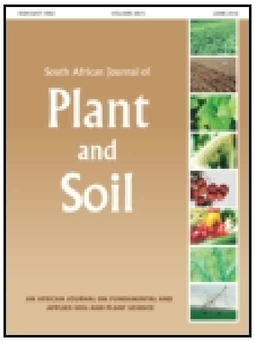

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Effects of nutrient regime on bulb yield and plant quality of Lachenalia Jacq. (Hyacinthaceae)

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Effects of nutrient regime on bulb yield and plant quality of *Lachenalia* Jacq. (Hyacinthaceae)

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The effects of different nutrient regimes on the *Lachenalia cvs* 'Romelia' and 'Namakwa' were studied over two successive seasons. The basic formulation of the Commisie Glastuinbouw (1992), *viz* 0.37 g KNO_3 + 0.36 g $Ca(NO_3)_2$ + 0.06 g $MgSO_4$ + 0.013 g $(NH_4)_2SO_2$ l^{-1} water was tested at different concentrations. (0, 50%, 100%, 200%). Bulb yield and plant quality grown in silica sand were evaluated. Both cultivar and nutrition level had highly significant effects on yield (% mass increase of bulbs and bulb size) and quality (leaf length, inflorescence length and number of florets per inflorescence). The standard 100% treatment is recommended for production of bulbs during the bulb preparation phase as well as for pot plant production as the treatment resulted in the best overall results. The % mass increase of small bulbs (4 cm circumference) was notably higher than for large bulbs (6 cm). The effect of bulb size on the number of florets was also clear: Large bulbs formed more florets than small bulbs. The importance of nutrition in the previous season as well as the season when plants flower, on the number of florets per inflorescence, was shown. Results appear to indicate that the nutritional requirements of the two cultivars may be different and that large bulbs may require higher nutrient levels than small bulbs.

Die effek van verskillende voedingstof regimes op *Lachenalia* cvs 'Romelia' and 'Namakwa', is vir twee agtereenvolgende seisoene bestudeer. Die basiese formulasie van Commisie Glastuinbouw (1992) is gebruik; 0.37 g KNO_3 + 0.36 g $Ca(NO_3)_2$ + 0.06 g $MgSO_4$ + 0.013 g $(NH_4)_2SO_2$ l^{-1} water. Die effek van die formulasie teen verskillende konsentrasies (0, 50, 100 en 200%) op bol opbrengs en kwaliteit van plante in silika sand is bepaal. Beide cultivar en konsentrasie van die basiese formulasie het hoogs betekenisvolle effekte op opbrengs (% massa toename van bolle en bolomtrek) en kwaliteit (blaarlengte, bloeisteellengte en aantal blommetjies per bloeisteel) getoon. Die 100% toediening van die standaard formulasie word aanbeveel vir produksie van bolle en potplante aangesien dit oor die algemeen gelei het tot die beste resultate. Die persentasie massa toename van klein bolle (4 cm omtrek) was aansienlik hoër as die van bemarkbare bolle (6 cm). Die invloed van die bolgrootte op die aantal blomme is duidelik aangetoon: groot bolle het meer blomme gevorm as klein bolle. Die belang van voeding in die voorafgaande seisoen, sowel as die seisoen waartydens plante blom is deur hierdie studie aangetoon. Resultate dui op die moontlikheid dat die voedingsbehoeftes van die twee cultivars verskil en dat bolle met 'n omtrek van 6 cm 'n hoër voedingsbehoefte het as bolle van 4 cm.

Keywords: Bulb size, flower bulbs, Hyacinthaceae, *Lachenalia*, nutrient regimes

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Introduction

Lachenalia Jacq. is a genus of flowering bulbs indigenous to South Africa and is winter growing with a dormant period in summer. Although *Lachenalia* cultivars have been developed (Hancke & Coertze, 1988), the commercialization of these plants has been limited by lack of knowledge on basic cultivation practices. The nutritional requirement of *Lachenalia* was one of the fundamental aspects that needed investigation.

Daughter bulb formation of *Lachenalia* takes place during the dormant period and occurs between the innermost bulb scales (Louw, 1993), while supernumerary bulblets form on the axillary meristems of the outermost leaf bases before flowering in the growing season (Roodbol & Niederwieser, 1998). The initiation and differentiation of the inflorescence takes place during the dormant period (Louw, 1993). The quality of the inflorescence and offsets (daughter bulbs and supernumerary bulblets) can thus be influenced by the nutritional status of the bulbs before flower initiation. *Lachenalia* bulbs are marketable when they have a circumference greater than 6 cm. Daughter bulbs, offsets and bulblets produced by means of leaf cuttings are grown on for at least one more season to reach marketable size and nutrition could influence the number of bulbs reaching a 6 cm circumference in only one season.

Bould (1939) found that the growth of tulip and narcissus bulbs in a given season is largely dependent on the inorganic substances absorbed and the nutrients metabolised during the previous season. According to Cheal & Hewitt (1963) nitrogen plays a major role in the propagation of tulips, and additionally the storage quality of bulbs during dormancy is influenced by the mineral status of the bulbs at harvest. Claassens (1990) studied the nutritional requirements of *Lachenalia* using a modified Hoagland nutrient solution as a basis for experiments and modifing it for different treatments. The main treatments consisted of (i) different levels of N, P, K; (ii) withholding all nutrients for certain parts of the growth season; and (iii) applying low levels of N and K for different lengths of time at the beginning of the growing season. Withholding nutrients from bulbs at the beginning of the growing season resulted in poor growth and chlorosis. When nutrients were reapplied the plants recovered slightly, but owing to the short growing season they could not recover fully. These experiments however, did not provide the fertilization requirements for maximum yield and plant vigour.

In the present study, an experiment was conducted to determine improved nutritional rates for *Lachenalia*. As the number of florets per inflorescence is determined by bulb size, the experiment was done for two successive growing seasons. The effects of the different rates were measured as yield (bulb size and mass) and vigour/quality (length of leaves and peduncles, and number of florets).

Material and methods

Bulbs of two *Lachenalia* cultivars (cvs) were used, *viz* 'Romelia' and 'Namakwa'. Bulbs were obtained from plantings at Roodeplaat Vegetable and Ornamental Plant Institute, Pretoria. Bulbs with a circumference of 4 cm were planted at the beginning of the first season (autumn) and cultivated in a glasshouse with an average minimum temperature of 10°C and average maximum temperature of 22°C. Each bulb received a unique number by which it could be identified throughout the two growth seasons and each bulb received the same treatment in the two seasons. The bulbs were planted singly in 10 cm plastic pots filled with well leached silica sand and irrigated three times a week using distilled water. At the end of the first growing season (early summer), the dormant bulbs were lifted, cleaned, and details of bulb circumference and mass recorded. The bulbs were stored dry at 25°C until the beginning of the second season, when they were planted and cultivated under conditions similar to those used during the first season. Offsets that had formed on bulbs during the first season were weighed, counted and discarded.

The basic nutrient solution consisted of 0.37g KNO_3 + 0.36 g $Ca(NO_3)_2$ + 0.06 g $MgSO_4$ +0.013 g $(NH_4)_2SO_2$ l^{-1} water. This formulation was recommended by the Commissie Bemesting Glastuinbouw (1992) as being a balanced regime for pot culture of a wide range of crops. Four rates of this nutrient formulation were applied as follows: (i) distilled water as control (TO), (ii) half the strength of the recommended formulation (T50), (iii) the basic formulation at recommended levels (T100) and (iv) the basic formulation at twice the recommended concentration (T200) The treatments were applied every third irrigation.

Micro nutrients were applied fortnighty as a foliar application using a commercial product (Trelmix ™). Super phosphate (10.5% P) was incorporated at a rate of 150 g m^{-3} sand before planting. The pots were randomly positioned in the glasshouse and each bulb was considered a replicate. There were 20 replicates of each cultivar for each treatment.

Yield was measured as percentage fresh mass increase of the original bulb plus its offsets, and as bulb circumference of the original bulbs. Plant quality was measured at full flower in terms of the length of the outermost leaf, the length of the inflorescence at flowering and the number of florets formed.

Statistical analyses were performed using Genstat (Genstat 5 Committee, 1993). The Anova included testing the two main effects, *viz.* cultivar and nutrition level and the interaction between the main effects. The results were analysed as a randomized blockless design. Bonferroni's test was used to test for significance of differences between values.

Results and discussion

Yield

Percentage fresh mass increase of bulbs: There was a significant effect (P<0.001) of nutrition level on the growth of bulbs of both cvs as shown in Figure 1. There was no interaction between fertilization level and cultivar. In year 1 the highest mass increase was observed at T100 for both cultivars but in year 2 the maximum mass increase was at T200 for both cultivars (Figure 1). The reasons for this observation are not clear at this stage, but could possibly reflect the residual effect of nutrition levels during year 1 on growth in year 2. The growth of bulbs of both cvs was notably higher in the first growth season than the second. This can probably be explained by the difference in size of the inflorescences in the different growth seasons or by the bulbs having reached an optimum size for flowering at the end of year 1. In both scenarios the reduction in bulb growth during year 2 can possibly be attributed to a re-distribution of assimilates from bulb growth to growing the inflorescence.

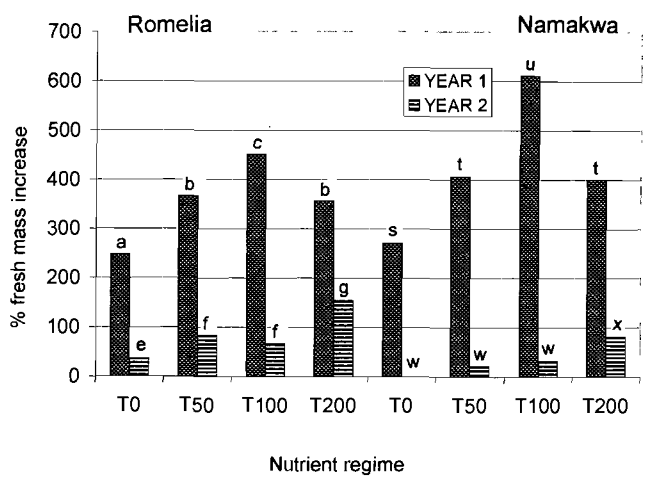

Figure 1 The % fresh mass increase of bulbs of two *Lachenalia* cultivars grown for two successive seasons at four different fertilization levels. Values accompanied by the same letter do not differ significantly (P>0.05), and the significance of differences was determined separately for each cultivar and each year.

Bulb size: There was a significant effect of nutritional level on the increase in bulb size (measured as circumference) (P<0.001) as shown in Figure 2. 'Namakwa' formed larger bulbs than 'Romelia' in the first growth season, but the size of bulbs at the end of the second season was approximately the same (not tested statistically) (Figure 2). The biggest bulbs were observed with the T100 treatment for 'Namakwa' in both seasons, but for 'Romelia' there was no significant difference between T50, T100 or T200 in year 1 or between T50 and T100 in year 2. The observation that there was no difference in bulb size between T50 and T100 for 'Romelia' and for 'Namakwa' between T100 and T200 after two growth seasons may mean that these two cvs have slightly different rates for optimal nutrition. Further experimental work will be required to determine this.

Quality

Length of leaves: The nutrition level and the cultivar both had

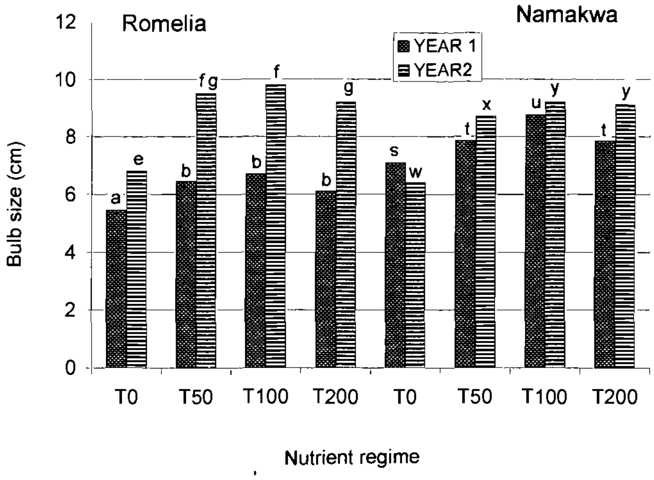

Figure 2 The average size (circumference in cm) of bulbs of tw *Lachenalia* cultivars grown for two successive seasons at four differ ent fertilization levels. Values accompanied by the same letter do no differ significantly (P>0.05), and the significance of differences wa determined separately for each cultivar and each year.

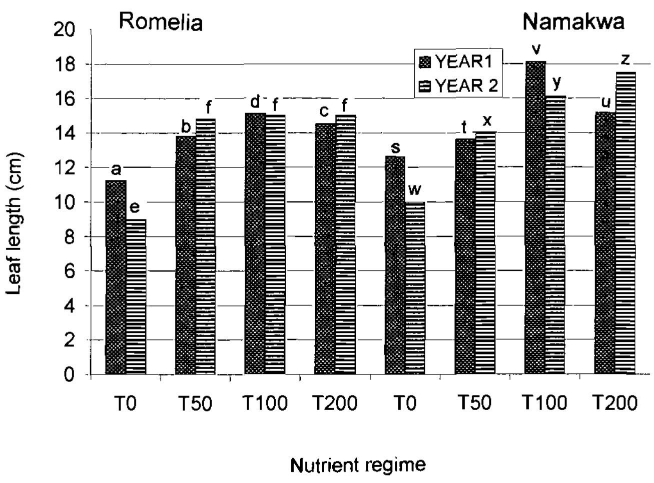

Figure 3 The average leaf length of two *Lachenalia* cultivars grow for two successive seasons at four different fertilization levels. Val ues accompanied by the same letter do not differ significantl (P>0.05), and the significance of differences was determined sepa rately for each cultivar and each year.

a significant effect (P<0.001) on the length of the leaves. The length of leaves for the two seasons was similar (Figure 3) for both cultivars despite the fact that the bulbs were smaller at the beginning of the first season than the second season. Leaves of large bulbs are generally broader than those arising from small bulbs. We recommend that future studies include leaf area measurements to obtain more complete data regarding growth responses. 'Namakwa' and 'Romelia' plants displayed a similar trend regarding leaf length in year 1 with T100 the optimal treatment. However, data of year 2 appear to reflect a residual effect of the treatments that the bulbs received in year 1 as 'Namakwa' leaves of T200 were significantly longer than those of T100. 'Romelia' did not show the same trend but in year 2 the differences between T50; T100 and T200 were not statistically different.

Length of inflorescences: The mean length of the inflores-

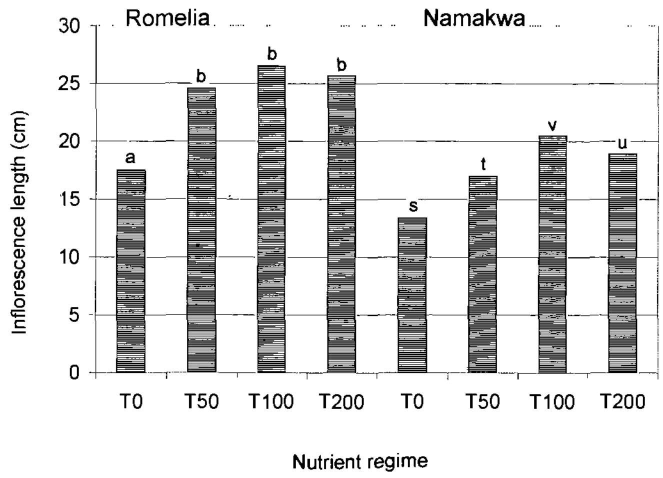

Figure 4 The average length of inflorescences of two *Lachenalia* cultivars grown for two successive seasons at four different fertilization levels. Values accompanied by the same letter do not differ significantly (P>0.05), and the significance of differences was determined separately for each cultivar and each year.

cence at full flower in year 2 is given in Figure 4. The longest peduncles were observed at the T100 treatment (P<0.001) for 'Namakwa'. For 'Romelia', the same trend was observed, but the T00 value was not significantly higher than for T50 or T200.

Number of florets per inflorescence: There was a significant effect (P<0.001) of nutrient regimes on floret number per inflorescence and particularly so in year 2 (Figure 5). The fact that the higher nutrient levels in the first year resulted in bigger bulbs is probably part of the reason why these bulbs developed more florets in the second year. But it is also clear that nutrition in the year of flowering is also important as the number of florets per inflorescence for T0 in year 1 for both cvs were significantly lower than for treatments T50; T100 and T200. These results point to the importance of growing

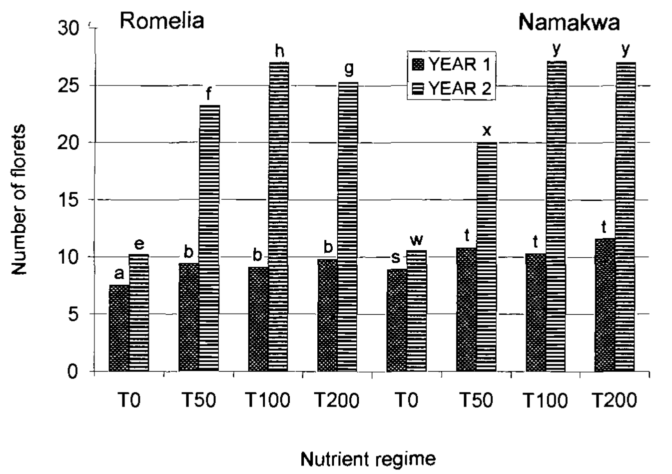

Figure 5 The average number of florets per inflorescence of two *Lachenalia* cultivars grown for two successive seasons at four different fertilization levels. Values accompanied by the same letter do not differ significantly (P>0.05), and the significance of differences was determined separately for each cultivar and each year.

conditions during the season before bulbs are used for pot plant production as well as the conditions during the forcing stage.

The effect of the size of bulbs on the number of flowers formed was demonstrated in the present study. Bulbs with a circumference of 4 cm formed approximately 10 florets per inflorescence whereas 6 cm bulbs of T50, T100 and T200 formed 20 florets and more per stem. These results are in agreement with studies on other bulbs (Rees, 1992; Beattie & White, 1993).

From the results in Figure 4 and Figure 5 it appears that inflorescence length alone can not be used as a parameter of flowering. For 'Romelia', the number of florets formed in year 2 were significantly different for all the treatments. The data for inflorescence length of T50, T100 and T200 did not differ significantly. For 'Namakwa', inflorescence length of year 2 showed significant differences, whereas number of florets per inflorescence did not. Cultivar related compactness of the inflorescence was also apparent from these results. 'Romelia' and 'Namakwa' formed approximately the same number of florets per inflorescence for T100 and T200, however, inflorescence length for T100 and T200 for 'Namakwa' was notably less than for 'Romelia'.

General

The ability of lachenalia bulbs to redistribute assimilates from senescing tissue to new bulb parts, was clearly demonstrated by the present study. After two successive growth seasons, 'Romelia' bulbs of the control treatment (T0), showed an increase in % mass increase (Figure 1) and the size of bulbs of the control treatment was greater after the second season than at the beginning of year 1. In addition, bulbs of both cvs produced inflorescences with more than 10 florets each, and this was higher than the average number formed in year1 (Figure 5).

The results point to the possibility that flowering size bulbs may require higher nutrition levels than small bulbs and that the nutrient requirement of cvs may differ. Three parameters used to evaluate growth and vigour of 'Namakwa' *viz.* % fresh mass increase of bulbs, bulb size and leaf length showed different responses in year 1 and 2. In year 1 maximum growth was recorded at T100, but in year 2 growth was maximal at T200. For 'Romelia' the same trend was observed for % fresh mass increase, but not for the other parameters. More experiments need to be carried out to confirm these observations.

Conclusion

Lachenalia responded positively to the fertilization formulation at the standard (100%) level of the basic nutrient solution and it is recommended that the T100 level of nutrition be used for growing these bulbs for commercial production. Such a nutrient supply is beneficial to bulb growth (% mass increase and circumference). This nutrition regime will give vigorous growth of *Lachenalia* plants being grown for the potted plant market. In a subsequent growth cycle a large number of florets would be produced per inflorescence and long leaves and inflorescences will be produced. Although only two cultivars were used in this study, this recommendation may be used on a general basis for *Lachenalia* until the value of the crop justifies trials for more specific recommendations.

Acknowledgements

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