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孤挺花田間與溫室內種球生產的比較

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摘　要

本實驗比較孤挺花在田間以及溫室內不同環境條件下的生長。孤挺花 4 品種的母球切割成瓣狀鱗片後，誘導形成小球。母球切割後 6.5 個月可得到周徑 6-10cm 的小球。4 品種的小球分成兩組，一組小球種植於田間、另一組小球種植於溫室內。種植 10 個月後，比較生長在田間與溫室內植株的葉片、鱗莖以及花的生長表現。在葉片數、鱗莖的乾物重以及開花表現方面，田間與溫室內兩者之間無顯著差異。然而，在田間生長的鱗莖周徑較大、且鱗莖上的小球數也較多。由本實驗可知，在戶外田間環境條件下的孤挺花鱗莖生長速度優於溫室內，從母球的切割開始，在 18 個月的期間可得到周徑 26-37cm 的鱗莖。

關鍵詞：孤挺花、球根生產、田間、溫室

A Comparison of Bulb Production of Amaryllis (*Hippeastrum Hybridum* Hort.) Grown in Field and Greenhouse

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Abstract

A study was conducted to compare the bulb growth rate of amaryllis (*Hippeastrum hybridum* hort.) grown in field and greenhouse. The mother bulbs of four cultivars were sliced into chips for bulblet formation and the bulblets were grown for 6.5 months until they were 6 - 10 cm in circumference. Then bulblets of these four cultivars were divided into two groups. One group was planted in open field and the other group was planted in a greenhouse. After ten months, the bulbs grown in the two environments were compared in terms of the growth of leaves and bulbs, and the flowering of bulbs. There were no differences

between the bulbs grown in the two environments in their leaves numbers, percentage of dry matter of bulbs, and flowering. However, the bulbs grown in open field had a larger bulb circumference, more number of bigger daughter bulbs than those grown in greenhouse. This study showed that bulbs grown in open field grow faster than those in greenhouse, and could reach a circumference of 26 - 37 cm in 18 months from the mother bulb cut.

Key words：Amaryllis, bulb production, open field, greenhouse.

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INTRODUCTION

The long growing period before a marketable flowering bulb is one of main problems for bulb production in amaryllis (*Hippeastrum hybridum* hort.) (phrath *et al.*, 2001). Improving the propagation method is one way to shorten time of bulb production. The commercial propagation of amaryllis is twin scaling, but the small bulblets developed from twin-scales into produce mature bulbs require about three years（Okubo, 1993）. By using the chipping and notching propagation, there were an increase in the size of bulblets and a shorter time to produce a marketable bulb（Ephrath *et al*., 2001; Sandler-Ziv *et al.*, 1997; Zhu, 2003）.

However, after bulblets formation, they should be planted for a bulb to mature. In this process, the cultural conditions influence the cropping period. There are four principal bulb production areas: the Netherlands, Israel, South Africa and Swaziland. Amaryllis is grown only in soil- heated greenhouses in the Netherlands, while it is grown in open fields in Israel, South Africa and Swaziland (Okubo, 1993). There was a decrease of bulb weight under light deficient conditions in winter greenhouse conditions in the Netherlands (Doorduin, 1990). However, in the outdoor growing of Israel, low winter temperatures imposed complete cessation of leaf and bulb development (Sandler-Ziv *et al*., 1997). Lower light and cool temperatures extend amaryllis bulb production period. The origins of amaryllis were in Central and South America (Traub, 1958). Bulb development is continuous under the appropriate temperature and light intensity (Rees, 1985). The base temperature for growth and development for amaryllis is around 8 (Hayashi and Suzuki, 1970).Weather of lowland of Taiwan is a subtropical with minimum temperature above 10 in the winter. The warm climate of Taiwan could be suitable for year-round growth of amaryllis bulbs, but experimental data regarding the influence of temperature and light conditions on bulb growth is limited. The objective of this study, therefore, was to compare the bulb production in open field and in greenhouse in Taiwan.

MATERIALS AND METHODS

The study was conducted on the experimental farm of National Ilan University in Ilan, Taiwan. Bulbs of amaryllis cvs. Double Record, Minerva, Lady Jane and Red Lion were obtained from the nursery company of the Netherlands in April 2001. At 25 April 2001, bulbs of 30 / 32 cm circumference were dipped in bleach with 0.5% active chlorine for 30 minutes for surface sterilization and then cut vertically into 12 equal segments. Ten bulbs were used for each cultivar.

On 26 April 2001, the bulb segments were planted at bed filled with a mixture of 3 soils, 2 sands and 1

peat moss (by volume) in greenhouse, at a density of 12 segments/m^2. After growing for seven months, the developing bulblets were lifted on 10 November 2001. They were counted and graded according to size.

On 10 December 2001, 50 propagated bulblets with a circumference of 6 - 8 cm were taken from each cultivar and were replanted in bed in greenhouse or open field, at a density of 9 bulblets / m^2. The mixture of 3 soils and 1 sand (by volume) was used both in greenhouse and in open field. As basal fertilizers, 11.1 kg of NH_4, 24.8 kg of P_2O_5 and 21.6 kg of K_2O per 1000m^2 were applied to the medium before planting. Plants were watered when the topsoil was dry.

In greenhouse, there was a natural air temperature condition and the highest air temperature was up to 30 at summer. The light intensity in the greenhouse was about 60% lower than those in the greenhouse during the experiment.

After ten months, all bulbs growth in greenhouse and open field were lifted on 27 October 2002. These bulbs were assessed for leaf and bulb growth. The longest leaves of plants were sampled to measured leaf length and width. In addition, 10 bulbs of each cultivar grown in greenhouse and open field were sampled for determining percentage of dry matter. The fresh and dry weights of bulb without roots were taken.

Ten bulbs with a circumference from 26 - 32 cm of four cultivars grown in greenhouse and open field were treated as follows: drying 2 weeks at 25 , 9 weeks at 10 , and 1 week at 15 . On 8 January 2003, these bulbs were replanted in 21-cm diameter pots filled with 8 soils and 2 peats (by volume). They were grown in greenhouse maintained at a minimum temperature of 20 . At harvest, the number of bulbs with flower, days to flowering, the number of inflorescence stalk per bulb and the number of florets of the first inflorescence were determined.

RESULTS AND DISCUSSION

1. Bulblet propagation

There were no differences between bultlet circumferences among four cultivars after chipping for 6.5 months (Fig.1). The bulblets of ‘Double Record’, ‘Lady Jane’, ‘Minerva’ and ‘Red Lion’ were 6.8 cm, 6.5 cm, 6.6 cm and 7.4 cm circumference, respectively.

2. Leaf and Bulb growth

The records of air temperatures and the global solar radiations during the experiment are presented in Fig. 2. There was a strong correlation ship between air temperatures and global solar radiation, the higher the global solar radiation, the higher the temperatures. The average minimum and maximum air temperature were 11.2℃ and 24.4℃ in the winter, 22.7℃ and 32.8℃ in the summer, respectively.

After ten months, the bublets were grown in greenhouse bed and open field, the leaves of ‘Red Lion’ bulbs grown in open field were longer than those grown in greenhouse (Table 1). The leaf shapes were different depending on the greenhouse or open field of planting. All of the four cultivars grown in open field, the bulbs had broader leaves and higher ratio of length/width than those in greenhouse. There were significant difference of light intensity between in greenhouse and open field. In greenhouse plant grown, clearly, the slender leaves are due to the weak light.

The fresh weights of leaves were similar regardless of planting site except of ‘Minerva’ (Table 2). All of four cultivars, greater fresh weights of underground parts were measured in open field planted bulbs. Further, the percentages of underground part were larger in open field growing bulbs.

The temperatures markedly influenced the growth and development of leaves (Hayashi and Suzuki, 1970；

Ijiro and Ogata, 1997). But there were little difference in the numbers, length and fresh weight of the leaves in our experiment (Table 1, 2). The light intensity in greenhouse was about 60 % lower than those in open field. The result indicated that the different light intensity had little qualitative effect on those growths of the leaves.

The bulb growth is presented in Table 3, 4. The mother bulbs' circumference sizes were different between the two planting places (Table 3). The bulbs grown in open field had larger sizes in 'Double Record' and 'Lady Jane', and particularly for 'Red Lion' showing an 18cm wider than those grown in greenhouse. However there was no difference in mother bulb size in 'Minerva' between greenhouse and open field.

The number of daughter bulbs per mother bulb was different between greenhouse and open field (Table3). In open field grown, there were 5.8, 1.8, 4.3 and 3.9 daughter bulbs in 'Double Record', 'Minerva', 'Lady Jane' and 'Red Lion', respectively. For greenhouse growing, there was no daughter bulbs in 'Red Lion' and 'Lady Jane', only 0.6 daughter bulbs per mother bulb in 'Double Record' and 1.5 daughter bulbs formatted in 'Minerva'. The average daughter bulb sizes were between 10 - 12 cm in circumference in the four cultivars grown in open field. But in 'Double Record' grown in greenhouse, the daughter bulbs circumference was only 6.8 cm. In 'Minerva', the daughter bulb sizes were similar between greenhouse and open field.

The results revealed that higher light intensity resulted in more bulb growth. In winter, there is little increase of the fresh bulb weight under optimum temperature conditions in the Netherlands (Doorduin, 1990). In potato tuber growth, the photosynthetic rate was higher and thus resulted in more tuber production under high light intensity (Bodlaender, 1963).

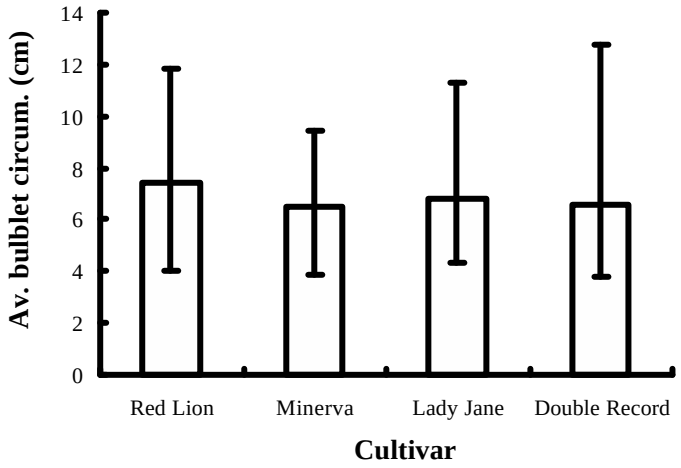

Fig. 1. Bulblet circumference of four amaryllis cultivars after chipping for 6.5 months. Bars indicate means ± s.e.(n=80)

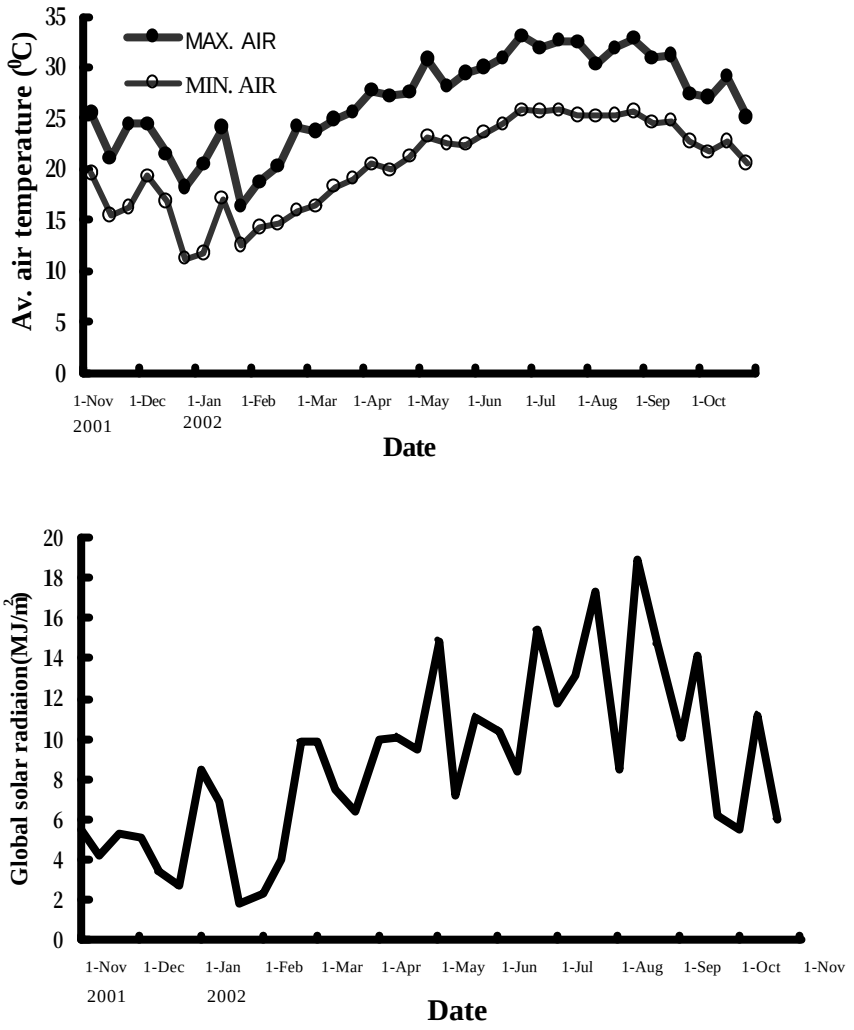

Fig. 2. Average maximum and minimum daily air temperatures and global solar radiation per 10 days during the experiment.

Table 1. Leaf growth of bulbs of four Amaryllis cultivars grown in field and greenhouse conditions for ten months.

Cultivar	Planting place	No. of leaves	Length of leaf (cm)	Width of leaf (cm)	Ratio of length and width
Double Record	Open field	12.0a[z]	85.7a	5.5a	15.7
	Greenhouse	10.3a	87.9a	4.4b	20.1
Lady Jane	Open field	12.0a	88.2a	5.8a	15.1
	Greenhouse	12.0a	89.8a	5.4a	16.6
Minerva	Open field	10.7a	77.5a	6.2a	12.4
	Greenhouse	11.2a	90.0a	5.3a	17.0
Red Lion	Open field	12.2a	102.5a	6.1a	16.7
	Greenhouse	10.0a	80.9b	4.2b	19.4

[z] Values in the same column and cultivar with same letter are no significantly difference according to 5 % Duncan's multiple test.

Table 2. Fresh weight of plants of four Amaryllis cultivars grown in field and greenhouse conditions for ten months.

Cultivar	Planting place	Fresh weight (g)			Percentage of underground part
		Plant total	Leaf	Underground part	
Double Record	Open field	1064a[z]	518a	546a	51.3
	Greenhouse	753b	496a	257b	34.1
Lady Jane	Open field	1115a	578a	537a	48.2
	Greenhouse	778b	501a	277b	35.6
Minerva	Open field	968a	451b	517a	53.4
	Greenhouse	883a	531a	352b	39.9
Red Lion	Open field	1184a	581a	597a	50.4
	Greenhouse	768b	519a	249b	32.4

[z] Values in the same column and cultivar with same letter are no significantly difference according to 5 %Duncan's multiple test.

Table 3. Growth of bulb of four Amaryllis cultivars grown in field and greenhouse conditions for ten months.

Cultivar	Planting place	Mother bulb	Daughter bulb	
		Size (cm)	Number per mother bulb	size (cm)
Double Record	Open field	34.0a[z]	5.8 a	11.6a
	Greenhouse	20.8b	0.6b	6.8b
Lady Jane	Open field	34.1a	4.3a	10.3a
	Greenhouse	23.7b	0b	0b
Minerva	Open field	26.3a	1.8a	10.3a
	Greenhouse	22.9a	1.5a	10.8a
Red Lion	Open field	37.0 a	3.9a	10.0a
	Greenhouse	18.5b	0b	0b

[z] Values in the same column and cultivar with same letter are no significantly difference according to 5% Duncan's multiple test.

Reduced fresh weight was measured in greenhouse grown bulbs in 'Lady Jane' (Table 4). The dry weight of bulbs was no different between the two planting places in the four cultivars. However, there were 12.7 % - 16.3 % dry matters of bulbs grown in open field, and 11.5 % - 15.5 % grown in greenhouse.

Even though bigger bulbs were harvested from open field, the percentages of dry matter of the bulbs were similar at the two planting places when they have similar sizes.

It had the smallest mother bulbs in 'Minerva', the bulb size at the harvest was nearly 5cm smaller in circumference than other cultivars. But the mother bulb size, number and size of daughter bulbs were similar in plants even that grown in open field or greenhouse in 'Minerva', and the growth rate of the bulbs did not decrease significantly even under low light conditions (Table 3). This suggests phenotypic differences of bulb growth in response to light intensity.

Table 4. Fresh and dry weights of bulbs of four Amaryllis cultivars grown in field and greenhouse conditions for ten months.

Cultivar	Planting place	Bulb size[z] (cm)	Fresh wt. (g)	Dry wt. (g)	Percentage of dry matter
Double Record	Open field	28.6a[y]	389a	52.1a	13.2
	Greenhouse	26.8a	323a	37.5a	11.5
Lady Jane	Open field	28.5a	354a	47.8a	13.5
	Greenhouse	24.5b	267b	34.6a	12.9
Minerva	Open field	23.8a	264a	34.5a	12.7
	Greenhouse	22.7a	235a	29.7a	12.4
Red Lion	Open field	29.8 a	393a	64.4a	16.3
	Greenhouse	27.2a	342a	52.9a	15.5

[z]The average of 10 bulbs selected randomly.

[y] Values in the same column and cultivar with same letter are no significantly difference according to 5 %Duncan's multiple test.

3. Flowering

There were no differences in flowering of bulbs which came from greenhouse or open field growing in each cultivar (Table 5). There were 80 % - 100 % flowering rates in all of bulbs. The days to flowering varied from 49.5 to 62.1 days. The first inflorescence height was different in the four cultivars, the longest in 'Red Lion' and the shortest in 'Double Record'. Most inflorescence per bulb was in 'Red Lion' and least in 'Minerva'. The average number of florets in the first inflorescence was larger in 'Red Lion' and 'Minerva', smaller in 'Lady Jane' and 'Double Record'.

The bulbs from open field or greenhouse growing, when they had the same flowering conditions, they had similar flowering behavior. These seem to mean the influence of light intensity on flower bud formation of the bulbs were fewer. The temperature is the most important factor for the flower buds initiation and growth; the bud initiation is not influenced directly by the light intensity (Doorduin, 1990).

There is a good correlation between the growth of the leaves and the initiation of the flower buds, and flower bud initiation occurs alternatively with the formation of each four leaves (Rees, 1972). The results in this study showed that both the numbers of the leaves and the flowering behavior of the bulbs had no difference no matter the bulblets grown in greenhouse or open field (Table 1, 2, 5). The temperature affects on the leaf growth and the flower bud initiation (Hayashi and Suzuki, 1970; Ijiro and Ogata, 1997). In the present study, the temperature conditions were under the natural climate and were no largely changes between open field and in greenhouse, so it leads to litter different of the leaf numbers and the flower bud formation.

When the bulbs growing at a higher temperature (30 / 24℃), the flower bud initiation and flowering were inhibited (Ijiro and Ogata, 1997). In our experiment, there were approximately 10% - 20% bulbs did not flower (Table 5). The further study is required to make clear whether that due to the high temperature of the summer season or not.

Green leaves became yellow color grown in open field during from July to August period, probably due to the excessive conditions of light of the summer season. So the shade culture is considered to be necessary for an outdoor culture at summer. The detail data of the appropriate climatic condition for the bulb

production is needed to establish.

Taiwan's natural climatic conditions were suitable for amaryllis bulb production. The bulbs grew faster in open field. For initial bulblet propagation by using the chipping method, it is possible to produce enough big bulbs for flowering within 18 months under the natural climate conditions. The bulb production period of amaryllis in Taiwan is shorter than that of in the Netherlands and in Israel by more than six months.

Table 5. Flowering of Amaryllis bulbs in greenhouse came from open field or greenhouse growing for ten months.

Cultivar	Planting place	Bulb size (cm)	Flowering Rate %	Days to flowering	Av. no. of inflore-scences per bulb	1st Inflore-scence height(cm)	Av. No. of florets in 1st inflorescence
Double Record	Open field	30/32	90	57a[z]	1.9a	14.1a	2.9a
	Greenhouse	30/32	85	58.1a	1.6a	13.7a	3a
Lady Jane	Open field	30/32	85	58.1a	1.6a	21.2a	2.3a
	Greenhouse	30/32	80	57.5a	1.7a	22.9a	1.8a
Minerva	Open field	24/26	100	49.5a	1.2a	28.6a	4.1a
	Greenhouse	24/26	100	51.7a	1.4a	27.1a	4a
Red Lion	Open field	30/32	90	60.9a	2a	34.5a	4.3a
	Greenhouse	30/32	85	62.1a	2a	35.2a	3.4a

[z]Values in the same column and cultivar with same letter are no significantly difference according to 5% Duncan's multiple test.

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