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Gladiolus vegetative, floral, and yield characteristics in response to corm size and gibberellic acid

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From May to August 2018, the effects of GA_3's four levels on gladiolus were researched at the Semnan Agricultural University's farm in Iran. Corm size and Gibberellic acid influenced plant growth and spikes development, corms, and cormels. When compared to the control, the corm size 120-125 g and the treatment GA_3 @ 150 ppm had a greater potential to improve % corm sprouting and 80 % flowering sooner by almost 3.74 and 5.87 days, respectively, and also the floret iflorescence-1 number and corm diameter has increased. As conjugated with corm size 120-125 g and GA_3 @ 150 ppm, the yield of corms, cormels, and spikes rose by approximately 33%, 18%, and 14%, respectively, in comparison to the control.

Keywords: Cut flower, sprouting, dormancy, vegetative propagation.

INTRODUCTION

Gladiolus (Gladiolus grandifloras) is a popular cut flower in Bangladesh. Because of its flower spikes with delightful florets of huge form, appealing forms, variable size, and long shelf life, it is known as the queen of bulbous flowers (Gholamin and Khayatnezhad 2020, Li, Mu et al. 2021). Gladiolus demand in Bangladesh is expanding day by day because of its brilliantly colored florets and significant economic potential for both the domestic and international markets. However, commercial production is still in its early stages because of lack of data about its cultivation technology, various factors like corm and cormel size, planting depth and time, fertilizer application, and the usage of various chemicals such as GA_3, IAA, and so on, all of which affect the gladiolus production and quality and also its corm and cormels (Khayatnezhad and Gholamin 2020, Ma, Ji et al. 2021, Xu, Ouyang et al. 2021, Zhang, Khayatnezhad et al. 2021).

Bulbous crops are heavily impacted by the size of the bulbs or corms. Gladiolus corm is the subterranean stem that stores food and serves as a spreading material. The corm size has a significant impact on its vegetative growth, development, and, eventually, the production of spikes, flowers, and corms (Gholamin and Khayatnezhad 2020, Si, Gao et al. 2020, Bi, Dan et al. 2021). Plant growth regulators refer to organic chemical substances that change or regulate physiological processes in plants in a significant way. One of the most essential variables in boosting growth, production, and bloom quality is the use of plant growth regulators (Abdolhakim 2021, Alerto 2021, Arjaghi, Alasl et al. 2021). At various concentrations, GA3 promotes gladiolus growth, development, and yield (Gholamin and Khayatnezhad 2020, Cheng, Hong et al. 2021). Gibberellic acid causes plants to grow taller, produce more blooms, and bloom earlier (Farhadi, Fataei et al. 2020, Elsayied Abdein 2021, Khayatnezhad and Gholamin 2021). With the above-mentioned role of GA_3 and corm size in mind, the current study sought to determine the optimal concentration of GA_3 for boosting floral quality, corm production, and breaking the gladiolus corm dormancy.

MATERIALS AND METHODS

The experiment was conducted in the Semnan Agricultural University's Farm in Iran from May to August 2018. The soil texture of the experimental field was silty loam in a subtropical environment with significant precipitation from April to September and limited precipitation from October to March. Four levels of GA_3 at 0, 50, 100, and 150 ppm, designated by G_0, G_1, G_2, and G_3, were evaluated on two levels of corm size, 80-100 g and 120-125 g and designated by C_1 and C_2, respectively. The necessary quantity of GA_3 was measured with an electronic balance, and by dissolving it in 1 mL of ethanol, a stock solution was made. The stock solution was then diluted with distilled water to make the working solutions. On the 16th of May, 2011, graded corms were immersed in the stock solution for one day before being planted in the prepared field at a depth of 7 cm at furrows. The experiment was designed using a Randomized Complete Block Design having three replications. A 0.8 m 0.8 m plot was increased up to 15 cm in height, with row to row and plant to plant spacing of roughly 20 20 cm 20 cm maintained. Applying the fertilizers occurred at the rates of 100, 300, 300, and 10000 kg ha-1 for urea, MP, TSP, and cowdung, respectively, and intercultural operations were provided to ensure appropriate crop growth and development in accordance. Spikes were gathered from August 3 to August 20, 2011, when the basal florets began to show color, and corm and cormel were collected on December 10, 2011. Ten plants were chosen at random from each unit plot to gather data on days to 80% sprouting, height of the plant, days to 80% flowering, spike length, rachis length, florets inflorescene-1 number, corm diameter, weight of single corm, and yield of corms, cormels ha-1, and spikes. The analysis of variance was used for evaluating the mean values of all parameters, and the means separation was assessed using Duncan's Multiple Range Test (DMRT) at a confidence level of 5%.

RESULTS AND DISCUSSION

A. Days to 80% sprouting

GA3 significantly enhanced corm sprouting. GA3 @ 150 ppm was more efficient than the other concentrations on 120-125 g corm size (Table 1). By breaking dormancy, large corms promote early sprouting. This might be due to larger ones having a greater amount of food components, which aids in the plant's early emergence. It has been claimed that big corms have a shorter dormancy period than tiny corms, which aids in the plant fast emergence (Gholamin and Khayatnezhad 2020, Jia, Khayatnezhad et al. 2020, Zhu, Liu et al. 2021, Zhu, Saadati et al. 2021). Corm treated with GA3 @ 150 ppm outperformed other treated corm in producing early sprouting. This might be related to the optimal level of GA3 absorbed by corms, which could modify the physiological mechanisms that drive corm dormancy. Other hypotheses include that GA3 alters hormonal balance and induces the creation of hydrolytic enzymes that control the mobilization of reserve food resources, leading to early sprouting. These findings are consistent with those of (Al-Khassawneh, Karam et al. 2006, ALAM, ALI et al. 2013, Ghomi Avili and Makaremi 2020, Jalili 2020, Gholamin and Khayatnezhad 2021, Zheng, Zhao et al. 2021), who found that plant growth regulators- GA3 absolutely induce early sprouting through breaking dormancy and boosts respiration in the gladiolus corms.

B. Plant height

Gradual increasing trend in plant height was significantly influenced by GA3 on corm size 120-125 g (Table 1). Comparatively large size corm produced the highest plant height and this might be occur due to higher food material storage reserves in larger corm than smaller ones, that ensuring the nutrient elements adequately for early and rapid vegetative growth of newly emergence plants. It was also reported that, large size corm produced the highest plant height through the supply of maximum nutrient elements adequately for newly emerge plants (Guo, She et al. 2021, Hou, Li et al. 2021, Huang, Wang et al. 2021). Plant height increases significantly with the increases of GA3 upto 150 ppm concentration that was more effective than other treatments. It might be occurs due to application of optimum doses of GA3 that helps to regulate the vegetative growth by inducing active cell division in the apical meristem. GA3 enhances cell division and cell elongation in plants resulting in more number of cells and increase in cell length which ultimately affects the plant growth. This result is in agreement with the findings of (Kirad, Banafar et al. 2001, Navale, Aklade et al. 2010, Awasthi, Yadew et al. 2012, Khan, Rahman et al. 2013, Karasakal, Khayatnezhad et al. 2020, Sun, Lin et al. 2021, Wang, Shang et al. 2021) and they reported that, the growth parameters of gladiolus plants were significantly altered due to the application of growth regulators.

C. Days to 80% flowering

As shown is Table 1, 80% flowering of gladiolus was significantly influenced by various levels of GA3 and corm size . The minimum number of days necessary for 80% blooming was in big size corms, whereas smaller ones took a longer period. It may occur as a result of the big size corm reserving more food and supplying more store nutrients in the corm, which initially aids the plant in growth and development, ultimately affecting blooming. Similar results were observed by (Karasakal, Khayatnezhad et al. 2020, Sadigh, Fataei et al. 2021, Sasani, Fataei et al. 2021, Sun and Khayatnezhad 2021) who reported that the time required for completing flowering was found to be gradually delayed as corm size decreased, and that a direct relationship was observed between corm size and gladiolus floral parameters. Flowering was delayed and took longer in plants that did not get GA3. GA3 @ 150 ppm outperformed other concentrations on flowering, but was statistically equivalent to GA3 @ 100 ppm. With corm sizes 120-125 g, optimal dosages of GA3 accelerate blooming by 5.87 days (Table 1). This might be a moderating impact of enhanced vegetative growth in the initial phase as a result of enhanced photosynthesis and Co2 fixation. Exogenous GA3 treatment has an effect on early floral initiation. According to (Muhibbu-din 2020, Ojaghi, Fataei et al. 2021), gibberellic acid enhances vegetative boosts photosynthetic and metabolic activities, resulting in more mobility and use of photosynthetic products and early flowering in gladiolus.

D. Length of spike and rachis

GA3 and corm size had a substantial effect on spike and rachis length (Table 1). The application of GA3 @ 150 ppm resulted in the longest spike and rachis length in big size corms. This might be owing to the increased quantity of stored food components from the big corm that stimulates gladiolus vegetative and reproductive development. Panwar et al. (2006)observed similar results, stating that greater food resources in the big corm resulted in improved vegetative and reproductive development of the plant. Spike and rachis lengths were greatly increased by applying GA3, which might be because GA3 promotes vegetative development, improves photosynthetic and metabolic activities, and results in higher plants, which offer longer spike and rachis lengths (Table 1). This study supports the findings of (Khayatnezhad and Gholamin 2020, Tao, Cui et al. 2021, Yin, Khayatnezhad et al. 2021).

E. Number of florets inflorescene-1

The application of GA3 and corm size had a substantial impact on the number of florets inflorescene-1. The largest corm generated the greatest amount of florets inflorescene-1 (Table 1). It is possible that the big size of the corm retains more food and supplies more storage nutrients, which aids in strong development and enhances the production of maximal florets inflorescene-1. (Khayatnezhad and Gholamin 2021) reported similar findings and indicated that lowering the size of the corm lowered the number of floret inflorescence-1 considerably. The number of florets inflorescene-1 is greatly affected by different amounts of GA3. The plant treated with GA3 @ 150 ppm produced the most florets inflorescene-1 (Table 1). Gibberellic acid promotes cell division and elongation, leads to fast development, and may also influence vegetative growth and floral initiation. This finding is consistent with the findings of (Ma, Khayatnezhad et al. 2021)

F. Diameter of corm

Various amounts of GA_3 greatly expanded the diameter of a corm diameter with a weight of 120-125 g. (Table 2). Corms with the largest diameter are often generated from big size corms since larger ones have a greater amount of food component, which aids the plant growth and is related to larger corm size. ALAM (2013) also stated that large size cormels generated the greatest diameter of corms. GA_3 @ 150 ppm was the most effective treatment in increasing corm diameter, although it was statistically comparable to the treatment of GA_3 @100 ppm (Table 2). ALAM (2013) reported a similar finding, stating that the growth regulator gibberellic acid dramatically enhanced corm diameter characteristics.

G. Weight of single corm

In comparison to single corm weight, corm size and GA_3 exhibited a substantial variance. The maximum weight of a single corm was obtained from a big corm. Corm size 120-125 g with GA_3 @ 150 ppm improves single corm weight by over 59 %, in comparison to plants treated with GA_3 @ 100 ppm (Table 2). Larger corms store more food component, which aids in the corm's healthy growth and development. Peng (2021) also found that large size corms produced the greatest corms weight. Among the GA_3 doses, the concentration @ 150 ppm was the most efficient treatment and it generated the greatest weight of one corm (Ren and Khayatnezhad 2021)

Table 1: Effect of GA_3 and corm size on vegetative and floral attributes of gladiolus

Treatments	Days to 80% sprouting	Plant height (cm)	Days to 80% flowering	Length of spike (cm)	Length of rachis (cm)	Number of floret inflorescene^{-1}
Gibberellic acid						
G_0	13.07 a	68.88 d	70.42 a	63.66 d	37.44 c	10.83 d
G_1	12.53 a	75.17 c	67.90 b	66.40 c	39.00 c	12.02 c
G_2	11.21 b	79.57 b	65.92 bc	71.49 b	42.28 b	13.01 b
G_3	9.82 c	83.69 a	64.69 c	75.80 a	44.16 a	14.03 a
LSD (0.05)	1.24	1.90	2.00	2.09	1.70	0.94
Corm size						
C_1	12.10 a	72.04 b	68.01 a	66.31 b	39.49 b	11.81 b
C_2	11.21 b	81.62 a	66.45 b	72.36 a	41.95 a	13.13 a
LSD (0.05)	0.59	4.14	1.13	2.34	1.28	1.19
Gibberellic acid x Corm size						
C_1G_0	13.17 a	65.37 f	71.14 a	61.55 f	36.66 d	10.61 e
C_1G_1	12.67 a-c	69.74 e	68.52 bc	63.44 ef	37.57 d	11.66 c-e
C_1G_2	12.16 c	74.51 d	66.82 cd	67.56 cd	40.69 bc	12.16 cd
C_1G_3	10.41 d	78.55 c	65.56 de	72.70 b	43.05 ab	12.80 bc
C_2G_0	12.97 ab	72.39 de	69.69 ab	65.77 de	38.23 cd	11.06 de
C_2G_1	12.39 bc	80.60 c	67.27 cd	69.35 c	40.42 c	12.38 cd
C_2G_2	10.26 d	84.64 b	65.03 de	75.41 b	43.87 a	13.85 b
C_2G_3	9.23 e	88.83 a	63.82 e	78.89 a	45.27 a	15.26 a
LSD (0.05)	0.56	2.69	2.22	2.94	2.41	1.33
CV (%)	5.39	10.28	6.15	8.33	7.11	7.35

Table 2: Effect of GA_3 and corm size on yield attributes of gladiolus

Treatments	Diameter of corm (cm)	Weight of single corm (g)	Yield of spikes (t ha^{-1})	Yield of corms (t ha^{-1})	Yield of cormels (t ha^{-1})
Gibberellic acid					
G_0	2.21 d	37.96 d	24.81 d	12.20 c	10.99 c
G_1	2.58 c	44.41 c	27.81 c	14.74 b	12.94 b
G_2	2.90 b	48.90 b	30.30 b	16.31 a	14.28 a
G_3	3.19 a	54.83 a	32.07 a	17.49 a	14.66 a
LSD (0.05)	0.22	1.99	1.32	1.49	0.83
Corm size					
C_1	2.45 b	42.81 b	27.52 b	14.43 b	12.81 b
C_2	3.00 a	50.24 a	29.98 a	15.94 a	13.63 a
LSD (0.05)	1.02	3.56	1.06	0.47	0.23
Gibberellic acid x Corm size					
C_1G_0	1.97 f	35.51 f	23.85 f	11.53 e	10.66 f
C_1G_1	2.25 ef	40.12 e	26.78 de	14.11 cd	12.67 e
C_1G_2	2.65 cd	45.41 d	29.08 b-d	15.74 b	13.73 cd
C_1G_3	2.92 bc	50.20 bc	30.36 bc	16.33 b	14.16 bc
C_2G_0	2.45 de	40.40 e	25.77 ef	12.87 de	11.32 f
C_2G_1	2.90 bc	48.70 c	28.84 cd	15.37 bc	13.21 de
C_2G_2	3.15 b	52.39 b	31.51 ab	16.88 b	14.84 ab
C_2G_3	3.47 a	59.45 a	33.78 a	18.65 a	15.16 a
LSD (0.05)	0.30	2.81	2.42	1.43	0.69
CV (%)	6.14	7.88	7.94	8.42	8.38

H. Yield of spikes, corms and cormels

The yield of Spikes, corms, and cormels rose significantly in relation to corm size and GA_3 treatment. Spikes, corms, and cormels yield rose by over 29%, 15%, and 13%, respectively, when a 120-125 g corm was used instead of a smaller one. When compared to the control, the treatment of GA_3 @ 150 ppm improved the production of spikes, corms, and cormels by approximately 3%, 17%, and 14%, respectively, and corms with the size of 120-125 g (Table 2). The reason might be the availability of more nutrients conserved on bigger corms, which are used by plants during the vegetative and reproductive stages. Healthy plants improve the photosynthesis rate and aid in the transfer of assimilates to the store food component, resulting in the largest output of spikes, corms, and cormels. This results is consistent with the findings of Bhat et al. 2009 and Uddin et al. 2002 in terms of the yield of spikes, corms, and cormels by corm size. Foliar treatment of GA_3 @ 100 ppm was most efficient method in achieving early blooming and the maximum production of high-quality gladiolus spikes and corm (Khayatnezhad and Nasehi 2021).

CONCLUSION

The treatment of GA_3 and corm size had a substantial impact on gladiolus vegetative, floral, and yield characteristics. A corm size of 120-125 g had a significant impact on the growth pattern, bloom, and corm production. Among the GA_3 treatments, "@ 150 ppm" concentration with 120-125 g corm size produced the most spikes and corms throughout the summer season.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Arda Karasakal conducted, planned, Analyzed the data, wrote manuscript and interpreted the results and involved in manuscript preparation. All authors read and approved the final version.

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