Journal of Horticultural Research 2014, vol. 22(1): 29-34
DOI: 10.2478/johr-2014-0003

EFFECT OF PLANTING TERM ON GROWTH AND FLOWERING OF TWO CULTIVARS OF LACHENALIA PRODUCED IN A GREENHOUSE AS POTTING PLANTS DURING WINTER MONTHS

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Received: April 15, 2014; Accepted: June 12, 2014

ABSTRACT

A greenhouse experiment was carried out on lachenalia plants to determine the effect of different bulb planting terms (from October to January) on the growth and flowering of cultivars 'Ronina' and 'Rupert', in the natural light conditions. From every planted bulb emerged stems and flowers, but the time of flowering was dependent on the planting term and genotype. Irrespective of the planting term, plants of 'Rupert' were taller than those of 'Ronina'. The planting term had an influence on the length of the inflorescence in 'Rupert', but did not affect in 'Ronina'. The bulbs of 'Rupert' produced more than twice as many florets as 'Ronina' bulbs. Irrespective of the genotype, the bulbs planted the earliest produced the thinnest stems. The two tested cultivars were long-lasting flowering pot plants – their inflorescences remained decorative for over 20 days.

Key words: cape hyacinth, forcing, plant morphology, flower quality

INTRODUCTION

The genus *Lachenalia* (Hyacinthaceae) represents spectacular and botanically diverse plants originating from southern Africa (Duncan 1988). Since 2001, new cultivars of this bulbous geophyte have been available on the international market with a trade name "Cape Hyacinth" (Kleynhans 2006). The forcing of well-known ornamental bulbs (e.g. *Tulipa*, *Hyacinthus*, *Narcissus*) for fresh-cut flowers and potted plants is a common procedure in commercial horticultural production (De Hertogh & Le Nard 1993). Establishing forcing schedules for other bulbous crops, which have a potential to be exploited commercially, requires systematic investigation. Retarding the natural flowering time of lachenalia (June-August) in order to obtain blooming plants from October to April could open for it market in Europe when demand for flowering potted plants is high. The timing of flowering is a highly photoperiod-dependent process (Jung & Müller 2009). It has been confirmed by Kleynhans (2006) that the local environment is a very important factor affecting the flowering behaviour of lachenalia. In the absence of information relating to the greenhouse cultivation of lachenalia in the natural photoperiod during winters, this study may provide insight in commercial production of lachenalia. In this study, the growth and flowering of two lachenalia cultivars as influenced by planting time is investigated and discussed.

MATERIALS AND METHODS

This study was conducted in 2009–2010 in a greenhouse of the Faculty of Horticulture of the University of Agriculture in Kraków. Two cultivars of lachenalia (*Lachenalia* J. Jacq. ex Murray, African Beauty® series) – 'Ronina' with yellow and 'Rupert' with lilac-purple flowers were investigated. The bulbs (average weight 4.5-5.0 g, circumference 6.0-6.5 cm) were purchased from the company Afriflowers (South Africa). The bulbs were planted at monthly intervals on: 19th October 2009,

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16th November 2009, 14th December 2009 and 11th January 2010. In each combination, 50 bulbs were planted in 5 replications, of 10 bulbs each. Prior to planting, the bulbs were soaked into the solution of 0.5% Kaptan 50 WP (kaptantriadimenol) for 30 min and then planted into 19 cm plastic pots (five bulbs per pot) to a depth equal to twice the height of the bulb. The growing substrate, consisted of peat and sand at the ratio of 3:1 (v/v), was enriched with the fertiliser Osmocote 6M (NPK: 13-9-11), at a dose of 6 $g \cdot l^{-1}$. The bulbs were forced in the greenhouse at 20/10 °C (day/night) temperature regime under natural light conditions. The average day lengths for particular months in Poland are given in Fig. 1.

The following parameters were used for evaluating plant quality: plant height (from the surface of the substrate to the apex of the inflorescence), inflorescence length, the number of florets in the inflorescence, inflorescence stalk diameter, the length of a single floret (the first developed one) and also the number of leaves produced by one bulb and the length and width of the first and second leaf. Moreover, records were kept for the percentage of bulbs that produced the second inflorescence, quality characteristics of the stalk of that inflorescence and the number of days from planting till opening of the first floret in the inflorescence (number of days to flowering). Additionally, the longevity of the inflorescences during the potted phase from the beginning of flowering was evaluated. The phase of wilting of the last flower in the inflorescence was adopted as the end of the flowering period.

All the data were analysed using the STATISTICA package. The results were statistically evaluated using a two-way analysis of variance for the factors: cultivar and planting terms. To determine significant differences, the Duncan test was used at $p \leq 0.05$.

RESULTS

All the bulbs planted in the experiment emerged and flowered. For the two cultivars tested, the same tendency was observed with delaying the term of planting, the time to the onset of flowering became shorter (Fig. 2). It was also found that the plants of lachenalia 'Rupert', irrespective of the term of bulb planting, flowered later compared with these of 'Ronina'. In the whole experiment, the earliest flowering (53 days from planting) was recorded in the 'Ronina' planted in January, and the latest – flowering 113 days after planting, in the 'Rupert' planted in October. With these terms of planting flowering pot plants of 'Ronina' could be produced since the second half of January to early March, while flowering plants of 'Rupert' could be obtained since the first half of February, up to early April.

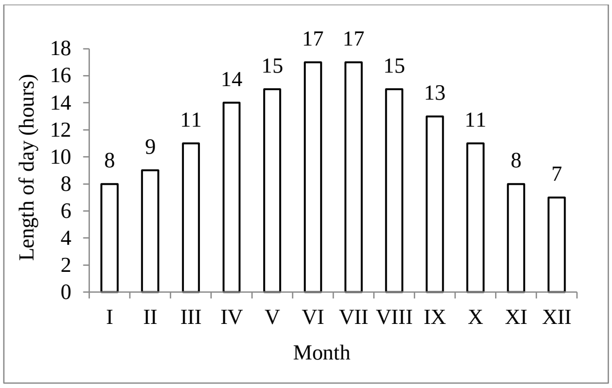

Fig. 1. Average length of day in Poland (Kalda & Smorąg 2012)

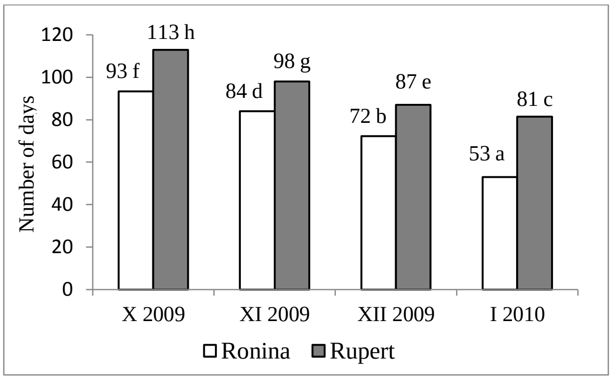

Fig. 2. Effect of planting term of lachenalia bulbs on the number of days to the beginning of flowering

*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
Mean cultivar and term effects: $F = 5173.9$ and $p = 0.00$ for cultivar, $F = 3335.6$ and $p = 0.00$ for term, $F = 153.5$ and $p = 0.00$ for cultivar and term.

The data presented in Table 1 indicates that irrespective of the term of planting bulbs, the plants of lachenalia 'Rupert' were taller than those of 'Ronina'. Depending on the combination, these differences ranged from 2.6 to 7.8 cm. In both genotypes, the plants obtained from the bulbs planted in October and November did not differ significantly in respect of height. Plants from bulbs planted in December and January were significantly shorter. The term of bulbs planting of 'Ronina' did not affect the length of inflorescences, but in 'Rupert' the longest inflorescences were recorded in plants from bulbs planted in January.

Significantly more florets per inflorescence were obtained in 'Ronina' planted in October compared with the subsequent three planting terms. Contrary to the above, florets of 'Ronina' were longest within plants obtained from bulbs planted in January. The number of florets obtained from the bulbs of 'Rupert' was less dependent on the planting term and the length of flowers was the same for all planting terms. Number of 'Rupert' florets was always double in comparison with 'Ronina'. Comparing the two evaluated cultivars, it was noted that irrespective of the term of bulb planting, the inflorescence stems of lachenalia 'Rupert' were thicker than those of 'Ronina'. Bulbs of 'Rupert' produced only one inflorescence. The second inflorescence stem was obtained only from 24% of the bulbs of 'Ronina' planted in October and from 10% of the bulbs of this cultivar planted in November. The quality of these stems were better in combination planted earlier (Table 2). The term of planting did not significantly affect the number of leaves obtained from one bulb (Fig. 3). The plants of 'Ronina' produced more leaves than those of 'Rupert'. With the delay in the term of bulbs planting, shorter leaves were obtained (Table 3). The differences observed in respect of this parameter were as follows: the leaves (first and second) of the 'Ronina' and 'Rupert' from bulbs planted in October were longer than the leaves from the bulbs planted in January. Regardless of the planting term, the bulbs of 'Rupert' produced plants with significantly wider leaves than on the plants of 'Ronina'. The widest leaves of 'Ronina' were obtained from the bulbs planted in October. Similar results were recorded in 'Rupert' plants, but only in relation to the second leaf.

Table. 1. Effect of planting term of lachenalia bulbs on flower yield and inflorescence characteristics

Feature	Term	Cultivar	
		Ronina	Rupert
Bulbs with the second inflorescence (%)	X 2009	24.0 c	0.0 a
	XI 2009	10.0 b	0.0 a
	XII 2009	0.0 a	0.0 a
	I 2010	0.0 a	0.0 a
Plant height (cm)	X 2009	30.0 d	37.8 e
	XI 2009	31.1 d	38.0 e
	XII 2009	26.5 b	29.1 cd
	I 2010	22.5 a	28.0 bc
Inflorescence length (cm)	X 2009	12.7 bc	11.1 a
	XI 2009	12.5 bc	13.3 c
	XII 2009	12.4 b	10.4 a
	I 2010	12.3 b	14.3 d
Number of florets	X 2009	23.1 b	49.0 d
	XI 2009	20.2 a	43.8 c
	XII 2009	20.7 a	48.3 d
	I 2010	19.8 a	44.0 c
Floret length (cm)	X 2009	2.8 a	2.8 a
	XI 2009	2.9 b	2.7 a
	XII 2009	3.0 c	2.7 a
	I 2010	3.1 d	2.7 a
Stem diameter (cm)	X 2009	0.6 a	0.78 c
	XI 2009	0.7 b	0.82 d
	XII 2009	0.75 c	0.9 e
	I 2010	0.7 b	0.9 e

*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.

Mean cultivar and term effects: bulbs with the second inflorescence – $F = 3678.00$ and $p = 0.00$ for cultivar, $F = 1641.8$ and $p = 0.00$ for term, $F = 1641.8$ and $p = 0.00$ for cultivar and term; plant height – $F = 216.77$ and $p = 0.00$ for cultivar, $F = 119.68$ and $p = 0.00$ for term, $F = 9.77$ and $p = 0.00$ for cultivar and term; inflorescence length – $F = 0.62$ and $p = 0.44$ for cultivar, $F = 16.82$ and $p = 0.00$ for term, $F = 19.46$ and $p = 0.00$ for cultivar and term; number of florets – $F = 1912.8$ and $p = 0.00$ for cultivar, $F = 12.39$ and $p = 0.00$ for term, $F = 2.22$ and $p = 0.11$ for cultivar and term; floret length – $F = 181.0$ and $p = 0.00$ for cultivar, $F = 12.8$ and $p = 0.00$ for term, $F = 21.7$ and $p = 0.00$ for cultivar and term; stem diameter – $F = 334.7$ and $p = 0.00$ for cultivar, $F = 15.89$ and $p = 0.00$ for term, $F = 2.35$ and $p = 0.09$ for cultivar and term.

Table 2. Effect of planting term of lachenalia 'Ronina' bulbs on the characteristics of the second inflorescence

Feature	Term	Ronina
Inflorescence stem length (cm)	X 2009	26.5 b
	XI 2009	22.3 a
Inflorescence length (cm)	X 2009	11.0 b
	XI 2009	6.8 a
Number of florets	X 2009	11.9 a
	XI 2009	11.5 a
Floret length (cm)	X 2009	2.8 b
	XI 2009	2.3 a
Stem diameter (cm)	X 2009	0.5 a
	XI 2009	0.5 a

*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
Mean term effects: inflorescence stem length – F = 6.32 and p = 0.02; inflorescence length – F = 16.22 and p = 0.00; number of florets – F = 0.07 and p = 0.79; floret length – F = 11.08 and p = 0.00; stem diameter – F = 3.19 and p = 0.09.

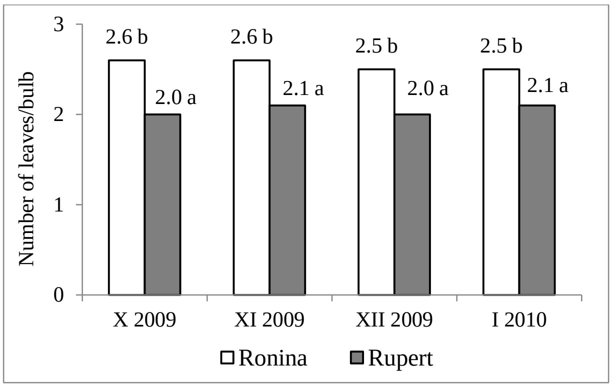

Fig. 3. Effect of planting term of lachenalia bulbs on the number of leaves

*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
Mean cultivar and term effects: F = 140.96 and p = 0.00 for cultivar, F = 0.31 and p = 0.82 for term, F = 0.03 and p = 0.99 for cultivar and term.

The longevity of the inflorescences of potted lachenalia plants depended on the planting term (Fig. 4). Inflorescences of lachenalia 'Ronina' lasted for an average of 23 days, while those of 'Rupert' for a period of 21 days.

Table 3. Effect of planting term of lachenalia bulbs on leaf characteristics

Feature	Term	Cultivar	
		Ronina	Rupert
First leaf length (cm)	X 2009	41.5 d	40.2 d
	XI 2009	38.0 c	34.2 b
	XII 2009	36.6 c	33.8 b
	I 2010	34.6 b	32.3 a
First leaf width (cm)	X 2009	4.1 c	4.6 e
	XI 2009	3.7 a	4.4 d
	XII 2009	3.8 ab	4.7 e
	I 2010	3.9 b	4.5 d
Second leaf length (cm)	X 2009	41.4 d	42.6 d
	XI 2009	38.6 c	35.8 b
	XII 2009	37.9 c	35.0 b
	I 2010	35.6 b	33.6 a
Second leaf width (cm)	X 2009	2.9 b	3.5 d
	XI 2009	2.6 a	3.2 c
	XII 2009	2.6 a	3.3 c
	I 2010	2.7 a	3.3 c

*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
Mean cultivar and term effects: first leaf length – F = 33.09 and p = 0.00 for cultivar, F = 51.77 and p = 0.00 for term, F = 1.39 and p = 0.26 for cultivar and term; first leaf width – F = 334.97 and p = 0.00 for cultivar, F = 15.89 and p = 0.00 for term, F = 2.35 and p = 0.09 for cultivar and term; second leaf length – F = 11.98 and p = 0.00 for cultivar, F = 45.56 and p = 0.00 for term, F = 4.29 and p = 0.01 for cultivar and term; second leaf width – F = 285.4 and p = 0.00 for cultivar, F = 8.83 and p = 0.00 for term, F = 1.89 and p = 0.15 for cultivar and term.

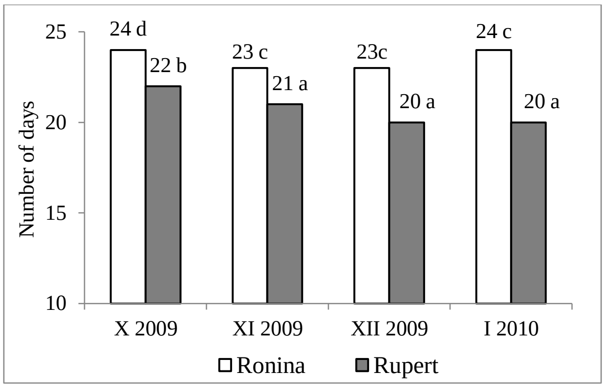

Fig. 4. Effect of planting term of lachenalia bulbs on the longevity of the inflorescence
*Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
Mean cultivar and term effects: F = 244.0 and p = 0.00 for cultivar, F = 19.75 and p = 0.00 for term, F = 1.09 and p = 0.37 for cultivar and term.

DISCUSSION

Lachenalia 'Ronina' plants started to flower after 53-93 days and plants of 'Rupert' after 81-113 days from the time of planting bulbs. Using planting terms evaluated in this work, it is possible to obtain flowering lachenalia pot plants from January to April and this period may be commercially advantageous for growers in places of the similar latitude, as it will respond to the demand for flowers on Valentine's Day and Women's Day. It can be assumed that obtaining flowering plants of lachenalia earlier, e.g. in December, would be possible by using an earlier term of planting than those evaluated in this study, perhaps together with using an extra illumination of plants as day length at the end of the year would not be sufficient to obtain good quality pot plants.

This study showed that, irrespective of the genotype and term of planting, all lachenalia bulbs emerged and all plants flowered. Ruffoni et al. (2013) investigated the forcing methods for lachenalia cultivars in the Mediterranean area on the same terms as in this study, and realised that some bulbs dead during the trial (10-20% of 'Ronina' and 2-4% of 'Rupert'), attributing this issue to the susceptibility of bulbs to rot during the winter months. Another problem in the greenhouse cultivation of lachenalia was noticed by Kapczyńska (2012). In that experiment, flower abortion was observed. Only about 50-70% of 'Ronina' and 'Rupert' bulbs produced inflorescences, the others remained in the vegetative phase. Such low flowering percentage could have been caused by the origin of the bulbs, which were reproduced in Polish conditions. In this study, the bulbs had been reproduced in the natural conditions of South Africa and all of them managed to flower. The flowering of lachenalia genotypes may depend on the prevailing environmental conditions during the growing season and prior to bulb harvest, because inflorescence differentiation in bulbs is initiated at that particular stage (Du Toit et al. 2004; Roh 2005).

Plant height and leaves were shorter if bulbs were planted later. This trend was apparently caused by the shorter forcing period (Roh et al. 1995) and by the lengthening of the day at the beginning of the year (Fig. 1) and, as De Hertogh and Le Nard (1993) reported, by the fact that light is one of the environmental factors which substantially affects bulb growth and development. Roh (2005) emphasises that commercial quality of pot plants of lachenalia should have a compact appearance and short leaves. In this context, delaying the planting time positively affects the compactness of plants *ipso facto*, facilitating the transport of plants, preventing overly long leaves from being damaged, and resulting in achieving plants of more suitable habit for market. On a commercial scale, controlling the height of many ornamental geophyte plants is achieved chemically (Currey & Lopez 2010; Taha 2012; Barnes et al. 2013). The arrangement of lachenalia bulbs during in-soil cultivation may also affect plant habit – an increase in the number of plants per square metre increases plant height (Kapczyńska 2013). The plants height of lachenalia is also dependent on bulb size (Kapczyńska 2014). Leaf length responds to the temperature during bulb storage. To obtain leaves shorter than 20 cm, it was recommended to store the bulbs of lachenalia 'Pearsonii' at 10 °C or 12.5 °C for 30 days, or at 10 °C for 45 days before greenhouse cultivation. By contrast, forcing bulbs without storage or stored at high temperature results in obtaining plants with excessively long leaves (>50 cm), which is considered a disadvantage during the packing and shipping stage (Roh 2005).

Lachenalia 'Rupert' produced more than twice as many florets as 'Ronina' bulbs. In many species of the family *Hyacinthaceae*, this feature is to a large degree genotypically determined (Addai 2011; Thompson et al. 2011). Kapczyńska (2012) showed that lachenalia 'Rupert' reproduced in Polish conditions and cultivated in the greenhouse, produced about 30% fewer florets than the plants from bulbs originated from South Africa, used in this study. Roodbol et al. (2002) found that the number of florets per inflorescence in lachenalia cultivars responded positively to fertilisation during the forcing stage. However this factor was not evaluated in this study. The results concerning flower longevity showed that both cultivars had very high quality of inflorescences – they kept their decorative value even for 3 weeks, which make them very attractive for sellers and consumers.

Acknowledgements
This study was financed by the Polish Ministry of Science and Higher Education, within the project “The use of biotechnological methods in intensifying the production of selected ornamental plants” (no. 3500/KRO/2009).

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