Effect of Two Temperature Regimes and Watering Frequency on the Growth of *Lachenalia* 'Ronina'

E.S. du Toit and P.J. Robbertse
Department of Plant Production and Soil Science, Faculty of Natural, Agricultural and Information Sciences, University of Pretoria, Pretoria 0002 South Africa

J.G. Niederwieser
Roodeplaat Vegetable and Ornamental Plant Research Institute, Agricultural Research Council, Private Bag X293, Pretoria, 0001 South Africa

***Lachenalia aloides* is endemic to South Africa and has good characteristics as a flowering pot plant. For optimal outdoor bulb production, the upper temperature limits for bulb yield and quality are needed for international bulb trade. The effect of two temperature regimes and two watering frequencies on the growth of small bulbs to a flowering export quality size were studied with *L.* 'Ronina'. Plants were grown under two temperature regimes and two watering frequencies. The fresh weight of plant parts was determined monthly. Quality bulbs of commercial size were produced under moderate temperature regimes. Under high temperature regimes, the retarding effect on plant growth was counteracted when sufficient water was supplied. Under both temperature regimes, bulb growth followed a typical sigmoidal curve. Bulb growth was delayed by floral emergence but increased after senescence.**

INTRODUCTION

The genus *Lachenalia* Jacq.f. ex Murray belongs to the family Hyacinthaceae (Duncan, 1988) which was previously a part of the family Liliaceae, *sensu lato* (Dahlgren, Clifford, and Yeo, 1985). It is the largest genus in the family consisting of approximately 110 species which are all geophytes with tunicate bulbs (Duncan, 1988). *Lachenalia* is endemic to Southern Africa where it has a wide distribution in the south and south-western regions of South Africa (Duncan, 1988).

A breeding programme was initiated at Agricultural Research Council (ARC) Roodeplaat near Pretoria to develop *Lachenalia* cultivars for commercial use as pot plants. *Lachenalia* 'Ronina' is one of the registered cultivars that has excellent characteristics for use as a flowering pot plant and has the potential to be accepted on markets in different countries (Coertze, et al., 1992). It follows a growth cycle of winter rainfall plants which usually entails rapid vegetative growth in autumn (April to May), followed by flowering in winter and spring (June to September). Flowering and fruiting are followed by a long dormant period during the hot dry summer months (November to March) (Duncan, 1988).

Temperature is an important environmental factor in the in vivo (Niederwieser and Vcelar, 1991; Perrignon, 1992) and in vitro (Nel, 1983; Louw, 1991) propagation of plants. Temperature regimes also have a major role (Louw, 1992) in in vivo bulb storage for successful flower forcing. In addition, the effects of temperature and watering frequency on the growth of small bulbs of *Lachenalia* 'Ronina' to bulbs of final commercial flowering size has not yet been extensively studied (De Hertogh and Le Nard, 1993; Roodbol and Niederwieser, 1998).

Lachenalia bulbs can contribute to the international bulb trade, for which high quality bulbs are required. For optimal outdoor bulb production information on the upper temperature limits for bulb yield and quality are needed as well as the interactions between moisture levels and temperature.

The objective of this study was to determine the effect of two temperature regimes (relatively high and moderate) and two watering frequencies on the growth of small bulbs to flowering size.

MATERIALS AND METHODS

Eight hundred flowering size bulbs (10 to 15 mm diameter, ±1 g) of *Lachenalia* 'Ronina' were received from the ARC Roodeplaat in 1996 and 1997. The quality of the bulbs differed between the 2 years because of different origins. For each year the bulbs were planted in 9-cm plastic pots containing a sterilized peat moss growing medium. On 1 March 1996 and 1997 the potted bulbs were moved into two environmental growth cabinets (Model PGW-36, Conviron, Canada) with 14-h illumination at ± 200 μmol m^{-2} s^{-1} photosynthetic active radiation (PAR) supplied by WHO fluorescent and incandescent bulbs at plant height level; each cabinet ran at a different temperature regime (Table 1). In 1996 all pots were flushed with distilled water three times a week. In 1997 the watering frequency of temperature regime (TR1) (high-temperature treated) pots was done daily. From 15 Aug. the watering frequency in both cabinets was gradually decreased until 15 Oct. whereafter no water was applied. This decrease in watering frequency forced the plants into a dormant stage before storage.

Table 1. Temperature regimes during the bulb preparation phase in 1996 and 1997.

	Temperature Regime 1 (TR1) (°C)		Temperature Regime 2 (TR2) (°C)	
Duration	Day 14 h	Night 10 h	Day 14 h	Night 10 h
1 March-15 June[1]	28	12	22	10
15 June 15 July[2]	28	12	22	10
15 July 15 August	28	12	27	15
15 August 15 October[3]	33	17	32	20
15 October 15 November[4]	35	35	35	35

[1]Foliage emergence
[2]Full-bloom (Anthesis)
[3]Foliage and Inflorescence senescence
[4]Bulbs were dormant

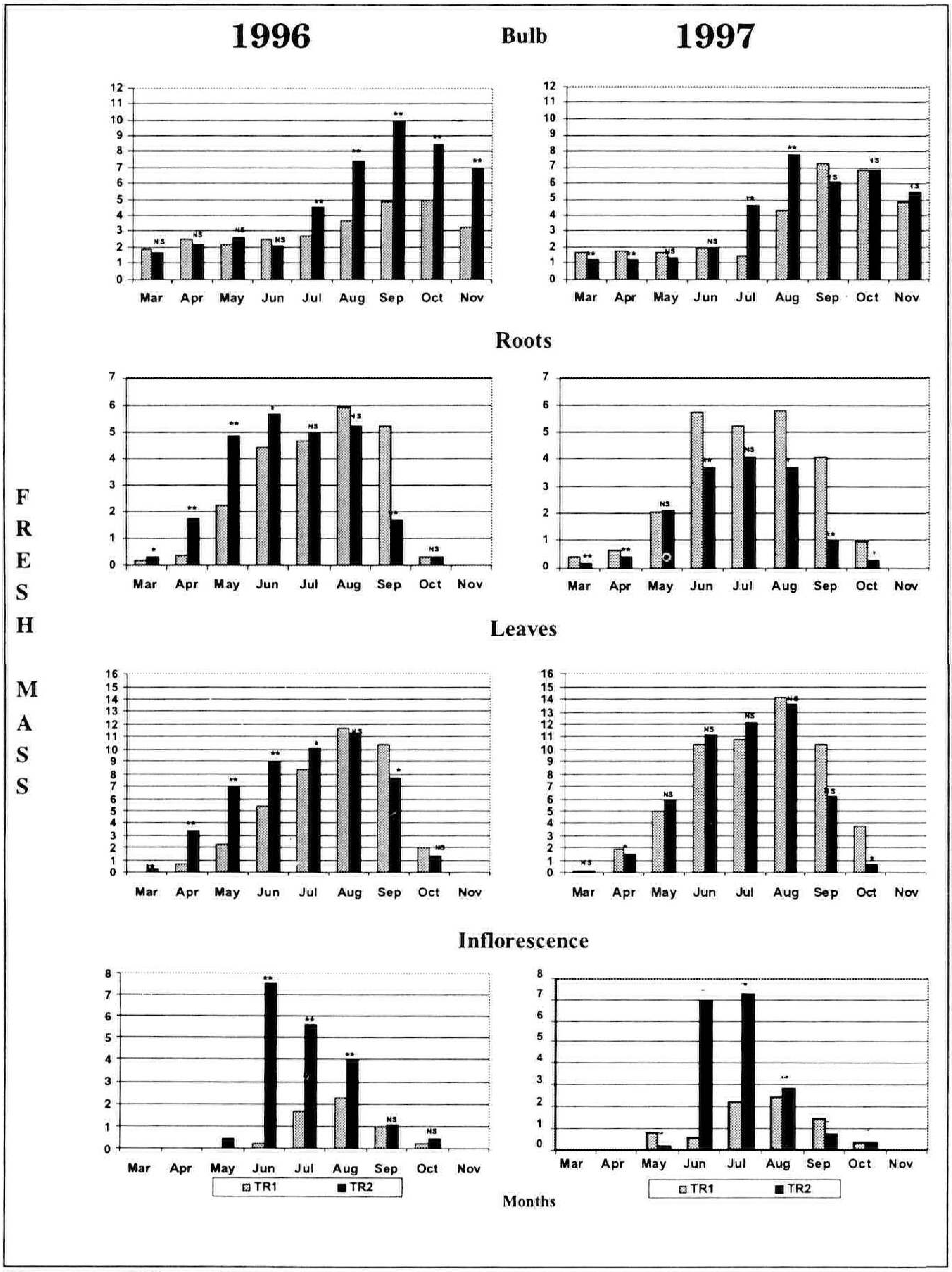

Figure 1: Effect of two temperature regimes on the growth of *Lachenalia* 'Ronina' during bulb preparation phase.

Ten replications of 40 potted bulbs each were randomly arranged in each of the two cabinets. On the 15th of every month during the growing phase, 10 plants from each cabinet (treatment) were dissected into bulbs, roots, leaves, and inflorescence and the fresh weight of each portion determined. Data were analysed using the PROC. G.L.M. (General Linear Models) procedure in the S.A.S. (Statistical Analysis

System) program. Analysis of variance was performed and the F-test (Steele and Torrie, 1980) was calculated to compare treatment means.

RESULTS AND DISCUSSION

Figure 1 illustrates the fresh weight of plant parts as effected by the two temperature regimes and the two watering frequencies during the bulb preparation phase in 1996 and 1997.

Bulb growth followed a typical sigmoidal curve up to the time of full flower (March to June) and irrespective of treatment, there was practically no increase in bulb mass (Fig. 1). Similar results were obtained by Roodbol and Niederwieser (1998) with 'Romelia'. During this period the inflorescence was the main sink for nutrients. Bulb mass increase coincided with flower senescence. In all treatments, except for the moderate temperature regime (TR2, 1997), bulb mass increase continued until September in spite of the water cut which started in August (Fig. 1). This phenomenon is probably a result of re-translocation of nutrients from the senescent leaves which started during August.

The high watering frequency treatment of the high temperature regime (TR1) bulbs in 1997 led to a significant increase in fresh weight compared to the bulbs grown in 1996 (Fig. 1). These results are in accordance with Rees (1992) on winter flowering bulbs in the northern hemisphere. It also shows that a long exposure of high temperatures and insufficient water supply adversely effects the growth rate as well as the fresh weight of *Lachenalia* bulbs.

Bulb growth was delayed by floral emergence which for TR2 plants occurred in May and for which TR1 plants started in June (Fig. 1). The inflorescence become the first major sink for photosynthates, where after bulb scales become the dominant sinks. Rees (1992) and De Hertogh and Le Nard (1993) found similar results with tulip and other winter flowering bulbs. After full-bloom, during June and July, the photosynthates were translocated into the bulbs (major sink), where a significant increase in bulb fresh weight occurred.

At the end of the 1996 season TR1-treated bulbs were smaller than those of the TR2 treatment and had an outer covering of hard, dry membranous tunics. A few of these bulbs were rotted. Due to the competitiveness between the two main sinks, it is clear that there were not sufficient amounts of photosynthates produced for simultaneous inflorescence and bulb development. These results are in accordance with those of Saniewski, et al. (1979) showing the relationship between bulb growth and aerial plant organs of *Hyacinthus*. Bulbs produced during the 1997 season under both temperature conditions were healthy and of export quality mainly because of the increase in watering frequency.

The maximum fresh weight of the roots was reached during full bloom which was 2 months before the leaves reached their maximum biomass. After the maximum fresh weight of the roots was reached, the roots maintained their fresh weight until full bloom, then decreased rapidly because of the senescence of the whole plant (Fig. 1).

The higher water application rate during 1997 increased the root fresh weight of TR1-treated plants (Fig. 1), thus stimulating root emergence and elongation. This confirms the results of Richards, et al. (1952) and Gregory (1983) that increasing root temperatures increase root meristem initiation and differentiation of higher plants.

Leaf emergence and growth in all treatments reached its peak during August after which the leaves started to age rapidly towards the end of the growing season (Fig.

1). The slower growth rate of leaves at the high temperature regime (TR1, 1996) indicated that a water deficiency under a high temperature regime may have led to low photosynthetic rates, followed by a decrease in overall carbon supplies (Chaves, 1991; Hsiao, 1973; Lauer and Boyer, 1992; Sharp and Davies, 1989). In 1997 the effect was reversed by the increase in watering frequency (Fig. 1). This evidence reflects that soil moisture, independent from the two temperature regimes, plays an important role in foliage emergence and growth. Leaves of the moderate temperature regime (TR2) were also robust, broad, lanceolate, upright, and healthy compared to long, narrow, and curved leaves of the high temperature regime (TR1).

Inflorescences of bulbs grown at the moderate temperature regime (TR2) emerged 1 month earlier and were much larger than those of plants grown at the TR1 (high temperature regime) (Fig. 1). Although flower initiation and differentiation took place at the same time and at the same temperature during storage before planting (Louw, 1992), we show evidence that different temperature regimes during the bulb preparation phase affected flowering rate. Roh and Meerow (1992) also stated that temperature plays an important role in inducing early flowering of *Eucrosia bicolor* bulbs. In 1997 the increase in watering frequency on TR1 plants (Fig. 1)minimized the high temperature effect on floral development. An increase in watering frequency thus improves inflorescence emergence, but not the inflorescence size. These results are in contrast with Roh and Meerow (1992) who claimed that watering treatments had no effect on days to flower of *Eucrosia bicolor* bulbs.

CONCLUSION

In conclusion, bulbs of a commercial flowering size can successfully be grown under a moderate temperature regime. The negative effect of a high temperature regime on bulb growth can be counteracted if sufficient water is supplied. It is also evident that temperatures to which the bulbs are subjected during their enlargement can affect their physiological state at harvest. A following report will stress about the timing, duration, and sequence by which drought-stressed plants reallocate their limited photosynthates to growth, reproductive development, and storage and the effect it will have on the commercial end product the following year.

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