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Measuring summer dormancy of perennial grasses in contrasting environments

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Introduction

The summer dormancy trait has been shown to confer enhanced levels of survival to temperate perennial forage species over long periods of intense summer drought (Voltaire and Norton 2006) and is therefore valuable in plant improvement. Normally found in species endemic to drier Mediterranean climates it is recommended that the trait be measured in the field under typical Mediterranean hot, dry summer conditions (Norton *et al.* 2008). However, this trait has potential utility in regions with summers that can receive substantial rainfall, but still experience extended periods of intense moisture deficit. Therefore, it is important to determine whether summer dormancy expression can be reliably measured in environments cooler and moister than those considered typically Mediterranean.

This paper compares the measurement of summer dormancy across a range of three commercially important temperate perennial grass species when undertaken in typical Mediterranean summer conditions and in a cooler and wetter summer environment.

Materials and Methods

Field trials were undertaken at Montpellier, France (44° N, 4° E, 10 m altitude) and Canberra, Australia (35° S, 149° E, 622 m altitude). At Montpellier the research

occurred over the summer of 2002 on a deep alluvial loam of pH (H₂O) 8.2 while that at Canberra took place between January and March 2011 and 2012 on a duplex soil, pH (H₂O) 5.3, of sandy loam overlying a dense clay. The test germplasm at both sites comprised *Dactylis glomerata* L. (cocksfoot) cultivars (cvv.) Medly and Kasbah, *Festuca arundinacea* Schreb. (tall fescue) cvv. Demeter and Flecha MaxP and *Phalaris aquatica* L. (phalaris) cvv. Australian and Atlas PG.

At both sites the expression of summer dormancy for each cultivar was measured by visually assessing the percentage of herbage (subsequently divided by 10 to transform into a 0-10 score) that remained senescent approximately 10 days after a storm or mid-summer irrigation had taken place. This is the method (or a modification thereof), first used by Oram (1983) and subsequently referred to as, 'visual rating of senescence after storm' (VSEns) by Norton *et al.* (2008).

Results and Discussion

Summer conditions at Montpellier in 2002 were hotter (average of 1-3°C) and drier (0.2-0.3 kPa different) than those experienced at Canberra in 2011 and 2012 (Table 1). There was a significant cultivar by environment interaction observed between the summer dormancy scores at Montpellier and those at Canberra. Thus, Flecha

Table 1. Mean monthly air temperatures (°C), vapour pressure deficits (VPD, kPa) and rainfall or irrigation (mm) over the summer months in 2002 at Montpellier, France and 2011-12 at Canberra, Australia.

	Montpellier 2002			Canberra 2011			Canberra 2012		
	July	August	September	January	February	March	January	February	March
Mean air temperature	23.2	22.6	18.9	21.9	20.8	17.4	20.0	19.1	16.0
Mean VPD	1.38	1.09	0.67	0.99	0.85	0.58	0.92	0.75	0.51
Rainfall/irrigation	0	40	0	52	174	44	33	127	305

tall fescue expressed greater summer dormancy in Canberra (7.3) than at Montpellier (4.0), while Atlas PG phalaris was more dormant in France (7.3) than in Canberra (4.9). Dormancy scores of the highly summer active cv Medly cocksfoot and Demeter tall fescue were similarly low at both locations while those of the highly summer dormant Kasbah cocksfoot were high (Figure 1). The relationship between summer dormancy rating scores observed at Montpellier and Canberra was significant ($R^2=0.335^*$) being described by the equation, $y = 0.48x + 2.72$ (Figure 1).

These results suggest that although the summer conditions encountered at Canberra were cooler and wetter than those considered optimal for the measurement of summer dormancy, it is still possible to measure the relative level of the trait across a range of cultivars. However, some expression of genotype by environment interaction in the trait may be evident. This was seen here in the cultivars Flecha and Atlas PG, which both have incomplete dormancy and therefore the potential to express different levels of the trait according to the environment.

At Canberra atypical ongoing, but very slow growth occurred even in the cultivar Kasbah (indicated by dormancy scores of 7.7), normally a highly summer dormant cocksfoot often used as a dormant control.

A key point was that the relative differences in summer growth (and therefore of senescence) between the cultivars meant that the dormancy expression that was observed under typical Mediterranean summer conditions at Montpellier was maintained under the cooler, moister summer at Canberra. Therefore, this suggests that summer dormancy can also be measured under cool, moist summer conditions provided that the

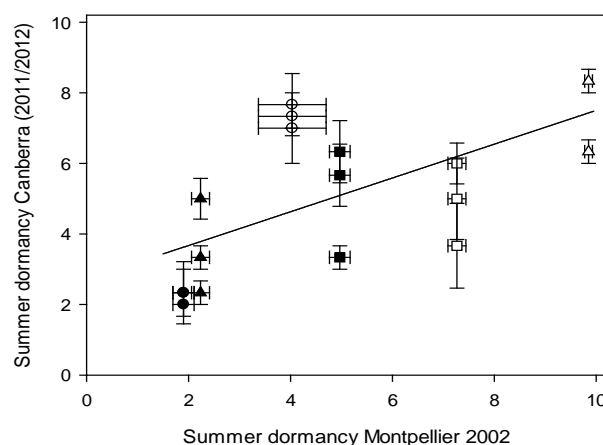


Figure 1. Expression of the summer dormancy trait of cocksfoot cv Kasbah (Δ) and Medly (▲), tall fescue cv Flecha (○) and Demeter (●) and phalaris cv Atlas PG (◻) and Australian (◼) using a 0-10 scale where 10 is maximum dormancy at 2 sites contrasting in summer weather conditions.

possibility of genotype X environment interactions are considered and cultivars with previously identified levels of summer dormancy used as controls.

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