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http://hdl.handle.net/2324/8274

出版情報：BIOTRONICS. 30, pp.75-83, 2001-12. Biotron Institute, Kyushu University
バージョン：
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BIOTRONICS **30**, 75–83, 2001

VARIOUS CUTTING METHODS FOR THE PROPAGATION OF HIPPEASTRUM BULBS

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(Received August 30, 2001; accepted October 1, 2001)

EPHRATH J. E., BEN–ASHER J., BARUCHIN F., ALEKPEROV C., E. DAYAN A and SILBERBUSH M. *Various cutting methods for the propagation of Hippeastrum bulbs.* BIOTRONICS **30**, 75–83, 2001. One of the major problems of Hippeastrum is the large amount of labor involved in its production. There are three common methods for the propagation of the Hippeastrum: Seeds, offset bulblets and twin scaling. Study on various cutting methods for the propagation of Hippeastrum was conducted in the Northern Israeli Negev Desert during two consecutive years. 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 bulblets. No correlation between the number of sections and the average weight of bulblets was found. The total weight of all the bulblets derived from one bulb, doubled after one growing year. Propagation coefficient, defined as the ratio between the bulblets number to the number of section into which the bulb was divided, was larger than one unit when the bulbs were cut into un–separated sections and smaller than one unit when the twin scaling method was used. Higher economic profit was found when the bulbs were divided into un–separated sections. By using the un–separated section method, it was possible to receive bulbs ready for marketing one year sooner, when compared to the twin scaling method. The greatest economical profit is expected when the mother bulb was divided into eight un–separated sections.

Key words: Economic analysis; bulb size; growing period

INTRODUCTION

The *Hippeastrum hybridum* is a bulb with a promising economic future. Nevertheless, this branch of agriculture is not steady and a large number of

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growers abandoned it, mainly because of the large amount of labor involved in its production.

The main problems Hippeastrum growers facing are: 1. The method of propagation which required a great deal of manual labor. 2. A long growing period (relative to other crops) before the bulbs are ready to bloom and market and 3. The difficulties involved in regulation and the control of flowering of the bulbs to coincide with the best marketing season. The last two problems are discussed in details in Ephrath et al., (*1, 2*) and by Hong (*4*). In this study we are focusing on propagation methods of Hippeastrum. There are three common methods for the propagation of the Hippeastrum: Seeds, offset bulblets and twin scaling (*11*). Because of the large variation in the characteristics of the flowers, plant shape, time of flowering etc., the propagation by seeds is usually used for the development of new cultivars. Only cultivars that produce at least three offset bulblets are suitable for propagation by offsets division. In most cases the propagation is done by a method known as twin scaling (*3, 7, 8, 9, 11*).

The currently recommended method of propagation involves dividing each bulb into twelve sections followed by separating each individual section into twin scales (two scales that are connected by a piece of the basal plate). This method requires about 100 working days per one hectare. The study presented here was part of a project that delt with improving the techniques of growing Hippeastrum. Two aspects of this project are published (*1, 2*) and the overall goal of the study presented here was to test methods for a fast and reliable technique for the propagation of Hippeastrum bulb.

MATERIALS AND METHODS

Hippeastrum mother bulbs (*Hippeastrum hybridum*, Var. Red Lion) of similar size (circumference of 22 cm) were cut for propagation using seven methods (Table 1). Each method was repeated five times. The dividing of the bulbs into sections was done in such a way, that each section contained a portion of the mother bulb's basal plate.

Table 1. Description of the seven cutting methods used in the propagation experiment and the number of section for each procedure.

Treatment	Description of procedure	Number of Section
1	Cut into halves	2 sections
2	Cut into quarters	4 sections
3	Cut into eights	8 sections
4	Cut into twelfths	12 sections
5	Cut into sixteenths	16 sections
6	Cut into eights and seperation	32 twin scales
7	Cut into twelfths and seperation	48 twin scales

Each cut from the different propagation methods was placed in a plastic bag filled with vermiculite for maintaining humidity. The bags were placed in an incubator at a temperature of 23℃ for the period of four months, from December until March.

At the beginning of April, the developed bulblets from the various propagation methods were planted in a field in the northern Israeli Negev for the duration of one growing year, which ended in the next April. At the end of the year, the propagation material was removed and examined for the following properties: Bulb diameter as described in Ephrath et al. (*1, 2*), weight and the number of daughter bulbs developed from each repetition of each procedure were measured. An evaluation of the economic profitability of the various cutting procedures was made.

RESULTS

Increasing number of section into which the bulb was cut into, resulted in a larger number of bulblets (Fig. 1). The proportion of the number of bulblets developed to the number of sections into which the bulb was divided was defined as a propagation coefficient (Eq. 1).

$$PC = \frac{NBD}{NS} \quad [1]$$

Where *PC* is the propagation coefficient, *NBD* is the number of bulbs developed and *NS* is the number of section the bulb was cut into. This coefficient was larger than one unit in cases where the bulbs were cut into un-separated sections, smaller than one in cases where the bulbs were cut into sections,

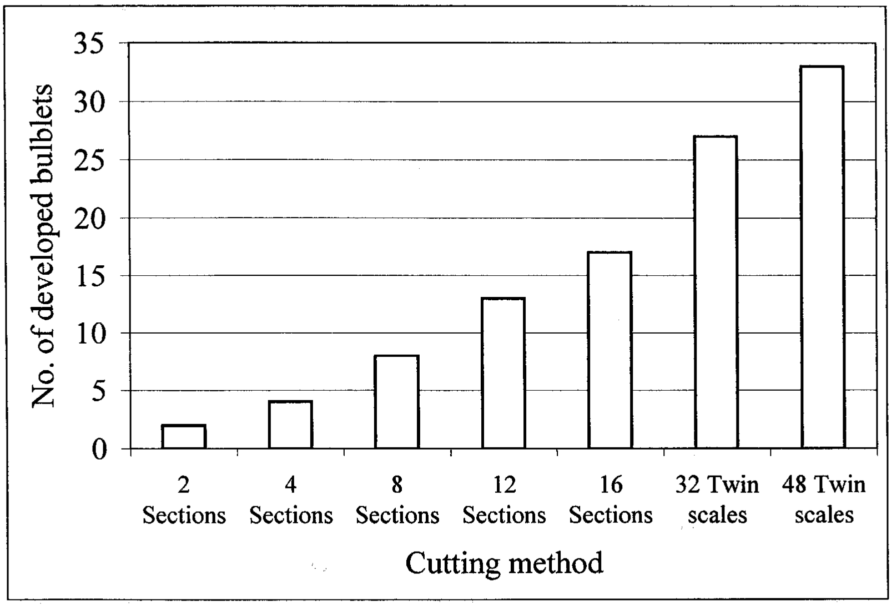

Fig. 1. Average number of bulblets derived from one mother bulb in seven cutting methods.

separated into twin scales. When the bulbs were cut into un-separated sections, each section produced at least one bulblet (Fig. 2).

The largest bulb circumference was achieved when bulbs were cut into two un-separate sections (Fig. 3). Up to eight sections the bulb circumference almost did not changed. Increasing the number of sections to 12, reduced the

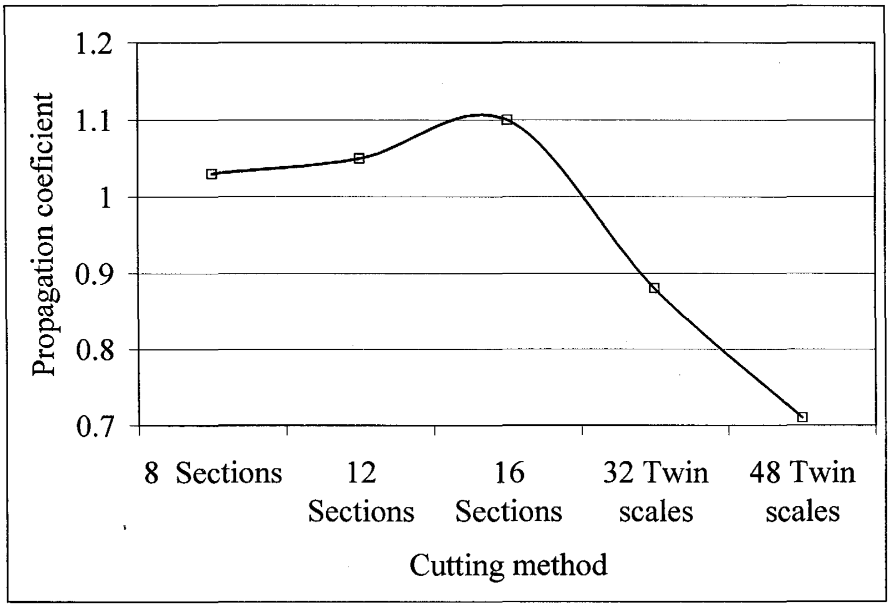

Fig. 2. The effect of the various cutting methods on the propagation coefficient (the proportion of the number of bulblets developed to the number of sections into which the bulb was divided. See text for details).

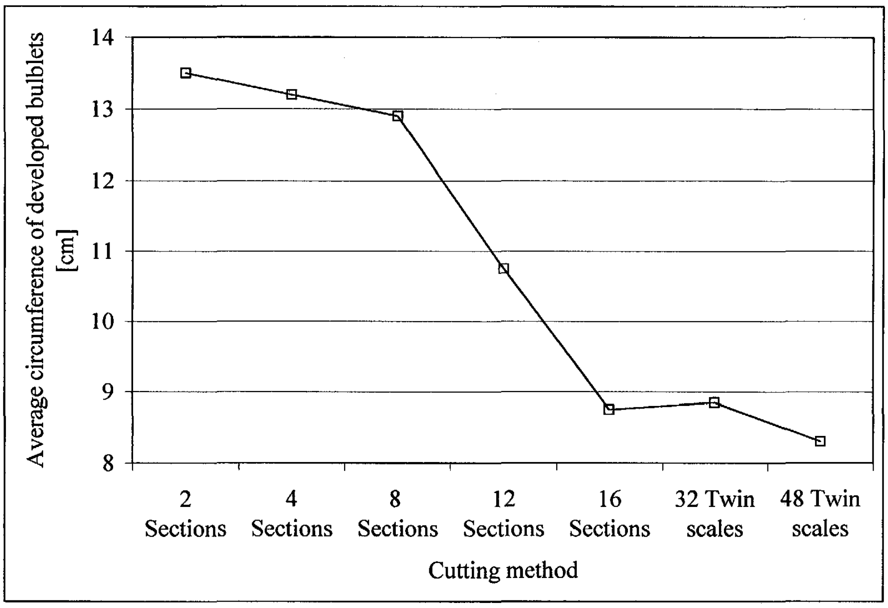

Fig. 3. The effect of the various cutting methods on the bulblets circumference.

circumference dramatically and when the bulb was divided into 16 sections, the average circumference of the resulting bulblets approached eight cm. This value did not change even when the bulbs were cut to 48 sections (Fig. 3).

The average weight of the bulblets resulting from the various cutting methods decreased as the number of the section into which the bulbs were divided, increased (Fig. 4). There was, therefore, an increase relation between the number of sections and the average weight of a bulblet after one year growth.

No distinct relation between the number of sections and the total weight of all bulblets developed from one mother bulb was found (Table 2). The total weight of all the bulblets derived from one bulb, doubled after one growing year (data are not shown).

The distribution in size by circumference of bulb developed from the different cutting methods is presented in Fig. 5. As the number of sections that the mother bulb was divided to decreased, the percentage of the developing bulblets with a large circumference increased. In treatment 3 (bulbs were cut

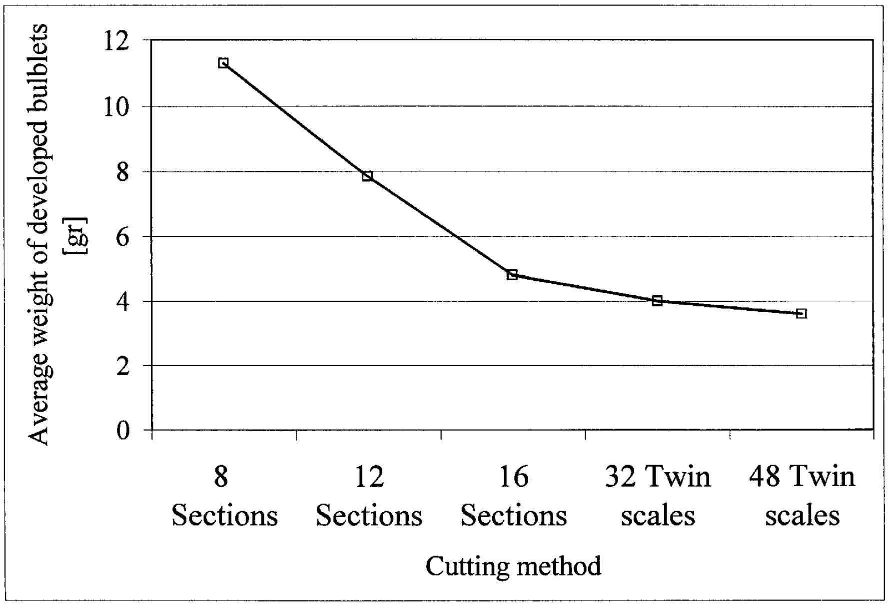

Fig. 4. The effect of the various cutting methods on the bulblets weight.

Table 2. Total weight of bulblets derived from one mother bulb at the end of the first growing year. Values are means ± SE (n=5).

Treatment	Cutting method	Weight
3	8 sections	458.4±56.9
4	12 sections	487.0±76.4
5	16 sections	431.4±44.3
6	32 twin scales	517.8±61.3
7	48 twin scales	459.8±62.4

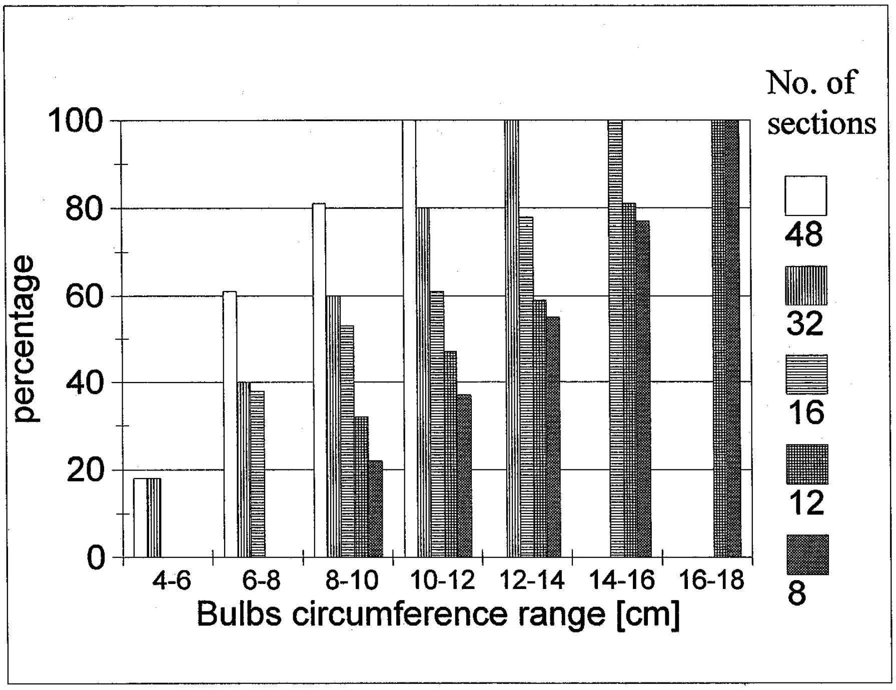

Fig. 5. The distribution of bulb size developed from various cuts methods of mother bulbs, by circumference.

into 8 sections, Table 1) 39% of the bulbs had a circumference of 8–12 cm, and the rest with had been developed up to 18 cm. In treatment 4 (bulbs were cut into 12 sections, Table 1), 58% of the bulbs produced, had a circumference of 8 –12 cm. The rest of the bulbs had been developed to the size of up to 18 cm. In treatment 5 (16 sections cutting, Table 1), most of the bulbs (67%) had a circumference of 6–10 cm with no bulbs with a circumference of less then 6 cm. In treatment 6 (bulb was cut to eight sections which were separated into twin scales, Table 1), 59% of the bulbs had a circumference of up to 10 cm. and the rest had a circumference ranging between 10 and 14 cm. In treatment 7 (cutting of the bulb to 12 sections and their separation into twin scales, Table 1) 81% of the bulbs had a circumference of 10 cm. or less. The circumference of the vast majority ranged between six and eight cm. 19% of the bulbs had a circumference of above 12 cm. There were no bulbs with circumference larger than 12 cm.

The data shown in Fig. 5 were used to estimate the number of mother bulbs that would have to be divided by each cutting method in order to obtain a cultivated area of 0.1 ha of Hippeastrum.

By measuring the size of the bulbs at the end of the experiment (after one year), we were able to estimate the number of bulbs that would be ready for marketing each year (Table 3).

We based our estimations on two assumptions: (1) 150,000 un-separated sections or twin scales would be planted in one ha and (2) bulbs with circumference size between 12 and 14 cm will be at the marketing size (above

Table 3. Forecast (for one ha) of planting and marketing of bulbs at the various cutting methods (see also Fig. 5. and calculations in text).

Year of planting	1	2	3	4	
	No. of bulbs per one ha				
Cutting method	Number of bulbs to be prepared (*NBP*, Eq 2)	Number of bulbs for marketing after 2 years (NBE_2, Eq 3)	Number of bulbs for marketing after 3 years (NBE_3, Eq 4)	Number of bulbs for marketing after 3 years (NBE_3, Eq 5)	Total
8 sections	18,750	96,000	61,500	0	157,500
12 sections	12,500	63,000	87,000	0	150,000
16 sections	9,370	35,790	119,000	0	155,540
32 twin scales	4,580	19,100	92,190	22,780	134,000
48 twin scales	3,120	0	92,480	17,610	110,080

circumference of 20 cm.) at the end of the second growing year (Table 3). The calculation in Table 3 were done by the following equations:
The number of bulbs to be prepared (*NBP*) is calculated in Eq. 2:

$$NBP=\frac{NB}{NS} \qquad [2]$$

Where NB is the number of bulbs per one ha and NS is the number of section per bulb.
The calculation of the number of bulbs for export after two years (NBE_2) (Eq 3):

$$NBE_2=(NB)\times(PCE_{12\text{–}14}) \qquad [3]$$

Where $PCE_{12\text{–}14}$ is the % of the bulbs with circumference of 12–14 cm.
The calculation of the number of bulbs for export after three years (NBE_3) (Eq 4):

$$NBE_3=(NB)\times(PCE_{6\text{–}12}) \qquad [4]$$

Where $PCE_{6\text{–}12}$ is the % of the bulbs with circumference of 6–12 cm.
The calculation of the number of bulbs for export after three years (NBE_3) (Eq 5):

$$NBE_3=(\mathrm{NB})\times(\mathrm{PCE}_{2\text{–}6}) \qquad [5]$$

Where $PCE_{2\text{–}6}$ is the % of the bulbs with circumference of 2–6 cm.
The percentages of the bulb in each treatment (*PCE*) were taken from the data presented in Fig. 5.

In drawing our conclusions of the most efficient cutting method, we prepared an economic evaluation to show which of the procedures yields the maximal profit to the grower. A separate estimation (not shown) was made of the various expenses incurred by each procedure. For example, when un-separated sections are planted some of the new bulbs are ready for marketing at the end of the second year. Twin scales, on the other hand, do not yield bulbs for export before the end of the third year. This means that, although the un-separated sections yield income earlier than twin scales do, un-separated sections also incur more costs since they must be harvested, sorted replanted at the end of the second year at the end of the third year.

DISCUSSION

Luyten (*7*) was the first to develop an artificial method for propagation of the Hippeastrum. Later his method was improved (*3, 9*) and for the last decade the twin scaling is the standard method for propagation (*11*). Huang et al. (*5, 6*) described why two scales are essential for the propagation of the Hippeastrum.

In our experiment we tried the standard twin scaling method with other methods (Table 1) in order to define the procedure that will decrease the manual labor and shorten the growing period. The average number of bulblets yielded from each mother bulb increases as the number of sections into which it was cut increases (Fig. 1), however, these bulblets were smaller than those that resulted where the mother bulb was divided into fewer sections (Figs. 3 and 4). An increase in the number of sections resulted in a smaller quantity of available nutrients in the twin scaled and sections, and the time period required for the bulb to become ready for marketing is lengthened.

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 circumference of the resulting bulblets. Since the factor for marketing bulbs is a bulb with a circumference of at least 24 cm, this means that by proper cutting methods it is possible to shorten the growing period from three into two years.

As the number of sections into which the bulb was divided increases, there is less probability of obtaining a new bulblet from each of those sections. This is shown from the calculation of the propagation coefficient (Fig. 2). Propagation coefficient of less then one unit was found when the twin scaling method was used, while it was more than one when the mother bulb was cut into un-separated sections.

In the past, small-scale cultivation of Hippeastrum, 0.5 ha or less, was done by planting the bulbs in a non-final stand for one year. At the end of the year, in the winter, the bulblets were removed from the ground, disinfected and replanted in their final stand (*10*). Nowadays, The change to large-scale cultivation (10 ha or more) necessitates a change in the agrotechnique methods: the bulb must be planted to final stand to avoid extensive manual labor. The economic evaluation (Figs. 5 and 6) indicates higher profits when the bulbs are divided into un-separated sections. That procedure which anticipates the greatest profits is the division into eight un-separated sections.

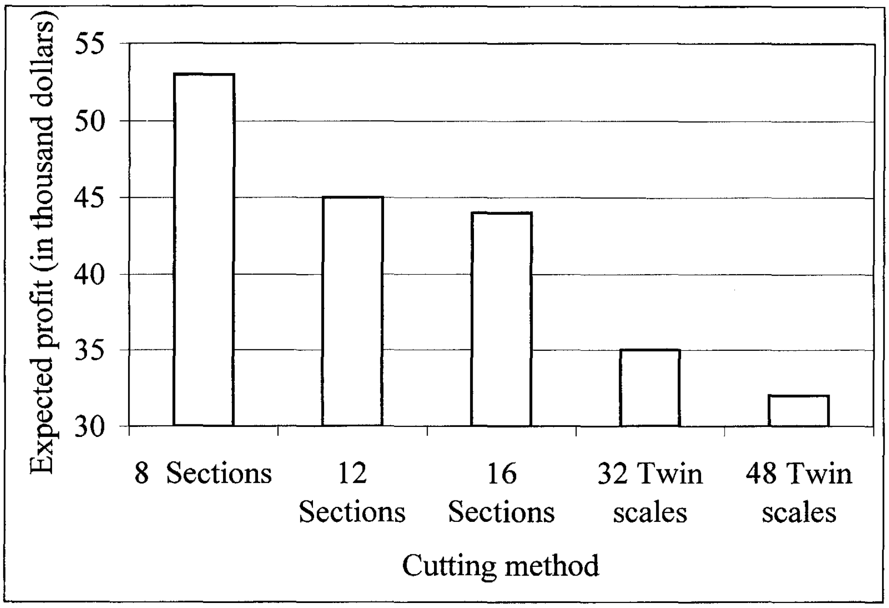

Fig. 6. Expected profit (in US $) for each of the cutting methods.

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