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EFFECT OF PLANT GROWTH REGULATORS ON FLOWER AND BULB PRODUCTION OF HIPPEASTRUM (*Hippeastrum hybridum* Hort.)

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Abstract

The experiment was conducted at the Horticultural research field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during October 2008 to July 2009 to investigate the effect of plant growth regulators on flower and bulb production of Hippeastrum. There were ten treatments comprising of three concentrations of three growth regulators viz., IAA (20, 60 and 100 ppm), ethrel (100, 300 and 500 ppm) and GA_3 (100, 300 and 500 ppm) along with control (soaked in water). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Flower and bulb characteristics of Hippeastrum were influenced significantly by different levels of growth regulators. Application of IAA at 60 and 100 ppm and GA_3 at 100, 300 or 500 ppm twice as foliar spray at an interval of 30 days promoted the number of bulblets on the treated plants. Ethrel at a concentration of 100 ppm increased the number of flowers per scape (4) and showed earliness in days to flower scape emergence (72.33 days) and first flower open (88.67 days). On the other hand, the biggest size of flower (15.14 cm x 12.44 cm) and flower scape (40.28 cm x 21.95cm) at harvest and the maximum days for flowering (11.50 days) were evident from plants treated with 500 ppm GA_3. The highest number of bulblets per plot (40.00), bulbs weight per plot (4056 g) along with bulb yield (40.56 t/ha) were also obtained in GA_3 at 500 ppm.

Keywords: Hippeastrum, indole-acetic acid (IAA), 2-chloroethylphosphonic acid (Ethrel), gibberrellic acid (GA_3), Hippeastrum flower and bulb yield.

Introduction

Hippeastrum (*Hippeastrum hybridum* Hort.) is an important ornamental bulbous plant used as cut flowers because of their large size, attractive colour, and good keeping quality. In Bangladesh, the agro-ecological conditions are very conducive for the survival and culture of Hippeastrum. It has great potential for local as well as export market.

Ornamental crops like Hippeastrum find extensive use of growth regulators for modifying their developmental processes. The major areas where growth regulators have successfully played their roles in ornamental plants are in vegetative propagation, inhibition of abscission, prevention of bud dormancy,

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growth control, promotion of flowering, prolonging the vase life of flowers and retarding their senescence (Murti and Upreti, 1995).

Growth and flowering of Hippeastrum is influenced by several factors. Among the various external factors, growth regulators play an important role in developmental process of the plants. There are only a few floricultural crops on which growth regulators were applied for the purpose of enhancing growth. The gibberrelic acid (GA_3) has been of considerable use for growth promotion. The cases in which growth promotion by growth regulators would be helpful are those where environmental factors delay or inhibit growth or where problems are encountered due to excessive application of retardants.

Application of growth regulators was found to improve the growth and flowering of Hippeastrum. Bhattacharjee (1983a) reported that treatment with GA_3 at 10 ppm markedly improved the flower production of lily (*Lilium tigrinum*, Ker-Gawl). Naphthalene acetic acid (NAA) at 100 ppm and GA_3 at 100 or 200 ppm induced early flowering in *Lilium longiflorum* whereas NAA at 200 ppm and GA_3 at 200 ppm markedly increased flower production as reported by Pal and Das (1990). In an experiment with growth regulators on Asiatic hybrid lily, Dantuluri *et al.* (2002) found that GA_3 at 200 ppm produced the tallest plants and GA_3 at 200 ppm exhibited earliest bud formation and flowering. Spraying with 2-chloro ethylphosphonic acid (ethrel) at 1000-4000 ppm, 1-3 times has been found to hasten the flower induction in Golden Shower Oncidium (Bose *et al.*, 1999).

Soaking of Hippeastrum bulbs in three concentrations each of Indole acetic acid (IAA), GA_3, Chlorocholine chloride (CCC) and ethrel showed various responses on growth and flowering. IAA increased the weight and number of bulblets while GA_3 enhanced the flower diameter and bulb weight. Application of IAA at 100 ppm and GA_3 at 10, 100 or 1000 ppm twice as foliar spray at an interval of 15 days promoted the number of bulbs on the treated plants while ethrel increased the weight of bulblets. All concentrations of IAA and GA_3 increased the number and size of flowers as reported by Bose *et al.* (1980). Bhattacharjee (1983b) concluded that ethrel had beneficial effect on bulb formation. Application of IAA and GA_3 each at 10 to 1000 ppm also promoted vegetative growth, induced early flowering, increased flower size and stalk length, enhanced the number of flower per stalk, extended flower longevity, improved number, size and weight of bulb. Information regarding the use of plant growth regulators on flower and bulb production of Hippeastrum in Bangladesh is very scanty. Keeping these views in mind, the present investigation was undertaken to study the effect of IAA, ethrel and GA_3 on flower and bulb production of Hippeastrum.

Materials and Method

The experiment was carried out at the Horticultural research farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during October 2008 to July 2009. The experiment was laid out in a Randomized Complete Block Design (RCBD) having ten concentrations of growth regulators viz., T_1 = 20 ppm

IAA, T_2 = 60 ppm IAA, T_3 = 100 ppm IAA, T_4 = 100 ppm ethrel, T_5 = 300 ppm ethrel, T_6 = 500 ppm ethrel, T_7 = 100 ppm GA_3, T_8 = 300 ppm GA_3, T_9 = 500 ppm GA_3 and T_{10} = Control (soaked in water) with three replications. The experimental field was first disc-ploughed and harrowed. Final land preparation was done by a power tiller followed by leveling with scrapper. Clods were broken and weeds were removed from the field to obtain desirable tilth. Irrigation and drainage channels were made around the block. There were 30 (10 x 3) unit plots; each measuring 1 m x 1.5 m with 15 cm raised bed to prevent the bulbs from fungal disease caused by water logging. The plots were separated from one another by 1 m spaces. Bulb to bulb distance 25 cm and row to row distance 50 cm were maintained which constituted 12 plants per plot. Total 360 (30 x 12) bulbs were used for different treatments in the experiment. Uniform sized (5 cm in diameter) bulbs were collected from the field and kept two weeks for curing. Curing is a drying process intended to dry off the necks and outer scale leaves of the bulbs to prevent the loss of moisture and the attack by decay during storage. After harvesting when the bulbs were matured as indicated by yellowing and drying of leaves, the bulbs were dug out and tops were cut down. Then the bulbs were stored in trays and kept in a cool room (13^0 C). Selected bulbs were cleaned carefully by removing the roots, leaves and dry scales by using a sharp knife which was sterilized to avoid spread of diseases. Selected bulbs were soaked for 24 hours in different concentrations of IAA, ethrel and GA_3 solution and also in water as per the treatment schedule. After soaking, the treated bulbs were wrapped in tissue paper and immediately planted in the field. The crop was fertilized with Cow dung = 10t/ha, Urea = 200 kg/ha, TSP = 400 kg/ha and MP = 200 kg/ha (Jana and Bose, 1980). Total amount of cow dung, TSP and MP were applied at the time of final land preparation. Urea 200 kg/ha was applied in two equal installments of 30 and 60 days after emergence which was followed by irrigation. Cultural operations such as irrigating the crop at different growth stages, weeding and pest and disease control measures were taken as and when necessary. The scape of the flower was cut when the buds were fully elongated. Harvesting of scape was done early in the morning and the stalks were placed in water. Diameter of mother bulb and bulblets were measured after curing of bulb. Necessary data on different characters were recorded and analyzed statistically using MSTAT- C program to find out the variation among the treatments by F-test. Treatment means were compared by Duncan's Multiple Range Test (DMRT) for interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

The results obtained in the study have been described and discussed along with tables and figures.

Days to first flower scape emergence

Days to flower scape emergence of Hippeastrum was significantly influenced by different growth regulators (Table 1). From the table it can be revealed that first

flower scape emergence (72.33 days) commenced the earliest with ethrel at 100 ppm while late (93.67 days) in plants with control. This is in agreement with the findings of Bose *et al.* (1999) who reported that spraying with ethrel at 1000-4000 ppm, 1-3 times at intervals, has been found to hasten the flower induction in Golden Shower Oncidium. In this connection a little bit different results were found by Dhiman (1997) where earlier flowering in *Lilium hybrids* (115.50 and 120.20 days) was observed with GA_3 at 100 ppm. Pal and Das (1990) also reported that NAA (100 ppm) and GA_3 (100 or 200 ppm) induced early flowering in *Lilium longiflorum*.

Days to first flower open

Different growth regulators was found to influence significantly the days to first flower open of Hippeastrum (Table 1). It can be revealed that days to first flower open was the earliest (88.67 days) in plants treated with ethrel at 100 ppm which was closely followed by ethrel at 300 ppm. The control plants took the longest period (113.40 days) for first flower open. This result is supported by Bose *et al.* (1999) who reported that spraying with ethrel at 1000-4000 ppm, 1-3 times at intervals, hastened the flower induction in Golden Shower Oncidium.

Flower scape per plant

Flower scape per plant of Hippeastrum was counted at the time of flower scape harvest. Significant variation was not found in flower scape per plant due to different growth regulators (Table 1). However, the highest flower scape per plant (2.00) was produced in ethrel at 500 ppm treated plant and the lowest (1.00) in control and IAA at 20 ppm.

Flowers per scape

The effect of different growth regulators showed significant influence on flowers per scape of Hippeastrum (Table 1). The maximum flowers per scape (4.00) was recorded in plants treated with ethrel at 100 ppm and the control plants produced the minimum (2.44). The result is in agreement with the report of Sujatha *et al.* (2002) and Karaguzel *et al.* (1999) who stated that the number of flowers per plant increased with different growth regulators. Similar trend in flowers per scape of Hippeastrum was also reported by Bose *et al.* (1980).

Length of flower

Length of flower of Hippeastrum was significantly influenced by different growth regulators (Fig. 1). However, the highest length of flower (15.14 cm) was recorded from plants treated with GA_3 at 500 ppm. The lowest value for flower length (12.24 cm) was noted in control. This might be due to the fact that GA_3 treated plant produced more number of leaves compared to control and other treatments, which might have resulted in production and accumulation of more photosynthates that were diverted to flowers resulting in longer and larger size flower. The findings are in agreement with those of Pal and Choudhury (1998)

who found that GA_3 at 100 ppm significantly increased leaf area, induced early appearance of flower spike, highest number of florets/spike and largest individual florets in gladiolus cv. Hunting Song. Prakash and Jha (1998) also observed that application of GA_3 at 150 ppm improved all the floral traits (time of flowering, inflorescence length, spike length, floret length and number of florets/spike) in gladiolus, cv. Friendship.

Table 1. Effect of plant growth regulators on flowering characteristics of Hippeastrum.

Treatment	Days to flower scape emergence	Days to first flower open	Flower scape per plant	Flowers per scape
IAA				
20 ppm (T_1)	91.00 ab	109.6 b	1.00	3.06 bc
60 ppm (T_2)	90.00 ab	105.9 c	1.06	3.42 ab
100 ppm (T_3)	88.67 bc	104.3 c	1.17	3.39 ab
Ethrel				
100 ppm (T_4)	72.33 e	88.67 h	1.11	4.00 a
300 ppm (T_5)	84.33 d	92.28 g	1.22	3.28 ab
500 ppm (T_6)	85.33 cd	95.83 f	2.00	3.06 bc
GA_3				
100 ppm (T_7)	93.33 a	102.1 d	1.28	3.45 ab
300 ppm (T_8)	92.67 ab	99.22 e	1.28	3.45 ab
500 ppm (T_9)	91.00 ab	95.11 f	1.28	3.72 ab
Control (T_{10})	93.67 a	113.4 a	1.00	2.44 c
Level of significance	**	**	ns	**
CV(%)	2.34	1.52	11.98	6.22

Means having same letter(s) in a column are not significantly different by DMRT. ** indicates significant at 1% level.

Diameter of flower

A significant variation in the diameter of flower of Hippeastrum was observed due to the effect of different growth regulators (Fig. 1). GA_3 at 500 ppm showed the maximum diameter of flower (12.44 cm) which was statistically similar with that of plants treated with ethrel at 500 ppm and the control plants produced the narrowest flower (10.89 cm). This might be due to the fact that GA_3 treated plant produced more food that was diverted to only a fewer sink and hence bigger flowers were produced. Similar result is reported by Bose *et al.* (1980) who studied the effect of growth regulators on the growth and flowering in Hippeastrum. Sujatha *et al.* (2002) found that foliar application of 100 ppm GA_3 at monthly interval from January to May was the best for obtaining best growth of plants, maximum number of cut blooms with stalk length as well as flower size in gerbera.

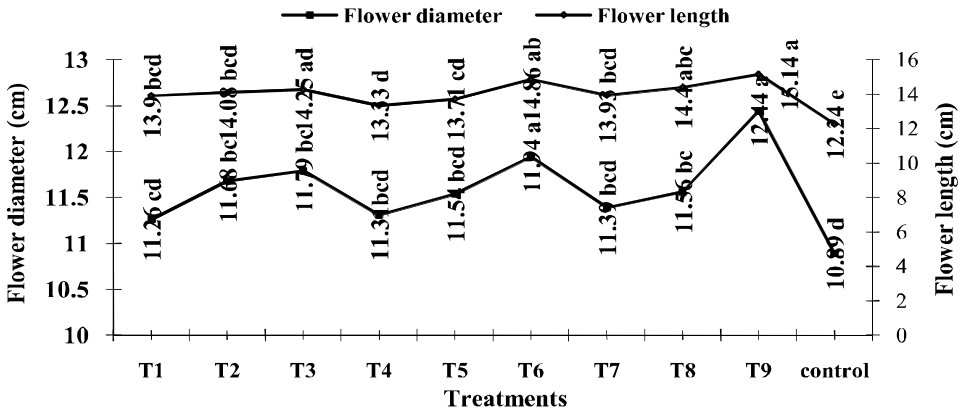

Fig. 1. Effect of growth regulators on flower length and diameter of Hippeastrum.

T_1 = 20 ppm IAA T_4 = 100 ppm Ethrel T_7 = 100 ppm GA_3
T_2 = 60 ppm IAA T_5 = 300 ppm Ethrel T_8 = 300 ppm GA_3
T_3 = 100 ppm IAA T_6 = 500 ppm Ethrel T_9 = 500 ppm GA_3 and
T_{10} = Control (soaked in water)

Flower scape length

Flower scape length of Hippeastrum was measured at the time of harvest. It was observed that flower scape length was significantly influenced by different growth regulators (Fig. 2). The longest flower scape (40.28 cm) was recorded from GA_3 at 500 ppm and the shortest (29.60 cm) was produced by control plants. This might be due to the fact that gibberrellic acids promote cell division and cell enlargement which ultimately resulted in longer flower scape. Similar results were reported by Karaguzel *et al.* (1999), Pal and Choudhury (1998) in gladiolus at 100 ppm GA_3, and Prakash and Jha (1998) in gladiolus at 150 ppm GA_3.

Flower scape diameter

Different growth regulators exhibited significant variation on flower scape diameter of Hippeastrum (Fig. 2). The maximum value for flower scape diameter (21.95 cm) was obtained from plants treated with GA_3 at 500 ppm and the minimum (17.09 cm) from control plants. This might be due to that the highest concentration of GA_3 enhanced plant growth which increased the diameter of flower scape. This is in line with the findings of Karaguzel *et al.* (1999) in gladiolus. They found that soaking of corms at 100 ppm GA_3 for one hour increased the length of flower stem and spikes, the number of flowers per spike and the diameter of flower stem.

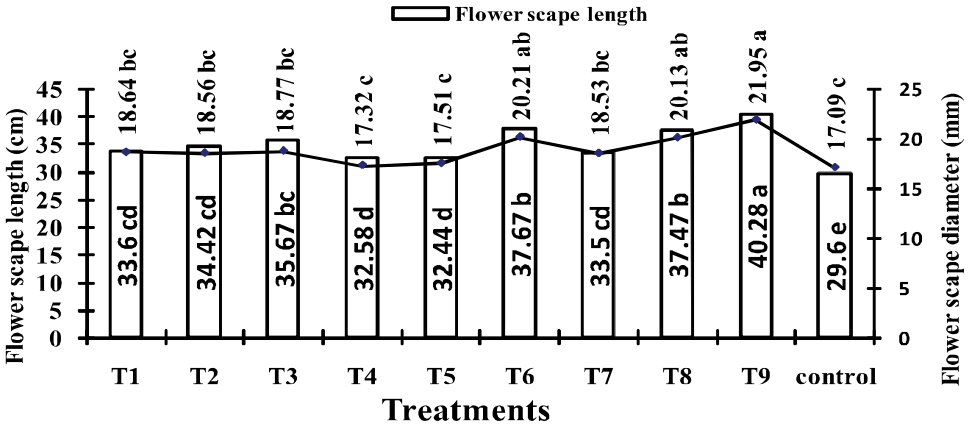

Fig. 2. Effect of growth regulators on flower scape length and diameter of Hippeastrum at harvest.

T_1 = 20 ppm IAA T_4 = 100 ppm Ethrel T_7 = 100 ppm GA_3
T_2 = 60 ppm IAA T_5 = 300 ppm Ethrel T_8 = 300 ppm GA_3
T_3 = 100 ppm IAA T_6 = 500 ppm Ethrel T_9 = 500 ppm GA_3 and
T_{10} = Control (soaked in water)

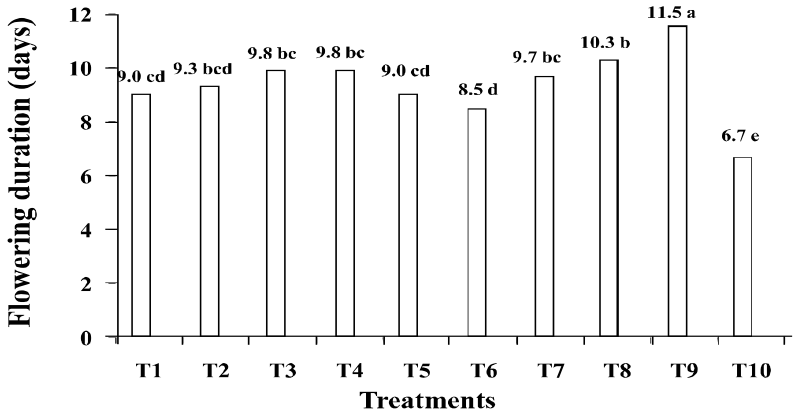

Fig. 3. Effect of growth regulators on flowering duration of Hippeastrum.

T_1 = 20 ppm IAA T_4 = 100 ppm Ethrel T_7 = 100 ppm GA_3
T_2 = 60 ppm IAA T_5 = 300 ppm Ethrel T_8 = 300 ppm GA_3
T_3 = 100 ppm IAA T_6 = 500 ppm Ethrel T_9 = 500 ppm GA_3 and
T_{10} = Control (soaked in water)

Flowering duration

Significant influence was observed on flowering duration of Hippeastrum by different growth regulators (Fig. 3). The maximum duration of flowering (11.50 days) was observed in T_9 (i.e. 500 ppm GA_3) while the minimum (6.70 days) was in control. The increased flowering duration could be attributed to the higher root

development by GA_3 and increased the efficiency of manufacturing carbohydrate which maintained the freshness of flower for longer time. Similar findings were reported by Verma *et al.* (1995) that a single foliar spray of GA_3 (100 and 200 ppm) in chrysanthemum enhanced vegetative growth and flowering. Application of 40 ppm GA_3 produced spikes having the longest (16.20 days) life in the field (Pal and Chowdhury, 1998).

Bulblets per plot

Number of bulblets per plot of Hippeastrum was counted after digging out of bulb. It was observed that different growth regulators significantly influenced the bulblets per plot (Table 2). The maximum number of bulblets per plot (40.00) was obtained from GA_3 at 500 ppm and the minimum (24.00) from control. This result is in full agreement with that of Bose *et al.* (1980). They reported that GA_3 at 10, 100 or 1000 mg l^{-1} twice as foliar spray at an interval of 30 days promoted the number of bulblets of the treated plants.

Table 2. Effect of plant growth regulators on bulb characteristics of Hippeastrum.

Treatment	Bulblets/plot	Bulb diameter (mm)		Bulb yield/plot (g)
		Mother bulb	Bulblets	
IAA				
20 ppm (T_1)	30.67 cd	68.14 b-e	28.67 bcd	3091 f
60 ppm (T_2)	36.00 abc	70.17 a-d	30.27 ab	3138 e
100 ppm (T_3)	38.67 ab	72.63 ab	32.48 a	3458 d
Ethrel				
100 ppm (T_4)	29.33 cd	64.19 ef	26.35 cd	2879 h
300 ppm (T_5)	30.67 cd	65.14 def	27.35 bcd	2898 g
500 ppm (T_6)	32.00 bc	66.75 c-f	28.35 bcd	2902 g
GA_3				
100 ppm (T_7)	34.67 abc	70.64 abc	29.71 abc	3615 c
300 ppm (T_8)	38.67 ab	72.34 ab	32.39 a	3927 b
500 ppm (T_9)	40.00 a	75.49 a	32.99 a	4056 a
Control (T_{10})	24.00 d	62.17 f	25.21 d	2639 i
Level of significance	**	**	**	**
CV%	7.52	2.72	4.22	16.35

Means having same letter(s) and without letters in a column are not significant by DMRT. ** indicates significant at 1% level.

Bulb diameter

Highly significant variation in diameter of bulb due to different growth regulators was found in this study (Table 2). However, the highest value for bulb diameter (75.49 mm) in case of mother bulb was recorded from GA_3 at 500 ppm and the lowest (62.17 mm) was found in control. Similar trend was also found in case of bulblets diameter. Gibberellin might accelerated cell division and cell elongation which lead to increased elongation of root (Stewart and Jones, 1977). Thus, it

enhanced the diameter of bulbs. The results are in partial agreement with Biswas *et al*. (1982) who reported that GA_3 at 100 ppm produced the highest diameter of bulb in tuberose.

Bulb yield per plot

The effect of different growth regulators on bulb yield per plot was found significant (Table 2). The maximum bulb yield (4056 g) was obtained from GA_3 at 500 ppm and the minimum (2639 g) from control. This may be due to that GA_3 enhanced better growth of bulbs and consequently produced the higher bulb yield per plot. These results are in conformity with the findings reported by Umrao *et al*. (2007) where they found increased weight of corm for treating with GA_3. A similar result was also reported by Bose *et al.* (1980) in Hippeastrum.

Bulb yield per hectare

Bulb yield per hectare of Hippeastrum varied significantly due to the influence of different growth regulators (Fig. 4). From the figure it can be revealed that the highest bulb yield (40.56 t/ha) was recorded in T_9 while the lowest (26.39 t/ha) in control. This finding is in full agreement with that of Bose *et al.* (1980) who reported that GA_3 enhanced the flower diameter and bulb yield of Hippeastrum.

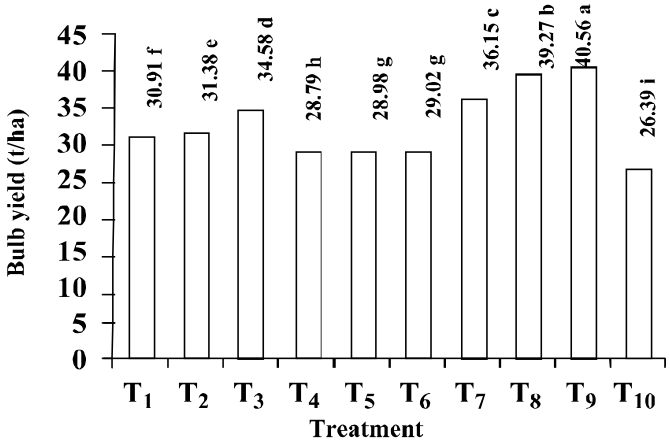

Fig. 4. Effect of growth regulators on bulbs yield (t/ha) of Hippeastrum.

T_1 = 20 ppm IAA T_4 = 100 ppm Ethrel T_7 = 100 ppm GA_3
T_2 = 60 ppm IAA T_5 = 300 ppm Ethrel T_8 = 300 ppm GA_3
T_3 = 100 ppm IAA T_6 = 500 ppm Ethrel T_9 = 500 ppm GA_3 and
T_{10} = Control (soaked in water)

Conclusion

Based on the above discussion, it can be concluded that the plant growth regulators has significant effect on flower and bulb production of Hippeastrum. Bulbs treated with ethrel at 100 ppm enhanced early emergence of flower scape and flowering, maximum flowers per scape while GA_3 at 500 ppm performed

better for bigger size flower and flower scape, flowering duration and bulb production of Hippeastrum.

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