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Effect of Bulb Cutting and Pot Medium on Propagation of Hippeastrum (*Hippeastrum hybridum* Hort.)

Mohammad Khalid Jamil[1], Mohammad Mizanur Rahman[2] and Mohammad Moshiur Rahman[3*]
[1] Senior Scientific Officer, Biotechnology Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh
[2] Professor, Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh
[3] Senior Scientific Officer, Horticulture Research Center, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh

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*Corresponding author's email: moshiur.bari@yahoo.com

Abstract

Experiments were conducted at the Horticulture Research Farm of Horticulture Department, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur during December, 2007 to May, 2009 to investigate the effect of bulb cutting and potting media on propagation of hippeastrum. The bulb cutting significantly influenced all the parameters except days required to first leaf emergence and leaf breadth at 60 DAP. Leaf number at 60 DAP, leaf length at 60 and 100 DAP, number of plant per section of bulb and number of bulb per pot were found to be significantly increased upto second treatment and then gradually decreased with the increase of bulb cutting. The highest number (2.20) of plant per section of bulb, bulblets (2.20) per section of bulb were obtained from 4 sections/bulb while diameter (20.74 mm) of bulb and combined weight (57.65 g) of bulb and plant were maximum at treatment 2 sections/bulb. Potting media also showed significant influence on all studied parameters. The maximum number (2.04) of plant per section of bulb and bulblets (2.04) per section of bulb were revealed at potting media containing only compost while the potting media contained sand, soil and compost at equal amount produced the biggest size of bulblets (20.07 mm) and maximum weight (44.75 g) of bulb and plant combinedly. However, the combined effect of T_2 x P_3 produced the maximum number (2.60) of plant and bulblets per section of bulb while the biggest size (23.05 mm) of bulblets and the highest yield (68.66 g) of bulb and plants were obtained in T_1 x P_4.

Keywords: Bulb cutting, Hippeastrum, Pot medium, Propagation.

INTRODUCTION

Hippeastrum (*Hippeastrum hybridum* Hort.) is a perennial and tunicated bulb suitable for planting in the bed, pot, rockery, shrubbery and in landscaping. They are also popular as cut flowers because of their large size, attractive color, and good keeping quality. Generally hippeastrum propagated through bulbs. The bulb is composed entirely of enlarged leaf bases only and there are no true bulb scales. There are usually six shoot units (generations) in a mature bulb. Daughter bulbs are initiated in the axils of senescing bulb scales in the outer parts of the bulb. New daughter bulbs produce nine leaves before initiating the first inflorescence. Because of their tropical origin, there is no real dormant period in the growth and development cycle of hippeastrum (Rees, 1985).

The basic objective of *ex-vitro* propagation of hippeastrum is to produce off-spring i.e. daughter bulbs that will be exactly similar to the mother plant and to get more bulb lets in a very short time than natural propagation method in a year of growth.

Conventional propagation of hippeastrum by bulb offsets is slow. Seasonal and variable with some hippeastrum hybrids not producing offsets (Smith *et al.*, 1999). In fact, normally a plant produces 2-3 bulb lets in a year of growth (Dohare, 1989). Since the natural multiplication rate of hippeastrum is slow, bulb cutting may be suitable to overcome this deficiency. Developments of plantlets from small sections of bulb i.e. scale and stem has been reported by a number of workers (Heaton, 1934). Ephrath *et al.* (2001) conducted an experiment on various cutting methods for the propagation of hippeastrum and found fewer bulblets were developed when the mother bulb was divided into un-separated sections, compared to twin scales. Increasing the number of sections into which the bulb was divided resulted in larger number of bulb lets. Zhu *et al.* (2005) reported that the chipping method was suitable for cutting mother bulb at propagation and the appropriate technique was to make 12-16 segments, depending on the size of the mother bulb. As the conventional propagation method by bulb offset is slow and they produce a few bulblets naturally, for this reason the experiment was taken to determine the suitable method for hippeastrum multiplication and to identify the appropriate media for hippeastrum plantlet development.

MATERIALS AND METHODS

The experiment was carried out at the horticultural research Farm of BSMRAU, Salna, Gazipur during March 2008 to June 2008. It is located between 24.090 N latitude and 90.260 E longitudes. The altitude of the location is 8.5 m from sea level. Cumulative rainfall of about 119 mm during August to May with average 82.9 % relative humidity. The mean maximum and minimum temperatures during cropping period were 26.290 C and 15.750 C, respectively. The soil of the experimental farm was clay loam having pH 6.2, organic carbon (0.95 %), phosphorus (9 ppm) and potassium (0.17 meq/100 g soil).

The bulbs of hippeastrum cv. `Apple Blossom, were collected from Kyushu University, Japan. The bulbs were grown in the garden of Horticulture Department at BSMRAU, Salna, Gazipur. When the bulbs attain 8-9 cm diameter then it were used as mother bulb for the experiment.

Mature and large size (8-9 cm in diameter) bulbs were selected for this experiment. Selected bulbs were cleaned by removing the roots, leaves and dry scales. The knife used in the cuttage operation was sterilized to avoid spread of diseases.

The bulbs were cut first horizontally keeping about 1.5 cm scale portion and basal stem portion of similar thickness and then longitudinally into small pieces according to the treatment, each containing scale and stem portions. The roots of the bulbs were cut back to about an inch in length from the basal plate. The extraneous matter sticking to the bulb was also removed through washing. Cut pieces of bulb were then dipped for 5 minutes into dithan M-45 (0.2%) solution to ensure proper disinfection. The green portion of the leaves was removed by cutting off the top of the 'neck' of the bulb. The treated bulbs were wrapped in tissue paper and immediately planted in a pot.

The experiment was consisted of two factors: Factor A- Five bulb segment: 2 sections, 4

sections, 8 sections, 12 sections and 16 sections and Factor B- Four potting media: Sand (100%), Soil (100%), Compost (100%) and Sand + Soil + compost (1:1:1).

The pot experiment was laid out in a (RCBD) with five replications. One bulb section was planted in one pot, containing the potting media according to the treatments and five plants were constituted the unit of treatment. Total 100 (20 x 5) bulb sections were used from different treatments in the experiment.

Fungicide treated cut pieces of bulbs were planted in a pot containing different type of potting media for rooting. The cut pieces became reddish in color, gradually turn greenish and finally shoot arises from the junction of scale-stem section within 35 to 40 days after planting. After a few days of shoot emergence, the seedlings were shifted everyday for a week from the shaded place to partly sunny place for hardening.

Data were collected on the following parameters for interpretation of the result of the experiment: i) Days to first leaf emergence, ii) Leaves per plant at 100 days after planting (DAP), iii) Plant height at 60 and 100 DAP, iv) Leaf breadth at 60 and 100 DAP, v) Number of plants emerged per bulb section at 100 DAP, vi) Bulblets per pot at 100 DAP, vii) Diameter of bulbs at 100 DAP and viii) Plant weight at 100 DAP.

The recorded data for different characters were 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

Effect of bulb segments

Days to first leaf emergence: Days to first leaf emergence of hippeastrum was not significantly influenced by bulb cutting (Table 1). However, the first leaf emergence (44.55 days) commenced earlier in T_1 (i.e. 2 sections per bulb) while late (48.65 days) in plants of T_5 (i.e.16 sections per bulb) which was followed by T_4, T_3 and T_2. This may be due to T_1 had more reserve food than other treatments which favoured the early leaf emergence of bulb sections. Misra, (1995) reported that entire corm and radial cut corm showed 100% sprouting which supports the present findings.

Leaves per plant: Number of leaf was counted at 100 days after planting (DAP) and exhibited significant variation among the different segments per bulb (Table 1). It varied from 1.5 to 2.65 per plant, the highest (2.65) leaves per plant was recorded from T_2 (i.e. 4 sections per bulb) and the lowest (1.5) from T_5 (16 sections per bulb). A gradual decrease of number of leaf per plant was found with the gradual increase in section per bulb except T_2 in the present investigation.

Plant height: Plant height of hippeastrum was measured at 60 and 100 days after planting. It was observed that plant height was significantly influenced by different segments per bulb at 60 DAP and 100 DAP (Table 1). The plant height increased gradually as the time passed after planting. The highest plant height (19.91 cm and 29.11 cm) was observed in T_2 at 60 DAP and 100 DAP respectively. On the other hand, it was the lowest (10.25 cm and 24.62 cm) in T5 at both 60 and 100 DAP, respectively. Plant height was statistically similar among up to 12 segmented bulb than 16 segmented bulb. These findings are partially agreed by Singh (1996) where he found statistically similar heights with whole and half corm use.

Leaf breadth: Leaf breadth of hippeastrum was not significantly influenced by the bulb cutting at 60 DAP but significantly differed at 100 DAP (Table 1). However, the broader leaf (1.37 cm at 60D AP and 2.12 cm at 100 DAP) was visualized in T_1 (2 sections per bulb) and the narrower leaves (1.12 cm at 60 DAP and 1.69 cm at 100 DAP) produced from T5 (16 sections per bulb). This might be due to that an increase in the number of sections resulted in a smaller quantity of available nutrients in the sections which failed to produce broader leaves.

Plants emerged per bulb section: Plants emerged per bulb section of hippeastrum were counted at the time of bulb lifting from the pot. A significant variation in plants per bulb section

Table 1. Effect of bulb cutting on vegetative growth of hippeastrum

Treatment	Days to first leaf emergence	Leaves per plant	Plant height (cm)		Leaf breadth (cm)		Plants emerged per bulb section
			60 DAP	100 DAP	60 DAP	100 DAP	
T_1=2 sections	44.55	2.05 ab	17.72 a	28.81 a	1.37	2.12 a	1.95 ab
T_2=4 sections	44.75	2.65 a	19.91 a	29.11 a	1.27	1.99 ab	2.20 a
T_3=8 sections	44.95	2.10 ab	18.03 a	26.90 ab	1.18	1.83 ab	1.70 abc
T_4=12 sections	46.65	1.70 b	16.98 a	25.63 ab	1.15	1.74 b	1.55 bc
T_5=16 sections	48.65	1.50 b	10.25 b	24.62 b	1.12	1.69 b	1.10 c
Level of significance	NS	**	**	**	NS	**	**
CV%	8.86	22.94	12.08	9.53	15.12	11.89	24.51

Means having same letter(s) in a column are not significantly different from each other
DAP = Days after planting.

was observed (Table 1). The value for plants/section of bulb decreased gradually from T_1 (2 sections) to T_5 (16 sections) except T_2 (Table 1). The maximum plants/bulb (2.2) was obtained when mother bulb was cut at 4 sections (T_2) and the lowest (1.1) was found in T_5 (i.e. 16 sections per bulb) which was at par with T_4 and T_3. Ephrath *et al*. (2001) also observed similar trend in hippeastrum.

Bulblets per pot: Number of bulblets per pot differs significantly due to mother bulb cutting (Table 2.). The highest number of bulblets per pot (2.20) was found in T_2 (i.e. 4 sections/bulb) which was at par with T_1 and T_3. The lowest number of bulblets per pot (1.10) was obtained from T_5 (i.e.16 sections/bulb) followed by T_4 and T_3. This was possibly due to size of bulb sections which produce bulb-lets after attaining optimum size. This was in line with the findings of Gromov (1972) who suggested that faster propagation in gladiolus was achieved by planting halved segments of large corms.

Bulb diameter: Bulb diameter of hippeastrum was significantly influenced by the bulb segments (Table 2). The highest diameter of bulb (20.74 mm) was recorded in T_1 (i.e. 2 segments per bulb) which was statistically identical to T_2. The lowest diameter of bulb (14.73 mm) was achieved in T_5 (i.e. 16 segments per bulb) followed by T_4 and T_3. The results of the study presented here revealed to the fact that the smaller the number of sections into which the mother bulb was cut, the larger the average diameter of the resulting bulblets. The result is in full agreement with the findings of Zhu *et al.* (2005) in hippeastrum who reported that the bigger the daughter bulb at planting, the larger the bulb obtained.

Plant weight: Plant weight of hippeastrum as influenced by bulb sections showed statistically significant (Table 2). It can be noted that plant weight including bulb decreased gradually with the increase of bulb sections. The highest plant weight (57.65 g) was obtained from T_1 i.e. 2

Table 2. Effect of bulb cutting on bulb production of hippeastrum

Treatment	Bulblets per pot	Bulb diameter (mm)	Plant weight (g)
T_1=2 sections	1.95 ab	20.74 a	57.65 a
T_2=4 sections	2.20 a	18.26 ab	51.09 b
T_3=8 sections	1.70 abc	17.38 bc	36.97 c
T_4=12 sections	1.55 bc	16.40 bc	24.68 d
T_5=16 sections	1.10 c	14.73 c	23.72 d
Level of significance	**	**	**
CV%	24.51	10.73	5.73

Means having same letter(s) in a column are not significantly different from each other

Table 3. Effect of potting media on vegetative growth of hippeastrum

Treatment	Days to first leaf emergence	Leaves per plant	Plant height (cm)		Leaf breadth (cm)		Plants emerged per bulb section
			60 DAP	100 DAP	60 DAP	100 DAP	
P_1= 100% Sand	50.36 a	1.24 c	11.50 b	19.45 c	0.76 c	1.31 b	1.32 b
P_2= 100% Soil	47.00 ab	1.72 bc	14.56 b	25.44 b	1.10 b	1.55 b	1.52 ab
P_3= 100% Compost	43.64 ab	2.64 a	19.60 a	30.90 a	1.43 a	2.20 a	2.04 a
P_4=Sand+Soil+Compost	42.64 b	2.40 ab	20.65 a	32.26 a	1.57 a	2.43 a	1.92 ab
Level of significance	**	**	**	**	**	**	**
CV%	8.86	22.94	12.08	9.53	15.12	11.89	24.51

Means having same letter(s) in a column are not significantly different from each other

sections per bulb and the treatment T_5 i.e. 16 sections per bulb produced the lowest weight (23.72 g) which was statistically similar with that of T_4. This finding is in agreement with that of Witomska *et al*. (2005) in hippeastrum. They found that cutting size significantly affected the number of re-generated bulblets, as well as their diameter and fresh weight.

Effect of potting media

Days to first leaf emergence: Potting media was found significantly influenced on days to first leaf emergence of hippeastrum (Table 3). Days to first leaf emergence was observed earlier (42.64 days) in P_4 [i.e. sand, soil and compost (1:1:1)] which was statistically similar to P_3 and P_2. Leaf emergence was late (50.36 days) in P_1 (i.e. 100% sand only). This might be due to suitable moisture content in P_4 which enhanced the leaf emergence earlier than other potting media. In an experiment with gladiolus, Misra, (1994) found maximum emergence of sprouts in pots by 50:50 sand and soil mixture which is also in partial agreement with the present findings.

Leaves per plant: The number of leaves per plant produced in different potting media varied significantly (Table 3). The maximum number of leaves per plant (2.64) was recorded from potting media P_3 which was statistically similar to P_4. It may be due to good aeration and nutrient availability to the plant which ultimately results proper vegetative growth of plant. Whereas the minimum leaves per plant (1.24) was produced in P_1 (100% sand) which was statistically identical to P_2.

Plant height: Potting media also showed significant influence on plant height of hippeastrum at 60 and 100 DAP (Table 3). Plant height increased gradually with the pave of time and it was observed that there was significant differences of potting media in respect of plant height at 60 DAP and 100 DAP. From table 3, it was clear that plant height increases sharply at 60 DAP and then slight increases at 100 DAP in all the potting media. However, the longest plant (20.65cm and 32.26 cm) at 60 DAP and 100 DAP was found in P_4 while the dwarf plant (11.50 cm and 19.45 cm) at 60 DAP and 100 DAP was recorded in P_1. Adequate numbers of leaves are essential for

Table 4. Effect of potting media on bulb production of hippeastrum

Treatment	Bulblets per pot	Bulb diameter (mm)	Plant weight (g)
P_1= 100% Sand	1.32 b	14.86 c	32.61 b
P_2= 100% Soil	1.52 ab	16.42 bc	36.20 b
P_3= 100% Compost	2.04 a	18.66 ab	41.73 a
P_4=Sand+Soil+Compost	1.92 ab	20.07 a	44.75 a
Level of significance	**	**	**
CV%	24.51	10.73	5.73

Means having same letter(s) in a column are not significantly different from each other

Table 5. Combined effect of bulb cutting and potting media on vegetative growth of hippeastrum

Treatment	Days to first leaf emergence	Leaves per plant	Plant height (cm)		Leaf breadth (cm)		Plants emerged per bulb section
			60 DAP	100 DAP	60 DAP	100 DAP	
T_1 X P_1	44.2 c-g	2.0 bc	12.08 efg	23.28	0.86 fg	1.50 ef	1.6 b-e
T_1 X P_2	45.4 c-f	2.8 abc	16.50 bcd	28.14	1.26 b-e	1.98 cd	1.8 a-e
T_1 X P_3	44.4 c-g	2.6 abc	20.46 ab	31.82	1.60 ab	2.40 abc	2.2 abc
T_1 X P_4	38.6 g	3.0 abc	21.84 a	32.00	1.74 a	2.60 a	2.2 abc
T_2 X P_1	50.2abc	2.0 bc	13.24 c-f	21.36	0.72 g	1.44 f	1.8 a-e
T_2 X P_2	49.6 abc	2.8 abc	16.90 bc	25.64	0.96 efg	1.66 def	2.0 a-d
T_2 X P_3	40.6 fg	3.6 a	24.68 a	34.24	1.40 a-d	2.38 abc	2.6 a
T_2 X P_4	45.8 b-f	3.6 a	24.80 a	35.22	1.64 ab	2.50 ab	2.4 ab
T_3 X P_1	51.8 ab	2.0 bc	12.54 d-g	18.96	0.78 fg	1.22 f	1.2 de
T_3 X P_2	47.2 b-e	2.4 abc	15.24 cde	23.92	1.16 c-f	1.42 f	1.4 cde
T_3 X P_3	45.0 c-f	3.4 ab	21.44 a	31.04	1.56 abc	2.28 abc	2.2 abc
T_3 X P_4	42.6 d-g	3.4 ab	22.90 a	33.66	1.58 ab	2.40 abc	2.0 a-d
T_4 X P_1	52.0 ab	1.6 c	11.26 efg	17.86	0.72 g	1.22 f	1.0 e
T_4 X P_2	44.8 c-g	2.2 abc	14.62 cde	24.18	1.06 d-g	1.36 f	1.4 cde
T_4 X P_3	41.2 efg	2.8 abc	20.50 ab	29.46	1.30 b-e	2.02 bcd	2.0 a-d
T_4 X P_4	40.2 fg	3.4 ab	21.52 a	31.00	1.50 abc	2.36 abc	1.8 a-e
T_5 X P_1	53.6 a	1.8 c	8.36 g	15.78	0.70 g	1.18 f	1.0 e
T_5 X P_2	48.0 a-d	2.4 abc	9.54 fg	25.30	1.06 d-g	1.34 f	1.0 e
T_5 X P_3	47.0 b-e	2.8 abc	10.92 efg	27.96	1.30 b-e	1.94 cde	1.2 de
T_5 X P_4	46.0 b-f	2.4 abc	12.18 efg	29.44	1.40 a-d	2.30 abc	1.2 de
Level of significance	*	**	**	NS	**	**	**
CV%	8.86	25.83	12.08	9.53	15.12	11.89	24.51

Means having same letter(s) in a column are not significantly different from each other
DAP = Days after planting
T_1 X P_1 = 2 sections x sand only
T_3 X P_3 = 8 sections x compost only
T_1 X P_2 = 2 sections x soil only
T_1 X P_3 = 2 sections x compost only
T_1 X P_4 = 2 sections x (sand+soil+compost)
T_2 X P_1 = 4 sections x sand only
T_2 X P_2 = 4 sections x soil only
T_2 X P_3 = 4 sections x compost only
T_2 X P_4 = 4 sections x (sand+soil+compost)
T_3 X P_1 = 8 sections x sand only
T_3 X P_2 = 8 sections x soil only
T_3 X P_4 = 8 sections x (sand+soil+compost)
T_4 X P_1 = 12 sections x sand only
T_4 X P_2 = 12 sections x soil only
T_4 X P_3 = 12 sections x compost only
T_4 X P_4 = 12 sections x (sand+soil+compost)
T_5 X P_1 = 16 sections x sand only
T_5 X P_2 = 16 sections x soil only
T_5 X P_3 = 16 sections x compost only
T_5 X P_4 = 16 sections x (sand+soil+compost)

normal growth and development of plants as well as bulbs. In the present study, P_4 media produced more leaves per plant, so it resulted in accumulation of more photosynthates that leading to better growth of the plant.

Leaf breadth: Significant variation was observed in leaf breadth as influenced by potting media (Table 3). A mixture of sand, soil and compost at the ratio of 1:1:1 (i.e.P_4) showed the highest value (1.57 cm at 60 DAP and 2.43 cm at 100 DAP) for leaf breadth and it was the lowest (0.76 cm at 60 DAP and 1.31cm at 100 DAP) was visualized in P_1 (100% sand media). This may be due to more numbers of leaves produced by P_4 media which favours the accumulation of more photosynthates leading to broader leaf of the plant.

Plants emerged per bulb section: Significant variation in the plants per bulb was also found due to different potting media (Table 3). A gradual increase in plants/bulb was observed when bulb sections were planted in compost media solely and also in the mixture of sand, soil and compost at the ratio of 1:1:1.The compost media (P_3) solely produced the maximum number of

Table 6. Combined effect of bulb cutting and potting media on bulb production of hippeastrum

Treatment	Bulblets per pot	Bulb diameter (mm)	Plant weight (g)
T_1 X P_1	1.60 b-e	18.48 b-f	45.32 d
T_1 X P_2	1.80 a-e	19.38 a-e	55.82 c
T_1 X P_3	2.20 abc	22.05 ab	60.82 b
T_1 X P_4	2.20 abc	23.05 a	68.66 a
T_2 X P_1	1.80 a-e	15.77 e-i	45.32 d
T_2 X P_2	2.00 a-d	17.00 d-h	47.30 d
T_2 X P_3	2.60 a	19.10 a-e	55.38 c
T_2 X P_4	2.40 ab	21.18 abc	56.36 c
T_3 X P_1	1.20 de	14.73 f-i	33.70 fg
T_3 X P_2	1.40 cde	16.16 d-i	35.70 ef
T_3 X P_3	2.20 abc	18.53 b-f	38.84 e
T_3 X P_4	2.00 a-d	20.08 a-d	39.62 e
T_4 X P_1	1.20 de	14.18 hi	20.90 j
T_4 X P_2	1.40 cde	15.36 e-i	21.38 j
T_4 X P_3	2.00 a-d	17.65 c-g	27.70 hi
T_4 X P_4	1.80 a-e	19.42 a-e	30.74 gh
T_5 X P_1	1.00 e	12.13 i	19.82 j
T_5 X P_2	1.00 e	14.20 ghi	20.78 j
T_5 X P_3	1.20 de	15.98 d-i	25.90 i
T_5 X P_4	1.20 de	16.60 d-h	28.38 hi
Level of significance	**	**	**
CV%	24.51	10.73	5.73

Means having same letter (s) in a column are not significantly different from each other

T_1 X P_1 = 2 sections x sand only
T_1 X P_2 = 2 sections x soil only
T_1 X P_3 = 2 sections x compost only
T_1 X P_4 = 2 sections x (sand+soil+compost)
T_2 X P_1 = 4 sections x sand only
T_2 X P_2 = 4 sections x soil only
T_2 X P_3 = 4 sections x compost
T_2 X P_4 = 4 sections x (sand+soil+compost)
T_3 X P_1 = 8 sections x sand only
T_3 X P_2 = 8 sections x soil only
T_3 X P_3 = 8 sections x compost only
T_3 X P_4 = 8 sections x (sand+soil+compost)
T4 X P_1 = 12 sections x sand only
T_4 X P_2 = 12 sections x soil only
T_4 X P_3 = 12 sections x compost only
T_4 X P_4 = 12 sections x (sand+soil+compost)
T_5 X P_1 = 16 sections x sand only
T_5 X P_2 = 16 sections x soil only
T_5 X P_3 = 16 sections x compost only
T_5 X P_4 = 16 sections x (sand+soil+compost)

plants per bulb (2.04) and the media contain solely sand (P_1) produced the lowest (1.32) plant per section of bulb. This may be due to good aeration and water holding capacity of the compost media which favors the regeneration ability of the cutting bulb. This result is also supported by the findings of Witomska *et al.* (2005). They observed in a trial regarding the effect of cutting size on propagation efficiency of Hippeastrum x chmielii by scale cuttings that perlite was more appropriate medium for incubation of cuttings than a mixture of perlite and peat.

Bulblets per pot: The number of bulblets per pot was significantly varied due to potting media (Table 4). However, the highest number of bulblets per pot (2.04) was found in potting media containing solely compost (P_3) which was closely followed by potting media P_4 that containing sand, soil and compost at the ratio of 1:1:1 and P_2. 100% compost (P_3) showed better performance may be due to the profuse rooting of the bulb sections which absorbed more nutrients that encourage the production of more bulblets per plant. On the other hand, the lowest number of bulblets per pot (1.32) was observed in potting media containing only sand (P_1). This may be due to that sand alone is a nutrient deficient medium. Misra, (1994) reported that the treatment sand and soil mixture was found to be superior among different soil media and provided largest size corms in gladiolus.

Diameter of bulb: Significant variation was observed in bulb diameter as influenced by

potting media (Table 4). The media P_4 (containing sand, soil and compost at the same ratio) showed the highest value (20.07 mm) for bulb diameter which was statistically similar to P_3. A mixture of sand, soil and compost (P_4) showed better performance may be due to the lower number of bulblets per pot which obtained available space to attain proper growth. On the other hand, the lowest diameter of bulb (14.86 mm) was recorded in 100% sand (P_1). This was also supported by Misra, (1994) in gladiolus where he found that the size of corms was highly discouraging in only sand.

Plant weight: Plants weight of hippeastrum was also observed significant as influence by potting media (Table 4). The highest plant weight (44.75 g) was recorded from potting media containing sand, soil and compost at the ratio of 1:1:1 (P_4) which was at par with P_3. The minimum plant weight (32.61 g) was recorded from potting media contained only sand (P_1). This may be due to that the longest root was produced by the treatment P4 and number of roots was also good in this treatment which was able to uptake necessary nutrients. On the other hand, though number of roots per plant was highest in 100% sand but root length was not good. So, these could not uptake sufficient nutrients from the soil.

Combined effect of bulb segments and potting media

Days to first leaf emergence: Days to first leaf emergence of hippeastrum were significant as influenced by the combined effect of bulb section and potting media (Table 5). From the table, it was found that T_1P_4 i.e. 2 sections per bulb with sand, soil and compost (1:1:1) media took the minimum period (38.6 days) for first leaf emergence which was at par with T_1P_1, T_1P_3, T_2P_3, T_3P_4, T_4P_2, T_4P_3 and T_4P_4. On the other hand, T_5P_1 i.e. 16 sections per bulb with 100% sand media took the maximum period (53.6 days) which was statistically similar with T_2P_1, T_2P_2, T_3P_1, T_4P_1 and T_5P_2. This may be due to available moisture content of the potting media (P_4) and sufficient food reserves in the bulb section (T_1) enhanced the leaf emergence of the bulb. This was in close conformity with the findings of Misra (1995) in gladiolus.

Leaves per plant: Regarding the combined effect of bulb sections and potting media on the number of leaves per plant, significant difference was observed (Table 5). Number of leaves per plant varied from 1.6 to 2.6, the highest (2.6) being observed in T_2P_3 followed by T_2P_4 (Table 5).This may be due to that T_2P_3 favours the congenial environment for the growth of bulb which encouraged to produce more leaves per plant for better growth. On the other hand, the minimum leaves (1.6) was visualized in T_4P_1 (i.e. 12 sections/bulb + 100% sand) which was statistically similar with T_5P_1 (16 sections/bulb + 100% sand). This may be due to insufficient food reserves to the bulb section (16 sections per bulb) and deficient in nutrient in potting media (100% sand only).

Plant height: The combined effect of bulb sections and potting media had significant influence on plant height of hippeastrum at 60 days after planting but it was not significantly differed at 100 DAP (Table 5). However, the periodic growth study revealed that plant height increased with the advancement of the plant duration. The maximum plant height (24.80 cm) was recorded in T_2P_4 at 60 DAP which was statistically identical to T_2P_3. The minimum plant height (8.36 cm at 60 DAP and 15.78 cm at 100 DAP) was found in T_5P_1.These findings are partially agreed by Singh (1996) where he found statistically similar heights with whole and half corm use.

Leaf breadth: The combined effect of bulb section and potting media also exhibited significant influence on leaf breadth of Hippeastrum (Table 5). Maximum leaf breadth (1.74 cm at 60 DAP and 2.60 cm at 100 DAP) was observed in T_1P_4 (2 sections per bulb + potting media containing a mixture of sand, soil and compost equally) which was statistically identical with that of T_2P_4 and T_3P_4 {i.e.4 and 8 sections per bulb + potting media containing a mixture of sand, soil and compost} (Table 5). The lowest value for leaf breadth (0.70 cm at 60 DAP and 1.18 cm at 100 DAP) was observed in T_5P_1 (16 sections per bulb + 100% sand media). Good aeration to the root zone, water and nutrient availability to the plant favoured

better growth and development of the plant, which eventually produced broader size of leaf in the experiment.

Plants emerged per bulb section: The combined effect of bulb sections and potting media showed significant influence on the plants produced per bulb of hippeastrum (Table 5). However, the maximum no. of plants (2.6) was produced in T_2P_3 and T_2P_4. This may be due to that smaller section of bulb and 100% compost or a mixture of sand, soil and compost possesses sufficient food reserves and available nutrients to the plant which encouraged new plantlets from bulb sections. On the other hand, the media contain only sand or only soil with 12 or 16 sections per mother bulb (T_4P_1, T_5P_1 and T_5P_2) produced the minimum number of plantlets per bulb section (1.0) (Table 5). This result is also in partial agreement with the findings of Misra (1994) who found that the highest percent of plant emergence in pots was obtained by 50:50 sand and soil mixture.

Bulblets per pot: The combined effect of bulb sections and potting media also showed significant influence on number of bulblets per pot of hippeastrum (Table 6). However, the maximum bulblets per pot (2.60) were recorded from T_2P_3 (i.e.2 sections/bulb and potting media containing sand, soil and compost at the ratio 1:1:1). This may be due to that maximum number of leaves per plant was produced in T_2P_3 which accumulated more photosynthates that diverted into sink (bulb) and ultimately produced more bulblets per plant. On the other hand, the minimum (1.00) was obtained from 16 sections /bulb with sand or soil media solely (T_5P_1 and T_5P_2).

Diameter of bulb: The combined effect of bulb sections and potting media also exhibited significant influence on bulb diameter of hippeastrum (Table 6). However, the maximum bulb diameter (23.05 mm) was observed in the treatment consists of T_1P_4 (i.e. 2 sections per bulb with potting media containing a mixture of sand, soil and compost at the same ratio). The lowest value for bulb diameter (12.13 mm) was observed in the treatment comprises of 16 sections per bulb and 100% sand containing potting media (T_5P_1). Potting media containing sand, soil and compost at the same ratio produced greater number of roots which uptake sufficient nutrients that favoured better growth and development of the individual plant, which eventually produced larger size of bulbs in the present experiment. This result is in full agreement with that of Ephrath *et al*. (2001) who reported that as the number of sections that the mother bulb was divided to decreased, the percentage of developing bulblets with a large circumference increased.

Plant weight: The combined effect between bulb sections and potting media on plant weight of hippeastrum was found significant (Table 6). However, the highest plant weight (68.66 g) was obtained from T_1P_4 i.e. 2 sections per bulb with potting media containing a mixture of sand, soil and compost which was closely followed by T_2P_4 i.e. 4 sections /bulb with potting media containing a mixture of sand, soil and compost (Table 6). The lowest value for plant weight (19.82 g) was found in T_5P_1 (i.e.16 sections per bulb and potting media contain only sand) which was closely followed by T_5P_1, T_5P_2 and T_4P_1. The combination of 2 sections /bulb and potting media contain sand + soil + compost at the same ratio produced the highest plant weight. Equal amount of sand, soil and compost in a pot ensured the availability of nutrient, moisture and aeration to the root zone which ultimately results in better growth and development of the plant and producing heavier bulb.

CONCLUSION

From this experiment it was revealed that bulb cutting significantly influenced all the parameters except days required to first leaf emergence and leaf breadth at 60 DAP. The highest number of plant per section of bulb, bulblets per section of bulb were obtained from treatment 2 while diameter of bulb and combined weight of bulb and plant were maximum at treatment 1. Potting media also showed significant influence on all parameters studied on hippeastrum bulb cutting. The maximum number of plant per section of bulb and bulblets per section of bulb were found at potting media containing only compost while the potting media contained sand, soil and compost at equal amount produced the biggest bulblets and heaviest bulb.

Literature Cited

Dohare, S.R. 1989. *Amaryllis* and *Hippeastrum*. In: Commercial Flowers. T.K. Bose, R.G. Maiti and R.S. Dhva, (eds.), Naya Prokash, Calcutta. pp. 558-564.

Ephrath, J.E., Ben-Asher, J., Baruchin, F., Alekperov, C., Dayan, E. and Silberbush, M. 2001. Various cutting methods for the propagation of hippeastrum bulbs. Biotronics. 30: 75-83.

Gomez, K.A. and Gomez. A.A. 1984. Statistical procedures for agricultural Research (2nd edition). Int. Rice Res. Inst. John Wiley and Sons Publication, New York. pp. 28-192.

Gromov, A.N. 1972. Propagation by division. In: The world of gladiolus, Edge. Wood Press, Maryland. pp. 98-102,

Heaton, I. W. 1934. Vegetative propagation of *Amaryllis*. Herbertia, 1: 75-82.

Misra, R.L. 1994. Propagatiion of gladiolus through sprouts- An entirely new method in gladiolus propagation. In: Floriculture Technology, Trades and Trends. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. pp. 67-70.

Misra, R.L. 1995. Studies on gladiolus propagation through fractionated corms. Haryanan Journal of Horticultural Science. 24(3-4): 203-208.

Rees, A.R. 1985. *Hippeastrum.* In: Handbook of flowering. A.H. Halevy (ed.), CRC Press, Boca Raton, Florida. pp. 294-296.

Singh, K.P. 1996. Response of whole and excised corms on production of spikes in gladiolus. Indian Journal of Horticulture. 53(3): 228-232.

Smith, R.H., Burrows, J. and Kurten, K. 1999. Challenges associated with micropropagation of *Zephyranthes* and *Hippeastrum* sp. (Amaryllidaceae). *In vitro* Cellular and Development of Biology Plant. 35(4): 281-282.

Witomska, M., Ilczuk, A. and Zalewska, I. 2005. Effect of cutting size on propagation efficiency of *Hippeastrum x Chmielii* by scale cuttings. Propagation of Ornamental Plants. 5(4): 205-209.

Zhu, Y., Liu, K.S. and Yiu, J.C. 2005. Effect of cutting method on bulb production of *Hippeastrum hybridum* in Taiwan. Acta-Horticulturae. 2: 531-535