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Effect of Benzyladenine and Gibberellic Acid on Dormancy Breaking, Growth and Yield of Gladiolus Corms over Different Storage Periods

F.N. Khan[1*], M.M. Rahman[2], M.M.Hossain[3]
[1]Senior Scientific Officer, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh
[2]Professor, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh
[3]Professor, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh

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*Corresponding author's email: khan_farjana @yahoo.com

Abstract

A study was conducted to determine the optimum concentration of benzyladenie (BA) and gibberllic acid (GA_3) to break the dormancy of gladiolus corms in relation to storage period and to find out the effect of BA and GA_3 on growth and development of gladiolus corm and cormels. The effect of GA_3 on dormancy breaking was most pronounced in the 100 ppm treatment being 26.93 days while in the water control took 49.60 days. Among different levels of BA, dormancy breaking was comparatively earlier by 29.60 days when treated with 50 BA. Considering storage periods, corms stored for 30 days followed by different growth regulator treatments sprouted 11.63 and 21.24 days earlier than 75 and 90 days stored corms, respectively. Corms treated with 75 ppm GA_3 and stored for 90 days produced the maximum percentage of spikes (56.9%) whereas 90 days stored corms treated with 125 ppm BA produced the highest number of plants (2.41) and corms (2.50) hill^{-1}. The corms treated with 100 ppm GA_3 and stored for 90 days produced the heaviest (21.50 g and 18.82 g, respectively) and largest (4.46 cm and 4.17 cm, respectively) corms.

Keywords: Benzyl adenine, Gibberellic acid, Dormancy breaking, Gladiolus, Storage period.

INTRODUCTION

Gladiolus is said to be the queen of bulbous flowers. Freshly harvested corm and cormels of gladiolus do not sprout immediately even after placing under favorable growing conditions due to a period of dormancy which is regulated by changes in the levels of endogenous promotory or inhibitory substances (Misra and Singh, 1998). Dormancy period of the freshly harvested gladiolus corms ranges from 2 to 4 months under natural storage conditions depending on the cultivars and the temperature during storage (Gonzales, 1996). This dormancy period limits the number of cropping cycles per year from the same planting material. Non-treated corms contain high concentrations of inhibitors and it was found that application of different growth regulators increased the concentrations of endogenous promoters in the corm tissue and decreased inhibitors within 24- h of treatments (Hosoki, 1995). Plant growth regulators play an important role for breaking dormancy and are being used for the production of good quality bloom. Among the chemicals so far used Benzyl adenine (BA) and Gibberellic acid (GA_3) were found very effective. 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. According to Narayana and Gowda (1994), BA at 100 ppm was optimum to break the dormancy of cormels of gladiolus cv. Friendship. Similarly, GA_3 induces the formation of hydrolytic enzymes which regulates the mobilization of reserves, ultimately resulting early sprouting of gladiolus corm (Groot and Karssen, 1987). GA_3 also was very much effective for seed germination, growth promotion, flowering and senescence inhibition (Murti and Upreti, 1995). For year round cultivation of gladiolus flowers, it is needed to keep the corms of previous year in cold storage. But in Bangladesh cold storage facilities are very much limited specially for the planting materials of flowers. Breaking of corm dormancy by applying different growth regulators could facilitates year round flower production and thus cold storing could be avoided. Moreover, information in this regards are not available in the country. So, the present study was undertaken to determine the optimum concentration of BA and GA_3 to break the dormancy of gladiolus corms in relation to storage period and to find out the effect of BA and GA_3 on growth and development of gladiolus corms and cormels.

MATERIALS AND METHODS

The experiment was carried out at Floriculture Research Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh from May 2007 to April 2008. Medium sized (3.5-4.0 cm diameter) corms of BARI Gladiolus 1 were used as planting materials. Two growth regulators such as benzyl adenine (BA) and gibberellic acid (GA_3), each at five levels viz., 50, 75, 100, 125, 150 ppm including a water control were used as treatments in this experiment. The treatments were compared separately for different parameters after 5 different storage periods (30, 45, 60, 75 and 90 days after lifting).

Freshly harvested corms were dried in shade for 30 days before initiating the experiments. After that, the corms were soaked for 24 hours in BA and GA_3 solutions and in water as per the treatments. The soaked corms were then dried in shade for 2 hours before planting. Similarly, corms from the other storage treatments such as 45, 60, 75 and 90 days were treated and planted in the same way. The experiment was laid out in the Completely Randomized Design (CRD) with three replications separately for each 5 storage periods. Twelve corms were included in each treatment. The treated corms from each storage period were planted in earthen pots (25 cm L x 38 cm D) containing about 5 kg well prepared soil. The planting of corms was started on 21 June 2007 and continued at 15 days intervals. After planting, the pots were kept in a shade house to protect from heavy rains. The average temperature of the shade house was 33 °C – 34 °C. The soils of each pot were fertilized with 1.064 g urea, 1.197 g TSP, 1.0108 g MOP and 53.20 g cowdung corresponding to 200 kg urea, 225 kg TSP and 190 kg MOP and 10 t cowdung ha^{-1} as suggested by Woltz (1976). Full dose of cowdung, TSP and MOP were applied as basal dose and the urea was applied in two installments, first at four leaves stage and second at spike initiation stage. Different intercultural operations like weeding, watering, etc. were done as and when necessary. The spikes were carefully removed before opening of the spike lets without causing injury to the foliage.

The pots were shifted to the open field in the month of October, 2007. Harvesting of corms and cormels was done through February to April, 2008 at 15 days intervals when the leaves turned brown as suggested by Mukhopadhaya (1995). After recording different data, the corms and cormels were kept in nylon net bags and stored at room temperature with proper labeling. Data on different growth and yield parameters from all plants of each pot were recorded and analyzed statistically by using MSTATC computer package program. Analysis of variance was performed separately for each storage period. Then combined analysis was performed for each character to identify the presence of any interaction effects between growth regulators and storage periods. Based on the results of combined analysis, the appropriate mean comparison was made. In case of significant interaction data, the growth regulators were compared for each level of storage period and storage period for each level of growth regulators. When the interaction effects were non-significant, the mean effect of growth regulators and storage period were evaluated. The percentage data were transformed to appropriate values before analysis.

RESULTS AND DISCUSSION

Interpretation of ANOVA

The results of combined analysis of variance for all parameters are presented in Table 1. The effect of interaction between growth regulators and storage period for the 1st emergence (days), plant emergence (%), 1st spike initiation (days), spikes (%), corm weight and diameter and cormels hill^{-1} was non-significant but single effect of both the factors were significant for most of the parameters except plant emergence (%) in storage period. On the other hand, effect of interaction between growth regulators and storage periods on plants hill^{-1}, corms hill^{-1} and cormels weight hill^{-1} was significant.

Comparison of means

1st emergence (days)

Days to 1st emergence of corms were influenced significantly due to treatment with growth regulators (Table 2). The 1st emergence was earlier by 26.93 days when treated with 100 ppm GAGA$_3$, which was statistically similar to 75 ppm (27.73 days) and 125 ppm GAGA$_3$ (28.67 days). This may be attributed to the breaking dormancy by GA3 treatment. 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 GAGA$_3$ (Groot and Karssen, 1987). The highest delay in emergence was in the control by 49.60 days.

Among different levels of BA, the 1st emergence was earlier by 29.60 days when treated with 50 ppm BA followed by 75 ppm BA. The lower concentration of BA showed early sprouting than higher concentration of BA which is supported by Gowda (1994). Pal and Chowdhury (1998) exhibited that BA induced early sprouting of corms (7 day after treatment, compared with 57 days after soaking in water for 24 h).

Days to 1st emergence differed significantly due to storage periods (Table 2). The minimum days (15.88) required for 1st emergence was for 90 days stored corms and the maximum (54.64 days) were for 30 days stored corms. But when total days were counted, the lowest days (84.64) were required at 30 days stored corms which were statistically similar to 45 days stored corms and 60 days stored corms. The emergence was delayed by 105.88 days when 90 days stored corms were planted. 30 days stored corms treated with different growth regulators sprouted 11.63 and 21.24 days earlier than 75 and 90 days stored corms, respectively. From these results it may be said that about 85 days after lifting of corms, dormancy was broken by the application of BA and GA$_3$.

Plants hill^{-1}

There were a significant interaction between growth regulators and storage periods (Table 3). The growth regulators did not have any significant effect for plants hill^{-1} produced by 30 and 45 days stored corms. However, it ranged from 1.0 to 1.17 plants for both 30 and 45 days stored corms. When 60 days stored corms were planted, the maximum number of plants (1.44) hill^{-1} was produced by 125 ppm BA, which was statistically similar to all levels of BA and 50 ppm GA_3 except 50 ppm BA. On the other hand, all levels of GA_3 (except GA_3 50 ppm) and control produced minimum number of plant (1.0) hill^{-1}.

Almost similar trend was observed at 90 days stored corms where 125 ppm BA produced highest number of plants (2.41 hill^{-1})which was statistically similar to 150 ppm and 100 ppm BA. When 75 days stored corms were planted, BA 150 ppm produced maximum number of plants (2.09) hill^{-1} followed by 125 ppm BA. From these results it may be said that when 60, 75 and 90 days stored corms were planted, the highest concentration of BA (BA 125 ppm and 150 ppm) enhanced multiple shooting (Plate 1). According to Murti and Upreti (1995), BA is responsible for multiple shooting. Baskaran and Misra (2007) found that BA at 100 ppm as corm dipping treatment gave the maximum number of shoots per corm.

With regard to storage periods of corms, GA_3 50 ppm and onwards did not have any effect on number of plants hill^{-1} (Table 3). Most of the BA levels had positive effect on increase of plant number hill^{-1}. At all levels of BA, 90 days stored corms produced the maximum number of plants per hill. It gradually reduced with reduction of storage period.

1st spike initiation (days)

Days to 1st spike initiation significantly influenced due to growth regulators (Table 4). GA_3 100 ppm took earliest days (120.33) to reach 1st spike initiation which was statistically similar with that of 50 ppm, 75 ppm and 125 ppm GA_3. The lowest concentration of BA (50 ppm, 75 ppm and 100 ppm) showed better performance compared to highest concentration of BA (125 and 150 ppm). Longer duration (135.47 days) was needed to reach 1st spike initiation when corms treated with water.

Significant variations were observed for different levels of storage periods (Table 4). Shorter duration (96.04 days) was needed to initiate 1st spike when 90 days stored corms were planted. In case of 30 days stored corms, longer duration (152.91 days) was needed. But no significant differences were observed when total days were counted after lifting of corms for 1st spike initiation.

Spikes (%)

Percent spikes were significantly affected by the application of growth regulators (Fig.1). Among different growth regulators, 75 ppm GA_3 obtained the highest percentage of spikes (56.9%) followed by rest of the levels of GA3, 50 ppm and 75 ppm BA. The lowest percentage were recorded in control (34.7%) followed by 125 ppm and 150 ppm BA (42.5% and 38.6%, respectively). These findings are in agreement with Misra *et al*. (1993) where they found GA3 application enhanced vegetative growth and flowering of gladiolus.

Percent spikes also varied significantly due to the effect of storage periods (Fig. 2). The maximum percentage of spikes (56.9%) was produced by 90 days stored corms whereas 60 days stored corms produced the lowest (41.7%) spikes followed by 30 and 45 days stored corms.

Corms hill^{-1}

The effect of interaction of growth regulators and storage period was significant (Table 5). The growth regulators did not have any significant effect for corms hill^{-1} produced by 30 and 45 days stored corms. However, it ranged from 1.0 to 1.25 and 1.0 to 1.17 corms for 30 and 45 days stored corms, respectively. When 60 days stored corms were planted, the maximum corm number

(1.44) was produced by 125 ppm BA, which was statistically similar to all levels of BA and 50 ppm GA_3. Trend of effect of BA was almost similar for 75 and 90 days stored corms. From these results it may be said that BA enhanced multiple shooting and hence has accelerated corm production. Richards and Wilkinson (1984) also reported that cytokinins induce good branching responses without any of the disadvantages. The number of corms was much higher for corms stored for longer periods than the corms stored for fewer period, which is indicative that effect of storage period on corms was much pronounced for increasing the number of corms than the effects of the growth regulators. The biochemical changes what happened in the corms during storage, might have been enhanced by the growth regulators resulting in increased corm production.

Regarding storage periods of corms, GA_3 50 ppm and onwards did not have any effect on number of corms $hill^{-1}$ (Table 5). Most of the BA levels had positive effect on increase of corm number $hill^{-1}$. At all levels of BA, 90 days stored corms produced the maximum number of corms $hill^{-1}$. It was gradually reduced with lowering of storage period.

Corm weight

Corm weight varied significantly due to treatment of corms with growth regulators (Table 6). The heaviest corm (21.50 g) was produced by the corms treated with 100 ppm GA_3 which was statistically identical to that of 50 ppm BA, 75 ppm and 125 ppm GA_3. Mahesh and Misra (1993) exhibited similar trends in which 50 ppm BA increased corm weight. The corms treated with water produced lightest corm (11.19 g).

Significant variations were also observed in corm weight due to storage periods (Table 6). The heaviest corm (18.82 g) was produced by 90 days stored corms followed by 75 days stored corms (18.67 g). The lightest corm (15.67 g) was produced by 30 days stored corms which were statistically similar to 45 days stored corms (16.41 g). Corm weight was gradually reduced with lowering of storage periods.

Corm diameter

Corm diameter was significantly influenced by the treatment of growth regulators (Table 7). The largest corm (4.46 cm) was recorded by the corms treated with 100 ppm GA_3 which was 31.56% increased over control. Gibberellins lead to increased cell division and cell growth apparently which lead to increased elongation of root (Stewart and Jones, 1977). Thus it enhances corm diameter. The result in the present study was in line with the earlier reports in tuberose by Jana and Biswas (1982). Among BA, the lowest concentration showed better performance compared to high concentration. Similar findings were found by Mahesh and Misra (1993) where 50 ppm BA obtained the largest corm compared to different levels of BA.

Corm diameter significantly influenced due to storage periods (Table 7). The largest corm (4.17 cm) was produced by 90 days stored corms followed by 75 days stored corms (4.02 cm). 30 days stored corms produced the smallest corm (3.80 cm) which was statistically similar with that of 45 and 60 days stored corms (3.92 cm and 3.97 cm, respectively).

Cormels $hill^{-1}$

Cormels $hill^{-1}$ influenced significantly due to treatment with growth regulators (Fig. 3). Corms treated with 100 ppm GA_3 produced the maximum number of cormels (8.2 $hill^{-1}$) which was statistically similar to 75 ppm GA_3, 125 ppm GA_3 and 50 ppm BA. Corms treated with 100 ppm GA_3 produced 135.84% higher cormels $hill^{-1}$ over control. Similar trends were found by Misra *et al*. (1993) where GA_3 100 ppm and 200 ppm gave encouraging results. Dua *et al*. (1984) also reported that number and weight of cormels produced plant-1 also increased by the application of GA_3. Whereas the minimum number of cormels $hill^{-1}$ (3.5) was recorded by the corms treated with water followed by BA 150 ppm (4.1).

Cormels $hill^{-1}$ also differed significantly due to storage periods (Fig. 4). The maximum number of cormels (8.0) $hill^{-1}$ was produced by 90 days stored corms which were statistically identical to 75 days stored corms (7.5). The minimum number of cormels (4.8) $hill^{-1}$ was produced by 30 days stored corms followed by 45 days stored corms (5.1). The number of cormels $hill^{-1}$ was much higher for corms stored for longer period than the corms stored for fewer periods.

Cormels weight $hill^{-1}$

There was a significant interaction between growth regulators and storage periods (Table 8). When 30 days stored corms were planted, GA_3 75 ppm produced the highest cormel weight (15.83 g $hill^{-1}$) which was statistically similar to GA_3 100 ppm (15.42 g) and BA 125 ppm (15.0 g). Whereas control showed the lowest cormels weight (5.08 g $hill^{-1}$). At 45 days stored corms, the maximum cormel weight (16.61 g $hill^{-1}$) were recorded by GA_3 100 ppm which was statistically similar with all levels of GA_3 except 50 ppm GA_3. When 60 and 75 days stored corms were planted, GA_3 100 ppm produced the highest cormel weight (23.83 g and 24.17 g, respectively) $hill^{-1}$ followed by GA_3 75 ppm. Control showed poor performances in both the cases (6.17 g and 6.72 g, respectively). Similarly at 90 days stored corms, GA3 100 ppm also produced the highest cormel weight (24.83 g$hill^{-1}$) followed by GA_3 75 ppm (24.25 g) and GA_3 125 ppm (22.12 g). The lowest cormel weight (7.15 g) $hill^{-1}$ was recorded in control which was closely similar with that of BA 150 ppm (9.92 g).

Regarding storage periods of corms, 90 days stored corms exhibited the highest cormel weight $hill^{-1}$ regarding all growth regulators (Table 8). The ranges of cormel weight $hill^{-1}$ of corms stored for 90 days were 7.15 g to 24.83 g. At 50, 75 and 100 ppm BA, 90 days stored corms produced the highest cormel weight (21.0 g, 16.67 g and 14.83 g, respectively) $hill^{-1}$ which was closely followed by 75 and 60 days stored corms. On the other hand, 30 and 45 days stored corms showed statistically similar results. At 125, 150 ppm BA and control, there were no statistical differences among different storage periods meaning that storage periods had no effect in that cases regarding cormel weight $hill^{-1}$. At all levels of GA_3, 90 days stored corms produced the maximum cormel weight which was statistically similar with that of 60 and 75 days stored corms.

CONCLUSION

Among the growth regulators, GA_3 at 100 ppm broke the dormancy of corms as early as 26.93 days and showed better performance in terms of growth and yield parameters. The lower concentration of BA showed early sprouting than higher concentration but higher concentration i.e., BA at 125 ppm enhanced multiple shooting and accelerated corm production. Corms stored for 30 days and treated with different growth regulators sprouted 11.63 and 21.24 days earlier than the corms stored for 75 and 90 days, respectively.

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Tables

Table 1. Significant level of F-test for combined analysis.

Parameters	F-value			
	Source of variation			
	Growth regulators (GR)	Storage period (SP)	SP x GR	CV (%)
1st emergence (days)	**	**	NS	8.5
Plant emergence (%)	**	NS	NS	16.9
Plants hill^{-1}	**	**	**	15.6
1st spike initiation (days)	**	**	NS	3.2
Spikes (%)	**	**	NS	22.6
Corms hill^{-1}	**	**	**	14.5
Corm weight (g)	**	**	NS	11.7
Corm diameter (cm)	**	**	NS	9.7
Cormels hill^{-1}	**	**	NS	20.5
Cormels weight hill^{-1} (g)	**	**	**	15.2

**, Significant at 1% level NS, Not significant

Table 2. Effect of BA and GA_3 on 1st emergence of corms stored for different periods.

Growth regulators (ppm)	1st emergence (days) Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	50.0	36.0	27.67	19.0	15.33	29.60 def
BA 75	53.67	36.33	27.0	21.33	15.67	30.80 d
BA 100	55.33	41.33	30.33	22.67	17.0	33.33 c
BA 125	57.67	42.67	33.67	23.0	17.67	34.93 bc
BA 150	58.67	44.67	35.33	25.0	19.33	36.60 b
GA_3 50	51.67	37.33	28.0	18.67	13.33	29.80 de
GA_3 75	49.0	35.33	26.0	17.0	11.33	27.73 fg
GA_3 100	47.33	35.33	25.0	16.0	11.0	26.93 g
GA_3 125	50.33	37.67	25.33	16.33	13.67	28.67 efg
GA_3 150	53.0	39.0	29.0	18.33	15.0	30.87 d
Control	74.33	61.0	50.67	36.67	25.33	49.60 a
Mean for SP	54.64 a	40.61 b	30.73 c	21.27 d	15.88 e	
Total days to 1st emergence	84.64 c	85.61 c	90.73 bc	96.27 b	105.88 a	

Means with the same letter(s) are not significantly different at 5% level by LSD
LSD (5%) for comparison of Growth regulators (GR) 1.99
LSD (5%) for comparison of Storage periods (SP) 1.34

Table 3. Effect of BA and GA_3 on plants hill^{-1} of corms stored for different periods.

Growth regulators (ppm)	Plants hill^{-1} Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	1.0 a C	1.0 a C	1.11 bc BC	1.38 d B	2.0 c A	1.30
BA 75	1.0 a C	1.0 a C	1.22 abc BC	1.50 cd B	2.09 bc A	1.36
BA 100	1.11 a C	1.11 a C	1.33 ab C	1.75 bc B	2.17 abc A	1.49
BA 125	1.17 a C	1.17 a C	1.44 a C	2.0 ab B	2.41 a A	1.64
BA 150	1.08 a B	1.11 a B	1.34 ab B	2.09 a A	2.33 ab A	1.59
GA_3 50	1.08 a A	1.0 a A	1.25 abc A	1.0 e A	1.17 d A	1.10
GA_3 75	1.08 a A	1.0 a A	1.0 c A	1.0 e A	1.25 d A	1.07
GA_3 100	1.0 a A	1.0 a A	1.0 c A	1.0 e A	1.0 d A	1.00
GA_3 125	1.0 a A	1.0 a A	1.0 c A	1.0 e A	1.0 d A	1.00
GA_3 150	1.0 a A	1.0 a A	1.0 c A	1.0 e A	1.0 d A	1.00
Control	1.0 a A	1.0 a A	1.0 c A	1.0 e A	1.0 d A	1.00
Mean for SP	1.05	1.04	1.15	1.34	1.58	

LSD (5%) for comparison of growth regulators (GR) at each level of storage period (SP) and SP at each level of GR= 0.31

Mean followed by a common small letter(s) in a column are not significantly different at 5% level by LSD and mean followed by a common capital letter(s) in a row are not significantly different at 5% level by LSD

Since interaction between GR and SP was significant, no mean comparison is given

Table 4. Effect of BA and GA_3 on 1st spike initiation (days) of corms stored for different periods.

Growth regulators (ppm)	1st spike initiation (days) Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	151.67	136.67	122.67	112.33	96.0	123.87 de
BA 75	154.0	137.0	121.0	114.0	96.0	124.40 de
BA 100	155.0	140.0	123.33	114.0	97.33	125.93 cd
BA 125	157.67	143.0	126.0	115.33	99.0	128.20 bc
BA 150	160.0	143.33	130.0	117.33	99.67	130.07 b
GA_3 50	149.33	135.0	123.0	111.33	95.0	122.73 efg
GA_3 75	147.0	132.0	123.33	109.0	92.0	120.67 fg
GA_3 100	147.0	132.33	121.0	109.67	91.67	120.33 g
GA_3 125	146.33	134.0	124.0	113.0	91.0	121.67 efg
GA_3 150	148.33	136.0	125.33	114.67	93.0	123.47 def
Control	165.67	147.33	133.33	125.0	106.0	135.47 a
Mean for SP	152.91 a	137.88 b	124.82 c	114.15 d	96.06 e	
Total days to 1st spike initiation	182.91	182.88	184.82	189.15	186.06	

Means with the same letters are not significantly different at 5% level by LSD

LSd (5%) for comparison of Growth regulators (GR) = 2.87

LSD (5%) for comparison of Storage periods (SP) = 1.93

Table 5. Effect of BA and GA_3 on corms hill^{-1} of corms stored for different periods.

Growth regulators (ppm)	Corms hill^{-1} Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	1.0 a C	1.0 a C	1.17 ab C	1.67 c B	2.0 b A	1.37
BA 75	1.0 a C	1.0 a C	1.28 ab C	1.75 bc B	2.25 ab A	1.46
BA 100	1.0 a B	1.11 a B	1.28 ab B	2.0 ab A	2.25 ab A	1.53
BA 125	1.11 a D	1.17 a CD	1.44 a C	2.0 ab B	2.50 a A	1.64
BA 150	1.25 a B	1.11 a B	1.34 a B	2.09 a A	2.33 a A	1.62
GA_3 50	1.08 a A	1.0 a A	1.25 ab A	1.0 d A	1.17 c A	1.10
GA_3 75	1.0 a A	1.11 a A	1.0 b A	1.0 d A	1.17 c A	1.06
GA_3 100	1.0 a A	1.0 a A	1.0 b A	1.0 d A	1.0 c A	1.0
GA_3 125	1.0 a A	1.0 a A	1.0 b A	1.0 d A	1.0 c A	1.0
GA_3 150	1.0 a A	1.0 a A	1.0 b A	1.0 d A	1.0 c A	1.0
Control	1.0 a A	1.0 a A	1.0 b A	1.0 d A	1.0 c A	1.0
Mean for SP	1.04	1.05	1.16	1.41	1.61	

LSD (5%) for comparison of Growth regulators (GR) at each level of storage periods (SP) and SP at each level of GR= 0.29
Mean followed by a common small letter(s) in a column are not significantly different at 5% level by LSD and mean followed by a common capital letter(s) in a row are not significantly different at 5% level by LSD
Since interaction between GR and SP was significant, no mean comparison is given

Table 6. Effect of BA and GA_3 on corm weight of corms stored for different periods.

Growth regulators (ppm)	Corm weight (g) Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	17.0	20.17	20.33	22.50	20.69	20.14 a
BA 75	16.0	18.39	19.0	20.14	19.17	18.54 bc
BA 100	14.33	14.50	16.0	18.58	17.86	16.25 d
BA 125	13.67	13.83	14.22	16.25	15.14	14.62 e
BA 150	12.50	12.13	14.0	13.57	14.81	13.40 e
GA_3 50	15.33	16.17	19.44	18.56	18.0	17.50 cd
GA_3 75	18.50	19.28	19.67	20.50	22.50	20.09 a
GA_3 100	19.28	19.50	21.0	21.17	26.56	21.50 a
GA_3 125	17.61	18.33	20.17	22.50	21.50	20.02 ab
GA_3 150	16.50	16.67	17.11	20.22	20.50	18.20 c
Control	11.67	11.50	11.17	11.33	10.27	11.19 f
Mean for SP	15.67 c	16.41 c	17.46 b	18.67 a	18.82 a	

Means with the same letters are not significantly different at 5% level by LSD
LSD (5%) for comparison of Growth regulators (GR) = 1.48
LSD (5%) for comparison of Storage periods (SP) = 1.0

Table 7. Effect of BA and GA_3 on corm diameter of corms stored for different periods.

Growth regulators (ppm)	Corm diameter (cm) Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	4.03	4.19	4.30	4.37	4.50	4.28 abc
BA 75	3.87	4.05	4.12	4.31	4.13	4.10 bcde
BA 100	3.65	3.79	3.78	3.95	3.99	3.83 ef
BA 125	3.45	3.63	3.71	3.80	3.88	3.69 fg
BA 150	3.15	3.60	3.43	3.42	3.80	3.48 gh
GA_3 50	3.79	4.18	4.03	4.04	4.04	4.02 cde
GA_3 75	4.23	4.18	4.30	4.31	4.55	4.31 ab
GA_3 100	4.33	4.23	4.37	4.32	5.06	4.46 a
GA_3 125	3.89	4.19	4.20	4.42	4.47	4.24 abcd
GA_3 150	3.85	3.80	3.93	3.99	4.30	3.97 def
Control	3.58	3.30	3.53	3.33	3.20	3.39 h
Mean for SP	3.80 c	3.92 bc	3.97 bc	4.02 ab	4.17 a	

Means with the same letter(s) are not significantly different at 5% level by LSD
LSD (5%) for comparison of Growth regulators (GR) = 0.28
LSD (5%) for comparison of Storage periods (SP) = 0.19

Table 8. Effect of BA and GA_3 on cormel weight hill-1 of corms stored for different periods.

Growth regulators (ppm)	Cormel weight hill-1 (g) Storage period of corms (days)					Mean for GR
	30	45	60	75	90	
BA 50	11.81 bcd B	11.0 bcd B	20.0 bc A	20.0 b A	21.0 bc A	16.76
BA 75	11.25 d BC	10.0 cd C	13.83 de AB	15.08 d A	16.67de A	13.37
BA 100	10.25 d B	9.72 cd B	11.50 ef AB	13.22 d AB	14.83 e A	11.91
BA 125	15.0 abc A	13.67 ab A	14.08 de A	13.58 d A	15.42 e A	14.35
BA 150	9.50 d A	9.08 de A	9.08 fg A	9.08 e A	9.92 f A	9.33
GA_3 50	11.0 d B	10.33 bcd B	19.67 c A	19.75 b A	20.08 cd A	16.17
GA_3 75	15.83 a B	16.17 a B	23.33 ab A	23.92 a A	24.25 ab A	20.70
GA_3 100	15.42 ab B	16.61 a B	23.83 a A	24.17 a A	24.83 a A	20.97
GA_3 125	12.0 bcd C	16.17 a B	19.33 c AB	19.25 bc AB	22.12 abc A	17.77
GA_3 150	11.75 cd C	13.17abc BC	16.50 cd AB	16.0 cd AB	17.25 de A	14.93
Control	5.08 e A	5.50 e A	6.17 g A	6.72 e A	7.15 f A	6.12
Mean for SP	11.72	11.95	16.12	16.43	17.59	

LSD (5%) for comparison of Growth regulators (GR) at each level of storage periods (SP) and SP at each level of GR = 3.63
Mean followed by a common small letter (s) in a column are not significantly different at 5% level by LSD and mean followed by a common capital letter (s) in a row are not significantly different at 5% level by LSD
Since interaction between GR and SP was significant, no mean comparison is given

Figures

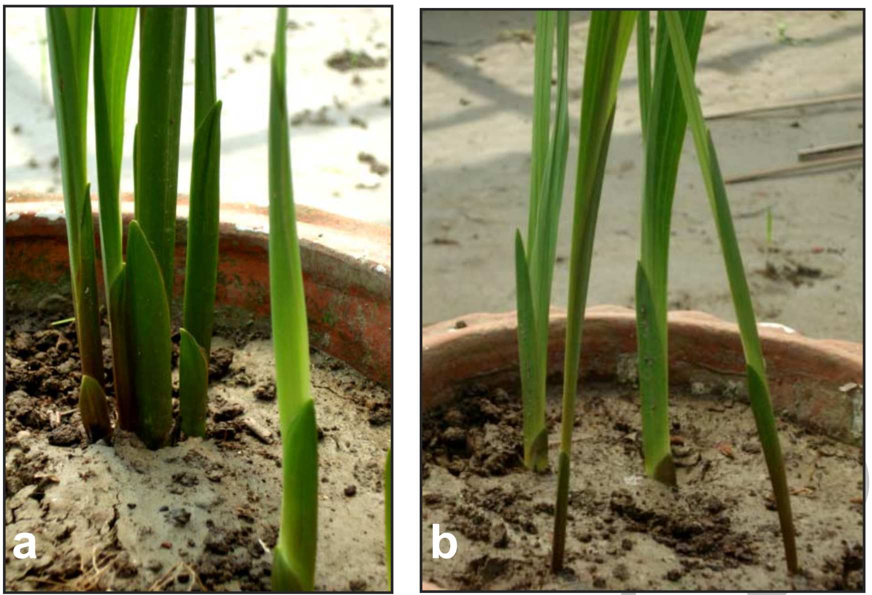

Fig. 1. (a) Multiple shooting enhanced by BA 125 ppm treated corms compared to (b) single plant by water soaked corms (control).

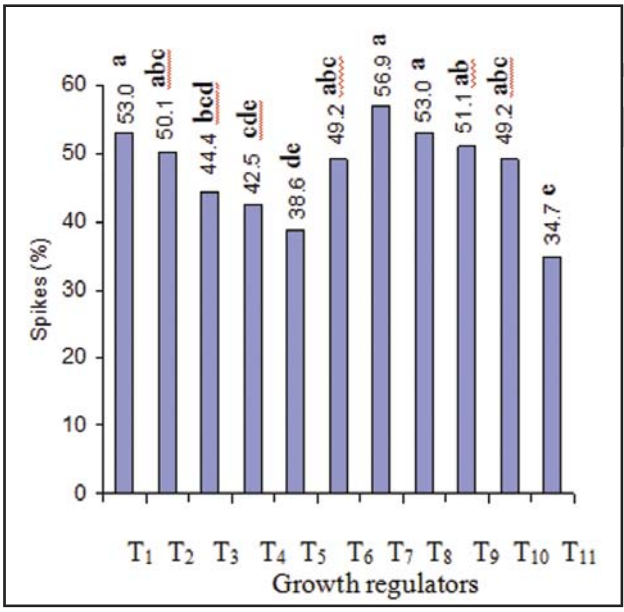

Fig. 1. Effect of BA and GA_3 on percentage of spikes.

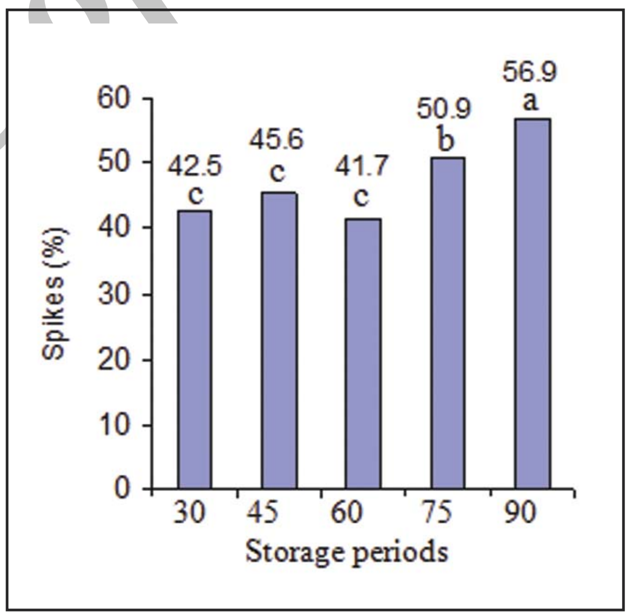

Fig. 2. Effect of storage periods on percentage of spikes.

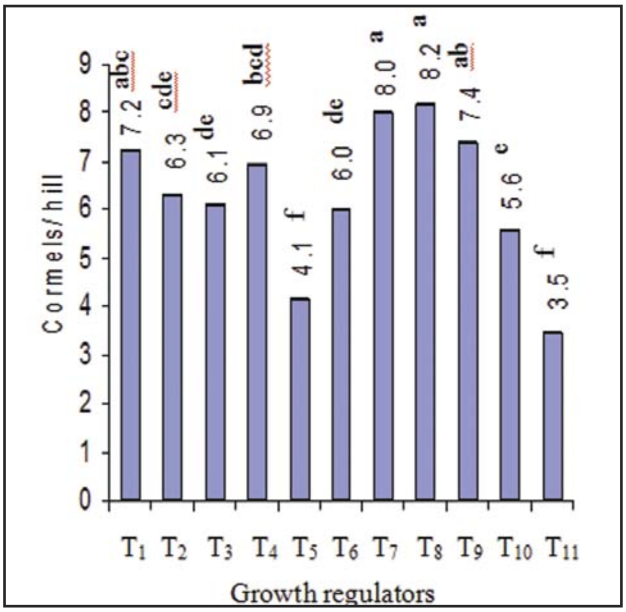

Fig. 3. Effect of BA and GA_3 on cormels hill $^{-1}$.

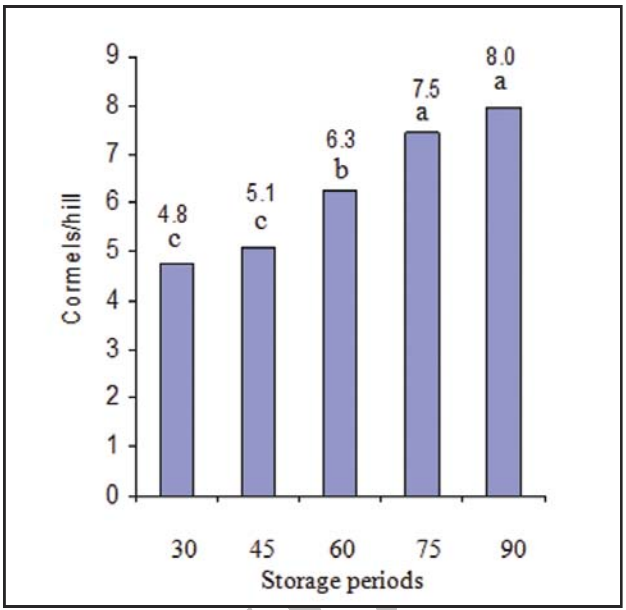

Fig. 4. Effect of storage periods on cormels hill^{-1}.

T_1-T_5 = 50, 75, 100,125, 150 ppm BA
T_6-T_{10} = 50, 75, 100,125, 150 ppm GA_3
T_{11} = Control (water soaked)