Effect of bulb size on growth, flowering and bulb formation in lachenalia cultivars

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Abstract

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A two-year field experiment was performed with three lachenalia cultivars of the African Beauty® series (Namakwa, Ronina, Rosabeth) to study the effects of bulb size on leaf formation, inflorescence quality and bulb formation. The test bulbs were divided into two size groups based on their circumference: 4.0–5.0 cm and 5.1–6.0 cm. The bulbs were cultivated in the open air in the conditions of southern Poland in 2009 and 2010. Plant height, inflorescence length, stem diameter and the number of florets, which are all very important quality features, increased with increasing bulb size at planting. The study showed that the larger bulbs of the cultivars from the African Beauty® series could produce even 3 leaves, whose width increased as the mother bulb circumference increased. In most cases, flower yield was dependent on bulb size. The cultivars proved to differ in terms of the time of blooming: cvs Namakwa and Ronina flowered earlier than cv. Rosabeth. The larger bulb size had a positive effect on the quality (circumference) of offsets.

Keywords: cape hyacinth; ornamental geophytes; flower quality; bulb development

The ornamental bulbous geophyte *Lachenalia* belongs to the Hyacinthaceae family and is native to South Africa and Namibia (Duncan 1996). The interest in South African indigenous plants has remained constant since the eighteenth century, but there are still flower bulb species with great potential for commercialization on the international cut and potted flowers market (Reinten et al. 2011). For this purpose, the Agricultural Research Council-Roodeplaat in South Africa in 1965 initiated a research and development programme (physiology, breeding, propagation) focused on the introduction of lachenalia and its adaptation to the international market requirements (Kleynhans 2002). The large diversity presented by new cultivars makes the lachenalia a perfect plant for garden, pot and cut flower cultivation. Nevertheless, this genus is still unknown in Europe (Kapczyńska 2009). In view of that, it seems particularly necessary that researchers should provide precise information on lachenalia's cultivation in order to secure commercial partners around the world and thereby increase the value of the South African floriculture industry. In recent years, the first attempts of cultivation of lachenalia were made to create precise cultivation methods of this plant in temperate climate of Europe (Kapczyńska 2013).

There have been no reports on the growth of individual new cultivars of lachenalia in relation to bulb size in temperate climate conditions. It is very important to know the growth and development cycle not only for each species of ornamental bulbs

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but also for all the available cultivars as they may strongly differ in their habit and response to a specific climatic factor (Kleynhans 2006). Therefore, the aim of this study is to investigate the effect of mother bulb size on the flowering, growth and offspring production in three cultivars from the African Beauty® series to pave the way for growing these splendid species in the open air in the central northern regions of Europe.

MATERIAL AND METHODS

The field experiment was conducted in 2009–2010 on the premises of the Faculty of Horticulture of the University of Agriculture in Krakow, Krakow, Poland. Three cultivars of lachenalia (*Lachenalia* J. Jacg. ex. Murray) were investigated – all from the African Beauty® series. In 2009, the bulbs of cvs Namakwa, Ronina and Rosabeth used in the experiment were reproduced in Polish conditions, while in 2010 the bulbs of the same cultivars were purchased from the company Afriflowers (Cullinan, South Africa). Two values of the experimental variable were used – the bulbs were divided into two size groups: bulbs 4.0–5.0 cm in circumference and bulbs 5.1–6.0 cm in circumference. The bulbs were planted at a spacing of 3.0 × 7.0 cm (plant spacing within and between the rows, respectively). In each combination, 120 bulbs were planted in 4 replications, each with 30 bulbs. On April 28 in 2009 and 2010, the bulbs were planted at a depth equal to twice the height of the bulb into lattice containers (60 × 40 × 20 cm). Before planting, the bulbs were treated with 0.5% Kaptan (Arysta LifeScience, Nogueres, Francie) for 30 minutes. For the growing substrate, a mixture of peat and sand was used at a ratio of 3:1, enriched with the fertilizer Osmocote (Scotts Company, Marysville, USA) (6 months), at a dose of 80 g/m². The following mean temperatures were recorded during the experiment:

– 2009, May: 13.2°C; June: 15.6°C; July: 19.3°C; August: 18.3°C
– 2010, May: 12.6°C; June: 17.0°C; July: 20.2°C; August: 18.0°C

In the experiment, measurements were taken of plant height from the surface of the substrate to the apex of the inflorescence, inflorescence length, the number of florets in the inflorescence, the number of inflorescence stalks produced by one bulb, 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 leaf. Additionally, in 2010 the diameter of the inflorescence stalk was measured. Records were kept of the number of days elapsed from the time of planting the bulbs to the beginning of flowering. Bulbs were dug up in October, and after drying them briefly, the crop of bulbs was assessed by sorting them according to their circumference into 4 classes: < 3.0 cm, 3.1–6.0 cm, 6.1–9.0 cm, and 9.1–12.0 cm.

All results were analysed using the Statistica 10.0 (Stat-Soft, Inc., Tulsa, USA) software package. Duncan's multiple range test at a 5% level of significance was used to separate the means for the combinations for both years.

RESULTS AND DISCUSSION

Little attention has been drawn to the role of bulb size in the growth and development of lachenalia. Kleynhans (2006) mentions in general terms that bulbs of lachenalia can be regarded as commercial sized bulbs when they reach more than 6 cm in circumference. However, according to Du Toit et al. (2002), bulbs of lachenalia cv. Ronina 4 cm in circumference have already acquired the capacity to flower. De Hertogh and Le Nard (1993) emphasize that the duration of the juvenile phase, during which plants are unable to flower, depends of the species and may last one (Tritonia, Brodiaea) or even six/seven years (Tulipa, Narcissus). In the case of lachenalia, the rate at which bulblets reach commercial size strongly depends on the cultivar (Kleynhans 2006). In 2009, the size of the starting material had no effect on the number of leaves produced by the bulbs of each cultivar. A comparison of the test genotypes, however, revealed that both in the group of bulbs with a smaller circumference and in the group with a larger one the most leaves were obtained from the bulbs of lachenalia cv. Namakwa (Table 1). In 2010, the larger bulbs of lachenalia cvs Namakwa and Ronina produced significantly more leaves compared to the bulbs with a smaller circumference. The cv. Rosabeth, like the year before, did not respond with respect to that test parameter. In the 2010 season, the most leaves were obtained from the bulbs of lachenalia cv. Namakwa 5.1–6.0 cm in circumference, which was 3.5 leaves per plant. It was noted that the bulbs with a circumference of 5.1–6.0 cm of all the three cultivars, reproduced in South Africa, produced significantly more leaves compared to the bulbs

Table 1. Effect of bulb size on leaf characteristics

Feature	Cultivar	2009 season		2010 season	
		bulb circumference (cm)			
		4.0–5.0	5.1–6.0	4.0–5.0	5.1–6.0
No. of leaves	Namakwa	2.6[cd]	2.9[d]	2.3[ab]	3.5[e]
	Ronina	2.1[ab]	2.4[bc]	2.3[ab]	3.0[d]
	Rosabeth	2.0[a]	2.0[a]	3.1[d]	3.0[d]
Leaf length (cm)	Namakwa	26.2[c]	27.3[c]	21.0[ab]	26.8[c]
	Ronina	23.5[b]	26.4[c]	21.0[ab]	22.5[b]
	Rosabeth	21.8[b]	23.5[b]	19.1[a]	31.5[d]
Leaf width (cm)	Namakwa	2.4[bc]	2.9[d]	2.0[a]	2.7[cd]
	Ronina	2.3[b]	3.8[f]	2.0[a]	2.5[bc]
	Rosabeth	2.1[a]	3.3[e]	2.6[bcd]	3.6[f]

*mean values marked with the same letters do not differ significantly at $P = 0.05$

of the same size, but reproduced in the temperate climate. In 2009, the size of the bulbs at planting significantly affected the length of leaves only in the case of lachenalia cv. Ronina. In 2010, significantly longer leaves, compared to those of the smaller bulbs, were produced by the bulbs of lachenalia cvs Namakwa and Rosabeth with a larger circumference. In terms of the width of the leaves produced, a similar trend was observed in both years of the experiment. The larger bulbs of each test cultivar produced wider leaves than the smaller bulbs. As the size of lachenalia bulbs increased, plant height also increased (Table 2). Similar observations were made by Addai and Scott (2011) in Hyacinthus and Lilium. In the present experiment, longer inflorescences were produced from the larger bulbs (except in cv. Rosabeth in 2009), and the number of florets was dependent on bulb size – in all the cases this parameter increased with the larger bulb size (Table 2). Du Toit et al. (2004) claim that starch

Table 2. Effect of bulb size on inflorescence characteristics

Feature	Cultivar	2009 season		2010 season	
		bulb circumference (cm)			
		4.0–5.0	5.1–6.0	4.0–5.0	5.1–6.0
Plant height (cm)	Namakwa	20.6[c]	23.5[d]	22.7[d]	27.8[e]
	Ronina	17.5[cb]	22.8[d]	17.1[ab]	23.2[d]
	Rosabeth	16.1[a]	18.3[b]	22.4[d]	31.0[f]
Inflorescence length (cm)	Namakwa	9.3[c]	11.7[de]	6.5[b]	10.5[cd]
	Ronina	9.6[c]	12.9[e]	6.3[b]	10.6[cd]
	Rosabeth	5.6[b]	6.7[b]	4.7[a]	9.4[c]
No. of florets	Namakwa	11.8[ab]	17.0[d]	10.5[ab]	20.7[e]
	Ronina	12.6[bc]	19.8[e]	9.7[a]	17.2[d]
	Rosabeth	10.4[a]	14.4[c]	10.3[a]	21.0[e]
Floret length (cm)	Namakwa	2.5[cd]	2.5[cd]	2.3[ab]	2.2[a]
	Ronina	2.4[abc]	3.0[f]	2.3[ab]	2.6[de]
	Rosabeth	2.5[cd]	2.7[e]	2.4[abc]	2.7[e]

*mean values marked with the same letters do not differ significantly at $P = 0.05$

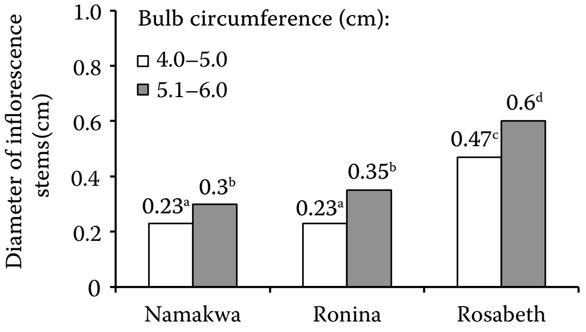

Fig. 1. Diameter of inflorescence stems in 2010
mean values marked with the same letters do not differ significantly at $P = 0.05$

is the major storage carbohydrate in lachenalia cv. Ronina and the concentration of this compound is highly correlated with the total dry weight of a bulb. However, De Hertogh and Le Nard (1993) emphasize that the capacity to flower may be also impacted by the size of the apical meristem. Noy-Porat et al. (2010) claim that the transition from the juvenile phase, when the apical meristem is in the vegetative phase, to the adult stage, when the apical meristem enters the reproductive phase, is the most important process observed during plant development. Moreover, the nature and timing of the transition of the apical meristem is species specific and may take a different course depending on the prevailing environmental conditions (Thompson et al. 2011). In the experiment described here, the larger bulbs produced longer florets, except for those of lachenalia cv. Namakwa (Table 2). For the other genotypes, we find that with the larger bulbs we get inflorescences with larger florets. Moreover, the diameter of inflorescence stems was proportional to bulb size (Fig. 1). For each cultivar, the diameter of the inflorescence stem became larger with an increase in the circumference of the mother bulb. Similar results in relation to stem quality were reported by Addai and Scott (2011) for *Hyacinthus orientalis*. In general, it can be stated that the quality of lachenalia inflorescence improves with increased bulb size. In 2009, the size of mother bulbs had a significant effect on flower yield only in the case of lachenalia cv. Namakwa – in the case of the smaller bulbs, for every ten plants only seven had flowered (Fig. 2). The following year, that tendency was no longer observed in that genotype. However, differences were observed in the yield of flowers obtained from plants of lachenalia cv. Rosabeth – for each ten bulbs with a circumference of 4.0–5.0 only six had flowered.

It was noted that the quality of the harvested material increased with a larger size of the mother bulb (Table 3); and so, for example, in the total yield of each of the tested cultivars obtained from the smaller bulbs there were no daughter bulbs with the largest circumference (9.1–12.0 cm), and in the total yield of these plants there were also significantly fewer bulbs with a circumference of 6.1–9.0 cm. It should be noted that the share of bulbs of a given circumference in the total yield differed between the cultivars and also varies depending on where the reproduction of the mother bulbs took place. The number of bulbs per one plant in the case of lachenalia cvs Namakwa and Rosabeth increased with a larger circumference of the mother bulbs (Fig. 3). This trend was also reported by Han et al. (1991) for Brodiaea plants – the authors presume that it may have been be a result of a high number of axillary buds produced by the larger mother corms. Analysing the whole experiment, it is evident that lachenalia cultivars have a rather low natural multiplication capacity, which is consistent with Duncan's (Duncan 1988) report. Kleynhans (2006) also mentions that offsets are an inefficient method of propagation and should be rather substituted with

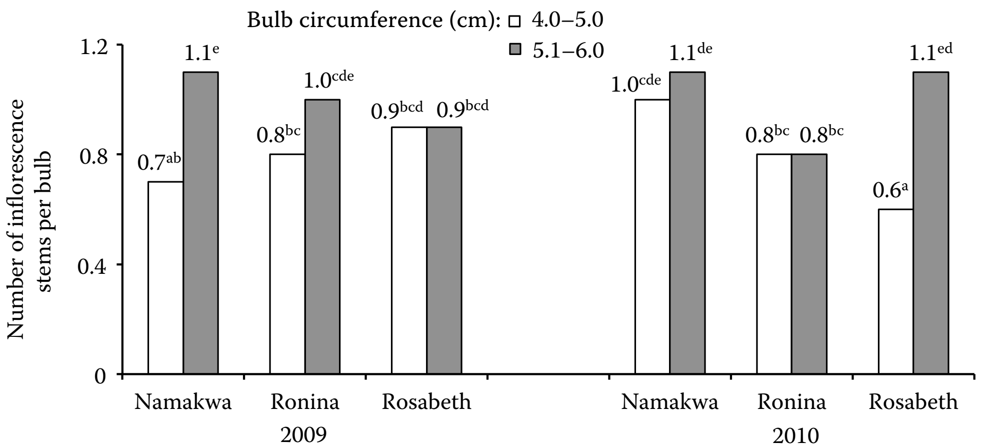

Fig. 2. Number of inflorescence stems per bulb
mean values marked with the same letters do not differ significantly at $P = 0.05$

Table 3. Share of bulbs of a given circumference in total yield (%)

Bulb circumference (cm)	Cultivar	2009 season		2010 season	
		mother bulb circumference (cm)			
		4.0–5.0	5.1–6.0	4.0–5.0	5.1–6.0
< 3.0	Namakwa	0.0[a]	8.2[bc]	10.4[c]	14.8[d]
	Ronina	0.0[a]	0.0[a]	8.0[bc]	6.2[b]
	Rosabeth	0.0[a]	6.9[bc]	0.0[a]	10.3[c]
3.1–6.0	Namakwa	64.3[e]	37.0[bc]	87.3[f]	51.2[d]
	Ronina	50.0[cd]	5.4[a]	75.8[e]	43.4[cd]
	Rosabeth	65.0[e]	32.0[b]	72.5[e]	47.4[bcd]
6.1–9.0	Namakwa	35.7[cd]	50.0[ef]	2.3[a]	28.3[bc]
	Ronina	50.0[ef]	82.1[g]	16.2[b]	41.1[de]
	Rosabeth	35.0[cd]	56.2[f]	27.5[bc]	42.3[de]
9.1–12.0	Namakwa	0.0[a]	4.8[b]	0.0[a]	5.7[b]
	Ronina	0.0[a]	12.5[d]	0.0[a]	9.3[c]
	Rosabeth	0.0[a]	4.9[b]	0.0[a]	0.0[a]

*mean values marked with the same letters do not differ significantly at $P = 0.05$

leaf cuttings, which are used in the commercial production of new cultivars. The size of the test bulbs had a significant effect on flowering time, but only in the second season of the experiment – the differences concerned two cultivars: Ronina and Rosabeth (Fig. 4). In both cases, the smaller bulbs came into flowering later, by seven and ten days, respectively. In addition, the results indicate that the time of flowering is cultivar specific: it is clearly evident that lachenalia cvs Namakwa and Ronina flower earlier than cv. Rosabeth. This was also reported by Kapczyńska (2012) following greenhouse cultivation of lachenalia. This fact indicates that the lachenalia is not only an extremely attractive plant in terms of the variations in flower colour, but also in terms of different flowering periods. By suitably selecting individual cultivars in the garden we can get the flowering period to extend over many weeks during the summer months. Surely, therefore, in moderate climate conditions the lachenalia can successfully compete with many bulbous ornamental plants whose short blooming period falls in the spring. In the experiment described here, the bulbs used in each of the two growing seasons came from different sources. Although in the two years of the experiment many parallels were found in relation to bulb size, it seems that the prevailing conditions during the growing season before lifting may also determine the results that were obtained in subsequent years. Moreover, De Toit et al. (2002) emphasize that the bulbs of lachenalia produced under different climatic condition may reach a certain physiological stage not necessarily at the same time.

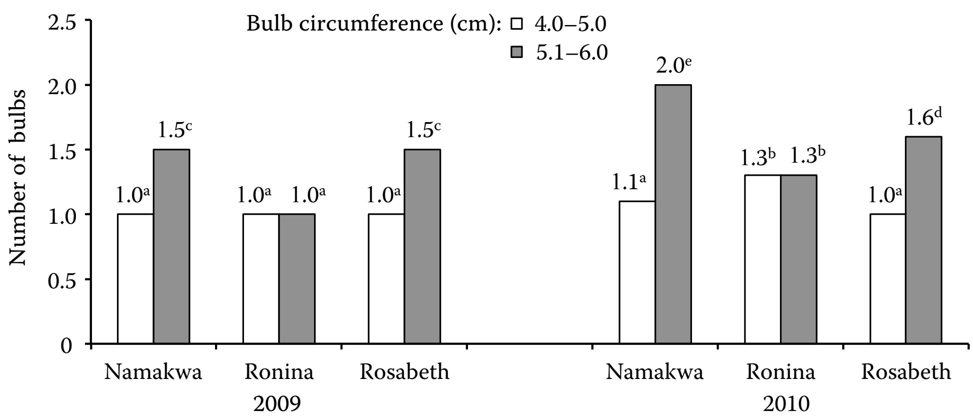

Fig. 3. Number of bulbs per one plant
mean values marked with the same letters do not differ significantly at $P = 0.05$

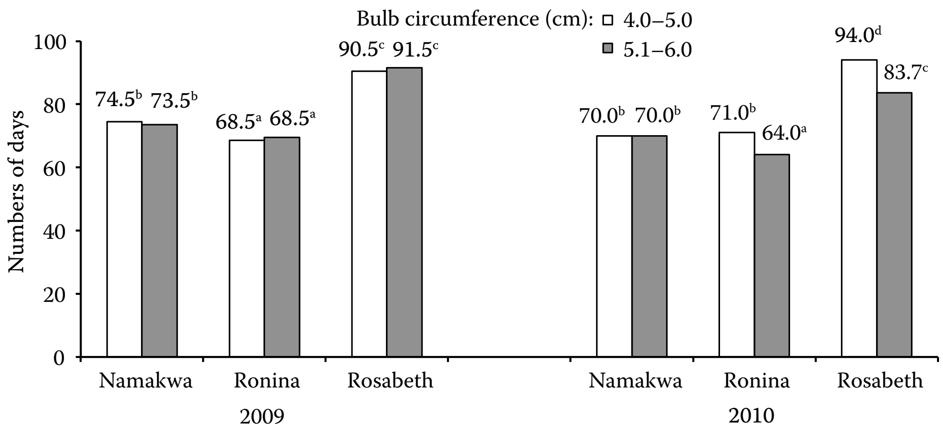

Fig. 4. Number of days to the beginning of flowering
mean values marked with the same letters do not differ significantly at $P = 0.05$

CONCLUSION

Taking into account the needs of the consumers who expect to obtain plants of the highest quality, it is recommended to cultivate large bulbs of lachenalia (5.1–6.0 cm in circumference) because they produce better quality inflorescences than small bulbs. At the same time, it is worth remembering that bulbs 4.0–5.0 cm in circumference also have the capacity to flower.

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