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'Namakwa' lachenalia's response to flurprimidol and different planting dates

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ABSTRACT

The genus *Lachenalia* has great potential as a floriculture crop used as a pot plant or cut flower. Flurprimidol preplant bulb soaks (from 15 to 30 mg dm^{-3}) and foliar sprays (from 15 to 60 mg dm^{-3}) were applied for the growth control of 'Namakwa' *Lachenalia*. Bulbs were planted in November, December, January and February and cultivated in a greenhouse. With a delaying of planting time, more compact plants with shorter and wider leaves and with floriferous inflorescence stems were obtained. Floret length, stem diameter and leaf number remained unaffected by planting date and flurprimidol treatment. The most evident impact of flurprimidol on shortening leaf and inflorescence stem length was noted after soaking the bulbs in 30 mg dm^{-3}. The later the planting date, the shorter the time to the beginning of flowering. Soaking the bulbs in flurprimidol at 15 and 30 mg dm^{-3} and spraying with flurprimidol at 60 mg dm^{-3} resulted in a delay of flowering by 3-6 days.

Key words: Cape Hyacinth, geophyte, morphology, Topflor 015 SL

INTRODUCTION

Ornamental geophytes have become an integral part of the world floriculture industry in recent times. They can be grown as landscape or interior plants, outdoor or forced cut flowers, and finally as forced potted plants (De Hertogh and Le Nard 1993). The genus *Lachenalia* (Asparagaceae) represents vegetation of a deciduous nature of plants originating from southern Africa. The biological rhythm of these bulbs in the natural environment consists of a dormant stage during the summer season and of an active growth and flowering stage during the winter when there are peaks of rainfall. Lachenalia ranks among ornamental crops for its variety in flower colour and unique spotted stems and leaves (Duncan 2012), thus possessing a commercial potential in cut flower and pot flower production. The genus *Lachenalia* has been the subject of breeding programs since the sixties, which have resulted in the release of nearly 30 cultivars but the process of their commercialization still continues (Reiten et al. 2011). The lack of knowledge on the technology of growing new flower bulbs that originate from areas with a high light intensity can constitute a significant problem in flower production in those regions of the world that experience a light deficit, especially at the turn of the calendar year. Basic and still insufficiently described issues in lachenalia production include the improvement of controlled cultivation methods of potted plants during the winter and early spring. During this period the demand for potted flowering plants seems to be the highest because of a rather low supply of decorative indoor pot plants. Success

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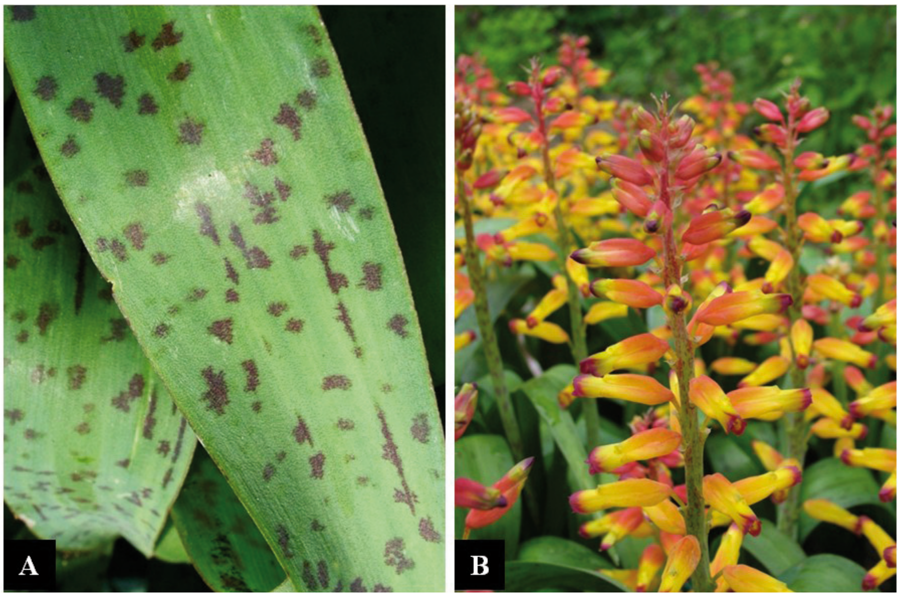


Figure 1. Morphological characteristics of 'Namakwa' lachenalia: A – spots on leaves, B – plants at flowering stage

of the floriculture business depends to a large extent on the standardization of production details, such us terms of cultivation and prediction of flowering time. For that reason, there is a need to investigate and estimate a suitable planting date for new flower bulbous plants, such as lachenalia, to obtain flowering plants at the required time.

The final quality of potted plants is closely related to their shape - they should be compact and have strong stems. In the present study, different flurprimidol treatments were tested to obtain plants with more desirable value in the market context. Flurprimidol effectively reduces the elongation growth of cells through the inhibition of gibberellin biosynthesis (Rademacher 2000). It has been shown that the application of flurprimidol is effective in inhibiting the growth of many ornamental geophytes (Krug et al. 2005, Pobudkiewicz and Treder 2006, Filios and Miller 2013, Sprzączka and Laskowska 2013), but so far, there is no information on the use of plant growth regulators in lachenalia cultivation. The objective of this study was to determine how planting date and flurprimidol affect the quality of 'Namakwa' potted lachenalia grown in the light conditions of a temperate climate.

MATERIAL AND METHODS

The experiment was conducted in 2012-2013 in the Faculty of Biotechnology and Horticulture glass greenhouse (University of Agriculture, Kraków, Poland) with a constant temperature set point of 18°C/15°C (day/night) and under natural light conditions. The plant materials were the bulbs of lachenalia (*Lachenalia* Jacq ex Murray) 'Namakwa' (Fig. 1) imported from the company Afriflowers (South Africa) (average: diameter 2.0-2.3 cm, weight 3.5-4.5 g). The studied factors included planting date and flurprimidol treatments. The bulbs were planted on four dates: 23 November 2012, 20 December 2012, 24 January 2013, and 25 February 2013. In each planting date the following flurprimidol (Topflor 015 SL) treatments were applied: soaking the bulbs before planting for 60 minutes in flurprimidol solutions at concentrations of 15 or 30 mg dm^{-3}, applying a single foliar spray when the average leaf length was 15 cm using flurprimidol at the following concentrations: 15, 30, 45, or 60 mg dm^{-3} (plant sprayed uniformly). The control plants were not treated with the retardant at all. The bulbs were planted into 19 cm plastic pots (5 bulbs per pot) containing a commercial peat substrate (Botanica Professional, Comeco, pH of 5.5-6.5). During the vegetative season, the plants were treated with liquid fertilizer (Florovit Universal; Inco-Veritas) every two weeks at the concentration of 1.0%.

Plants were evaluated at the beginning of flowering. The data regarded: inflorescence stem height (soil level to the apex of the inflorescence), inflorescence length (from the lowermost floret to the apex of the inflorescence), the number of florets in the inflorescence, the inflorescence stem diameter, 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, second and third leaf and the number of days to the beginning of flowering.

The experiment was a completely randomized design with four replications of each treatment combination: 4 planting dates × 7 flurprimidol treatments (including the control). Each replication consisted of one pot containing five plants (20 bulbs per treatment combination).

The data were statistically analysed by software system STATISTICA 10.0 (Stat-Soft, Inc., USA) and the means were compared using Tukey's multiple range test at a significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

The course of flowering and the quality of crops are coordinated with seasonal environmental factors – one of them is the photoperiod, which plays an especially important role in temperate climates (Andrés and Coupland 2012, Ream et al. 2014). In the present study, there is a clearly visible downward trend in the inflorescence stem height with a delaying of planting date (Tab. 1), which in practice means more a compact plant shape. This feature is crucial in term of production, transport and marketing. Shorter inflorescences with fewer flowers were observed in plants from the groups planted at the end of the year (November and December) than in plants planted at the beginning of the year (January and February). The shortest stems with the largest diameter and with the largest number of florets were recorded for bulbs planted in February. The study revealed that floret length was not influenced by planting date and that the average value of this parameter was 2.8 cm. Shorter and wider leaves were obtained with the delay in the planting date (Tab. 2). Irrespective of the planting date and flurprimidol treatment, 'Namakwa' lachenalia formed the same number of leaves - an average of 2.7 leaves per bulb (data not shown). The determination of the proper planting date has been described for many ornamentals geophytes (Fukai et al. 2013, Thakur et al. 2014, Yang et al. 2014, Kocira et al. 2015, Nayeem and Qayoom 2015). Using standardized forcing schedules approved for particular species may reduce production costs and increase the number of elite plants with increased market value (Adil et al. 2013).

Lachenalia planted in November and December had the lowest quality. Plants were characterized by too long stems and leaves and a lower number of florets, which may be the result of short days and low average insolation noted in this part of Europe at the end of the year (Matuszczyk et al. 2015). According to Du Toit et al. (2001), lachenalia is a geophyte in which the initiation of flowering

Table 1. Effect of planting date (PD) and flurprimidol treatment (FT) on the inflorescence quality of 'Namakwa' lachenalia

Factor	Infloresc. stem ht (cm)	Infloresc. length (cm)	No. of florets	Floret length (cm)	Stem diam. (cm)
			Planting date		
Nov	37.1±0.6 d*	12.9±0.2 a	19.9±0.3 a	2.7±0.02 a	0.5±0.01 a
Dec	35.7±0.4 c	12.4±0.2 a	19.4±0.3 a	2.8±0.01 a	0.5±0.01 a
Jan	33.5±0.5 b	14.6±0.2 b	25.1±0.3 b	2.8±0.01 a	0.6±0.01 b
Feb	29.5±0.6 a	14.7±0.2 b	28.6±0.4 c	2.8±0.01 a	0.7±0.01 c
		Flurprimidol treatment: application /concentration (mg dm^{-3})			
Control/0	36.4±0.9 d	14.2±0.4 b	24.2±1.1 b	2.8±0.02 ab	0.6±0.03 a
Soak/15	32.9±1.1 a-c	13.6±0.4ab	23.5±1.1 b	2.9±0.02 b	0.6±0.03 a
Soak/30	31.1±1.2 a	13.7±0.3 ab	21.7±1.1 a	2.8±0.02 ab	0.6±0.02 a
Spray/15	36.2±0.9 d	14.1±0.3 ab	24.1±1.0 b	2.8±0.02 ab	0.6±0.03 a
Spray/30	34.6±1.0 cd	13.4±0.4 ab	23.6±1.1 b	2.8±0.03 ab	0.6±0.02 a
Spray/45	33.7±0.6 bc	13.5±0.4 ab	23.1±1.0 ab	2.7±0.01 a	0.6±0.02 a
Spray/60	32.6±0.5 ab	12.9±0.3 a	22.8±1.0 ab	2.8±0.02 ab	0.6±0.02 a
			Main effects**		
PD	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FT	<0.0001	<0.0002	<0.0001	<0.0144	NS
PD × FT	<0.0001	<0.0349	NS	<0.0025	NS

*Mean values in columns followed by a different letter(s) are significantly different according to Tukey's least significant difference test at $p \leq 0.05$
**Significant effects ($p \leq 0.05$)

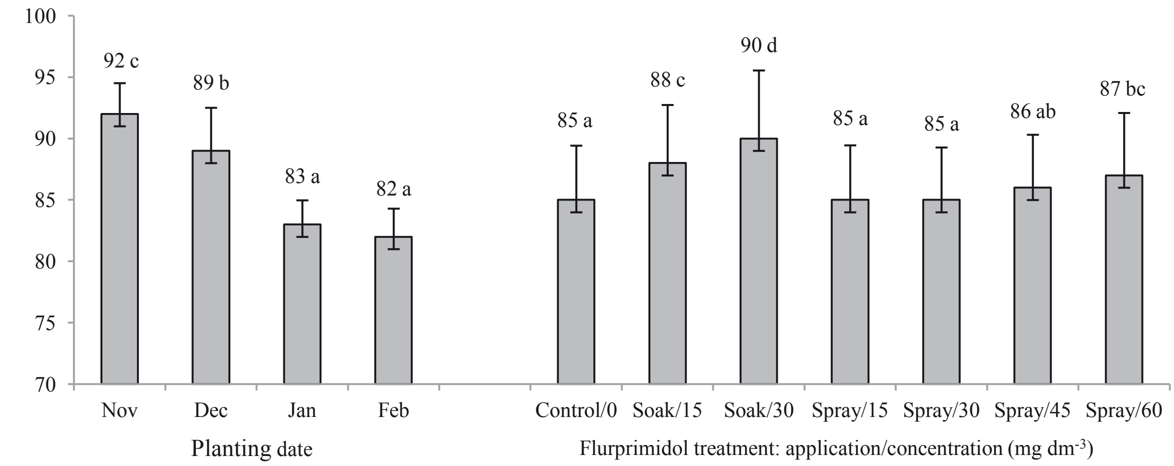
Table 2. Effect of planting date (PD) and flurprimidol treatment (FT) on the leaf characteristics of 'Namakwa' lachenalia

Factor	First leaf length (cm)	First leaf width (cm)	Second leaf length (cm)	Second leaf width (cm)	Third leaf length (cm)	Third leaf width (cm)
			Planting date			
Nov	39.0±0.7 d*	3.7±0.1 a	39.0±0.8 d	2.9±0.1 b	34.8±0.8 d	1.8±0.5 a
Dec	37.0±0.8 b	3.7±0.1 a	37.6±1.0 c	2.7±0.1 a	32.6±0.8 c	1.8±0.5 a
Jan	33.2±0.9 a	3.9±0.1 b	31.1±0.9 a	3.0±0.1 c	28.5±0.9 a	2.0±0.5 b
Feb	36.4±0.8 b	4.4±0.1 c	34.8±0.8 b	3.5±0.1 d	30.3±0.9 b	2.3±0.6 c
		Flurprimidol treatment: application /concentration (mg dm^{-3})				
Control/0	40.1±0.5 f	3.7±0.1 a	40.2±0.9 d	2.8±0.1 a	36.0±0.6 d	1.8±0.1 a
Soak/15	29.7±0.6 b	4.1±0.1 b	32.9±1.4 b	3.2±0.1 b	28.9±1.4 b	2.1±0.1 b
Soak/30	24.1±1.2 a	4.5±0.1 c	28.2±0.7 a	3.5±0.1 c	24.4±0.7 a	2.4±0.1 c
Spray/15	39.8±0.5 ef	3.8±0.1 b	39.9±0.9 d	2.9±0.1 b	35.8±0.6 d	1.8±0.1 a
Spray/30	38.2±0.8 de	3.8±0.1 b	36.8±1.1 c	2.9±0.1 b	32.9±0.9 c	1.8±0.1 a
Spray/45	37.0±0.9 cd	3.8±0.1 b	36.0±1.0 c	2.9±0.1 b	31.8±0.7 c	1.9±0.1 a
Spray/60	36.0±0.7 c	3.8±0.1 b	35.3±0.8 c	2.9±0.1 b	31.1±0.7 c	1.9±0.1 b
			Main effects**			
PD	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FT	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
PD × FT	<0.0001	<0.0001	<0.0001	<0.0029	<0.0001	<0.0001

*Mean values in columns followed by a different letter(s) are significantly different according to Tukey's least significant difference test at $p \leq 0.05$
**Significant effects ($p \leq 0.05$)

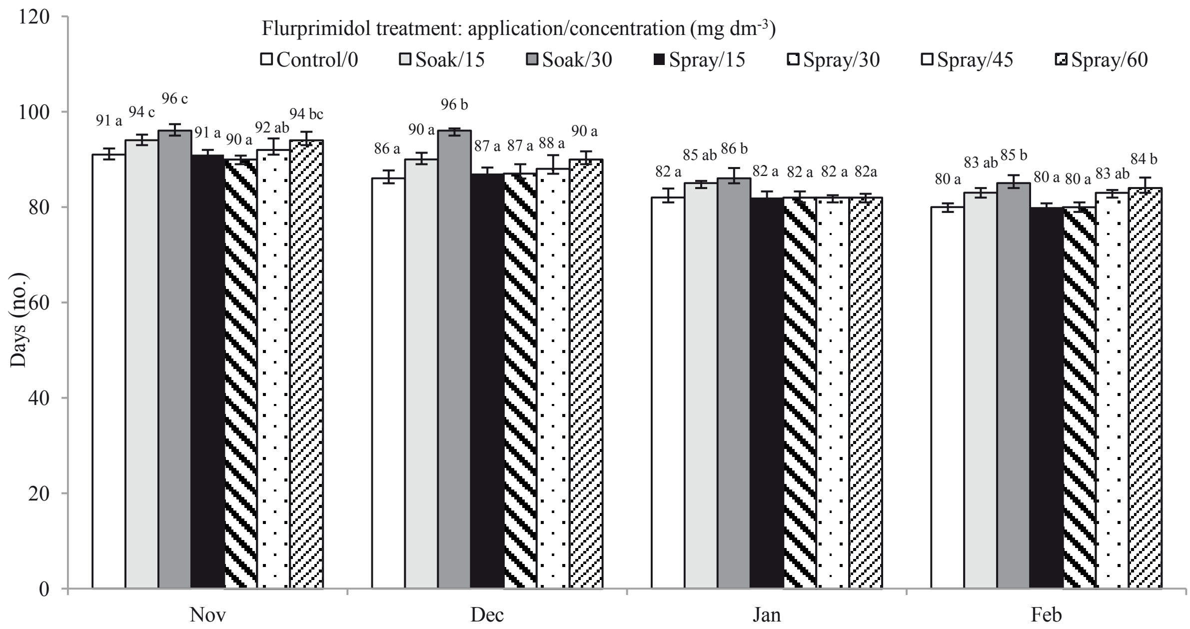
occurs during the dormancy period, when the development of newly formed flowers and leaves occurs. The results of our experiment show that morphogenesis is not completely finished during the storage of bulbs and that light is one of the main environmental factors which controls the growth and development of plants during the cultivation stage. Ehrich et al. (2009) report that low natural light levels and short days during fall and winter months may lead to flower abortion or a delay in flowering of different African geophytes with a high potential as floricultural crops. In order to have an extend marketing period and manipulate the flowering of potted lachenalia, supplemental lighting should be considered by future commercial growers during the winter months.

Compared to the control plants, soaking the bulbs in flurprimidol at 15 and 30 mg dm^{-3} and spraying the leaves with flurprimidol at 45 and 60 mg dm^{-3} resulted in the shortening of inflorescence stem height (Tab. 1). The most evident impact of the flurprimidol treatment was noticed for soaking the bulbs in 30 mg dm^{-3}; in this case the inflorescences stems were about 5.3 cm shorter than the stems of the control plants. We noticed that only plants sprayed with flurprimidol 60 mg dm^{-3} had shorter inflorescences (by 1.3 cm) than the control plants. Various methods of flurprimidol treatments have been effective, causing the height reduction of other bulbous species, such as *Eucomis* (Filios and Miller 2013), *Tulipa* (Sprzączka and Laskowska 2013), *Lilium* (Pobudkiewicz and Treder 2006) or *Allium* (Laskowska et al. 2013). In the present study, soaking the bulbs of lachenalia in flurprimidol at 30 mg dm^{-3} resulted in a decrease in the number of florets by 10% compared to the control, but it did not affect the visual quality of the plants. Compared to the control plants, soaking and spraying with retardant did not influence the floret length and stem diameter of 'Namakwa' lachenalia. In previous research, the excessive growth of lachenalia in containerised production was observed; during greenhouse cultivation in winter months the leaves produced by the plants exceeded the length of 40 cm (Kapczyńska 2014), which made the plants' shape not well balanced to pot size. In the present study, the influence of flurprimidol treatment on leaf length was stronger as its concentration increased and all types of flurprimidol treatment, except spraying at 15 mg dm^{-3}, resulted in a shortening of the leaf length (Tab. 2). The shortest and widest leaves were obtained from bulbs soaked in flurprimidol at 30 mg dm^{-3}. Compared to the control plants, this treatment reduced the first, second and third leaf



*Mean values followed by a different letter(s) are significantly different according to Tukey's least significant difference test at $p \leq 0.05$

Figure 2. Effect of planting date and flurprimidol treatment on the number of days to the beginning of flowering of 'Namakwa' lachenalia



*Mean value followed by a different letter(s) are significantly different by Tukey's least significant difference test at $p \leq 0.05$

Figure 3. Effect of flurprimidol treatment in each planting date on the number of days to the beginning of flowering of 'Namakwa' lachenalia

length by 26%, 30% and 32% and their width by 22%, 25% and 33%, respectively. This is consistent with Ranwala et al. (2005), who claim that preplant bulb soak is more effective than other methods of retardant application, because it controls the plant height from the start of cultivation.

In our study, we observed that by delaying the planting date, the time to the beginning of flowering became shorter, except for bulbs planted in January and February, which flowered after the same period of time (Fig. 2). Seasonal changes in day length during plant cultivation influence the timing of flowering (Song et al. 2013), thus bulbs of lachenalia planted in conditions of insufficient light needed more time to flower than bulbs planted later. Compared to the control plants, soaking the bulbs in flurprimidol at 15 and 30 mg dm^{-3} and spraying them with flurprimidol at 60 mg dm^{-3} resulted in a delay of flowering of 3-6 days (Fig. 2). This confirms the results obtained by Pobudkiewicz and Nowak (1992), who observed that soaking the bulbs of Asiatic hybrid lilies in flurprimidol delayed their flowering by a few days. On the bases of our experiment we can state that the flowering period of 'Namakwa' lachenalia produced in a greenhouse during the winter months begins an average of three months after bulb planting, so the bulbs can be forced to bloom for early spring sales (Valentine's Day, Woman's Day). In Figure 3, the detailed mean values for the number of days to the beginning of flowering for each flurprimidol treatment in each planting date are shown separately, as they may have a great importance in lachenalia production.

The genus *Lachenalia* represents the impressive biodiversity of South Africa and has a great potential to become a competitive component of the international flower trade, but the commercialization of a new crop in the international bulb industry requires a long period of scientific research to transfer them into practical production methods (Niederwieser et al. 2002). The presented results may be helpful in establishing a cultivation scheme for lachenalia in the light conditions of a temperate climate.

CONCLUSIONS

1. Thinner stems and shorter inflorescences were formed by bulbs planted in November and December.
2. A delay in planting time resulted in an increased number of florets in the inflorescence.
3. With a delay in the date of bulb planting, shorter and wider leaves were obtained.
4. The most visible impact of flurprimidol treatment on the reduction of the elongation growth of leaves and stems resulted from soaking the bulbs in the concentration of 30 mg dm^{-3}.

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AUTHOR CONTRIBUTIONS

A. Kapczyńska – contributed to the entire process, data analysis, interpretation and writing; A. Kidawska – conducted biometric measurements and was involved in the literature research.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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