Effect of crop regulation practices on spike and corm yield of gladiolus (*Gladiolus hybrids* Hort.) cv Sarala

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ABSTRACT

Standardization of the crop regulation practices is vital for spike and corm yield maximization in gladiolus (*Gladiolus hybrids* Hort.). Hence, a field experiment was conducted in factorial randomized block design with three replications at Annamalai University, Annamalai Nagar, during 2019 with the objective to maximize the spike and corm yield of gladiolus by growth regulators and leaf regulation practices done after spike harvest. The gladiolus cv. Sarala was tested with 15 treatment combinations comprising growth regulator treatments of corms viz., 100ppm GA₃(G₁), 150ppm GA₃(G₂), 100ppm IAA(G₃), 150ppm IAA (G₄), and Control(G₅) and leaf regulation practices viz., harvesting spike leaving all leaves (L₁), harvesting spike with three leaves (L₂), and clipping leaves at 20cm above the base (L₃). The results revealed that the growth regulator treatments, given to corms significantly influenced the growth, flowering, and spike yield of gladiolus. Corm soaking treatment of GA₃@150 ppm evinced the best treatment in respect of growth, flowering, and spike yield of gladiolus. Though, the effect of leaf regulation practices on growth and flower yield were insignificant, but their influence in corm yield was significant. The interaction of growth regulator soaking of corms with leaf regulation practices significantly influenced the spike and corm yield. The maximum spike (1.01) and corm yield (1.94) were observed with Corm soaking of GA₃@150ppm and harvesting of spikes with three leaves. Leaf regulation by clipping of leaves at 20 cm above the base (L₃) had negative influence on corm growth when compared to harvesting of spikes leaving all leaves (L₁). The maximum corm diameter (3.25cm) and corm weight (25.4g) were observed with 150 ppm GA₃ and harvesting spikes with three leaves. The least corm diameter (2.08cm), number of corms per plant (1.22) and corm weight (17.3g) were recorded with control treatment with cutting leaves at 20cm above the base.

Keywords: Gladiolus, corm soaking, GA₃, IAA, leaf regulation

INTRODUCTION

Gladiolus, a popular flowering plant in international cut flower trade is grown throughout the world in a wide range of climatic conditions and it belongs to the family Iridaceae. Though, it was brought under commercial cultivation later decades of sixteenth century, its cultivation in south India is very scanty at certain pockets. In India, it is cultivated in West Bengal, Himachal Pradesh, Sikkim, Karnataka, Uttar Pradesh, Tamil Nadu, Punjab and Delhi over an area of 11.85 thousand ha 2015(NHB,2020). Though, there are over 30,000 varieties of gladiolus available, only few are commercially cultivated in many parts of the world. Commercial cultivation of gladiolus primarily depends on the quality of spikes as well as the quality of corms. Hence, the crop management practices should focus on production of good quality marketable spikes with at least 13 florets to meet both local and

international standard and production of jumbo size corms. Achieving marketable quality standards in spikes and corms can be approached by addressing the nutrient requirement and growth regulation practices. Poor multiplication rate, extended dormancy in corms, and slower growth rate of cormels restrict their immediate use in the following season and cause lack of planting material. These are the hindering factors for year round production of gladiolus in coastal areas.

Corms are the important factors which govern the growth and development of gladiolus, further, the physiological functions inside the corms are controlled by plant growth regulators (Sudhakar and Ramesh Kumar, 2012). Plant growth regulators are the organic chemical compounds which modify or regulate physiological processes in an appreciable measure in plants when used in small concentrations. In general the plant growth

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regulators play an important role and are being used for breaking dormancy and production of quality corms and spikes in gladiolus. This also results in high cost of corms, which is often higher than the sale price of the spike produced by that corm. Application of GA₃, (Panwar *et al.*, 2006) IAA were found best in early initiation of spike and for higher spike yield. Dipping of corms in the GA₃ solution breaks the dormancy and promotes the sprouting of lateral buds resulting in splitting (division into two or more daughter corms) of corms and thus increasing the number of corms and cormels per plant (Memon *et al.*, 2016). Application of growth regulators by foliar means and corm soaking was studied and found to increase the growth and quality of spikes in gladiolus at varying levels. Enhanced growth and spike production was observed due to application of growth regulators like GA₃, IAA, NAA in gladiolus by Sudhakar and Ramesh Kumar (2012), Neha Chopde *et al.*, (2012) and Priyanka and Saravanan (2019). These growth regulators play a vital role in apportioning the photosynthates towards the enhanced growth and spike production. The corm growth and quality of gladiolus is decided by the physiological process that occurs after spike harvest in a plant. A growth regulation process that stimulates apportioning the residual carbohydrates in the shoots portion of the plants after the spike harvest, is not yet commercially tried in gladiolus. Leaf regulation practices after spike harvest apparently helped to conserve the plant's energy and metabolites that ultimately enhanced the multiplication of corms and cormels. Removal of spike with three leaves treatment was found effective in cormel production. The energy required for flower production may also be diverted towards corm and cormel development by removing the spike (Memon *et al.*, 2016). Improved techniques used to promote corm and cormel production in *Gladiolus* are removal of flower spikes, leaf clippings (Memon *et al.*, 2009) and manual removal of apical buds. Hence, the present study was carried out to evolve a crop regulation practice by combining application of growth regulators and leaf regulation practices to maximize spike and corm yield of *Gladiolus* (*Gladiolus hybrids* Hort.) cv. Sarala under coastal region of Tamil Nadu.

MATERIALS AND METHODS

The experiment was carried out in factorial randomized block design during the year 2019 in Annamalai University, Annamalai nagar, Tamil Nadu. Corms of Sarala were collected from commercial floriculture units in Kalimpong. These corms were planted in ridges and furrows made at a spacing of 45 cm x 15 cm in a plot size of 2m x 2m dimension. The soil of the experiment site is sandy loam having the pH range of 7.0 – 7.5. Vermicompost (25 t ha⁻¹) was applied 15 days prior to planting during land preparation. Standard package of practices were adopted throughout the experiment to grow a healthy crop. Growth regulator treatments to corms at five levels viz., 100ppmGA₃(G₁), 150ppmGA₃(G₂), 100ppm IAA(G₃), 150ppm IAA(G₄), and Control(G₅) as one factor and leaf regulation practices at three levels viz., harvesting spike leaving all leaves (L₁), harvesting spike with three leaves (L₂), and clipping of leaves at 20cm above the base (L₃) as second factor are combined to form 15 treatment combinations. Growth regulators were applied as corm dipping before planting. The leaf regulation practices were adopted as per treatments during spike harvest. For L₁, only spikes were harvested leaving all the leaves intact with plant. The spikes were harvested at the first floret opening stage. For L₂, the spikes were harvested along with three leaves attached with them. For L₃, the spikes were harvested leaving all the leaves attached with the plant and the leaves were immediately clipped leaving 20 cm above the base of the plant. The corms were harvested at 45 to 50 days after spike harvest based on the soil moisture condition. Observations on various morphological parameters including plant height, number of leaves per plant, leaf length, leaf width, days to spike emergence, spike length, number of floret per spike, flower length, flower diameter, diameter of corm and number of cormels were recorded periodically. The data were analysed as per the procedure given by the Panse and Sukhatme (1967). Mean and critical difference for each character was computed to derive meaningful conclusion.

RESULTS AND DISCUSSION

Growth characters

Results revealed that the growth characters were significantly influenced by the growth regulator application. The days taken for corm sprouting was observed the earliest of 7 days in 150ppm GA₃(G₂). It took more than 8 days in IAA treatments and 10 days in control (Table 1). Among the growth regulators, the highest mean of growth parameters viz., plant height (111.0 cm), leaf length (76.9cm), leaf area (128.5cm²) and DMP (41.4 g plant⁻¹) were observed in corm soaking of 150ppm GA₃(G₂). It was followed by the 100ppmGA₃ (G₁). IAA treatments have recorded significantly higher growth parameters when compared to the

control treatments which recorded the least growth parameters viz., plant height (97.9 cm), leaf length (65.6 cm), leaf area (114.5 cm²) and DMP (34.8 g plant⁻¹). The *per se* effect of leaf regulation practices were not significant in growth characters as these treatments were incorporated only after spike harvest. Among the interaction treatment, the highest mean growth parameters viz., plant height (112.0 cm), leaf length (77.5 cm), leaf area (129.6 cm²) and DMP (41.8 g plant⁻¹) were observed in the treatment of corm soaking of 150ppm GA₃ and harvesting of spikes with three leaves (G₂×L₂). The growth parameters observed in the interaction of 150ppm GA₃ and harvesting spikeleaving all leaves and 150ppm GA₃ and clipping of leaves at 20cm above the base were on par with G₂×L₂.

Table 1: Effect of growth regulators and leaf regulation after spike harvest on growth and flowering in gladiolus

Treatments	Days taken for corm sprouting	Plant height	Leaf length	Leaf area cm ²	DMP (g/ plant)	Days taken for spike emergence	Spike length	Spike weight
G x L Mean								
G ₁ X L ₁	7.6	107.6	74.0	124.8	39.8	72.3	94.7	101.5
G ₁ X L ₂	7.7	108.2	74.4	125.5	40.0	72.8	95.3	102.1
G ₁ X L ₃	7.7	108.0	74.3	125.3	39.9	72.6	95.1	101.9
G ₂ X L ₁	7.0	110.9	76.7	128.3	41.4	70.2	98.3	104.5
G ₂ X L ₂	7.1	112.0	77.5	129.6	41.8	70.9	99.3	105.5
G ₂ X L ₃	7.0	110.3	76.4	127.7	41.2	69.8	97.8	103.9
G ₃ X L ₁	9.2	100.5	68.0	117.2	36.2	78.0	86.9	95.2
G ₃ X L ₂	9.1	99.5	67.3	116.1	35.9	77.3	86.0	94.3
G ₃ X L ₃	9.2	100.7	68.2	117.5	36.3	78.2	87.0	95.4
G ₄ X L ₁	8.4	104.4	71.3	121.5	38.2	75.4	91.1	98.7
G ₄ X L ₂	8.4	103.7	70.8	120.6	37.9	74.9	90.5	98.0
G ₄ X L ₃	8.5	105.2	71.8	122.3	38.4	76.0	91.8	99.4
G ₅ X L ₁	10.1	98.1	65.8	114.7	34.9	81.7	83.9	93.1
G ₅ X L ₂	10.0	98.0	65.7	114.6	34.9	81.6	83.8	93.0
G ₅ X L ₃	10.0	97.6	65.4	114.2	34.7	81.3	83.5	92.7
CD(P= 0.05)	0.7	2.84	2.46	3.01	1.46	2.80	3.23	2.51
G Mean								
G ₁	7.7	107.9	74.2	125.2	39.9	72.6	95.0	101.8
G ₂	7.0	111.0	76.9	128.5	41.4	70.3	98.4	104.6
G ₃	9.2	100.3	67.8	116.9	36.2	77.8	86.6	95.0
G ₄	8.4	104.4	71.3	121.5	38.2	75.4	91.1	98.7
G ₅	10.0	97.9	65.6	114.5	34.8	81.5	83.7	92.9
CD	0.4	1.56	1.36	1.65	0.80	1.54	1.78	1.38
L Mean								
L ₁	8.5	104.3	71.2	121.3	38.1	75.5	91.0	98.6
L ₂	8.5	104.3	71.2	121.3	38.1	75.5	91.0	98.6
L ₃	8.5	104.4	71.2	121.4	38.1	75.6	91.0	98.7
CD(P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Corm soaking		G3- IAA @100 ppm			L1 – Harvesting of spikes leaving all leaves			
G1- GA3@100 ppm		G4- IAA@150 ppm			L2 – Harvesting of spikes with three leaves			
G2- GA3@150 ppm		G5- Control			L3- Clipping of leaves at 20cm above the base			

Among all the interaction treatments, the lowest growth in terms of plant height (97.6 cm), leaf length (65.4 cm), leaf area (114.2 cm²) and DMP (34.7 g plant⁻¹) was observed in G₂×L₂ which was on par with G₂×L₁ and G₂×L₃. Enhancement in growth parameters observed due to the application of GA₃ might be due to its influence in early conversion of reserve carbohydrates that activated early sprouting of corms as evident by Priyanka and Saravanan (2019) in gladiolus due to GA₃ application. The enhancement in cell elongation due to application of GA₃ would have contributed for increased plant height, leaf area and dry matter production. Increase in number of leaves might be due to gibberellins cause stem elongation which results from rapid elongation of internodes due to cell division and cell elongation leading to the production of more number of leaves as reported by Padmalatha *et al.* (2013) and Sable *et al.* (2015) in gladiolus. Similar results have been reported by Patel *et al.*, (2013). The spike emergence is an indicator for the plant to attain its maximum growth. The earliest spike emergence on 70.9 days was observed in treatment combination G₂×L₂. The spike emergence was significantly late in control treatment G₅×L₃ (81.3 days). This could be due to early emergence of corms and early completion of vegetative phase, augmented by the GA₃ influenced rapid cell division cell and elongation, in reducing the juvenile period of plants as reported by Wagh *et al.* (2012).

Flowering and spike yield characters

The flowering characters in Sarala were significantly influenced due to *per se* effect of growth regulators only as the *per se* effect of leaf regulation practices begin only after adoption of treatments at spike harvest stage (Table 1 and 2). However, significant differences were observed in interaction treatment due to the influence of growth regulators. The maximum spike length of 99.3 cm was observed in treatment combination G₂×L₂ which was on par with G₂×L₁ (98.3 cm) and G₂×L₃ (97.8 cm). The least spike length of 83.5 cm was recorded in control treatment. The maximum spike weight of 105.5 g was observed in treatment combination G₂×L₂ which was on par with G₂×L₁ (104.5 g) and G₂×L₃ (103.9 g). Increase in spike length in treatment may be attributed due to the fact that optimum level of GA₃ promoted the efficacy of

plants in terms of photosynthetic activity, enhanced uptake of nutrients and their translocation, better partitioning of assimilates into reproductive parts. These results are in conformity with the findings of Tawar *et al.* (2007) and Chopde *et al.* (2013). The highest length of rachis was observed in interaction of G₂×L₂ (68.1 cm) which was on par with G₂×L₁ (67.4 cm) and G₂×L₃ (67.1 cm). The least rachis length was recorded in control treatment (55.6 cm). The rachis length was enhanced due to increase in number of florets per spike due to the treatments. The least diameter of floret recorded in control treatment (7.03 cm) was on par with other interactions G₅×L₂ (7.06 cm) and G₅×L₁ (7.06 cm). The first floret opening observed in treatment of G₂×L₂ (82.4 days) was significantly earliest and it was on par with the treatments G₂×L₁ and G₂×L₃ as these treatments include 150 ppm GA₃. The highest diameter of floret was observed in treatment of G₂×L₂ (8.75 cm) was on par with G₂×L₁ (8.66 cm) and G₂×L₃ (8.62 cm) as these treatments include 150 ppm GA₃. The first floret open was significantly late in control treatment G₅×L₃ (91.1 days) which was on par with other control treatment G₅×L₂ (91.5 days) and G₅×L₁ (91.6 days). Earliness in flowering observed in gladiolus by the application of GA₃ treatments might be due to increase in endogenous level of GA₃ as well as increase in respiration powered by the enhanced carbohydrates in the shoots, which resulted in early flowering. The findings are in accordance with the findings of Sudhakar and Ramesh Kumar (2012) in gladiolus.

The highest number of spike yield per plant was observed with G₂×L₂ (1.01) which was on par with G₂×L₁ (1.00) and G₂×L₃ (1.00). The least number of 0.68 spike per plant was recorded in control treatments G₅×L₃, G₅×L₂ and G₅×L₁. The increased spike yield, observed in GA₃ treatments, might be due to the maximum number of leaves and leaf area that contributed for highest growth rate and more photosynthate accumulation that enhanced the spike growth. Reduction in number of spikes per plant observed in control treatment was due to lack of enough growth. Similar views have also been expressed by Kumar and Singh (2005) and Chopde *et al.* (2013) in gladiolus. The maximum of 1.01 marketable spikes per plant was observed in treatment of G₂×L₂. The least marketable spikes per plant (0.62) was recorded in control treatment (G₅×L₃).

Table 2: Effect of growth regulators and leaf regulation after spike harvest on flowering and spike yield in gladiolus

Treatments	Rachis length	Floret diameter	Days taken for first floret open	Spike yield / plant	Marketable Spikes per plant	Corm diameter	No. of corms / plant	Corm weight (g)
G x L Mean								
G ₁ X L ₁	64.6	8.27	83.3	0.94	0.92	2.96	1.76	23.3
G ₁ X L ₂	65.0	8.32	83.9	0.95	0.92	3.12	1.86	24.4
G ₁ X L ₃	64.8	8.31	83.7	0.95	0.92	2.86	1.70	22.7
G ₂ X L ₁	67.4	8.66	81.5	1.00	1.00	3.15	1.88	24.7
G ₂ X L ₂	68.1	8.75	82.4	1.01	1.01	3.25	1.94	25.4
G ₂ X L ₃	67.1	8.62	81.1	1.00	1.00	3.05	1.82	24.0
G ₃ X L ₁	58.4	7.41	88.2	0.82	0.73	2.65	1.57	21.2
G ₃ X L ₂	57.8	7.34	87.4	0.81	0.72	2.75	1.63	21.9
G ₃ X L ₃	58.5	7.43	88.4	0.82	0.73	2.52	1.49	20.3
G ₄ X L ₁	61.7	7.87	86.1	0.88	0.83	2.73	1.62	21.7
G ₄ X L ₂	61.3	7.82	85.5	0.88	0.82	2.85	1.69	22.6
G ₄ X L ₃	62.2	7.93	86.7	0.89	0.83	2.62	1.56	21.0
G ₅ X L ₁	55.9	7.06	91.6	0.76	0.65	2.31	1.36	18.9
G ₅ X L ₂	55.9	7.06	91.5	0.76	0.64	2.42	1.43	19.7
G ₅ X L ₃	55.6	7.03	91.1	0.76	0.64	2.08	1.22	17.3
CD(P= 0.05)	2.60	0.36	2.48	0.055	0.082	0.09	0.05	0.61
G Mean								
G ₁	64.8	8.30	83.6	0.95	0.92	2.98	1.77	23.5
G ₂	67.5	8.67	81.7	1.00	1.00	3.15	1.88	24.7
G ₃	58.2	7.39	88.0	0.81	0.73	2.64	1.57	21.2
G ₄	61.7	7.87	86.1	0.88	0.83	2.73	1.62	21.8
G ₅	55.8	7.05	91.4	0.76	0.64	2.27	1.34	18.6
CD	1.43	0.20	1.36	0.030	0.045	0.05	0.03	0.33
L Mean								
L ₁	61.6	7.86	86.2	0.88	0.82	2.76	1.64	22.0
L ₂	61.6	7.86	86.1	0.88	0.82	2.88	1.71	22.8
L ₃	61.6	7.86	86.2	0.88	0.82	2.63	1.56	21.1
CD(P= 0.05)	NS	NS	NS	NS	NS	0.04	0.02	0.274

Corm Characters

The corm characters were significantly influenced by the growth regulators as well as the leaf regulation practices (Table 2). Among the growth regulators, the highest mean corm diameter (3.15cm), number of corms per plant (1.88) and corm weight (24.73g) were recorded with 150 ppm GA₃(G₂) followed by 100 ppm GA₃(G₁). Among the leaf regulation treatments, the highest mean corm diameter (2.88cm), number of corms per plant (1.71) and corm weight (22.84g) were recorded when the spikes were harvested along with three leaves (L₂) and it was followed by the treatments where spikes was harvested leaving all the leaves intact with plant (L₁). Clipping of leaves at 20cm above the base (L₃) has resulted poor performance in terms of the corm growth. Among all the interaction treatments, the maximum corm

diameter (3.25cm), number of corms per plant (1.94) and corm weight (25.4g) were observed with 150 ppm GA₃ and harvesting spikes with three leaves (G₂xL₂). The least corm diameter (2.08cm), number of corms per plant (1.22) and corm weight (17.3g) were recorded with control treatment with cutting leaves at 20cm above the base. Enhancement in the corm growth observed in the treatment G₂xL₂ might be attributed by the influence of GA₃ coupled with the early initiation carbohydrate apportioning from source leaves to sinks, the corms, due to the stress signals activated by harvesting of spikes along with three leaves. Whereas, when clipping of leaves at 20cm above the base (L₃) was done, it might have caused more stress and reduced the source content needed for sink apportioning that caused reduction in corm growth. These results on leaf clipping are in line with the reports of Memon *et al.*(2009).

It could be concluded that the corm dipping of 150ppmGA₃ and harvesting of spikes along with three leaves could be adopted to

enhance the production of marketable spikes and good quality corms.

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