Optimizing the growth and flowering of Gladiolus (Gladiolus grandiflorus L.) cv. Arka Amar: Date of planting & Gibberellic acid effects

ABSTRACT

Twelve treatment combinations of the date of planting and gibberellic acid treatment of the corm were replicated three times in the Randomized Block Design (RBD) factorial concept investigation conducted in Gladiolus (*Gladiolus grandiflorus* L.) cv. Arka Amar during the 2022–2023 rabi season at SOADU, Bhubaneswar (Odisha). The findings showed that on September 15, the planting date and dipping the corms with 150 ppm GA3 concentration resulted in the maximum number of sprouting (2.56), plant height (62.42 cm), number of floret per spike (20.72), floret length (11.56 cm), rachis length (68.41 cm), vase life (7.33 days), and diameter of harvested corm (5.71 cm). Comparably, on November 15th planting with a 100 ppm GA3 concentration of corm treatment, the number of leaves/plant (14.47) and spike length (88.49 cm) demonstrated the greatest results; on October 15th planting, with a 150 ppm GA3 concentration of corm treatment, the least number of days required for spike initiation (72.73) and total number of corms per plot (67) was concluded. Maximum flowering time of 10.2 days was noted in planting on September 15th, using corms bathed in 100ppm GA3. The optimal way to maximize gladiolus cv. Arka Amar flowering and yield was determined by treating the 15th of September planting with dipping corms at 150 ppm GA3 concentration. In general, the research of maximizing gladiolus development by taking into account planting dates and the impacts of gibberellic acid is crucial for raising scientific understanding of gladiolus agriculture as well as yield, quality, and resource efficiency.

Keywords: Gladiolus, Planting date, Gibberellic acid, spike, cut flower

1. INTRODUCTION

The gladiolus (*Gladiolus grandiflorus* L.) is a common bulbous cut flower with chromosome number 2n = 60. It belongs to a genus of perennial flowering plants in the Iridaceae family. Its impressive flower spike with acropetal flower opening, lovely colours, different flower sizes, stunning colour tones, ease of growing, and long vase life have all contributed to its enormous appeal. As a result, it is known as the "Queen of bulbous plants". It is also known as “corn flag” and “sword lily” (Raghava and Negi, 1997).

Higher yields can be achieved by knowing when to sow gladiolus corms and how gibberellic acid works. Growers can guarantee that their gladiolus plants attain maximum potential in terms of size, quality, and quantity of blooms by maximizing these criteria. Gladiolus bloom quality can be affected by gibberellic acid treatments and different planting dates. This includes color, size, and longevity. Growers can make flowers that satisfy customer tastes and market standards by researching these effects. Understanding the relationship between planting dates, gibberellic acid treatments, and environmental conditions can help mitigate risks associated with factors such as frost damage, disease susceptibility, and adverse weather effects. Investigating the effects of planting dates and gibberellic acid on gladiolus growth contributes to scientific knowledge about plant physiology, hormone regulation, and environmental interactions. This knowledge can inform future research and agricultural practices beyond gladiolus cultivation.

In the plains of North India, planting the right types from September to December will yield high-quality spikes (Swarup *et al*.,1972; Khanna *et al*.,1983). Gladiolus growth and quality are significantly influenced by the date of planting (Khan *et al*., 2008). The quality and vegetative development of gladiolus are enhanced by timely planting, which also meets customer needs (Zubair *et al*., 2006). Growth hormones like GA3 and Indole Acetic Acid (IAA), etc., can affect the quality and output of gladiolus blooms, as well as the corm and cormel size of the plant. The application of GA3 was found to significantly reduce the number of days to flowering, increase spike length, number of flowers per spike, floret diameter, shoot elongation, and vegetative growth. Gibberellic acid causes early flowering, increases plant height, and increases the quantity of leaves and flowers also enhance the yield at various concentrations (Roychowdhury,1989; Chopde*et al*., 2011). The present investigation was undertaken to arrive at the most suitable planting date and gibberellic acid concentration in gladiolus cv. 'Arka Amar' for optimal growth and flowering.

2. MATERIAL AND METHODS

The experiment was carried out al Agricultural Research station (Binjhagiri) Chatabara of Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be university), Bhubaneswar which is geographically situated at 20° 23' N longitude and 85° 83' E latitude and about 25.5m above mean sea level (MSL) which comes under east and south eastern coastal plain agroclimatic zone characterized by warm moist climate with mild winter termed as hot and humid condition. The experiment was conducted on clay soil having pH 4.36. The soil have 125.44 kg/ha Nitrogen content, 19.7 kg/ha of phosphorus content and 66.17kg/ha of potassium content. The organic carbon content of soil was 0.24 % and electrical conductivity was 1.46 dS/m. The plot size was 1m x 1.5m, with a spacing of 30cm x 20cm in three replications with randomized complete block design. Before planting, the corms were first treated with fungicide Blitox 50 for 15min then with various levels of GA3 viz, 50ppm(C1),100ppm(C2) and 150ppm(C3) for 10-12 hours. The corms were sown on different planting dates, viz, 15th September(D1), 15th October(D2) and 15th November (D3) of 2022. Data was recorded for various parameters like Days takes to 80% Germination (Days), Maximum sprouting/corm, plant height, Number of leaves per plant, Days taken to initiation of spike, Spike length(cm), Length of floret(cm), Number of floret/spike, Length of rachis, Duration of flower(longevity) (days), corm diameter(cm), Vase life of gladiolus. Data were statistically analyzed as per Panse and Sukhatame (1985) at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Effect of planting date and gibberellic acid on vegetative parameters:

Observations on Days takes to 80% Germination (Days), Maximum sprouting/corm, plant height, Number of leaves per plant are represented below in table(1).

3.1.1. *Days takes to 80% germination (Days):* The results revealed that the early emergence of 80% sprouting (7.66 days) was shown in interaction effect of planting date(D) and Gibberellic Acid(C) of 15th November and 150ppm GA3 concentration(7.66 days) is significantly at par with D3C2(8 days), D3C1(8.66 days),D3C0(10 days), D2C3(10.33 days) and D1C3(10.33 days) . Late emergence shown in interaction of 15th September and control(D1C0) which was 10.5 days. Plant growth and development may be significantly influenced by the ratio of hormones that encourage and inhibit growth. It might be because of the high levels of nutrients still present and gibberellic acid, which can boost cell growth and encourage DNA synthesis in cells. With the aid of the hydrolytic enzymes included in GA3, gibberellic acid was actively used to break down the saved dietary material, which may have caused the highest sprouting percentage. Similar results have been reported by Gowda (1985), Nagarajaiah & Reddy (1986), Padmalatha *et al*. (2013), Rahman *et al*. (2019). Nijiasure*et al*. (2005) also reported similar results.

3.1.2. *Maximum sprouting of corm*: The results revealed that significant variations in number of sprouting per corm according to interaction effect of date of planting and GA3 concentration. Maximum number of sprouts per corm (2.56) was observed in D1C3 which is significantly at par with D3C2(2.41) and D3C3(2.28) and significantly superior than other treatments. The minimum number of sprouts per corm was observed in D2C2(1.10). This might be due to the variations in the percentage of corms that sprout were anticipated, as this percentage was influenced by edaphic elements in the soil. Similar results were reported by Bhat and Ahmad (2007) in gladiolus planting under Kashmir condition. These Results are consistent with those of earlier scientist like Ginzburg (1973), Ram *et al*.(2001), Sudhakar and Kumar (2012) and Ashwini *et al*.(2019) in Gladiolus.

3.1.3. *Plant height*: From the table (1) it is concluded that highest plant height was observed in D1C3 treatment (62.42 cm) which is significantly at par with D1C1(60.66 cm) and significantly better than other treatments. However the lowest plant height was observed in D2C0 (36.78 cm). Plant height increased when GA3 was applied because it may have encouraged cell elongation (Tonecki ,1980). Gibberellic acid administration increased cell length and cell division in plants, as well as their number and length, which could have an impact on gladiolus growth. Similar positive effect was also recorded by Taiz & Zeiger (1998), and Rahman *et al*. (2019).

3.1.4. *Number of leaves plant-1*: The results represented in the table(1) which is significantly effected with other interaction treatments. Among 12 different interaction treatments of D3C2(14.47) recorded maximum number of leaves which is at par with D1C2(14.44) and D1C3(14.26) whereas least number of leaves per plant was recorded in D2C0(9.63). Gladiolus cultivars can develop more quickly due to a variety of causes, including their genetic make-up and favourable environmental conditions. The increased cell division that occurred in the shoot tip due to cell elongation and the growth-promoting effects of gibberellic acid and may be the cause of an increase in the growth parameter, or number of leaves, with the application of GA3. These findings are in lined with Quyoom S. (2011), Sudhakar(2012) and Rahman *et al*.(2019). Additionally, the function of GA3 in plant tissues may be the cause of the improved growth characteristics. Thus, GA3 is recognised for its active involvement in a variety of plant development processes (Hooley, 1994).

Table-1: Effect of planting date and Gibberellic acid on vegetative parameters of Gladiolus cv. Arka Amar

Treatments	***Days takes to 80% Germination (Days)***	***Maximum sprouting/corm***	***Plant height***	***Number of leaves/plant***
D_1C_0(D_1= 15th September; C_0=control)	18.33	1.9	53.59	9.93

D_1C_1(D_1=15th September; C_1= 50ppm)	13.66	2.06	60.66	12.46
D_1C_2(D_1=15thSeptember; C_2=100ppm)	13	1.96	58.44	14.44
D_1C_3(D_1=15thSeptember; C_3=150ppm)	10.33	2.56	62.42	14.26
D_2C_0(D_2= 15th October; C_0= control)	13.66	1.7	36.78	9.63
D_2C_1(D_2= 15th October; C_1=50ppm)	14.33	1.76	40.72	11.31
D_2C_2(D_2= 15th October; C_2=100ppm)	14.66	1.10	40.44	13.47
D_2C_3(D_2= 15th October; C_3=150ppm)	10.33	2.03	41.61	11.33
D_3C_0(D_3=15th November; C_0= control)	10	1.53	48.42	10.4
D_3C_1(D_3= 15th November; C_1=50ppm)	8.66	1.93	47.18	10.66
D_3C_2(D_3=15thNovember; C_2=100ppm)	8	2.41	45.96	14.47
D_3C_3(D_3=15thNovember; C_3=150ppm)	7.66	2.28	50.64	11
S.Em.(±)	2.75	0.13	0.99	0.22
CD at 5%	0.93	0.38	2.91	0.67

3.2. Effect of planting date and gibberellic acid on flowering character:

Observations on Days taken to initiation of spike, Spike length(cm), Length of floret(cm), Number of floret/spike, Length of rachis, Duration of flower(longevity) (days), corm diameter(cm), Vase life (Days) are presented below in table(2)

3.2.1. *Days taken to initiation of spike*: Among the interaction between planting date and GA3 concentration the early emergence was observed in D2C3 (D2-15th October×C3-150ppm GA3) 72.73 days followed by D3C1(D3- 15th november×c1 50ppm GA3) 73.06 days. However late emergence was observed in D1C0(D1- 15th September×C0- Control) i.e 90.05 days. This treatment's early blossoming could be attributed to corms that emerged earlier than usual. Parmar et al.(1994) discovered similar findings in tuberose. Baskaran and Misra (2007) reported an earliness in flowering at various GA3 levels. Similar results recorded by Khan *et al*.(2011).

3.2.2. *Spike length*(cm): An inquisition of data presented in table (2) interaction among date of planting and GA3 concentration shows that highest spike length was observed in D3C2(D3- 15th November C2-100 ppm GA3) 88.49cm followed by D1C2(D1-15th September C2- 100ppm GA3) which were significantly at par with each other. However minimum spike length was showed in D2C0(D2- 15th October C0- Control) with 73.55cm. Gibberellic acid encourages vegetative development, boosts photosynthetic and metabolic activity, and increases the transport and utilisation of photosynthetic products in gladiolus. As a result, spike length and rachis length increased, allowing florets to grow larger. Similar findings were recorded by Taiz & Zeiger (1998), Al-Humaid (2004), Singh & Srivastava (2009), Sudhakar & Kumar (2012) and Rahman et al.(2019).

3.2.3. *Length of floret*(cm): Among all the interaction effect the length of floret have significant effect with other interaction treatments. From the table the maximum length of floret was recorded in D1C3 (11.56 cm) which was significantly superior than other treatments followed by D1C2 (11.26 cm) which is a interaction between 15th September 100ppm GA3 concentration. The minimum length of floret observed in the interaction treatment of D1C0 (10.08 cm) which is an interaction between 15th September control. The floret size is a result of the genotypes' total and products, increased photosynthesis, cell division, and enlargement, which finally leads to increased floret size and more growth of the sink (flowers). The findings of Kumar *et al*.(2015) in gladiolus provide additional support for the conclusions. The growth conditions that prevailed during the crop season, which included mild temperatures, high relative humidity, and a low rate of evaporation, may have made it possible for gladiolus to produce larger flowers when planted in October. Similar results have been recorded by Mohanty et al.(2012) in African marigold and Nagar *et al*.(2018) in gladiolus.

3.2.4. *Number of floret spike-1*: As per the results the interaction effect of planting date and gibberellic acid concentration the results have significant effect with other interaction treatments. It presented that the maximum number of floret observed in the interaction of D1C3(D1- 15th September C3-150ppm GA3 concentration) with average of 20.72 number and at par with D2C3(D2-15th October C3-150ppm) with average of 20 number, D1C2(D1-15th September C2-100ppm GA3 concentration) with average of 19.6 number and D1C0(D1- 15th September C0-control) which are significantly superior than other treatments. The minimum number of floret was observed in D3C1(D3-15th November C1-50ppm GA3 concentration) with average of 11.8 number. The rise in leaf count and ultimately leaf area, which led to an increase in photosynthates required to boost plant reproductive growth, was the cause of the increase in floret spike-1 number (Yousif, 2006). The amount of food needed by the number of floret spike-1 might rise as the number of leaves increases. Similar results recorded by Rahman *et al*.(2019).

3.2.5. *Length of rachis*: The results of data length of rachis have significant effect with Gibberellic Acid concentration. The maximum length of rachis observed in interaction treatment of 15th September planting and 150ppm GA3 concentration (68.41cm) which is significantly superior than other interaction treatment, whereas minimum length of rachis observed in interaction of 15th October planting and control treatment(47.77cm). Temperature, humidity, and photoperiod throughout the growth period were all directly connected with the best quality spike and rachis length. The findings of Bagde*et al*. (2009), who stated that planting on October 13th offered better quality of spike and rachis length, are supported by the data. Similar results were recorded by Tirkey *et al*.(2018).

3.2.6. *Duration of flower(longevity)* (days): The data of table (2) revealed that days taken for degradation of flower had brought about significant influence on interaction of planting date and Gibberellic Acid concentration. The maximum duration of flower was observed in D1C2(10.2 days) interaction of 15th September and 100ppm GA3 concentration which significantly better than other concentration. However minimum duration was observed in D2C0(7.68 days) which is a interaction between 15th October and control treatment. Due to the continual supply of food provided by pre-soaking corms in GA, which boosted photosynthetic rates in treated plants relative to control plants, spike duration was also increased. These outcomes concur with those of Han (1995). When compared to control plants, flowers made from GA3 treated plants had the longest shelf life, according to Singh and Srivastava (2009), Emami *et al*.(2011) and Rani *et al*.(2015).

Table-2: Effect of planting date and Gibberellic acid on flowering parameters of Gladiolus cv. Arka Amar

Treatments	*Days taken to initiation of spike*	*Spike length (cm)*	*Length of floret (cm)*	*Number of floret/spike*	*Length of rachis*	*Duration of flower (days)*
D_1C_0(D_1= 15th September; C_0=control)	90.05	76.71	10.08	18.73	52	8.23
D_1C_1(D_1=15th September; C_1= 50ppm)	83.46	79.03	10.26	12.5	61.71	9.29
D_1C_2(D_1=15thSeptember; C_2=100ppm)	85.49	86.32	11.26	19.6	53.42	10.2
D_1C_3(D_1=15thSeptember; C_3=150ppm)	76.92	81.27	12.28	20.72	68.41	9.52
D_2C_0(D_2= 15th October; C_0= control)	80.39	73.55	10.28	17.8	47.77	7.68
D_2C_1(D_2= 15th October; C_1=50ppm)	76.33	78.58	10.65	13.66	49.36	8.67
D_2C_2(D_2= 15th October; C_2=100ppm)	74.46	79.7	10.63	16.93	48.27	9.46
D_2C_3(D_2= 15th October; C_3=150ppm)	72.73	75.50	10.57	20	55.66	8.68
D_3C_0(D_3=15th November; C_0= control)	75.6	75.64	10.6	12.66	50.11	8.12
D_3C_1(D_3= 15th November; C_1=50ppm)	73.06	79.67	10.18	11.8	56.37	8.28
D_3C_2(D_3=15thNovember; C_2=100ppm)	76.53	88.49	10.19	12.46	51.35	9.40

D_3C_3(D_3=15thNovember; C_3=150ppm)	73.27	77.10	10.71	12.86	58.74	8.4
S.Em.(±)	1.07	0.89	0.24	0.82	0.14	0.12
CD at 5%	3.14	2.6	0.72	2.40	0.42	0.37

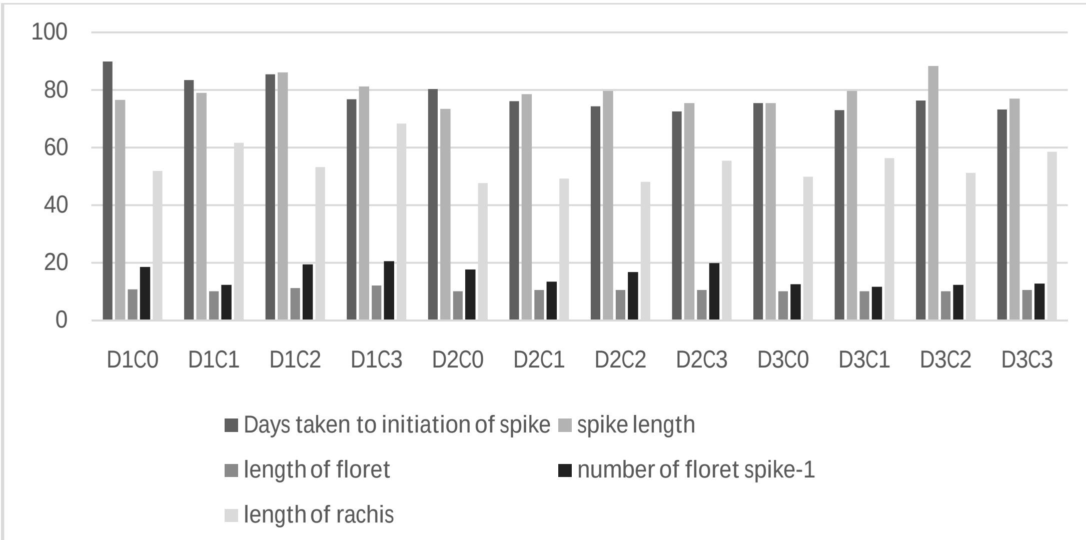

Figure 1: Effect of planting date and Gibberellic acid on flowering parameters of Gladiolus cv. Arka Amar

3.3. Effect of planting date and gibberellic acid on corm yield and vase life:
Observation on total number of corms plot-1 and corm diameter(cm) are taken below in the table (3).

3.3.1. *Total number of corms plot-1*: From the analysis table(3) it is concluded that the interaction between 15th October with 150 ppm gibberellic acid showed maximum number of corms i.e 67 which is at par with 15th September and 150ppm gibberellic acid(61.33) and superior than other treatments. However the inferior results showed by the treatment with 15th September and 50ppm GA3 concentration.Increased photosynthetic assimilates for transferring to corms, which in turn increase the size and quantity of leaves resultant corms, may be the cause of the increased number and weight of corms and cormels with application of GA. Similar results were recorded by Kumar *et al*.(2009) and Rani *et al*.(2015).

3.3.2. *Corm diameter*(cm): An analysis of data presented in table(3) revealed that maximum corm diameter 5.71 cm was noted due to interaction effects of planting date and GA3 concentration D1C3(D1- 15th september×C3-150 ppm GA3 concentration) which was superiorly better than other treatments. However minimum corm dimeter of 4.18 cm was noted in D1C0(D1- 15th September×C0- Control). Gibberellins appear to enhance cell proliferation and division, which in turn increases root elongation (Stewart and Jones, 1977). Thus, it increases corm diameter. The findings of the current investigation support a previous report in tuberose by Biswas *et al*. (1982). They claimed that GA3 at 100 mg L-1 increased bulb diameter. Similar results have been recorded by Khan *et al*.(2011).

3.3.3. *Vase life* (Days)(Sucrose 4%): An analysis of data presented in table revealed that vase life was noted due to interaction effects of planting date and GA3 concentration D1C3(D1- 15th september×C2- 100 ppm G¬A3 concentration) which was superiorly better than other treatments. However minimum vase life(7.33 days)was noted in D1C0(D1- 15th November×C0- Control). This might be due to attribute of higher Auxin activity which reported to delay senescence and translocation of metabolites.

Table-3: Effect of planting date and Gibberellic acid on corm yield and vase life cv. Arka Amar

Treatments	*Total number of corms plot^{-1}*	*Corm diameter*	*Vase life (Days)*
D_1C_0(D_1= 15th September; C_0=control)	35.81	4.18	9.33
D_1C_1(D_1=15th September; C_1= 50ppm)	33.37	4.7	10.66
D_1C_2(D_1=15thSeptember; C_2=100ppm)	33.62	4.26	13.33
D_1C_3(D_1=15thSeptember; C_3=150ppm)	39.82	5.71	12
D_2C_0(D_2= 15th October; C_0= control)	40.02	3.20	10
D_2C_1(D_2= 15th October; C_1=50ppm)	38.35	4.27	9.33
D_2C_2(D_2= 15th October; C_2=100ppm)	39.08	4.18	11.33
D_2C_3(D_2= 15th October; C_3=150ppm)	40.92	4.52	10.33
D_3C_0(D_3=15th November; C_0= control)	41.08	3.30	7.33
D_3C_1(D_3= 15th November; C_1=50ppm)	40.43	3.79	8.33
D_3C_2(D_3=15thNovember; C_2=100ppm)	40.72	3.73	9.66
D_3C_3(D_3=15thNovember; C_3=150ppm)	41.22	3.84	8.33
S.Em.(±)	1.94	0.13	0.37
CD at 5%	2.31	0.40	1.11

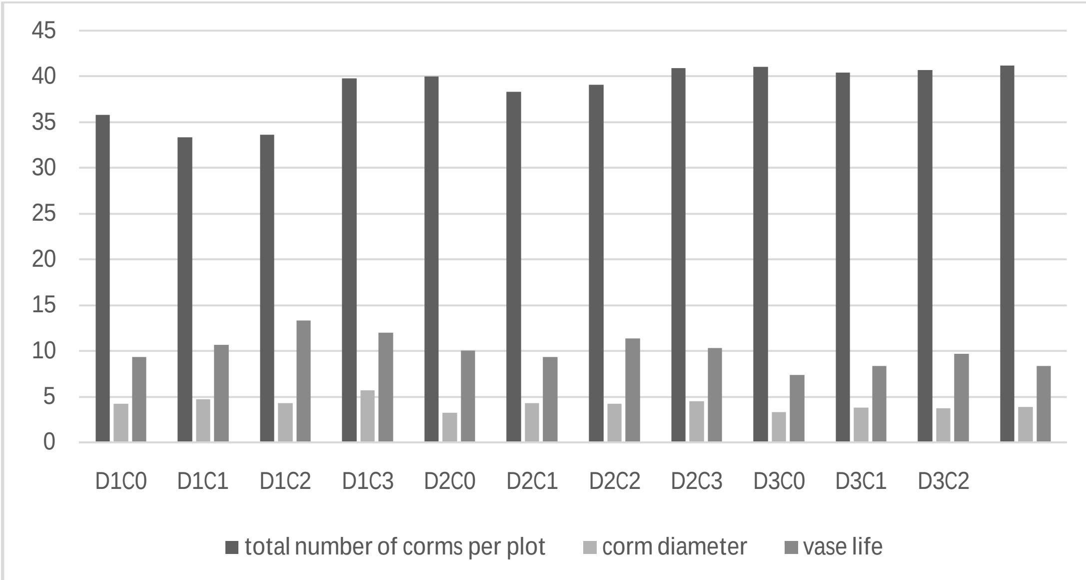

Figure 2: Effect of planting date and Gibberellic acid on corm yield and vase life of Gladiolus cv. Arka Amar

4. CONCLUSION

The current study leads to the conclusion that gladiolus cv. Arka Amar in Odisha, specifically in the Bhubaneswar condition, exhibited improved vegetative, blooming, and corm quality when corms were soaked with GA3 at 150 ppm (10–12 hours) and planted on September 15 (D1C3).

COMPETING INTERESTS

When conducting a study on the effect of planting date and gibberellic acid on gladiolus, it's essential to disclose any competing interests to ensure transparency and integrity. The standardisation of planting date of this excellent variety of Gladiolus need to be done in Odisha in specific to Bhubaneswar condition. Treatment with GA is done for breaking the dormancy of the corm for early sprouting and flowering for long blooming period to earn more may have beneficial result for farmers. The authors have no personal relationships with any stakeholders in the industry that could influence the study's outcome. The results of this study may influence the career advancement of the researchers involved. Orissa horticulture association may have an interest in the outcomes of this research. There are no patents or other intellectual property associated with this study.

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