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Effect of plant spacing on the growth, flowering and bulb production of four lachenalia cultivars

A. Kapczyńska *

Department of Ornamental Plants, University of Agriculture in Krakow, al. 29 Listopada 54, 31-425 Kraków, Poland

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ABSTRACT

A 2-year field experiment was performed with lachenalia ('Namakwa', 'Ronina,' 'Rosabeth' and 'Rupert') to study the effects of planting density on leaf formation, inflorescence quality and bulb production. Bulbs 6.0 cm in circumference were planted at a spacing of 2.0 × 5.0 cm, 3.0 × 7.0 cm and 5.0 × 10.0 cm, and cultivated in the open air in Polish conditions in 2009 and 2010. The spacing affected the number of leaves only in lachenalia 'Namakwa' in 2010. In the other cases, the bulbs formed 2–3 leaves. Plant height increased with the high-density treatment, but flower yield and the total time to the beginning of flowering were independent of planting density. The cultivars proved to differ in terms of the time of blooming: 'Namakwa' and 'Ronina' flowered earlier (after 63–73 days) than 'Rosabeth' and 'Rupert' (after 82–90 days). Plant arrangement had little effect on inflorescence length and the number of florets. Irrespective of the spacing, lachenalia 'Rupert' seemed to be the most floriferous — one bulb produced even 30 flowers. Lower planting density influenced advantageously the quality of bulbs (circumference and weight), without affecting their quantity (number of bulbs from one plant).

1. Introduction

Lachenalia (*Hyacinthaceae*) is a bulbous genus endemic to Namibia and South Africa, where the Cape Floral Kingdom is located (Duncan, 1996). Because most of the rain in this region falls in the winter, the active growth of lachenalia occurs in this season and as the weather warms up the dormancy period of bulbs is initiated (Duncan, 1988; Kleynhans, 2006). Some species of *Lachenalia* have a narrow range of distribution and others are in an endangered position, thus they need the conservation efforts (Duncan, 1988). Doutt (1994) points out that the Cape area is the richest in the world in bulb flora but, on the other hand, it may also be the most threatened. Cultivation in private gardens may keep the precious species alive. The Southern African flora is well described (Goldblatt, 1978; Helme and Trinder-Smith, 2005) and lots of species are extremely popular in Europe. Flower bulb species, e.g. gladiolus and freesia, have been successfully introduced to the international flower market (Kleynhans, 2009a), but there is still a great diversity of geophytes in the Cape Floral Kingdom (Van Staden and Fennell, 2004) with an excellent horticultural potential (Doutt, 1994; Reinten et al., 2011). One of them is lachenalia, with its long and interesting historical background (Duncan, 1988). It has been chosen for the experimental programme of ARC-Roodeplaat to develop a new crop for commercial production (Kleynhans, 2002). Advanced techniques were applied in the research and breeding of the genus in order to develop new cultivars (Niederwieser, 2004). But Kleynhans (2009b) stresses that these new breeding methods are very expensive and often exceed the commercial value of the new crop. In Poland, as in all central and northern Europe, the bulbs cannot be kept in the open all year long as they are not frost-tolerant (Duncan, 1988). In spite of this, lachenalia can be successfully cultivated in European conditions in gardens, but should be removed from the ground when frost is expected (October–November) and stored dry at a warm temperature. The bulbs should be stored at 20–25 °C for not less than 18 months for flower initiation (Kleynhans, 2009a). As a result of the *Lachenalia* breeding programme, a new series of cultivars, called 'African Beauty,' has been developed. Spotted leaves, combined with variously colored flowers, make these cultivars ideal garden and pot plants. As Kleynhans (2006) emphasizes, not only do the cultivars differ in growth habitat but also the microclimate of the production area of lachenalia may affect the behavior of the plants. Thus it is very important to formulate a precise description of lachenalia cultivation in particular geographical conditions. In Poland, lachenalia is completely new to horticulture and rather rare among bulb collectors (Kapczyńska, 2009). Making this plant popular still requires a lot of commitment and effort on the part of researchers, producers and retailers. The research presented in this paper is the first attempt at growing this plant in the temperate climate conditions, aimed to determine the optimal spacing of planting of lachenalia bulbs in the ground. The results obtained may lead to the development of recommendations for growing the cultivars from the 'African Beauty' series. The flower market is still open to new ideas for gardening, and lachenalia has a great potential to enhance the range of plants grown in gardens, as well as for cut flowers. The present project was undertaken to determine the optimum planting density in

* Tel.: +48 12 6625249; fax: +48 12 6625266.
E-mail address: akapczynska@op.pl.

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order to obtain plants with good quality flowers as well as optimally-sized bulbils to be utilized in future cultivation.

2. Materials 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 (Poland). Four cultivars of lachenalia (*Lachenalia* J. Jacq. ex Murray) were investigated: 'Namakwa,' 'Ronina,' 'Rupert,' 'Rosabeth' (all from the 'African Beauty' series). The bulbs (approx. 6.0 cm in circumference) were bought from the company Afriflowers (South Africa). Three values of the experimental variable were used — the bulbs were planted at a spacing of: 2.0 × 5.0 cm, 3.0 × 7.0 cm, and 5.0 × 10.0 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 to 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 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 (6 months), at a dose of 80 g/m^2.

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. 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, their crop was assessed by sorting them according to the circumference into 4 classes: <3.0 cm, 3.1–6.0 cm, 6.1–9.0 cm, 9.1–12.0 cm.

All the data were analyzed separately for each season using the STATISTICA package. The results were statistically evaluated using a two-way analysis of variance for factors: cultivar and spacing. To determine significant differences, the Duncan test was used at $p \leq 0.05$. Bulb yield data were arcsine transformed before the analysis.

3. Results

Density of planting of bulbs in 2009 and 2010 significantly affected the number of leaves only in the case of lachenalia 'Namakwa' (Table 1). In 2009, the bulbs of this cultivar planted at the largest spacing produced 1 leaf more compared with the plants grown at a reduced spacing. In 2010, the spacing of 5.0 × 10 cm also proved to be the most advantageous in terms of this characteristic — plants grown at that density developed nearly 6 leaves per plant.

In 2009, the significantly shortest leaves (about 18 cm long) were obtained from the bulbs of lachenalia 'Rosabeth' planted at the largest spacing (Table 1). Also in that season, in the case of this cultivar, there is clear evidence of a significant decrease in the length of the leaf blade from the most densely planted bulbs to those planted at the lowest density — the difference is as high as 6 cm. In 2010, while analyzing this cultivar, a similar trend was observed — the longest leaves were obtained from the bulbs planted at the highest density. From the bulbs of lachenalia 'Rupert' planted in 2009 at a spacing of 5.0 × 10 cm leaves were shorter by about 3 cm in relation to those obtained from the bulbs planted at 2.0 × 5.0 cm and 3.0 × 7.0 cm. In the following year of the experiment, the most densely planted bulbs of 'Rupert' produced leaves longer by about 3 cm compared with the plants grown at 3.0 × 7.0 cm and 5.0 × 10.0 cm. After analyzing lachenalia 'Namakwa,' it was found that in 2009 the longest leaves were obtained from the most densely planted bulbs, but this trend was not repeated the following year. In the case of 'Ronina,' in the first year the bulbs planted at spacing of 5.0 × 10 cm produced shorter leaves than the bulbs cultivated at a spacing of 3.0 × 7.0 cm. In the second year the shortest leaves were obtained by planting bulbs at a spacing of 3.0 × 7.0 cm; that was also the lowest value that was recorded for the whole experiment in 2010.

Bulb planting density had a significant effect not only on the length but also on the width of the measured leaves (Table 1). Considering the whole experiment, it was found that the broadest leaves were produced in 2009 by the bulbs of lachenalia 'Ronina' planted at a spacing of 5.0 × 10.0 cm, and in 2010 by the bulbs of lachenalia 'Rupert' and 'Rosabeth' also grown at this density and planted at a spacing of 3.0 × 7.0 cm. After analyzing each cultivar separately, it was noted that in the first year of the experiment the bulbs of lachenalia 'Namakwa' planted at the largest spacing produced leaves by 0.5 cm wider than the bulbs of this cultivar planted at the highest density. The following year, beneficial in this regard proved to be both the largest and the medium plant spacings. In the case of lachenalia 'Ronina,' in the two years of the experiment, the bulbs planted at the largest spacing produced significantly wider leaves in relation to the bulbs planted at 2.0 × 5.0 cm and 3.0 × 7.0 cm — the difference was about 0.5 cm. In the case of lachenalia

Table 1
Effect of plant spacing of lachenalia bulbs on leaf characteristics.

Feature	Cultivar	2009 Season			2010 Season		
		Plant spacing (cm)					
		2.0 × 5.0	3.0 × 7.0	5.0 × 10.0	2.0 × 5.0	3.0 × 7.0	5.0 × 10.0
No. of leaves	Namakwa	1.8 a	2.0 ba	2.8 d	3.9 c	3.6 bc	5.8 d
	Ronina	2.2 bc	2.4 c	2.3 c	2.6 a	3.0 ab	2.8 a
	Rosabeth	1.9 ab	2.0 ab	2.0 ab	3.0 ab	3.1 ab	3.1 ab
	Rupert	2.1 abc	2.1 abc	2.0 ab	2.5 a	2.9 ab	2.7 a
Leaf length (cm)	Namakwa	26.3 fg	22.4 bc	24.2 cde	25.3 b	26.8 bc	26.2 bc
	Ronina	25.5 efg	26.4 g	24.0 cde	25.7 b	22.5 a	24.8 b
	Rosabeth	24.1 cde	23.1 bcd	18.4 a	31.5 d	26.8 bc	26.7 bc
	Rupert	24.9 def	24.4 def	21.8 b	31.3 d	28.3 c	28.1 c
Leaf width (cm)	Namakwa	2.1 a	2.3 ab	2.6 bcd	2.3 a	2.7 bc	2.9 cd
	Ronina	4.1 g	3.8 fg	4.5 h	2.5 ab	2.5 ab	2.9 cd
	Rosabeth	2.4 abc	2.9 d	2.7 cd	3.1 d	3.7 ef	3.6 ef
	Rupert	3.7 ef	3.4 e	3.7 ef	3.1 d	3.5 e	3.8 f

Mean values marked with the same letters do not differ significantly at $p \leq 0.05$.
2009 mean cultivar and spacing effects: no. of leaves — $F = 10.630$ and $p = 0.000$ for cultivar, $F = 10.384$ and $p = 0.000$ for spacing, $F = 12.511$ and $p = 0.000$ for cultivar and spacing; leaf length — $F = 17.224$ and $p = 0.000$ for cultivar, $F = 23.471$ and $p = 0.000$ for spacing, $F = 6.588$ and $p = 0.000$ for cultivar and spacing; leaf width — $F = 128.788$ and $p = 0.000$ for cultivar, $F = 9.353$ and $p = 0.000$ for spacing, $F = 4.027$ and $p = 0.000$ for cultivar and spacing.
2010 mean cultivar and spacing effects: no. of leaves — $F = 36.12$ and $p = 0.000$ for cultivar, $F = 7.027$ and $p = 0.02$ for spacing, $F = 7.049$ and $p = 0.000$ for cultivar and spacing; leaf length — $F = 33.42$ and $p = 0.000$ for cultivar, $F = 14.8$ and $p = 0.000$ for spacing, $F = 5.84$ and $p = 0.000$ for cultivar and spacing; leaf width — $F = 79.35$ and $p = 0.000$ for cultivar, $F = 35.24$ and $p = 0.000$ for spacing, $F = 2.21$ and $p = 0.066$ for cultivar and spacing.