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Effect of plant growth regulators on corm production and vase life in gladiolus

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ABSTRACT

Influence of plant growth regulator sprays on corm production and post-harvest life of two gladiolus cultivars, Darshan and Dhiraj, was investigated for two consecutive years, 2008-09 and 2009-10. Growth regulators, viz., gibberellic acid (100 and 150ppm), tri-iodo benzoic acid (TIBA) (50 and 100ppm), 2-chloro, 4-pyridyl phenyl urea (CPPU) (2.5 and 5ppm) and brassinosteroid (BR) (5 and 10ppm) were sprayed at the 3rd and 6th leaf stage. Cv. Darshan recorded maximum number of large cormels per plant and cormel weight, while, cv. Dhiraj recorded maximum number of small cormels per plant in treatments of pre-harvest foliar sprays with plant growth regulators. Foliar sprays of BR (10ppm) and GA_3 (150ppm) significantly increased number of corms produced per plant, corm size, corm weight, and propagation coefficient. Number of large cormels and total number of cormels per plant were significantly higher in BR (10ppm), followed by TIBA (100ppm). BR (10ppm) and TIBA (100ppm) produced maximum number of small cormels per plant. Weight of cormels per plant was maximum in BR (10ppm) and GA_3 (150ppm). Post-harvest studies revealed that cv. Darshan recorded maximum diameter of second fully-opened floret and higher vase-life than cv. Dhiraj with pre-harvest foliar spray of plant growth regulators. Pre-harvest foliar spray of GA_3 (150ppm), BR (10ppm) and CPPU (5ppm) induced earliest first-floret opening and recorded maximum value for number-of-florets-open-at-a-time per spike, diameter of second fully-opened floret, and vase-life. Foliar spray of BR (10ppm) and GA_3 (150ppm) at 3rd and 6th leaf stage can be recommended for large-scale multiplication of quality planting material and longer vase-life of flower spikes, respectively, in gladiolus.

Key words: Gladiolus, corm, vase-life, GA_3, brassinosteroids, CPPU

INTRODUCTION

Floricultural experts on various occasions have stated that there is a severe dearth of planting material of elite ornamental cultivars in the country for commercial cultivation, and that there is an acute need to develop comprehensive protocols for clonal multiplication of all such crops. Use of quality planting material or seed is the foundation for successful cultivation of all flowers. Shortage of quality planting material is a major constraint hindering the progress of floriculture industry in India (Choudhury and Prasad, 2004). Gladiolus, one of the important bulbous cut-flower crops, is commercially propagated using corms. Profitability in gladiolus flower-spike production and export is closely linked to cost of the corms. Poor multiplication rate of corms and cormels (with each corm producing just 1-2 corms) in gladiolus results in a high cost of the corms, often higher than the sale-price of the flower spike produced by that corm. For many years, achieving a high rate of multiplication and good corm-enlargement under various soil and climatic conditions has been the chief objective in breeding gladioli for corm production. Micropropagation protocols, although standardized for gladiolus (Hussain *et al*, 1997), are not followed commercially as the plantlets take 2-3 seasons for producing flower-grade corms. Various approaches were tried for increasing the rate of corm multiplication in gladiolus. Although leaf and spike removal increases corm and cormel production to some extent (Das, 1998), it results in a decrease in spike yield and quality. Research on the effect of traditional plant growth regulators like gibberellins and tri-iodo benzoic acid (TIBA) for improving corm multiplication rate and corm enlargement in gladiolus has been reported by various workers from different parts of the country (Tawar *et al*, 2007; Devi *et al*, 2007). However, there has been no organized research on the effect of new classes of plant growth regulators, viz., brassinosteroids (BR) and 2-chloro 4-pyridyl phenyl urea (CPPU) on corm multiplication in gladiolus from India or abroad.

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Claims have been made that 30-70% of the potential lasting-quality in several flower crops is predetermined at harvest. In gladiolus, pre-harvest application of chemicals and plant growth regulators was found to extend vase-life of cut spikes (Raju *et al*, 2008). Similarly, for extending vase-life in gladiolus, use of sucrose in combination with aluminium sulphate [$Al_2(SO_4)_3$] as the holding solution is reported by various workers (Namita *et al*, 2006; Nelofar and Paul, 2008). Hence, an investigation for ascertaining the effect of foliar spray of brassinosteroids (BR), 2-chloro, 4-pyridyl phenyl urea (CPPU) along with gibberellic acid (GA) and tri-iodo benzoic acid (TIBA) on corm multiplication and post-harvest life in two gladiolus cultivars, Darshan and Dhiraj, was made at Herbal garden, Hyderabad, for two consecutive years, 2008-09 and 2009-10.

MATERIAL AND METHODS

Corms of gladiolus cultivars Darshan and Dhiraj, resistant to fusarium wilt disease and suitable for growing in and around Hyderabad, were used in the study. Nine growth regulator treatments were imposed, viz., GA_3 (100 and 150ppm), TIBA (50 and 100ppm), CPPU (2.5 and 5.0ppm), BR (5.0 and 10.0ppm) and Control (water spray), each replicated thrice in Factorial Randomized Block Design. Corms were planted at a spacing of 30cm x 20cm and at a depth of 5cm in 1m x 1m size plots, during the month of September, 2008 and 2009. Treatments were imposed as foliar sprays at the 3rd and 6th leaf stage. Well-decomposed farmyard manure at 10t ha^{-1} was incorporated into all the experimental plots, uniformly, as basal application. N, P, and K @ 200:200:300 kg/ha were applied in the form of urea, single super phosphate and muriate of potash, respectively. Urea was applied in 3 splits, the first dose as basal application and the other two split doses at 30 and 60 days after planting. The entire dose of single super phosphate and muriate of potash was applied at the time of planting, as the basal dose. Standard cultural practices were followed during the entire crop period in all the experimental plots. Observations on corm attributes, viz., number of corms per plant, corm size (cm), corm weight (g), number of large and small cormels per plant, total number of cormels per plant, weight of cormels per plant (g) and propagation coefficient (%) were recorded. Data were subjected to Analysis of Variance (ANOVA) as applicable to Factorial Randomized Block Design.

For post-harvest studies, uniform-sized spikes were harvested from all the experimental plots early in the morning (when the basal 1-2 florets showed color-break) and brought immediately to the laboratory in a bucket of water. Lowermost leaves of the spikes were removed, and the basal 2cm portion was re cut under water before placing in the holding solution. A solution containing sucrose (4%) in combination with $Al_2(SO_4)_3$ (300ppm) was used as the holding solution. The experiment was laid out in Completely Randomized Block Design (CRD) with factorial concept. Three replications comprised three spikes per replication. Observations on days-to-first-floret-opening, number of florets-open-at-a-time per spike, diameter of the second fully-open floret (cm), and vase-life were recorded. Data were subjected to Analysis of Variance (ANOVA) as applicable to Factorial Completely Randomized Block Design.

RESULTS AND DISCUSSION

Results in the present study (Tables 1, 2, 3 and 4) indicated that the two cultivars used did not differ significantly in respect of number, size or weight of corms during the two years of study. However, the varieties differed significantly in respect of number of large and small cormels per plant, weight of the cormels per plant, and propagation coefficient. Cv. Darshan produced a higher number of large cormels and weight of cormels per plant, whereas, cv. Dhiraj was efficient in terms of producing higher number of small cormels, and, a higher propagation coefficient. Variation in cultivars on individual gladiolus corm characteristics was earlier reported by several workers (Seenivasan, 2001; Umadevi, 2002).

BR (10ppm), followed by GA_3 (150ppm) significantly increased number of corms per plant, size and weight of corms per plant and weight of cormels, and thereby, propagation coefficient during both the years of investigation. BR (10ppm) also recorded a high number of large and small cormels per plant. These results represent the first demonstration of a clear, favorable effect of BR at 10ppm on corm and cormel induction in gladiolus cvs. Darshan and Dhiraj. This also indicates a potential of BR in increasing the number of corms significantly, without impairing quality of the corms, i.e., size and weight of the corms. Results obtained with BR treatment in respect of corm and cormel production are in line with Ramraj *et al* (1997) who reported a significant increase in potato tuber yield with foliar application of BR, and, Nunez *et al* (1998) in onion. Thus, it can be concluded that two foliar sprays of BR (10ppm) at 3rd and 6th leaf stage increases number of corms and cormels in gladiolus. The increase in corm size and weight of corms/cormels with application of GA_3 (150ppm) can be attributed to the growth regulator's ability to improve growth which, in turn, increased the amount of photosynthetic assimilates. These assimilates may have been transported to the developing daughter-corms and cormels, thereby effecting an increasing in their size and weight. Similar results were reported by Vijai Kumar and Umrao (2007).

Except in the case of number of large and small cormels per plant, TIBA (100ppm) treatment recorded significantly low values for all the corm and cormel characters under study. CPPU at 5ppm increased the number of corms per plant and corm size significantly, and was on par with BR (10ppm) and GA_3 (150ppm).

Variation in the number of corms per plant may be attributed to a variation in the number of buds sprouted per corm, a parameter governed by the presence of number of active buds in a corm. Gladiolus has two sources, corm or cormel, used for planting and these serve as reserve food material in the initial stages of plant development and photosynthesizing leaves take over this function in the later stages. Likewise, gladiolus has two competing sinks: flower spike or inflorescence, and the developing corm and cormel. TIBA (100ppm) treatment promoted sink activity in developing cormels (Devi *et al*, 2007) which could be the reason for an increase in number of large and small cormels.

As for post-harvest attributes (Tables 5 and 6), cv. Darshan recorded higher diameter in second fully-open floret

Table 1. Effect of foliar spray of plant growth regulators on number of corms per plant and corm size in gladiolus cvs. Darshan and Dhiraj

Treatment	Number of corms per plant						Corm size (cm)					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	1.67	1.60	1.64	1.67	1.60	1.64	4.43	4.51	4.47	4.26	4.54	4.40
GA_3 (150ppm)	1.87	1.67	1.77	1.93	1.67	1.80	5.00	4.86	4.93	4.81	4.85	4.83
TIBA (50ppm)	1.53	1.37	1.45	1.53	1.40	1.47	4.15	4.68	4.42	4.28	4.72	4.50
TIBA (100ppm)	1.47	1.27	1.37	1.43	1.30	1.37	3.84	3.86	3.85	3.91	3.80	3.86
CPPU (2.5ppm)	1.53	1.47	1.50	1.60	1.43	1.52	4.30	4.71	4.51	4.37	4.58	4.48
CPPU (5ppm)	1.60	1.60	1.60	1.63	1.67	1.65	4.59	4.83	4.71	4.55	4.74	4.65
BR (5ppm)	1.63	1.53	1.58	1.53	1.60	1.57	4.39	4.94	4.67	4.52	4.73	4.63
BR (10ppm)	1.93	1.72	1.83	1.80	1.85	1.83	4.98	5.17	5.08	4.73	5.30	5.02
Control (Water)	1.47	1.37	1.42	1.47	1.33	1.40	4.26	4.40	4.33	4.30	4.31	4.31
Mean	1.64	1.50		1.65	1.54		4.44	4.66		4.41	4.62	
CD *(P=0.05)*												
Cultivars (C)		N.S.			N.S.			N.S.			N.S.	
Treatments (T)		0.16			0.19			0.44			0.47	
Interaction (CxT)		N.S.			N.S.			N.S.			N.S.	

N.S.: Non-significant

Table 2. Effect of foliar spray of plant growth regulators on corm weight and number of large cormels per plant in gladiolus cvs. Darshan and Dhiraj

Treatment	Corm weight (g)						Number of big cormels per plant					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	30.23	33.91	32.07	29.56	36.55	33.06	3.33	2.87	3.10	3.00	2.07	2.54
GA_3 (150ppm)	33.80	35.81	34.81	32.89	36.95	34.92	3.67	2.87	3.27	3.67	3.33	3.50
TIBA (50ppm)	30.99	32.87	31.93	29.15	33.54	31.34	3.07	2.07	2.57	2.47	2.00	2.23
TIBA (100ppm)	27.45	31.05	29.25	27.80	29.72	28.76	4.87	3.53	4.20	5.00	3.00	4.00
CPPU (2.5ppm)	31.62	34.55	33.09	30.67	33.60	32.14	3.00	2.40	2.70	3.33	2.00	2.67
CPPU (5ppm)	32.75	35.18	33.97	31.99	35.01	33.50	3.67	3.20	3.44	4.33	3.40	3.87
BR (5ppm)	33.15	33.49	33.32	32.79	32.37	32.58	3.00	2.00	2.50	3.00	3.33	3.17
BR (10ppm)	34.11	36.66	35.39	35.04	36.76	35.90	6.07	4.80	5.44	5.00	4.33	4.67
Control (Water)	31.46	32.33	31.90	31.94	31.10	31.52	2.67	1.87	2.27	3.27	1.53	2.40
Mean	31.73	33.98		31.31	33.96		3.70	2.84		3.66	2.78	
CD *(P=0.05)*												
Cultivars (C)		N.S.		N.S.				0.34			0.32	
Treatments (T)		1.28		1.08				0.72			0.66	
Interaction (CxT)		N.S.		N.S.				N.S.			N.S.	

N.S.: Non-significant

Table 3. Effect of foliar spray of plant growth regulators on number of small cormels and total number of cormels per plant in gladiolus cvs. Darshan and Dhiraj

Treatment	Number of small cormels per plant						Total number of cormels per plant					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	4.67	3.33	4.00	4.87	3.00	3.94	8.00	6.20	7.10	7.87	5.07	6.48
GA_3 (150ppm)	3.67	4.67	4.17	3.80	5.33	4.57	7.34	7.54	7.44	7.47	8.66	8.07
TIBA (50ppm)	3.00	3.67	3.33	3.07	4.33	3.70	6.07	5.74	5.90	5.54	6.33	5.93
TIBA (100ppm)	5.67	6.33	6.00	5.53	6.07	5.80	10.54	9.86	10.20	10.53	9.07	9.80
CPPU (2.5ppm)	2.00	3.33	2.67	1.93	3.93	2.93	5.00	5.73	5.37	5.26	5.93	5.60
CPPU (5ppm)	4.33	4.00	4.17	4.33	4.20	4.27	8.00	7.20	7.60	8.66	7.60	8.14
BR (5ppm)	5.00	6.67	5.84	4.80	6.33	5.57	8.00	8.67	8.33	7.80	9.66	8.74
BR (10ppm)	6.00	8.20	7.10	5.93	8.00	6.97	12.07	13.00	12.54	10.93	12.33	11.64
Control (Water)	3.67	4.33	4.00	4.33	5.07	4.70	6.34	6.20	6.27	7.60	6.60	7.10
Mean	4.22	4.95		4.29	5.14		7.92	7.79		7.95	7.92	
CD *(P=0.05)*												
Cultivars (C)		0.59			0.76			N.S.			N.S.	
Treatments (T)		1.23			1.28			1.28			1.33	
Interaction (CxT)		N.S.			N.S.			N.S.			N.S.	

N.S.: Non-significant

Table 4. Effect of foliar spray of plant growth regulators on weight of cormels per plant and propagation coefficient in gladiolus cvs. Darshan and Dhiraj

Treatment	Weight of cormels per plant (g)						Propagation coefficient (%)					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	4.57	4.45	4.51	5.83	4.36	5.10	131.34	144.78	138.06	133.58	154.37	143.97
GA_3 (150ppm)	7.06	4.91	5.99	6.80	4.94	5.87	154.21	153.64	153.93	149.77	158.08	153.92
TIBA (50ppm)	5.17	4.82	5.00	5.03	4.78	4.91	136.50	142.22	139.36	128.98	144.58	136.78
TIBA (100ppm)	5.94	4.40	5.17	5.86	4.93	5.40	126.08	133.77	129.92	127.02	130.78	128.90
CPPU (2.5ppm)	4.00	3.85	3.93	3.77	3.78	3.78	134.44	144.92	139.68	129.95	141.06	135.50
CPPU (5ppm)	4.63	4.61	4.62	5.52	4.94	5.23	141.07	150.16	145.61	141.56	150.78	146.17
BR (5ppm)	4.89	3.78	4.34	4.86	3.99	4.43	143.53	140.63	142.08	142.08	137.21	139.64
BR (10ppm)	6.86	5.19	6.03	7.02	5.55	6.29	154.63	157.93	156.28	158.74	159.64	159.19
Control (Water)	4.23	4.03	4.13	4.40	3.80	4.10	134.68	137.20	135.94	137.14	131.69	134.41
Mean	5.37	4.45		5.44	4.57		139.61	145.03		138.76	145.35	
CD *(P=0.05)*												
Cultivars (C)		0.23			0.32			3.85			4.71	
Treatments (T)		0.48			0.66			8.08			9.88	
Interaction (CxT)		N.S.			N.S.			N.S.			N.S.	

N.S.: Non-significant

and longer vase-life than cv. Dhiraj. Variation in vase-life among cultivars may be attributed to a differential accumulation of carbohydrates due to dissimilar leaf production profiles and sensitivity of the cultivars to ethylene (Kalasareddi *et al*, 1997). In turn, variations in these aspects may be due to the genetic make-up of the plant (Kamble *et al*, 2004). GA_3 (150ppm), followed by BR (10ppm) and CPPU (5ppm), induced significantly earlier first-floret opening, with greater number of florets-open-at-a-time per spike. Perhaps spikes from these treatments had sufficient food material for opening of the florets. Diameter of the second fully-opened floret and vase-life were also influenced significantly by pre-harvest spray of plant growth regulators in both the years of investigation. GA_3 (150ppm), BR (10ppm) and CPPU (5ppm) registered maximum diameter of second floret, and longest vase-life. All the post-harvest parameters had the least values with TIBA at 100 or 50ppm. Increased vase-life with foliar spray of GA_3 has been reported by Pal and Choudhury (1998) in gladiolus. Improvement in floret-size by foliar spray of GA_3 was reported by Nagarjuna *et al* (1988) in chrysanthemum. Halevy and Shild (1970) observed that GA_3 increased photosynthetic and metabolic activity, resulting in greater transport and utilization of photosynthesis products necessary for growth and development of a flower. Maximum diameter of second-floret with foliar application of GA_3 can be attributed to increased drawal of photosynthates by the flower as a consequence of intensification of the sink (Zieslin *et al*, 1974).

Padmapriya and Chezhiyan (2002) reported that higher flower diameter in chrysanthemum cv. Indira with foliar spray of BR could be due to a synergism between BR and auxins. BR may have altered bio-physical properties of the cell wall, leading to a high energy-conversion for expanding flower diameter. An increase in floret diameter with CPPU (5ppm) treatment is perhaps be due to a trigger for cell division and cell enlargement.

Reduction in floret-size caused by application of TIBA is probably due to its anti-auxin activity (preventing the transport of naturally-produced auxins) and, thereby, reduced cell elongation. These results are in line with Nanjan and Muthuswamy (1975) in rose. Reduction in vase-life due to TIBA application was reported by Umadevi (2002) in gladiolus.

In addition to pre-harvest foliar spray of GA_3 (150ppm) or BR (10ppm) or CPPU (5ppm), exogenous supply of sucrose in the holding solution balanced the depletion in carbohydrates, and improved vase-life and quality of the spikes. Sucrose also maintained the water balance and osmotic potential, since; sugar has been observed to decrease

Table 5. Effect of foliar spray of plant growth regulators on days to first-floret-opening and number of florets-open-at-any-time per spike in gladiolus cvs. Darshan and Dhiraj

Treatment	Days to first-floret opening						Number of florets-open-at-any-time per spike					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	1.67	2.22	1.95	1.67	2.11	1.89	2.56	2.11	2.33	2.45	2.22	2.34
GA_3 (150ppm)	1.45	1.56	1.51	1.44	1.56	1.50	3.22	2.67	2.95	3.11	2.89	3.00
TIBA (50ppm)	2.44	2.22	2.33	2.33	2.45	2.39	2.22	1.89	2.06	2.11	2.00	2.06
TIBA (100ppm)	2.45	2.44	2.45	2.45	2.44	2.45	2.00	1.78	1.89	2.11	1.78	1.95
CPPU (2.5ppm)	2.11	2.33	2.22	2.22	2.44	2.33	2.11	2.22	2.17	2.33	2.00	2.17
CPPU (5ppm)	1.56	1.89	1.73	1.56	2.11	1.84	2.89	2.33	2.61	2.78	2.33	2.56
BR (5ppm)	2.00	2.33	2.17	2.00	2.33	2.17	2.33	2.22	2.28	2.44	2.00	2.22
BR (10ppm)	1.44	1.78	1.61	1.44	1.78	1.61	2.67	2.56	2.62	2.78	2.67	2.73
Control (Water)	2.22	2.33	2.28	2.33	2.33	2.33	2.11	2.33	2.22	2.34	2.22	2.28
Mean	1.93	2.12		1.95	2.17		2.48	2.24		2.49	2.24	
CD *(P=0.05)*												
Cultivars (C)		N.S.			N.S.			N.S.			N.S.	
Treatments (T)		0.43			0.51			0.50			0.50	
Interaction (CxT)		N.S.			N.S.			N.S.			N.S.	

N.S.: Non-significant

Table 6. Effect of foliar spray of plant growth regulators on diameter of second fully-opened floret (cm) and vase life (days) in gladiolus cvs. Darshan and Dhiraj

Treatment	Diameter of second fully-opened floret (cm)						Vase life (days)					
	2008-09			2009-10			2008-09			2009-10		
	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean	Darshan	Dhiraj	Mean
GA_3 (100ppm)	1.67	2.22	1.95	1.67	2.11	1.89	2.56	2.11	2.33	2.45	2.22	2.34
GA_3 (100ppm)	8.74	8.31	8.53	8.71	8.35	8.53	9.00	8.44	8.72	8.89	8.55	8.72
GA_3 (150ppm)	9.24	8.83	9.04	9.32	8.87	9.10	9.44	9.33	9.39	9.56	9.33	9.45
TIBA (50ppm)	8.43	7.38	7.91	8.38	7.63	8.00	8.50	7.83	8.17	8.39	8.06	8.23
TIBA (100ppm)	7.60	7.20	7.40	7.61	7.17	7.39	8.00	7.61	7.81	7.78	7.50	7.64
CPPU (2.5ppm)	8.65	8.30	8.48	8.70	8.30	8.50	9.11	8.28	8.70	9.00	8.17	8.59
CPPU (5ppm)	8.86	8.55	8.71	8.93	8.54	8.74	9.00	9.11	9.06	9.22	9.11	9.17
BR (5ppm)	8.72	8.31	8.52	8.70	8.33	8.52	8.78	8.56	8.67	8.67	8.56	8.62
BR (10ppm)	8.94	8.67	8.81	9.04	8.69	8.87	9.22	9.11	9.17	9.44	9.00	9.22
Control (Water)	8.67	8.00	8.33	8.71	8.03	8.37	8.72	8.11	8.42	8.67	7.78	8.23
Mean	8.65	8.17		8.68	8.21		8.86	8.49		8.85	8.45	
CD *(P=0.05)*												
Cultivars (C)		0.28			0.30			0.28			0.32	
Treatments (T)		0.61			0.65			0.60			0.68	
Interaction (CxT)		N.S.			N.S.			N.S.			N.S.	

N.S.: Non-significant

moisture stress in cut-flowers by affecting stomatal closure and preventing water-loss (Ranvir Singh and Sashikala, 2002). $Al_2(SO_4)_3$ present in the holding solution helped improve keeping-quality owing to its antimicrobial action.

From this study, it can be concluded that foliar spray of BR (10ppm) and GA_3 (150ppm) at the 3rd and 6th leaf stage can be recommended for large-scale multiplication of quality planting-material and for longer vase-life in flower spikes, respectively, in gladiolus.

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