Planting Time and Flurprimidol Treatment Influence the Growth and Flowering of *Lachenalia*

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SUMMARY. The growth and flowering of ‘Rupert’ and ‘Ronina’ lachenalia (*Lachenalia*) in a greenhouse environment were manipulated by varying planting times and flurprimidol treatments. Bulbs were planted in November, December, January, and February. At each planting date, the following flurprimidol treatments were tested: soaking the bulbs before planting (15 and 30 mg·L⁻¹) or a single foliar spray (15, 30, 45, and 60 mg·L⁻¹). The results showed that foliar application of flurprimidol was ineffective in controlling inflorescence stem height and inflorescence length; only soaking bulbs of ‘Rupert’ in flurprimidol at the concentration of 30 mg·L⁻¹ shortened the inflorescence stem height. Moreover, soaking bulbs in the concentration of 30 mg·L⁻¹ may be recommended for potted lachenalia production, as shorter and wider leaves were obtained and every planted bulb emerged and flowered. The later the date of planting of the bulbs, the more quickly the plants began to flower. As planting time was delayed, inflorescence stem length and leaf length decreased, and the number of florets and leaf width increased. Soaking the bulbs in the retardant (30 mg·L⁻¹) delayed the emergence of flowers for 5–6 days, but the retardant did not affect the number of leaves or the number of florets per inflorescence. Regardless of the factors applied, the two cultivars of lachenalia differed with respect to each of the analyzed traits.

Globalization and increased competition in the floriculture sector have led to the creation of new flower production centers. Africa, where a significant increase in horticultural production and flower exports has been observed, is one of these (Benschop et al., 2010). The genus *Lachenalia* is particularly interesting due to its rich palette of flower colors and unique spotted leaves. This great diversity of flower and foliage characteristics has attracted considerable interest among researchers and breeders, and was a decisive factor in the selection of this genus for the experimental program to release and commercialize new cultivars for use as cut flowers or potted ornamentals (Duncan, 2012; Kleynhans, 2002). Since 2001, new cultivars of this geophyte have been available commercially under the trade name Cape Hyacinth (Kleynhans, 2006). Successful commercialization of new plants depends not only on their

unique morphological features but also on more practical aspects, such as the ability to obtain flowering plants when demand is high (winter and early spring months). Hence, one of the most important stages in the process of introducing new cultivars is the determination of the optimal planting time to produce true-to-type, high-quality potted plants or cut flowers within a strictly scheduled time frame. To maintain compact, greenhouse-grown ornamental plants (and thus, help to improve the appearance of those plants and their marketability), plant growth regulators are applied during the production phase. Treating plants with growth retardants is especially recommended during winter and spring, when low light levels cause excessive stretch. No information has been published on the use of commercially

available growth retardants to control growth of lachenalia. Many studies have been conducted on the use of plant growth retardants in the cultivation of well-known ornamental bulbous plants (Krug et al., 2006a, 2006b; Salachna and Zawadzińska, 2013), but De Hertogh and Le Nard (1993) emphasize that information on the effect of plant growth regulators is not transferable from one genus (or even cultivar) to another. For example, paclobutrazol applied exogenously to alstroemeria (*Alstroemeria*) plants is ineffective, whereas in the case of the freesia (*Freesia*), lily (*Lilium*), and tulip (*Tulipa*) species, it has a positive effect in controlling the height of the marketable plant (De Hertogh and Le Nard, 1993).

The objective of this study was to determine how flurprimidol, applied at different concentrations and planting dates as a preplant bulb soak or a foliar spray, influences the growth of ‘Ronina’ and ‘Rupert’ lachenalia.

Materials and methods

The experiment was carried out in 2012–13 in a glass-glazed Venlo-type greenhouse (equipped with Integro 724 process computers; Priva, De Lier, The Netherlands) of the Faculty of Biotechnology and Horticulture of the University of Agriculture in Kraków, Poland (lat. 50.08°N, long. 19.95°E). The day and night greenhouse air temperature set point was 18 and 15 °C, respectively, under ambient light conditions (Fig. 1). Two cultivars of lachenalia were investigated: Ronina (yellow flowers) and Rupert (lilac-purple flowers), both from the African Beauty® series. The bulbs (average weight 4.0–4.5 g, circumference 5.5–6.0 cm) were purchased from Afriflowers (Cullinan, South Africa). The bulbs were prepared for the experiment by application of a cold (9 °C) treatment, followed by 2 weeks at 35 °C and 22 weeks at 25 °C. The period at 9 °C

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
29.5735	fl oz	mL	0.0338
0.0929	ft ²	m ²	10.7639
2.54	inch(es)	cm	0.3937
28.3495	oz	g	0.0353
1	ppm	mg·L ⁻¹	1
3.8745	Wh/ft ²	J·cm ⁻²	0.2581
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Fig. 1. Weekly average (A), lowest (L) and highest (H), day (D) and night (N) temperatures (T), and radiation (RAD) during the experiment on lachenalia (from week 47 of 2012 to week 20 of 2013); $(1.8 \times ^\circ\text{C}) + 32 = ^\circ\text{F}$, $1 \text{ J}\cdot\text{cm}^{-2} = 0.2581 \text{ Wh/ft}^2$.

was varied between 25 and 37 weeks to facilitate four different planting dates. The bulbs were planted at monthly intervals on 23 Nov. 2012, 20 Dec. 2012, 24 Jan. 2013, and 25 Feb. 2013. The bulbs, soaked (for 30 min) in a 0.25% captan suspension, were planted at a depth equal to twice the height of the bulb in 19-cm plastic pots (five bulbs per pot, 16 pots/m²) filled with a peat substrate [pH 5.5–6.5 (Botanica Professional; Comeco, Plock, Poland)]. After the first leaves had appeared, 30N–0P–16.6K liquid fertilizer, with microelements (Florovit Universal; Inco-Veritas, Warsaw, Poland) at the concentration of 1.0%, was used every 2 weeks in the amount of 250 mL per pot. For each month of planting (first factor), the following flurprimidol (Topflor 015 SL; SePRO, Carmel, IN) treatments (second factor) were used: soaking the bulbs for 60 min in flurprimidol solutions before planting, at either of two concentrations: 15 or 30 mg·L⁻¹; applying a single foliar spray when the average leaf length was 15 cm (6 weeks after planting) using flurprimidol at the following concentrations: 15, 30, 45, or 60 mg·L⁻¹ (each plant was sprayed uniformly); or no treatment with retardant at all (the control plants).

When the first floret opened (beginning of flowering), inflorescence stem height (from the substrate to the apex of the inflorescence), the inflorescence length (from the lowermost

floret to the apex of the inflorescence), the floral part ratio (the quotient of inflorescence length to inflorescence stem height), the number of florets in the inflorescence, the diameter of the inflorescence stem, the length of a single floret (the first developed one), the number of leaves produced by one bulb, and the length and width of the first and second leaf, were recorded, as well as the number of days to the start of flowering.

The experiment was set up in a completely randomized system with four replications of each treatment combination: four planting dates $\times$ seven flurprimidol treatments (including control). Each replication consisted of one pot containing five bulbs (20 bulbs per treatment combination). For each cultivar, 140 bulbs were used in each planting date (month). All data were analyzed using STATISTICA 10.0 data analysis software system (StatSoft, Tulsa, OK). Experimental data were subjected to variance analysis, and the *t* test or Tukey's multiple range test were used to separate the means at a significance level of $P \leq 0.05$. In addition, all evaluated parameters were regressed as the function of the number of days to the start of flowering (time to flowering) using linear regression procedures.

Results

PLANTING DATE. The study revealed that all evaluated parameters,

except the number of leaves (data not shown), were influenced by the planting date (Tables 1–4). The shortest plants were obtained by planting bulbs on the latest date. The inflorescence stem height for February was 8 cm ('Ronina') and 22 cm ('Rupert') shorter than those obtained from the bulbs planted in November. The shortest inflorescences were noted for the November 'Ronina' and the February 'Rupert'. However, for both cultivars, the floral part ratio (the share of the inflorescence in the inflorescence stem) increased as the planting date was later. A similar tendency was observed for stem diameter. The number of florets of 'Rupert' and 'Ronina' increased as the planting date was delayed; however, for 'Ronina' no differences were noted for bulbs planted in November and December. The mean length of a single floret for 'Ronina' and 'Rupert' was 3.1 and 2.5 cm, respectively. With the delay in the planting date, shorter and wider leaves were obtained and the plants began to flower sooner.

As the number of days to flower initiation decreased (the later planting date), the inflorescence stem height and leaf length of both cultivars and the inflorescence length of 'Rupert' decreased linearly. However, the floral part ratio, number of florets, floret length, stem diameter of both cultivars, and inflorescence length of 'Ronina' increased linearly.

FLURPRIMIDOL TREATMENT. The application of flurprimidol and its concentration affected length and width of leaves and number of days to flowering of 'Ronina' and 'Rupert' lachenalia. In addition, flurprimidol treatment influenced the inflorescence stem height and floret length of 'Rupert' (Tables 2–4). The shortest and the widest leaves were obtained from bulbs soaked in flurprimidol at 30 mg·L⁻¹. As compared with the control plants, it reduced the first and second leaf length by 18% and 17% for 'Ronina' and 23% and 23% for 'Rupert', and it increased the first and second leaf width by 13% and 15% for 'Ronina' and 17% and 20% for 'Rupert'. Compared with control plants, soaking the bulbs and spraying the leaves of 'Ronina' delayed the emergence of flowers for 3–5 d and 1–4 d, respectively. In the case of 'Rupert', only soaking the bulbs caused a delay in the

Table 1. Effect of planting date (PD) on inflorescence quality of 'Ronina' lachenalia.^z

PD	Inflorescence stem ht (cm) ^y	Inflorescence length (cm) ^x	Floral part ratio	Florets (no.)	Floret length (cm)	Stem diam (cm)
(mean ± SD)						
Nov.	27.0 ± 1.7 c ^w	10.7 ± 1.8 a	0.39 ± 0.04 a	17.2 ± 2.6 a	3.0 ± 0.1 a	0.58 ± 0.04 a
Dec.	26.6 ± 1.5 c	11.8 ± 0.9 b	0.45 ± 0.04 b	18.0 ± 1.7 a	3.1 ± 0.1 a	0.63 ± 0.03 b
Jan.	23.4 ± 1.1 b	12.5 ± 0.8 bc	0.53 ± 0.04 c	22.1 ± 1.5 b	3.2 ± 0.1 b	0.68 ± 0.04 c
Feb.	18.7 ± 1.8 a	12.6 ± 1.0 c	0.68 ± 0.03 d	25.8 ± 2.0 c	3.1 ± 0.1 ab	0.76 ± 0.07 d
Main effects ^v						
	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Time to flowering (d) linear regression						
P value	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001
R ²	0.5872	0.4720	0.4883	0.6312	0.3785	0.5150

^zTime to flowering trend lines: inflorescence stem height ($y = -15.36 + 0.46x$), inflorescence length ($y = 21.56 - 0.11x$), floral part ratio ($y = 1.77 - 0.01x$), florets ($y = 62.98 - 0.49x$), floret length ($y = 3.74 - 0.008x$), stem diameter ($y = 1.43 - 0.009x$).

^yMeasured from the substrate to the apex of the inflorescence; 1 cm = 0.3937 inch.

^xMeasured from the lowermost floret to the apex of the inflorescence.

^wMean separation by Tukey's honestly significant difference test at $P \leq 0.05$.

^vSignificant effects ($P \leq 0.05$), NS = not significant.

Table 2. Effect of planting date (PD) and flurprimidol treatment (FT) on leaf characteristics and time to flowering of 'Ronina' lachenalia.^z

PD	First leaf length (cm) ^y	First leaf width (cm)	Second leaf length (cm)	Second leaf width (cm)	Time to flowering (d)
(mean ± SD)					
Nov.	37.7 ± 3.6 c ^x	3.8 ± 0.3 a	37.9 ± 3.3 c	2.7 ± 0.3 a	93.1 ± 1.6 d
Dec.	36.2 ± 3.2 b	3.8 ± 0.4 ab	35.3 ± 2.7 b	2.8 ± 0.3 a	89.3 ± 2.2 c
Jan.	29.2 ± 2.9 a	4.0 ± 0.3 b	27.8 ± 2.7 a	2.9 ± 0.2 b	80.0 ± 2.0 b
Feb.	28.9 ± 1.6 a	4.7 ± 0.2 c	27.2 ± 1.5 a	3.3 ± 0.2 c	81.5 ± 2.5 a
FT [application/concn (mg·L ⁻¹)] ^y					
Control/0	34.4 ± 4.4 b	3.9 ± 0.4 a	33.8 ± 5.3 c	2.8 ± 0.4 a	83.3 ± 5.8 a
Soak/15	33.0 ± 6.1 b	4.1 ± 0.5 ab	32.7 ± 6.0 bc	3.0 ± 0.4 b	86.6 ± 4.2 c
Soak/30	28.3 ± 2.8 a	4.5 ± 0.4 c	27.9 ± 3.4 a	3.3 ± 0.3 c	88.6 ± 5.5 e
Spray/15	33.6 ± 4.1 b	3.9 ± 0.4 a	32.5 ± 5.1 bc	2.8 ± 0.3 a	84.2 ± 5.9 b
Spray/30	33.4 ± 5.1 b	3.9 ± 0.4 ab	31.8 ± 5.8 b	2.8 ± 0.3 a	84.7 ± 6.1 b
Spray/45	34.0 ± 4.8 b	4.1 ± 0.4 ab	32.5 ± 5.3 bc	2.9 ± 0.3 ab	86.9 ± 5.7 cd
Spray/60	34.5 ± 4.4 b	4.1 ± 0.5 b	33.2 ± 4.9 bc	2.9 ± 0.3 ab	87.6 ± 6.1 d
Main effects ^x					
PD	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FT	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
PD × FT	<0.0001	<0.0001	<0.0001	0.0060	<0.0001
Time to flowering (d) linear regression					
P value	<0.0001	NS	<0.0001	NS	—
R ²	0.4920	0.1305	0.5957	0.1317	—

Time to flowering trend lines: first leaf length ($y = -15.98 + 0.569x$), first leaf width ($y = 6.36 - 0.03x$), second leaf length ($y = -27.50 + 0.69x$), second leaf width ($y = 4.72 - 0.02x$).

^z1 cm = 0.3937 inch, 1 mg·L⁻¹ = 1 ppm.

^yMean separation by Tukey's honestly significant difference test at $P \leq 0.05$.

^xSignificant effects ($P \leq 0.05$), NS = not significant.

emergence of flowers, and that for 5–6 d; spray treatments did not affect the time of the onset of flowering. The plants obtained from the bulbs of 'Rupert' soaked in the retardant at 30 mg·L⁻¹ were shorter and had shorter florets than the other experimental plants.

GENERAL COMPARISON. The two test cultivars of lachenalia differed in respect to each of the traits analyzed (Table 5). 'Ronina' produced more leaves per bulb, and they were longer,

but narrower, than the leaves of 'Rupert'. The plants obtained from the bulbs of 'Ronina' were shorter by more than 2 cm and the inflorescences were 4 cm longer. 'Ronina' inflorescences had half the number of florets compared with 'Rupert', whose inflorescences consisted of more than 40 individual florets. These florets, however, were shorter by more than 0.5 cm than the florets of 'Ronina'. The inflorescence stems of 'Rupert' were thicker and emerged

on average a week later than the stems of 'Ronina'.

Discussion

In this study, bulbs of lachenalia were planted from November to February to obtain flowering plants in late winter and early spring (a period of high demand for flowering pot plants). The inflorescence stem height decreased with later bulb planting date; this correlates with the results reported by Ruffoni et al. (2013), who forced

Table 3. Effect of planting date (PD) and flurprimidol treatment (FT) on inflorescence quality of 'Rupert' lachenalia.^z

PD	Inflorescence stem ht (cm) ^y	Inflorescence length (cm) ^x	Floral part ratio	Florets (no.)	Floret length (cm)	Stem diam (cm)
(mean ± SD)						
Nov.	37.2 ± 3.5 d ^w	8.3 ± 1.5 b	0.22 ± 0.03 a	37.0 ± 3.2 a	2.5 ± 0.4 ab	0.66 ± 0.03 a
Dec.	34.0 ± 2.9 c	9.5 ± 0.9 c	0.28 ± 0.02 b	40.3 ± 3.1 b	2.7 ± 0.1 c	0.74 ± 0.04 b
Jan.	21.6 ± 2.2 b	7.8 ± 0.9 b	0.36 ± 0.03 c	47.7 ± 3.1 c	2.4 ± 0.1 a	0.93 ± 0.06 c
Feb.	15.4 ± 2.0 a	6.8 ± 0.9 a	0.44 ± 0.04 d	49.9 ± 2.6 d	2.6 ± 0.1 bc	1.00 ± 0.05 d
FT [application/concn (mg·L ⁻¹)] ^v						
Control/0 ^v	26.9 ± 10.8 b	8.2 ± 1.7	0.34 ± 0.10	43.4 ± 6.4	2.6 ± 0.1 b	0.85 ± 0.15
Soak/15	27.7 ± 10.3 b	8.4 ± 1.4	0.34 ± 0.10	42.8 ± 4.3	2.6 ± 0.2 b	0.82 ± 0.13
Soak/30	23.7 ± 6.1 a	7.4 ± 1.5	0.33 ± 0.09	45.5 ± 6.0	2.3 ± 0.4 a	0.82 ± 0.12
Spray/15	27.6 ± 9.3 b	8.0 ± 1.2	0.32 ± 0.08	43.2 ± 5.7	2.6 ± 0.1 b	0.84 ± 0.15
Spray/30	28.2 ± 9.4 b	8.5 ± 1.2	0.33 ± 0.09	44.1 ± 6.0	2.6 ± 0.1 b	0.83 ± 0.15
Spray/45	27.4 ± 8.9 b	8.3 ± 1.5	0.32 ± 0.08	44.2 ± 6.7	2.6 ± 0.1 b	0.82 ± 0.15
Spray/60	27.1 ± 9.7 b	8.0 ± 1.5	0.32 ± 0.10	42.8 ± 7.5	2.6 ± 0.1 b	0.82 ± 0.16
Main effects ^u						
PD	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FT	<0.0001	NS	NS	NS	<0.0001	NS
PD × FT	<0.0001	0.0042	0.0220	NS	<0.0001	0.0200
Time to flowering (d) linear regression						
P value	<0.0001	0.0086	<0.0001	<0.0001	NS	<0.0001
R ²	0.6678	0.2292	0.6607	0.6632	0.0236	0.7741

^zTime to flowering trend lines: inflorescence stem height ($y = -96.06 + 1.31x$), inflorescence length ($y = -1.46 + 0.10x$), floral part ratio ($y = 1.54 - 0.01x$), florets ($y = 119.34 - 0.80x$), floret length ($y = 3.04 - 0.005x$), stem diameter ($y = 2.81 - 0.02x$).

^yMeasured from the substrate to the apex of the inflorescence; 1 cm = 0.3937 inch.

^xMeasured from the lowermost floret to the apex of the inflorescence.

^wMean separation by Tukey's honestly significant difference test at $P \leq 0.05$.

^v1 mg·L⁻¹ = 1 ppm.

^uSignificant effects ($P \leq 0.05$), NS = not significant.

Table 4. Effect of planting date (PD) and flurprimidol treatment (FT) on leaf characteristics and time to flowering of 'Rupert' lachenalia.^z

PD	First leaf length (cm) ^y	First leaf width (cm)	Second leaf length (cm)	Second leaf width (cm)	Time to flowering (d)
(mean ± SD)					
Nov.	34.6 ± 3.1 b ^x	3.7 ± 0.3 a	34.5 ± 4.0 c	3.6 ± 0.4 a	100.4 ± 2.5 d
Dec.	32.8 ± 3.9 b	3.8 ± 0.5 a	33.1 ± 3.6 b	3.7 ± 0.3 a	96.6 ± 2.6 c
Jan.	25.7 ± 2.8 a	5.2 ± 0.5 b	27.6 ± 2.9 a	3.9 ± 0.4 b	91.7 ± 2.9 b
Feb.	25.9 ± 2.2 a	5.3 ± 0.3 b	27.3 ± 2.3 a	3.9 ± 0.3 b	87.3 ± 2.2 a
FT [application/concn (mg·L ⁻¹)] ^y					
Control/0 ^x	31.9 ± 5.1 d	4.2 ± 0.7 a	32.8 ± 4.4 c	3.5 ± 0.3 a	92.4 ± 5.0 a
Soak/15	28.7 ± 6.6 b	4.6 ± 0.9 b	29.8 ± 5.6 b	3.8 ± 0.3 c	98.0 ± 5.3 b
Soak/30	24.5 ± 3.1 a	5.1 ± 0.9 c	25.1 ± 2.6 a	4.4 ± 0.3 d	97.8 ± 5.4 b
Spray/15	31.0 ± 4.5 cd	4.4 ± 0.7 ab	32.4 ± 3.7 c	3.6 ± 0.2 ab	92.6 ± 5.1 a
Spray/30	31.2 ± 4.3 cd	4.5 ± 0.8 ab	31.0 ± 3.0 c	3.6 ± 0.3 ab	92.6 ± 5.1 a
Spray/45	30.0 ± 3.7 bc	4.4 ± 0.8 ab	31.0 ± 3.6 bc	3.7 ± 0.4 bc	92.6 ± 5.1 a
Spray/60	31.0 ± 4.0 cd	4.3 ± 0.8 ab	31.0 ± 3.6 bc	3.8 ± 0.3 c	92.6 ± 5.1 a
Main effects ^w					
PD	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FT	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
PD × FT	<0.0001	0.0410	0.0003	NS	NS
Time to flowering (d) linear regression					
P value	0.0041	0.0001	0.0162	NS	—
R ²	0.2673	0.4289	0.1959	0.0283	—

^zTime to flowering trend lines: first leaf length ($y = -11.99 + 0.44x$), first leaf width ($y = 13.20 - 0.09x$), second leaf length ($y = -0.80 + 0.33x$), second leaf width ($y = 4.71 - 0.01x$).

^y1 cm = 0.3937 inch, 1 mg·L⁻¹ = 1 ppm.

^xMean separation by Tukey's honestly significant difference test at $P \leq 0.05$.

^wSignificant effects ($P \leq 0.05$), NS = not significant.

the same cultivars of lachenalia from October to February in Italy. Both cultivars responded to the lengthening of the day by increasing the floral part

ratio of the inflorescence stem. In our study, 'Rupert' bulbs soaked in flurprimidol at 30 mg·L⁻¹ were the shortest. For 'Ronina', the flurprimidol

application method and concentration did not affect inflorescence stem height. Drenching the pots with plant growth regulators may have

Table 5. Comparison of the two tested cultivars of lachenalia irrespective of planting date and flurprimidol treatment.

Feature	'Ronina'	'Rupert'	Main effects ^z
	(mean ± SD)	(mean ± SD)	
Inflorescence stem ht (cm) ^y	24.5 ± 3.7 a ^x	26.9 ± 9.2 b	0.0014
Inflorescence length (cm) ^w	12.0 ± 1.3 b	8.2 ± 1.5 a	<0.0001
Floral part ratio	0.5 ± 0.1 b	0.3 ± 0.1 a	<0.0001
Florets (no.)	21.1 ± 4.0 a	43.8 ± 6.1 b	<0.0001
Floret length (cm)	3.1 ± 0.1 b	2.5 ± 0.2 a	<0.0001
Stem diam (cm)	0.7 ± 0.1 a	0.8 ± 0.1 b	<0.0001
Leaves (no.)	2.4 ± 0.2 b	2.1 ± 0.1 a	<0.0001
First leaf length (cm)	33.6 ± 4.9 b	29.5 ± 5.0 a	<0.0001
First leaf width (cm)	4.1 ± 0.5 a	4.5 ± 0.8 b	<0.0001
Second leaf length (cm)	32.3 ± 5.3 b	30.3 ± 4.5 a	0.0313
Second leaf width (cm)	3.0 ± 0.4 a	3.8 ± 0.4 b	<0.0001
Time to flowering (d)	86.0 ± 5.8 a	94.0 ± 5.6 b	<0.0001

^xSignificant effects ($P \leq 0.05$).

^yMeasured from the substrate to the apex of the inflorescence; 1 cm = 0.3937 inch.

^zMean separation by Tukey's honestly difference test at $P \leq 0.05$.

^wMeasured from the lowermost floret to the apex of the inflorescence.

been a more effective way to control growth of 'Ronina'. Krug et al. (2006b) and Barnes et al. (2013) reported that different cultivars of hyacinth (*Hyacinthus orientalis*) and lily (*Lilium lancifolium*) respond differently to the same method of soaking bulbs in flurprimidol. Janowska (2010) tested six cultivars of calla lily (*Zantedeschia albomaculata*), applying flurprimidol directly to the soil in concentrations ranging from 75 to 150 mg·L⁻¹. Not all cultivars responded to the retardant; flurprimidol, irrespective of the concentration, did not affect the stem length of calla lily 'Pacific Pink'. Therefore the insufficient regulation of growth observed in 'Ronina' plants may have been the result of the cultivars' specificity and tolerance to growth regulators. The growth retardant did not affect the number of individual florets composing the inflorescence, the very important trait that to a large extent determines the decorative value of a plant. Floret number depended on the bulb planting date. In lachenalia, flower formation starts during the dormancy period (Louw, 1991). Moreover, Du Toit et al. (2001) observed that inflorescence differentiation may start even earlier, during the prior growing season before lifting. As the present results show, this process is not entirely completed at the stage of storing the bulbs. The quality of the inflorescence differed depending on the photoperiod during greenhouse cultivation—the bulbs planted later produced inflorescences consisting of more florets. However,

irrespective of the planting time and flurprimidol treatment, 'Rupert' lachenalia produced more florets in the inflorescence than 'Ronina'. The cultivars differed in respect of each trait being assessed.

In the present study, photoperiod proved to be the determinant factor influencing the phenotypical characteristics of leaves. Regardless of the genotype, the leaves were shorter and wider if bulbs were planted later, which can be explained by the lengthening of the day at the beginning of the calendar year. In this part of Europe, in March, the day is longer than in December by four hours (Kalda and Smorag, 2012). Soaking bulbs of the two cultivars in the retardant at the concentration of 30 mg·L⁻¹ resulted in a shortening of the leaves (by 18% for 'Ronina' and 23% for 'Rupert'). This information may be important to future growers of lachenalia, because flowering pot plants whose leaves are too long can pose a significant impediment during greenhouse production, and later in packaging, transport, and final sale. The application of a single foliar spray did not control the leaf length at all or shortened it only by 6% (second leaf of 'Ronina' sprayed with 30 mg·L⁻¹) or 5% (first leaf of 'Rupert' sprayed with 45 mg·L⁻¹). An earlier foliar spray in the forcing cycle or a second spray treatment may be necessary to help control leaf length (Krug et al., 2005; Pobudkiewicz and Treder, 2006). As demonstrated by earlier research, the length of the leaves of

lachenalia plants grown in the ground can also depend on the size of the planted bulbs (Kapczyńska, 2014a) and the spacing at which they are grown (Kapczyńska, 2013).

Irrespective of the planting time, genotype, or flurprimidol treatment, all of the planted lachenalia bulbs developed foliage and flower stalks. No phytotoxicity or negative effects were noted with any of the tested treatments or concentrations of flurprimidol. As reported by others (Asgarian et al., 2013; Cochran and Fulcher, 2013; Holcomb and Beattie, 1990; Miller et al., 2012), plants treated with growth regulators may produce abnormally short flower spikes, have a reduced number of flowers, or eventually abort the flowers. In our study, delaying the planting date reduced the time to the start of flowering. The same tendency has been observed during tuberos forcing culture (Yang et al., 2014). Soaking lachenalia bulbs in flurprimidol delayed the emergence of flowers for 3–6 d. These results are consistent with the data presented by other authors, who observed a delay in flowering when using flurprimidol in the cultivation of star of bethlehem (*Ornithogalum saundersiae*) and pineapple lily (*Eucomis* sp.) (Carlson et al., 2015; Salachna and Zawadzińska, 2013). Accurate timing of flowering is the key to achieving success in commercial horticultural production. In our study, by planting lachenalia bulbs from November to February, we obtained flowering plants from February to May. These months include several important days in terms of the commercial sale of flowers, namely Valentine's Day and the International Women's Day. In addition, the inflorescences of the cultivars studied are characterized by unusual longevity, keeping their decorative value for up to 3 weeks (Kapczyńska, 2014b).

Lachenalias have the potential to become an extremely attractive pot plant or cut flower given their variations in flower color and longevity. On the basis of our results, we recommend soaking bulbs in flurprimidol at the concentration of 30 mg·L⁻¹ to improve plant appearance and marketing quality. The results indicate that daylength greatly influences the growth and flowering of lachenalia plants. Prospective growers should

also consider the need for supplemental (photoperiodic and assimilation) lighting during autumn–winter cultivation.

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