Plant traits associated with winter growth of perennial grass cultivars

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Abstract

The availability of perennial grass cultivars with contrasting winter herbage productivity provided the opportunity to examine plant traits that may underlie these differences. In cultivar comparisons within phalaris, tall fescue, cocksfoot and perennial ryegrass between June and September at Canberra, ACT, leaf elongation was positively correlated with the minimum temperatures recorded and was significantly greater in the winter-active type of phalaris, tall fescue and cocksfoot. No significant differences were found between cultivars for tiller number or leaves per tiller. Cultivar differences in leaf elongation were consistent with differences in winter herbage productivity reported from field trials in Victoria.

Media summary

Leaf elongation is a significant indicator of cultivar differences in winter growth of phalaris, tall fescue and cocksfoot.

Key words

Perennial grass cultivars, winter growth, leaf elongation.

Introduction

In temperate southern Australia pasture production during the winter months is often a serious limitation to the productivity of animal production enterprises (Obst 1987). For this reason plant breeding programs in the major perennial grass species, phalaris (*Phalaris aquatica*,), tall fescue (*Festuca arundinacea*), cocksfoot (*Dactylis glomerata*) and perennial ryegrass (*Lolium perenne*) have developed cultivars with higher herbage productivity in winter, mainly using germplasm from the Mediterranean (Reed 1996). Although these advances have been documented in field trials (e.g. Anderson et al 1999) little is known of physiological or structural characters that underlie growth responses to cold temperatures in these cultivars. The availability of contrasting winter active and non-winter active cultivars of the four most important grass species in temperate Australia provides the opportunity to analyse plant traits associated with cold temperature growth. This knowledge will advance the plant growth models that are components of decision support systems and could also be used as selection criteria for plant breeding programs.

This study compared the winter growth, in terms of leaf elongation and morphology of eight perennial grass cultivars during the winter at Canberra, A.C.T. In each species the cultivars were chosen to represent a winter active and a less winter-active type.

Materials and Methods

The eight cultivars compared were Australian and Sirosa phalaris, Demeter and Fraydo tall fescue, Currie and Porto cocksfoot, and Ellett and Kangaroo Valley "Gold" perennial ryegrass. In each species, the first-mentioned is the non-winter active type. The experiment was designed as a randomized complete block with 4 replications. Plots were sown in 12-row, 2 x 8m plots on 3 April 2003; phalaris and cocksfoot were sown at 4kg/ha, tall fescue at 15kg/ha and perennial ryegrass at 10kg/ha. Two establishment irrigations were applied in April. Emerging wheat seedlings were controlled by spot spraying with glyphosate. A broad-leaf herbicide was applied on 22 May 2003. Air temperature at 5cm above ground level was recorded using thermo-couples placed in the centre of 8 plots across the area of the trial. Temperature was recorded every 15 minutes over 17 weeks and reported on a data logger as the mean of 4 readings every hour.

Leaf elongation.

The length of the youngest expanding leaf was measured on twelve tillers randomly selected in each plot in 4 replications. Approximately 48h later leaf length was measured again. This procedure was repeated at two-week intervals between 26 May 2003 and 16 September 2003.

Tiller and leaf measurements.

Between 26 May and 30 September, at two-week intervals, a length of 25 cm of row was dug up from each plot in one replication. Five plants were isolated. The number of extended tillers was counted on each plant. A single dominant tiller was chosen from each plant and the number of expanded leaves and the length and width of the leaves was recorded. The apical meristem of this tiller was isolated and its developmental stage (vegetative or reproductive) and was determined.

Results

Temperature: Mean minimum temperatures over the course of the experiment were below 0°C over the whole period of measurement and below -5°C during July and August (Fig. 1). Maximum temperatures were between 15 and 20°C until late August after which they rose above 20°C in September. The weekly 24h temperature ranged between 2 and 10°C during the period. During the 48h period when measurements were taken, mean leaf elongation was positively correlated with minimum temperatures recorded ($r = 0.57$; $P < 0.001$) and the mean 24h temperature over the period ($r = 0.29$; $P < 0.05$), but was not correlated with the maximum temperature recorded ($r = -0.06$; $P > 0.10$).

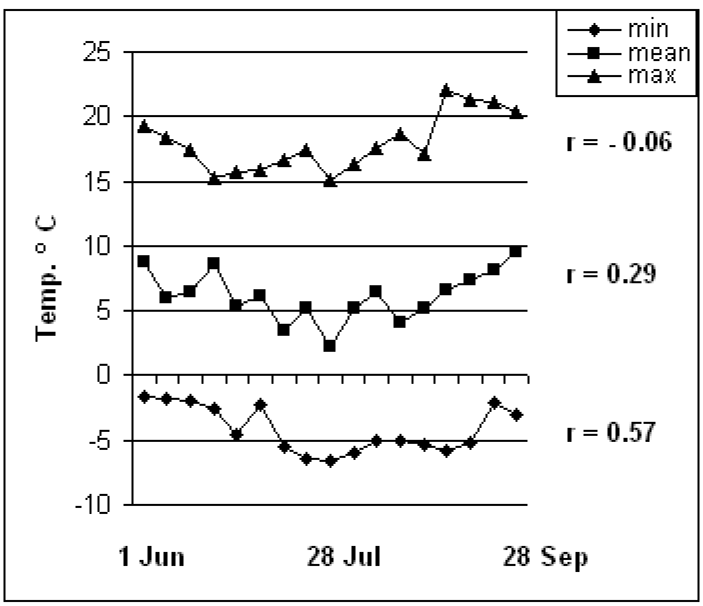

Figure 1: Weekly minimum, maximum and 24h mean temperatures and correlation of temperature with mean cultivar leaf elongation

Leaf elongation. The 48h leaf elongation of Sirosa phalaris was significantly greater than that of Australian phalaris at all times of measurement (Fig. 2). Similarly, in the more winter active Fraydo tall fescue leaf elongation was greater than that of Demeter tall fescue on all except one occasion (2 September). Porto cocksfoot leaf elongation was significantly greater than Currie cocksfoot in the period 12 June to 22 July, but thereafter differences were not significant. In contrast to the other cultivar comparisons, Ellett and Kangaroo Valley “Gold” perennial ryegrass did not differ significantly until after 19August when Ellett had greater leaf elongation than the supposedly more winter active Kangaroo Valley “Gold”.

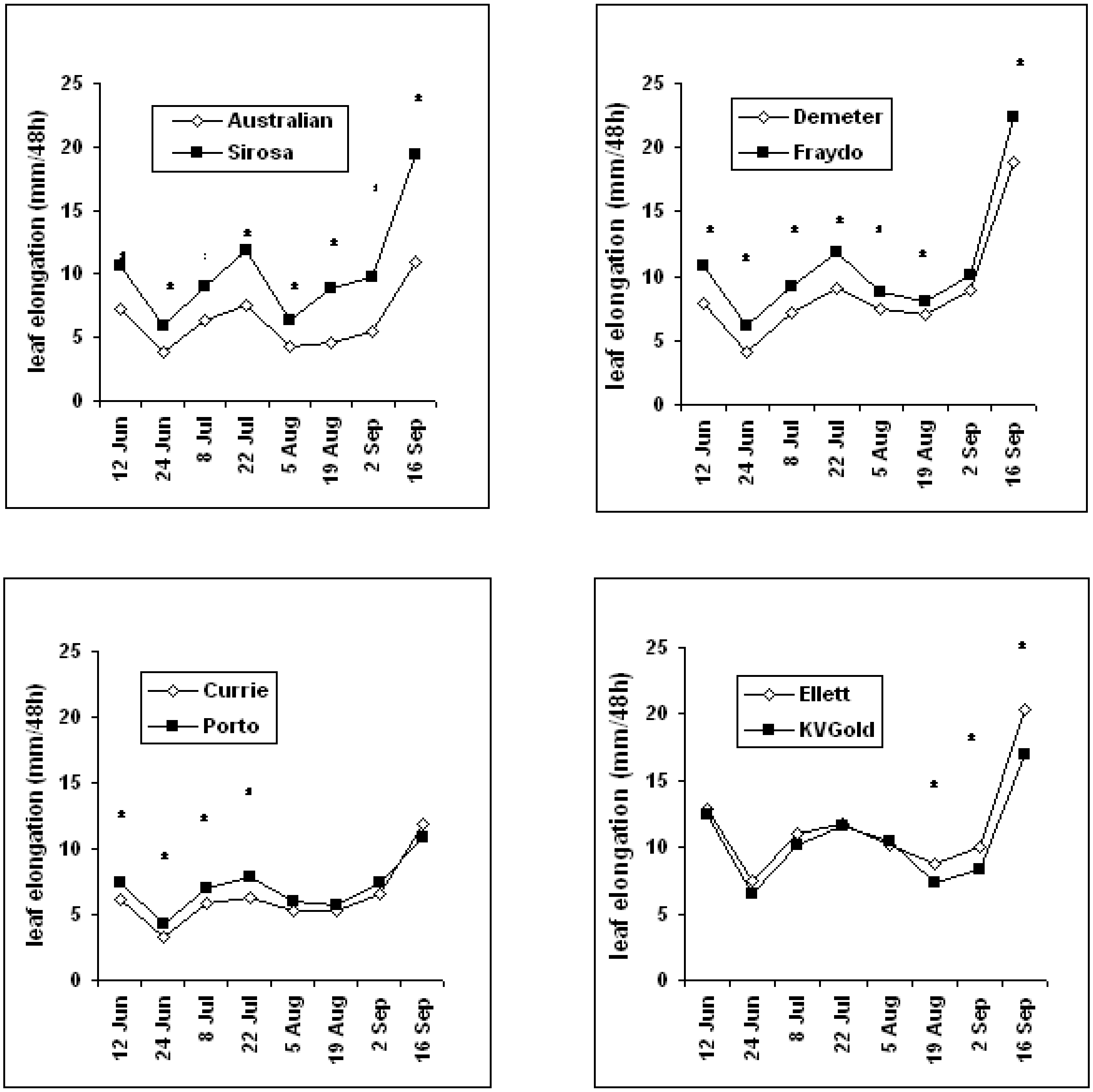

Figure 2: Leaf elongation of phalaris (Australian, Sirosa), tall fescue (Demeter, Fraydo), cocksfoot (Currie, Porto) and perennial ryegrass (Ellett, Kangaroo Valley “Gold”) over winter at Canberra, ACT. * indicates cultivar differences significant at P = 0.05

Tiller and leaf measurements: Average leaf length of the winter active member of phalaris, tall fescue and cocksfoot cultivars was consistently longer than the less winter active cultivars. Leaf width was also consistently greater in the winter active member of phalaris and cocksfoot, but differences between the tall fescue and perennial ryegrass cultivars were not large. Consequently the development of average leaf area per leaf was more rapid in the winter active cultivars of phalaris and cocksfoot (Fig. 3, for phalaris), but there was no consistent difference between the tall fescue or perennial ryegrass cultivars. Differences in tiller number and in the number of leaves per tiller were not significantly different (P>0.05) between the pairs of cultivars within each species (Fig 3 for phalaris).

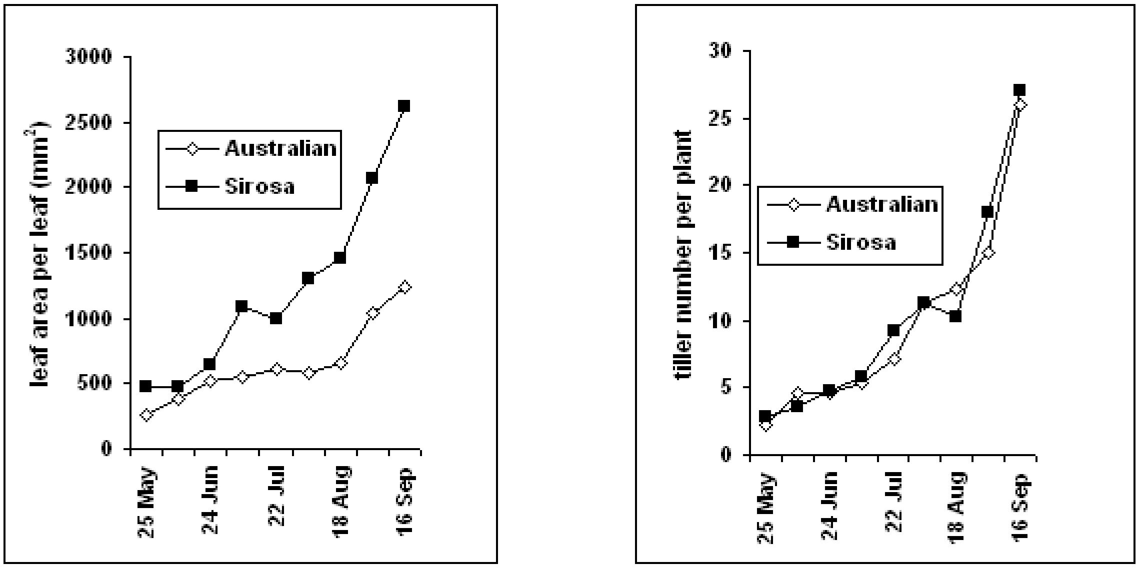

Figure 3: Development of leaf area per leaf and tiller number per plant in phalaris cultivars, Australian and Sirosa during the establishment year.

Discussion

Differences between cultivars in leaf elongation are consistent with reported differences in winter herbage productivity between winter active and non-winter active cultivars of phalaris, tall fescue and cocksfoot from field trials in Victoria (Anderson et al 1999). The greater winter growth activity of the winter active phalaris, tall fescue and cocksfoot cultivars during the establishment year was associated with greater development of leaf area rather than in greater tiller numbers or leaf number per tiller. It should be noted, however, that these measurements were from single plants in the first season and may not represent tiller numbers in more mature swards. For example, in phalaris, second year swards of Australian were found to have greater tiller numbers per plant and greater tiller density per square meter than Sirosa (Culvenor 1997).

Conclusion

Leaf elongation is an easily measured trait that is associated with productivity. It was most strongly correlated with low temperature exposure and clearly differentiated winter active from non-winter active cultivars of phalaris, tall fescue and cocksfoot.

References

Anderson MW, Cunningham PJ, Reed KFM and Byron A (1999). Perennial grasses of Mediterranean origin offer advantages for central western Victorian sheep pasture. Australian Journal of Experimental Agriculture 39, 275-284.

Culvenor RA (1997). Observations on tillering in cultivars of phalaris under rotational grazing in a year with a summer-autumn drought. Australian Journal of Agricultural Research 48, 467-476.

Obst JM (1987). Grazing management and pasture utilization by sheep, goats or cattle. In: ‘Temperate Pastures, their Production, Use and Management’. Australian Wool Corporation Technical Publication. (Eds. JL Wheeler, CJ Pearson and GE Roberts) pp. 477-485 (CSIRO, Melbourne).

Reed KFM (1996). Improving the adaptation of perennial ryegrass, tall fescue, phalaris and cocksfoot for Australia. New Zealand Journal of Agricultural Research 39, 457-464