Effect of Benzyl Adenine and Gibberellic Acid on Dormancy Breaking and Growth in Gladiolus Cormels

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Abstract

The study was conducted at the Floriculture Research Field, Horticulture Research Centre, Bangladesh Agricultural Research Institute during the period from November 2006 to May 2008 to determine the optimum concentration of BA and GA_3 on dormancy breaking of gladiolus cormels and their effect on cormel growth and subsequent production of gladiolus corm and cormels. Application of 100 mg GA_3 gave the maximum corm (117,000) and cormel yield (1.49 t ha^{-1}) followed by GA_3 75 mg L^{-1}. Among various levels of BA, 50 mg L^{-1} and 125 mg L^{-1} showed statistically similar corm and cormel yield ha^{-1}. Moreover, BA 125 mg L^{-1} enhanced multiple shooting. Partial budget analysis revealed that the highest marginal rate of return for BA and GA_3 was 921% and 775%, respectively.

Keywords: benzyl adenine, gibberellic acid, dormancy breaking, growth and gladiolus cormel

Introduction

Gladiolus is a very popular bulbous ornamental having great economic value as a cut flower. Commercial production of gladiolus flower needs a good amount of high quality virus free flower grade corms. These corms are developed through cormels normally in the third year. So, in commercial point of view, it is needed to reduce the duration for production of flower grade corms from cormels. But the quality and quantity of daughter corms depend on several factors like dormancy and quality of cormels. Dormancy is more pronounced in cormels than corms. Because the cormels are encased in a brown shell, which is impervious to water and if cormels planted without its removal, it takes longer time to germinate. So, soaking of cormels before planting is advised (Mukhopadhaya, 1995).

Now a day the use of growth regulators is a common practice for modifying the developmental processes of flowers and ornamental plants. Freshly harvested corms and cormels of gladiolus under go a period of dormancy which is regulated by changes in the levels of endogenous promoting or inhibitory substances (Misra and Singh, 1998). The major area where benzyl adenine (BA) and gibberellic acid (GA_3) have successfully played their roles in ornamental plants, dormancy breaking and growth are important. BA and GA_3, are known to promote corm and cormel sprouting. Bhattacharjee (1984) found that GA_3 influenced seed germination, the growth, flowering, floret size and number of florets $spike^{-1}$ in gladiolus. BA was suitable for breaking dormancy of gladiolus corm and cormels (Narayana and Gowda, 1994). Simultaneously, stimulated sprouting of cormels by GA_3 treatment has been reported by Arora et al. (1992).

Some technologies are available for the production of gladiolus flower, but information regarding the use of plant growth regulators on cormels for the production of corm and cormel in Bangladesh are very scanty. Keeping these factors in mind, the present study was undertaken to find out the optimum concentration of BA and GA_3 on dormancy breaking of gladiolus cormels and to find out the effect of BA and GA_3 on cormel growth and subsequent production of gladiolus corm and cormels.

Materials and Methods

The experiment was carried out at Floriculture Research Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during the period from November 2006 to May 2008. Medium sized (1.5-2.0 cm diameter) cormels of BARI Gladiolus 1 were used as planting materials. There were 11 treatments. Two growth regulators such as Benzyl adenine (BA) and Gibberellic acid (GA_3), each at five levels viz., 50, 75, 100, 125, 150 mg L^{-1} and control (water soaking) were used in this experiment.

Medium sized cormels were soaked for 2 hours in BA and GA_3 solution and also in water as per the treatment schedule. The soaked cormels were then shade dried for 2 hours and then planted. The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. The cormels were planted at 20 cm × 15 cm spacing in unit plot of 1.2 m × 1.05 m.

The crop was fertilized with 200 kg urea, 225 kg TSP and 190 kg MOP ha^{-1} (Woltz, 1976). Cowdung, TSP and MOP were applied as basal and urea was top-dressed in two equal splits at 4 leaf stage and spike initiation stage. The cormels were planted on November 30, 2006. Different intercultural operations like weeding, watering were done as and when necessary. The cormel plants were not allowed to flower as that would reduce the production of corm and cormels. The spikes were removed carefully without foliage injury, before they open. Harvesting of corms and cormels were done only when leaves turned brown (Mukhopadhaya, 1995). After taking necessary records, the corms were stored in a perforated nylon bag in normal room temperature according to treatments. The stored corms were planted on December 6, 2007 to observe the performance of flower production. Data on different growth and yield parameters were recorded and analyzed statistically. Considering only the variable costs, a partial budget analysis was done.

Results and Discussion

Effect of BA and GA_3 on Vegetative Growth

Emergence (50%)

GA_3 at 100 mg L^{-1} took the minimum days (15 days) to 50% emergence followed by other concentrations of GA_3. Among BA levels, 50 mg L^{-1} of BA showed better performance (19.67 days) than higher concentration of BA and control (Table 1). Gowda (1994) reported that lower concentration of BA resulted in early sprouting than higher concentration of BA. The effect of gibberellic acid in inducing the formation of hydrolytic enzymes may be a factor, which regulates the mobilization of reserves, ultimately resulting in early sprouting with GA_3 (Groot and Karssen, 1987). Arora et al. (1992) also found 100 mg L^{-1} GA_3 hastened the sprouting of cormels.

Plant emergence

The maximum percentage of plants (97.62) was emerged in the treatment of GA_3 at 100 mg L^{-1} which was statistically identical with all other concentrations of GA_3 and BA 50 mg L^{-1}. The minimum number of plants (66.67%) was emerged in the treatment BA 150 mg L^{-1} (Table 1). In an experiment, Miller and Holcomb (1982) showed that GA_3 treatment increased the rate of germination of *Primula x polyantha,* and control seeds germinated significantly more slowly than GA_3 treated seeds.

Plants hill^{-1}

The highest number of plants hill^{-1} (1.29) was found in BA 125 followed by BA 150 mg L^{-1} (1.23). BA 100 mg L^{-1} also showed significantly higher number of plants hill^{-1} (1.16) than other treatments (Table 1). According to Murti and Upreti (1995), BA is responsible for lateral branching. Baskaran and Misra (2007) also found more shoots per corm by the application of BA 100 mg L^{-1} (2.33) followed by BA 50 mg L^{-1} (2.05).

Table 1 Effect of BA and GA_3 on vegetative growth of gladiolus from cormel

Treatment ($mg\ L^{-1}$)	50% emergence (day)	Plant emergence (%)	Plants $hill^{-1}$	Plant height (cm)	Leave $plant^{-1}$
BA 50	19.67 bcd	90.48 (69.71) abc	1.04 cd	42.76 ab	9.82 abc
BA 75	20.67 bc	83.33 (63.61) bcd	1.02 d	42.36 ab	10.41 a
BA 100	22.0 ab	80.95 (61.89) bcd	1.16 bc	41.86 ab	10.19 ab
BA 125	24.0 ab	78.57 (60.28) cd	1.29 a	40.73 abc	9.87 abc
BA 150	25.67 a	66.67 (52.86) d	1.23 ab	40.34 bc	9.92 abc
GA_3 50	16.67 cde	91.27 (72.93) abc	1.01 d	41.65 ab	9.33 c
GA_3 75	16.0 de	92.86 (72.41) abc	1.0 d	42.15 ab	9.47 bc
GA_3 100	15.0 e	97.62 (79.66) a	1.0 d	43.05 a	9.47 bc
GA_3 125	15.33 de	94.45 (74.0) ab	1.0 d	42.22 ab	9.43 bc
GA_3 150	16.67 cde	94.45 (74.0) ab	1.0 d	41.35 abc	9.30 c
Control	23.67 ab	81.74 (62.54) bcd	1.0 d	39.03 c	9.23 c
F-test	**	**	**	*	**
CV (%)	8.76	7.45	5.10	3.17	3.18

Means with the same letter(s) are not significantly different at 1% and 5% by DMRT, ** Significant at 1% level, * Significant at 5% level.

Plant height

The longest plant (43.05 cm) was recorded in the treatment GA_3 100 mg L^{-1} followed by all concentration levels of GA_3 and BA except BA 150 mg L^{-1}. Control (water soaked) showed the shortest plant (39.03 cm). Increase in plant height due to GA_3 application was in accordance with the work of Roychoudhury (1989).

Leaves per plant

The maximum number of leaves $plant^{-1}$ (10.41) was produced by the treatment BA 75 mg L^{-1} followed by other levels of BA. The minimum was found in control which was statistically similar with all other levels of GA_3 (Table 1). In this connection little bit different results were found by Baskaran and Misra (2007) where BA and GA_3 showed similar trends.

Effect of BA and GA_3 on Spike Emergence

1st spike initiation

The minimum period (79.7 days) was required to reach 1st spike initiation i.e. flowering by the cormels treated with 50 mg L^{-1} GA_3 which was statistically similar with all levels of GA_3, BA 50 mg L^{-1} and 75 mg L^{-1} and also along with the control (Figure 1). The early flowering of this treatment might be due to early emergence of corms. Similar trends were found by Parmar et al. (1994) in tuberose. Earliness in flowering (83.87 to 86.33 days) at different levels of GA_3 was reported by Baskaran and Misra (2007). Statistically the higher concentration of BA took the maximum period to reach 1st spike initiation. These might be due to higher concentration of BA (100- 150 mg L^{-1}) enhanced multiple shooting which may take the longer time to reach spike initiation.

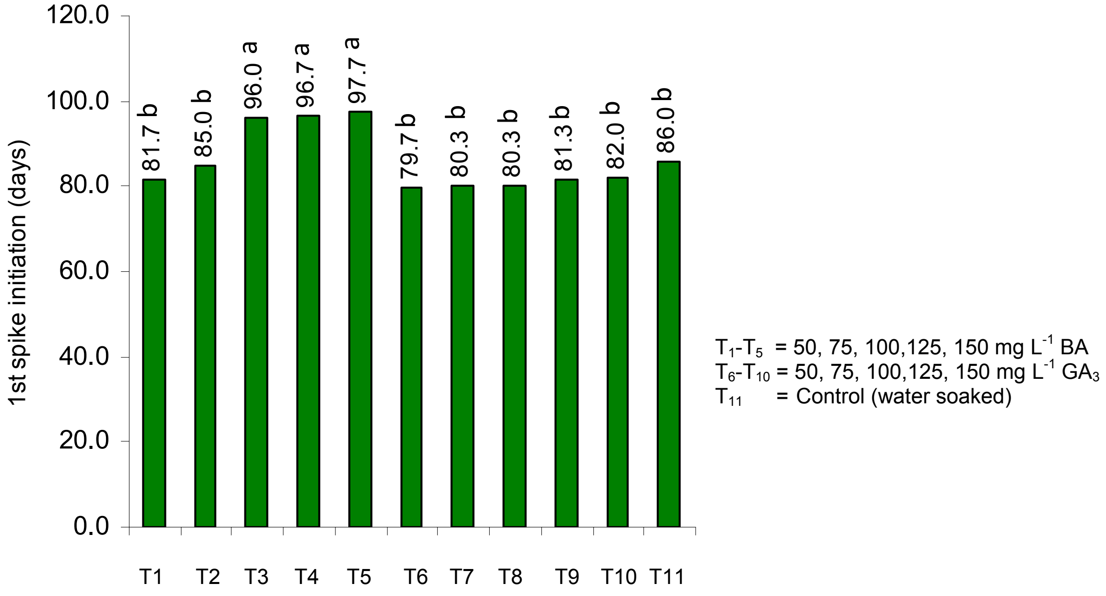

Figure 1 Days required for 1st spike initiation of gladiolus cormel treated with BA and GA_3.

Spikes

Though flowers from cormel were not allowed due to enhancement of corm and cormel production yet the maximum percentage of spikes (68.9%) were produced by the treatment $GA_3$150 mg L^{-1} followed by all concentration levels of GA_3. Whereas the lowest percentage (16.7%) was recoded in BA 150 mg L^{-1} followed by BA 125 and BA 100 (Figure 2). It was observed that higher concentrations of BA (100 to 150 mg L^{-1}) produced the lowest percentage of spikes. This may be due to that the highest concentration of BA enhanced multiple shooting which may reduce the spike percentage.

Effect of BA and GA_3 on Corm Production

Corms

The highest percentage of corms (95.24%) was found under the treatment GA_3 100 through cormel planted plot^{-1} which was statistically similar with all GA_3 levels and BA 125 mg L^{-1} (Table 2). The minimum was recorded in control which was only 62.70% of cormel planted plot^{-1}. Among BA levels, BA 125 mg L^{-1} showed better performance due to higher number of plants hill^{-1}.

Corm weight

The treatment with GA_3 at 100 mg L^{-1} produced the heaviest corm (19.74 g) which was 30.56% higher than in control (Table 2). All levels of GA_3, BA 50 mg L^{-1}, BA 75 mg L^{-1} and BA 100 mg L^{-1} showed significantly similar trends. The highest increase in corm weight with GA_3 100 mg L^{-1} was in confirmation with earlier in gladiolus by Umrao et al. (2007)

Corm diameter

The treatment GA_3 100 mg L^{-1} significantly increased the diameter of corm by 18.46% over control. Gibberellins lead to increase cell division and cell growth apparently which lead to increased elongation of root (Stewart and Jones, 1977). Thus it enhances diameter of corms. The results in the present study are in agreement with the earlier report in tuberose by Biswas et al. (1982). They reported that GA_3 at 100 mg L^{-1} enhanced diameter of bulb.

Flowering sized corm

Cent percent flowering sized corms were produced by the treatment GA_3 75 mg L^{-1}, GA_3 100 mg L^{-1} and GA_3 150 mg L^{-1} those were statistically similar to rest of the levels of GA_3, BA 50 mg L^{-1}, BA 75 mg L^{-1} and control (Table 2). Higher concentrations of BA (100 to 150 mg L^{-1}) showed lower performance due to higher number of plants hill^{-1} which was mentioned earlier.

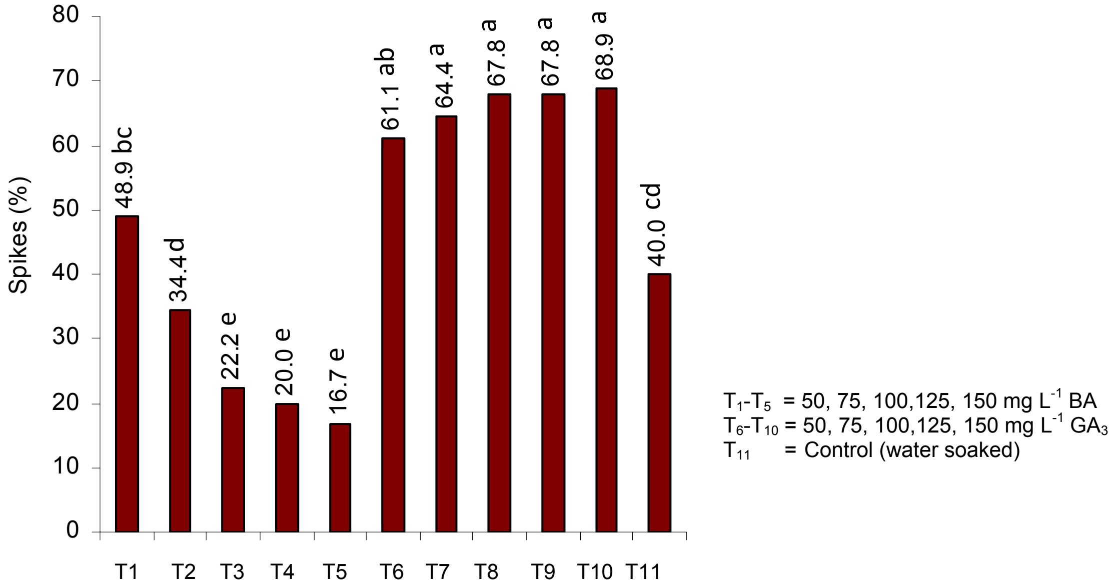

Figure 2 Percentage of spikes from gladiolus cormel treated with BA and GA_3.

Table 2 Effect of BA and GA_3 on corm production of gladiolus from cormel.

Treatment (mg L^{-1})	Corm (%)	Corm weight (g)	Corm diameter (cm)	Flowering sized corm (%)	Corm yield	
					$plot^{-1}$ (g)	ha^{-1} (000)
BA 50	85.71 (65.58) bc	18.47 ab	3.62 abc	98.25 (82.04) ab	656.7 bc	106.0 ab
BA 75	73.02 (56.72) de	17.43 abc	3.62 abc	97.98 (81.72) ab	510.0 de	90.0 c
BA 100	77.78 (59.74) cd	16.36 abc	3.35 cd	91.88 (70.89) b	511.7 de	96.0 bc
BA 125	87.3 (66.95) abc	15.18 bc	3.32 d	90.02 (69.08) b	571.7 cd	108.0 ab
BA 150	72.22 (56.19) de	14.35 c	3.18 d	90.23 (69.35) b	436.7 e	89.0 cd
GA_3 50	87.3 (66.95) abc	18.69 ab	3.67 ab	98.10 (81.86) ab	671.7 abc	108.0 ab
GA_3 75	88.89 (68.13) abc	19.17 a	3.75 a	100.0 (86.04) a	701.7 ab	109.0 a
GA_3 100	95.24 (74.93) a	19.74 a	3.85 a	100.0 (86.04) a	781.7 a	117.0 a
GA_3 125	91.27 (70.37) ab	17.25 abc	3.59 abc	98.29 (82.09) ab	680.0 abc	112.0 a
GA_3 150	88.10 (67.42) abc	16.18 abc	3.45 bcd	100.0 (86.04) a	603.3 bcd	108.0 ab
Control	62.70 (50.52) e	15.12 bc	3.25 d	93.49 (74.89) ab	406.7 e	77.0 d
F test	**	**	**	**	**	**
CV (%)	5.13	8.63	3.14	6.37	8.22	5.07

Means with the same letter(s) are not significantly different at 1% and 5% by DMRT, ** Significant at 1% level, * Significant at 5% level.

Corm yield per plot

The maximum corm yield (781.7 g) $plot^{-1}$ was registered in the treatment with GA_3 100 mg L^{-1} which was statistically identical to GA_3 75 mg L^{-1}, GA_3 125 mg L^{-1} and GA_3 50 mg L^{-1} (Table 2). Among the concentration levels of BA, BA 50 mg

L^{-1} showed the highest corm yield (656.7 g). The lowest corm yield (406.7 g) was produced by the treatment control followed by BA 150 mg L^{-1}, BA 75 mg L^{-1} and BA 100 mg L^{-1}.

Corm yield per hactare

The treatment 100 mg L^{-1} GA_3 produced the maximum number of corms ha^{-1} (117,000) which was statistically similar to rest of the levels of GA_3, BA 50 mg L^{-1} and BA 125 mg L^{-1} (Table 2). It was observed that all levels of GA_3 and the lowest level of BA (50 mg L^{-1}) showed better performance. BA 125 mg L^{-1} also showed better performance. This may be due to BA 125 was responsible for multiple shooting which produced higher number of corms $plot^{-1}$ i.e. higher number of corms ha^{-1}. Umrao et al. (2007) reported that treatment of corms in GA_3 increased the weight $corm^{-1}$ and total yield of corms ha^{-1} over respective control.

Effect of BA and GA_3 on Cormel Production

Cormels per hill

The maximum number of cormels (11.17) $hill^{-1}$ was recorded in the treatment GA_3 100 mg L^{-1} which was statistically similar with other levels of GA_3 and BA 50 mg L^{-1} (Table 3). The lowest (8.17) were produced at BA 75 mg L^{-1} followed by control, rest of the levels of BA and 50 mg L^{-1} and 150 mg L^{-1} GA_3.

Cormel weight per hill

The highest cormel weight (12.67 g) $hill^{-1}$ was also registered in the treatment GA_3 100 mg L^{-1} followed by all levels of GA_3, BA 50 mg L^{-1} and BA 125 mg L^{-1} (Table 3). The lowest (9.33) was recorded in the treatment control. It was observed that 35.80% cormel weight was increased $hill^{-1}$ by the treatment GA_3 100 mg L^{-1} over control. Arora *et al*. (1992) showed that cormel weight increased by 239.4% in Mayur (cv. of gladiolus) when treated with 100 mg 1^{-1} GA_3.

Cormel yield per plot

The highest cormel yield $plot^{-1}$ (510 g) was recorded at GA_3 100 mg L^{-1} which was statistically similar with that of GA_3 125 mg L^{-1} and GA_3 75 mg L^{-1} (Table 3). BA 150 mg L^{-1} produced the lowest cormel yield $plot^{-1}$ (261.67 g) due to the lowest percentage of plant emergence followed by control, 75 mg L^{-1} and 100 mg L^{-1} BA.

Cormel yield per hactare

The maximum yield of cormel ha^{-1} was produced by the treatment GA_3 100 mg L^{-1} (1.49 t ha^{-1}) followed by GA_3 125 mg L^{-1} and GA_3 75 mg L^{-1} (Table 3). The lowest yield was recorded in BA 150 mg L^{-1} which was statistically identical to BA 75 mg L^{-1}, BA 100 mg L^{-1} and control.

Table 3 Effect of BA and GA_3 on cormel production of gladiolus from cormel .

Treatment (mg L^{-1})	Cormels $hill^{-1}$	Cormel weight $hill^{-1}$ (g)	Cormel yield $plot^{-1}$ (g)	Cormel yield ha^{-1} (t)
BA 50	9.57 abcd	10.67 ab	401.67 bc	1.18 bc
BA 75	8.17 d	9.50 b	300.0 de	0.88 de
BA 100	8.40 cd	9.67 b	310.0 de	0.91 de
BA 125	9.33 bcd	10.42 ab	350.0 cd	1.03 cd
BA 150	9.17 bcd	9.58 b	261.67 e	0.77 e
GA_3 50	9.67 abcd	10.83 ab	415.0 bc	1.22 bc
GA_3 75	10.0 abc	11.17 ab	435.0 ab	1.28 ab
GA_3 100	11.17 a	12.67 a	510.0 a	1.49 a
GA_3 125	10.30 ab	10.83 ab	450.0 ab	1.32 ab
GA_3 150	9.87 abcd	10.33 ab	410.0 bc	1.20 bc
Control	8.37 cd	9.33 b	300.0 de	0.88 de
F test	*	**	**	**
CV (%)	9.85	9.02	8.74	8.81

Means with the same letter(s) are not significantly different at 1% and 5% by DMRT, ** Significant at 1% level, * Significant at 5% level.

Effect of BA and GA_3 on Flower Production of Gladiolus from Corm Produced in the Previous Year

Plant emergence

Though this parameter did not show significant variations among the treatments but 100% plants were emerged in the treatment BA 50 mg L^{-1} and all levels of GA_3 except GA_3 150 mg L^{-1} (Table 4). It was observed that those treatments exhibited better performance in respect of corm and cormel production, also showed better emergence.

Florets per spike

The maximum number of florets spike^{-1} (13.70) was registered in GA_3 100 mg L^{-1} followed by rest of the GA_3 levels and 50 mg L^{-1} BA (Table 4). This may be due to the better quality corm obtained through the previous year by these treatments performed better. Choudhury (1987) reported that treatment with 50 mg L^{-1} GA_3 produced more number of florets stick^{-1} in tuberose.

Plant height

The tallest plant (51.87 cm) was recorded in the treatment GA_3 100 mg L^{-1} which was statistically similar to rest of the GA_3 levels, BA 50 mg L^{-1}, BA 75 mg L^{-1} and BA 100 mg L^{-1}. The shortest plant (47.58 cm) was produced by the corm obtained from the treatment BA 150 mg L^{-1} (Table 4). Khan and Tewari (2003) reported that the plant height of dahlia was increased by the application of 90 mg L^{-1} gibberellic acid which confirms the present findings.

Spike length

Statistically similar spike length was produced by the corm obtained from the treatments of all levels of GA_3 and BA including control except BA 150 mg L^{-1} (Table 4). The range of similar spike length was 78.58 cm to 85.55 cm. It was observed that corm obtained from the treatment water also showed better performance. Similar findings were reported by Parmer et al. (1994) where the longer spike of tuberose was harvested in the crop raised from bulbs treated with water and GA followed by BA.

Table 4 Performance of flower production of gladiolus from corm produced in the previous year by the use of different levels of BA and GA_3.

Treatment (mg L^{-1})	Plant emergence (%)	Floret spike^{-1}	Plant height (cm)	Spike length (cm)	Rachis length (cm)	Flower stick weight (g)
BA 50	100.0 (86.04)	13.23 abc	51.58 ab	85.55 a	46.67 ab	64.67 a
BA 75	98.61 (82.51)	12.70 bc	48.55 abc	81.45 ab	44.56 abc	58.13 ab
BA 100	98.61 (82.51)	12.67 bc	48.26 abc	79.13 ab	43.87 abc	54.70 ab
BA 125	98.61 (82.51)	12.32 c	47.81 c	78.72 ab	42.32 bc	53.90 ab
BA 150	97.22 (78.99)	12.30 c	47.58 c	76.18 b	41.43 c	50.46 b
GA_3 50	100.0 (86.04)	13.30 ab	51.43 ab	84.90 a	46.90 ab	64.07 a
GA_3 75	100.0 (86.04)	13.43 ab	51.38 ab	85.20 a	48.05 a	64.07 a
GA_3 100	100.0 (86.04)	13.70 a	51.87 a	85.02 a	48.23 a	64.67 a
GA_3 125	100.0 (86.04)	13.13 abc	51.75 a	83.42 a	46.62 ab	62.33 ab
GA_3 150	98.61 (82.51)	12.97 abc	50.42 abc	82.38 ab	44.82 abc	60.17 ab
Control	98.61 (82.51)	12.50 bc	48.08 bc	78.58 ab	42.48 bc	54.67 ab
F test	NS	*	*	**	**	**
CV (%)	5.60	3.74	3.74	3.25	4.14	8.42

Means with the same letter(s) are not significantly different at 1% and 5% by DMRT, ** Significant at 1% level, * Significant at 5% level.

Rachis length

The longest rachis (48.23 cm) was produced by the corm obtained from the treatment GA_3 100 mg L^{-1} which was statistically similar to the rest of the levels of GA_3, BA 50 mg L^{-1}, 75 mg L^{-1} and 100 mg L^{-1} (Table 4). These results are in conformity with the findings reported by Parmer et al. (1994). The shortest rachis (41.43 cm) was recorded in the treatment BA 150 mg L^{-1}.

Flower stick weight

Statistically similar weighted flower stick was produced by the corm obtained from the treatments of all levels of GA_3 and BA including control except BA 150 mg L^{-1} which produced the thinnest flower sticks (50.46 g) (Table 4).

Flower sticks

Though percentage of flower stick did not show significant variations among the treatments but corms obtained from the treatment GA_3 100 mg L^{-1} and 75 mg L^{-1} through the previous year produced the highest percentage of flower sticks (110 %) (Figure 3).

Whereas corm obtained from the control treatment produced 97% flower sticks. Corm obtained from the treatment GA_3 50 mg L^{-1}, GA_3 125 mg L^{-1} and BA 50 mg L^{-1} produced more than 100% flower sticks. Similar findings were reported by Umrao et al. (2007) and they found gibberallic acid treated corms resulted in higher yield of spikes per unit area than untreated ones.

Partial budget analysis

Partial budgeting technique was employed to calculate gross margin from each treatment and then marginal analysis was performed to find out the treatment in which the marginal rate of return is highest. Gross return was the multiplication of yield of corm and cormel hectare^{-1} by the price. In Table 5, the gross margin from different treatments has been rearranged from the highest to lower in order to eliminate the cost-dominated treatments. It was observed that GA_3 125 mg L^{-1}, GA_3 150 mg L^{-1}, BA 75 mg L^{-1}, BA 100 mg L^{-1}, BA 125 mg L^{-1}, BA 150 mg L^{-1} were dominated by cost. In normal circumstances, the farmer is not expected to select any of these cost dominated treatments. There were other treatments which had higher gross margins with lower variable cost. The performance of cost-undominated treatment has been shown through marginal analysis in Table 6. The treatment BA 50 mg L^{-1} showed the highest marginal rate of return which was 921%. It signifies that if the farmer spends additional taka one hundred, they will get Tk 921 ha^{-1}.

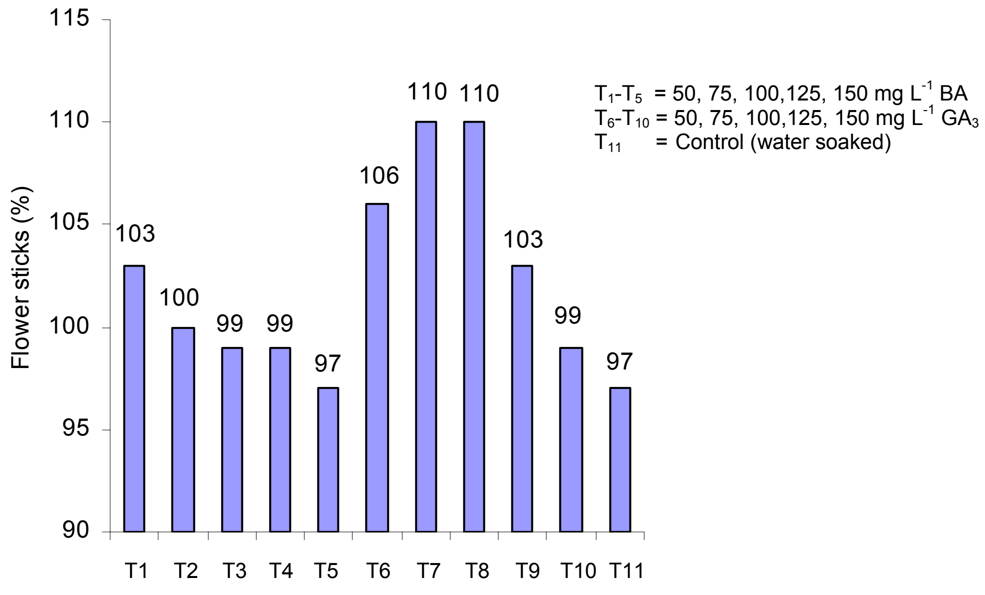

Figure 3 Percent flower sticks from corm obtained through the previous year by the use of different levels of BA and GA_3.

Table 5 Dominance analysis of BA and GA_3 response data.

Treatments (mg L^{-1})	Gross margin (Tk ha^{-1})	Variable cost (Tk ha^{-1})
GA_3 100	308500	16000
GA_3 125	280000	20000
GA_3 75	279500	12000
GA_3 50	276000	8000
BA 50	269800	7200
GA_3 150	258000	24000
BA 125	247000	18000
BA 100	220600	14400
BA 75	212200	10800
Control	203500	0
BA 150	188900	21600

Prices of Plant Growth Regulators during 2006-2007 : Cost of BA= Tk 180 g^{-1}, Cost of GA_3= Tk 200 g^{-1}, Farm gate price of corm (Healthy corm Tk 1.50 $piece^{-1}$, Tk 100 kg^{-1}) during May 2007 to October 2007.

Table 6 Marginal analysis of undominated levels of BA and GA_3 response data (gladiolus)

Treatment	Gross margin (Tk ha^{-1})	Variable cost (Tk ha^{-1})	Marginal gross margin (Tk ha^{-1})	Marginal variable cost (Tk ha^{-1})	Marginal rate of return (%)
GA_3 100 mg L^{-1} (T_8)	308500	16000	29000	4000	725
GA_3 75 mg L^{-1} (T_7)	279500	12000	3500	4000	87.5
GA_3 50 mg L^{-1} (T_6)	276000	8000	6200	800	775
BA 50 mg L^{-1} (T_1)	269800	7200	66300	7200	921
Control (T_{11})	203500	0	-	-	-

Among different levels of GA_3, the treatment GA_3 50 mg L^{-1} obtained maximum marginal rate of return (775%). GA_3 100 mg L^{-1} also showed acceptable marginal rate of return (725%). The farmer who has sufficient capital for investment he may treat the cormels with GA_3 100 mg L^{-1} for better corm and cormel production. Because this treatment gave the highest gross margin (308,500 Tk ha^{-1}). Sharma et al. (2002) also reported that 100 mg L^{-1} GA_3 registered the maximum benefit: cost ratio when they worked with some growth regulators on economics of gerbera.

Conclusions

From the above discussion it may be concluded that application of BA 50 mg L^{-1} or GA_3 50 mg L^{-1} showed better performance for corm and cormel production from cormel along with the highest marginal rate of return 921% and 775%, respectively. GA_3 100 mg L^{-1} gave much higher gross margin (308,500 Tk ha^{-1}) compared to 50 mg L^{-1} GA_3. The resultant corms of the treatments 50 mg L^{-1} BA or GA_3 or 100 mg L^{-1} GA_3 could give better yield of corms and cormels including flowers in the next year. So, Cormel can be treated with BA 50 mg L^{-1}, GA_3 50 mg L^{-1} and GA_3 100 mg L^{-1} for dormancy breaking, growth and yield of gladiolus corm and cormel.

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