Leaf Elongation Rate of Mediterranean and Temperate Tall Fescue Cultivars under Water Deficit

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Abstract

The leaf elongation rate of a temperate (*Festuca arundinacea* Schreb.) and a Mediterranean (*F. arundinacea* var. *letourneuxiana*) tall fescue cultivar in response to water deficit was studied in a glasshouse experiment. Plants of both cultivars were grown in the same containers and received water daily with gradation in intensity of water deficit achieved by varying the daily water ration per container. Leaf elongation rate (LER) was calculated for eight successive subperiods during the application of the water treatments. Under the high temperatures registered in this experiment, the Mediterranean cultivar showed lower LERs and tended to be less affected by a moderate water deficit but more affected by a severe water deficit than the temperate one.

Keywords: *Festuca arundinacea*, Mediterranean populations, leaf elongation rate, tall fescue, water deficit.

Introduction

Tall fescue is the most widely sown perennial grass in Argentina and is cultivated mainly in the Pampa region (Mazzanti and Arosteguy, 1985). There is climatic variability in the humid and sub-humid Pampa region and tall fescue occupies areas that experience winter or summer drought.

A higher winter and early spring growth of Mediterranean than temperate tall fescues cultivars has been found in field trials carried out in Argentina. Therefore the complementary use of both kinds of cultivars to improve continuity of seasonal forage supply for temperate animal production systems has been suggested (Mazzanti & Arosteguy, 1985; Mazzanti *et al.*, 1985).

Comparative studies of growth responses of Mediterranean and temperate tall fescue populations to water deficit are scarce. It has been found that Maris Kasba, a Mediterranean tall fescue cultivar, had a higher root : shoot ratio and a lower capacity for osmotic adjustment under severe water deficit conditions (Assuero, 1998). Nevertheless, it is uncertain how these adaptations would affect growth capacity under water deficit. This study reports some leaf elongation rate measurements as a preliminary answer to this question.

Material and methods

The experiment was carried out in a heated glasshouse at Unidad Integrada INTA-FCA Balcarce, under natural photoperiod (37 ^{o} 45 ' S). On 8 July 1996, 70 day-old endophyte-free plants of Maris Kasba (MK) and El Palenque (EP) cultivars were transplanted to 12 polystyrene containers of 305 x 375 x 323 mm, lined with a perforated plastic bag and filled with friable loam soil arranged in three blocks. Each container contained four rows of five plants (main tiller only) with the two cultivars arranged in alternate rows. EP tillers were defoliated to a similar leaf area as MK when transplanted. Containers were watered daily and once a week received 250 mL of half-strength Hoagland=s solution.

From 17 October to 11 November four water treatments were imposed. The treatments were: Control = 1,000 mL water d^{-1} $container^{-1}$, S1 = 800 mL water d^{-1} $container^{-1}$, S2 = 650 mL water d^{-1} $container^{-1}$ and S3 = 500 mL water d^{-1} $container^{-1}$.

Average minimum and maximum daily air temperatures from 10 October to 14 November were 11.9 ± 2.7 and 39.9 ± 5.7 ^{o}C, respectively.

Leaf elongation rate (LER) was calculated for eight successive subperiods between 15 October and 11 November on one marked tiller of the three central plants of each cultivar per container. The method was adapted from those described by Davies (1993).

The experiment was a split-plot design with watering treatments as main units, cultivars as subunits and three complete randomised blocks. Analyses of variance were performed using SAS GLM (General Linear Models) procedure (SAS Inst., Cary, NC, USA). Means were separated using the LSD at 5 % significance level.

Results and discussion

The temperate cultivar EP showed a significantly higher LER than MK (Figure 1) probably due to the high temperatures registered during the experimental period. High temperatures are known to induce a quiescent state in Mediterranean grasses (Morgan, 1964; Volaire and Thomas, 1995).

Both cultivars showed distinctive responses to water deficit in all the subperiods studied (Figure 1). During the first subperiod LER was more negatively affected in EP than in MK by the S1 treatment. In the second subperiod, while LER of both cultivars significantly decreased in response to water deficit, no differences were found between S1 and S2 in EP .

There was a null or even favorable effect of S1 on LER of MK from the third subperiod which could indicate a competitive advantage of MK plants over EP plants under moderate soil water deficit. Nevertheless, MK was more affected than EP under more severe water deficit conditions. This cultivar x water treatment interaction ($P = 0.12$) for the average LER of subperiods 3 to 8 (excluding subperiod 5, see below) is shown in Table 1. This finding is consistent with characteristics of MK plants reported previously by Assuero (1998). Our suggested explanation of the results in Table 1 is that under moderate water deficit conditions MK could maintained a higher water status than EP because of its small plant size, high root : shoot ratio and thick roots (Assuero, 1998), but that the opposite occurred under lower soil water availability because of the limited soil volume of the container and the lower capacity of MK for osmotic adjustment, compared with EP. However, no water relation measurements were carried out during the experimental period to confirm this hypothesis.

For the third and fifth subperiods unexpected LER values were measured (Figure 1). In subperiod 3 both cultivars showed a gradation in LER from Control to S3. However, except for S3 in EP and for S2 and S3 in MK, values increased compared with subperiod 2. The reason for this response is unclear. During the fifth subperiod EP plants showed higher LERs under the most severe water deficit treatments. This result could be due to the low mean air temperatures that occurred in that subperiod which might have decreased the atmospheric vapor pressure deficit. Since in our experiment plants were watered daily, low temperatures may have allowed the plants to maintain a high water content even under S3 treatment. This response could be related to the findings of Durand et al. (1995), who measured higher rates of emergence of leaf cells from the growth zone during the first two days after rewatering than before drought. This response was not observed in MK plants probably because of the effect of high temperatures of the experiment as discussed above.

The results above confirm that these cultivars are differentially adapted to water deficit conditions. The morphological adaptation of increased root : shoot ratio (Assuero, 1998) in the cultivar MK would have little benefit where soil volume is restricted, as it was in the current experiment. Presumably, the mixed planting of the MK cultivar together with EP cultivar which exhibits osmotic adjustment in response to water deficit, and therefore may reduce soil moisture to lower levels than MK, would have further stressed MK plants, also. In addition, the response observed in the fifth period would suggest that differences between cell dynamics in leaf meristems of both cultivars might be involved. We therefore suggest that future studies of water deficit on these contrasting cultivars should be carried out under field conditions and incorporate water relations measurements, a recovery phase after drought and evaluate cell dynamics in leaf meristems. Comparison of soil water levels in pure swards of the two cultivars could also be useful.

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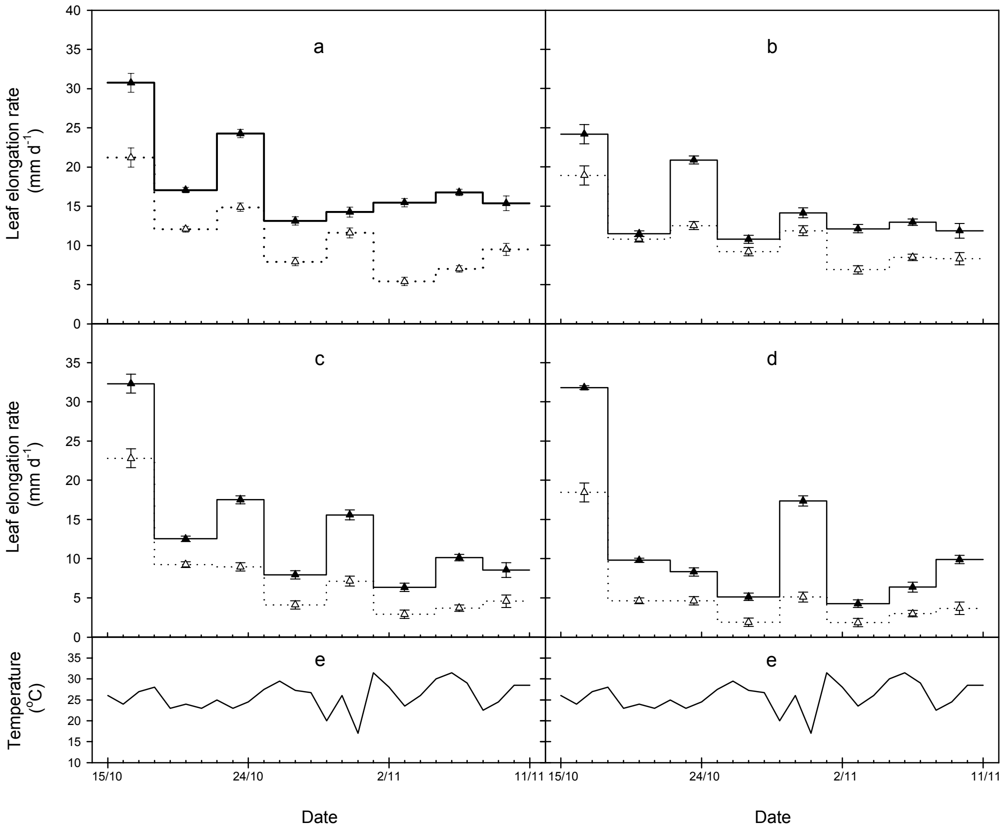

Figure 1 - Leaf elongation rate of a temperate (El Palenque, solid line) and a Mediterranean (Maris Kasba, dotted line) tall fescue cultivars receiving four different daily water rations per container (a) Control = 100 %, (b) S1 = 80 %, (c) S2 = 65 % and (d) S3 = 50 %. (e) Mean air temperature. Each point is the mean of four measurements ± standard error.