to accumulate enough food, which leads to improved plant growth and development and ultimately higher cormel weights per plant. Similar findings are observed by Baskaran *et al*. (2009) [8], Gaur *et al*. (2003) [19] and Padmalatha *et al.* (2012) [32].

Conclusion

It can be inferred from the results of the present investigation, that the treatment with GA_3 at 200 ppm proved to be the best in improving vegetative and flowering characteristics, including days taken for sprouting, plant height, number of leaves per plant, number of days taken to spike initiation, spike length, number of florets, vase life, weight of corms and cormels per plant. The maximum number of sprouts per corm, number of spike and number of corms per plant was obtained in BA at 50 ppm. Whereas in case of organic stimulants cow dung slurry at 50% performed best in improving spike length.

In terms of commercial potency, for quality flower production the application of GA_3 at 200 ppm maybe recommended to get good quality spike with longer vase life. On the other hand, from economic point of view, the application of BA at 50 ppm can be considered best for getting more number of spikes and corms.

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