Phalaris and cocksfoot prove superior to tall fescue in two drought prone environments of southern NSW

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Abstract

Two tall fescue (*Festuca arundinacea*) cultivars, Fraydo and Demeter, were tested against cocksfoot (*Dactylis glomerata*) cv. Currie, and phalaris (*Phalaris aquatica*) cv. Landmaster, for persistence and productivity at Wagga Wagga and Cootamundra in the medium rainfall zone (long-term annual average 530-615 mm) of southern New South Wales, Australia. Herbage quality was assessed at the Cootamundra site only. Summer dormant cocksfoot cv. Kasbah was also included at the Wagga Wagga site. Fraydo tall fescue was shown to be more persistent in both environments than the summer active cultivar, Demeter, maintaining a basal frequency of >10% into year 4 of the experiment at both sites where annual rainfall ranged from 243 - 566 mm. However, there was no corresponding increase in herbage yield ($P = 0.05$) at either location. Kasbah cocksfoot maintained a higher basal frequency into year 4 and yielded more cumulative herbage than both tall fescue cultivars at Wagga Wagga. The Mediterranean cultivar of tall fescue, Fraydo, was shown to be no more persistent than the summer active cultivar of phalaris at either site. However, phalaris produced 97% and 138% more herbage than cv. Fraydo. Over all, the herbage quality of phalaris was similar to that of both tall fescue cultivars but the crude protein content of Currie cocksfoot (16.2%) was higher than both tall fescue cultivars and phalaris (mean 14.3%). It is concluded that tall fescue – even summer dormant cultivars – should not be included in general purpose pasture swards in drought-prone medium rainfall cropping environments where phalaris or Kasbah cocksfoot are viable alternatives.

Key Words

Lolium arundinaceum

Introduction

The release of several Mediterranean cultivars of tall fescue in the last decade has reinvigorated interest in this species as a potential alternative forage in lower rainfall environments which typically experience summer droughts, such as the medium rainfall cropping zone of south-eastern Australia. Farmers in this region currently have a very limited number of perennial pasture plant options available to them with sufficient persistence to underpin their extensive grazing enterprises (such as Li et al. 2008; Nie et al. 2008), so the adaptation of an existing species to drier environments is a positive step towards increasing the diversity and resilience of pasture stands in these regions.

An evaluation of phalaris and tall fescue at Hamilton, south-western Victoria, Australia, showed phalaris to be generally more productive than tall fescue (Reed et al. 2008a) with the most productive phalaris line out-yielding the most productive tall fescue cultivar, Fraydo, by 19%. However, another study showed tall fescue cv. Fraydo to have similar or superior productivity to phalaris at 5 out of 7 locations across southern Australia (Reed et al. 2008b) indicating that Mediterranean tall fescue cultivars may be viable alternatives in these environments. The toxins present in phalaris herbage (Oram et al. 2009) provide an additional incentive to consider alternative species, such as tall fescue, even if it is not always shown to have superior productivity. The current study examined the productivity and persistence of tall fescue relative to phalaris and cocksfoot at two locations in southern NSW, and compared the herbage quality of the three species.

Methods

Two field experiments were established in 2004 at Cootamundra (average annual rainfall 617 mm) and Wagga Wagga (524 mm) in the medium rainfall cropping zone of southern Australia. Soil at both sites was acidic with a pH_{CaCl2} of 4.5 and 4.4, respectively, and aluminium comprising 19% of the effective cation exchange capacity of the Cootamundra soil in contrast to 6% at Wagga Wagga. Each experiment had 4 replications in a randomised design that accounted for spatial distribution in rows and columns. Plots were 6 ? 4 m and sown with a cone seeder. Four perennial grasses treatments at Cootamundra were sown as monocultures on 26 August 2004 which included tall fescue cv. Fraydo and cv. Demeter (each sown at 12.5 kg/ha), phalaris cv. Landmaster (4 kg/ha) and cocksfoot cv. Currie (4 kg/ha). An additional treatment, cocksfoot cv. Kasbah (4 kg/ha), was also included at Wagga Wagga with all treatments at this site sown on 21 May 2004 with subterranean clover (*Trifolium subterraneum* L.) cv. Seaton Park (4 kg/ha). Both experiments received an application of 180 kg/ha starter fertiliser (14.9% N, 13% P, 10.5% S) at sowing. In subsequent years both experiments were top-dressed with an application of 160 kg/ha superphosphate (8.8% P, 11% S) in autumn annually. Nitrogen fertiliser (granulated urea, 46% N) was applied at 100 kg/ha annually at the Cootamundra experiment only.

Initial seedling density of perennial species was assessed in both experiments approximately 9 weeks after sowing using a fixed 1 m^2 quadrat, replicated twice per plot. From year 3 onwards, basal frequency was measured to estimate relative plant density of the perennial species by placing a 1 m^2 quadrat, divided into squares 0.1 ? 0.1 m, over the fixed sampling area and counting the percentage of squares occupied or partially occupied by the base of a sown perennial plant. A visual technique was used for the assessment of total biomass at both experiments which involved splitting each plot into 6 cells to account for within-plot variability and giving each a score between 1 and 10. Scores of each cell were averaged to give a mean plot score. Scores were calibrated at each assessment by taking 10-12 representative cuts using a 0.1 m^2 quadrat. The proportion of sown perennial species, annual legumes and weeds was assessed at the same time as herbage yield using the dry weight rank technique (t' Mannetje & Haydock 1963) replicated 10 times within each plot. Botanical composition data was used to calculate the herbage yields of the respective components of each sward. During 2005-06, samples of sown perennial plants at Cootamundra only were taken for quality analysis from each plot on 7 occasions within a 12 month period; 12 September, 13 October, 9 November and 9 December 2005, and in 2006 on 23 March, 8 June and 22 August. Samples were analysed for ash content, acid detergent fibre, neutral detergent fibre and crude protein. Estimates of dry matter digestibility (DMD) and dry organic matter digestibility (DOMD) were obtained using near infra-red (NIR). Metabolisable energy (ME) was calculated from DOMD values using the following formula; ME = 0.203 ? DOMD – 3.001. A more detailed outline of the experimental methodology is given in Hayes *et al*. (2010b).

Results

Seasonal conditions were generally much drier than average at both locations during the 5-year experimental period. Compared to the long-term average of 617 mm, Cootamundra received approximately 472, 637, 243, 566, and 445 mm between 2004-2008, respectively. Wagga Wagga received 403, 476, 272, 382 and 414 mm compared to its long-term average of 524 mm, excluding 350 mm that was applied as irrigation in 2006 (Hayes et al. 2010a)

Table 1. Basal frequency (%) of grasses in years 3 - 5 at Cootamundra and Wagga Wagga.

Values within columns followed by the same letter were not significantly different at *P* = 0.05.

Species/cultivar	Cootamundra			Wagga Wagga		
	Year 3	Year 4	Year 5	Year 3	Year 4	Year 5
Phalaris (cv. Landmaster)	30^{ab}	32^{b}	7^{b}	24^{b}	13^{b}	4^{bc}
Cocksfoot (cv. Kasbah)	-	-	-	45^{d}	23^{c}	6^{c}
Cocksfoot (cv. Currie)	42^{b}	7^{a}	6^{b}	34^{c}	4^{ab}	0^{ab}
Tall fescue (cv. Demeter)	23^{a}	1^{a}	1^{a}	1^{a}	0^{a}	0^{a}
Tall fescue (cv. Fraydo)	39^{b}	25^{b}	7^{b}	22^{b}	11^{b}	2^{ab}

All grasses at Cootamundra established at densities between 90-148 plants/m^2 9 weeks after sowing but declined to 19-40 plants/m^2 by July of year 2. Plant establishment was higher at Wagga Wagga ranging from 125-370 plants/m^2. Density of all grasses at this location declined to between 17-33 plants/m^2 by July of year 2, with the exception of Demeter tall fescue which declined to just 4 plants/m^2.

Kasbah cocksfoot was more persistent than all other grasses at Wagga Wagga, although by year 5 differences between cv. Kasbah and phalaris were not significant at $P = 0.05$. Phalaris and tall fescue cv. Fraydo were shown to have very similar levels of persistence at both locations, which was superior to the summer active cultivars of cocksfoot (cv. Currie) and tall fescue (cv. Demeter; Table 1).

There was no significant difference ($P = 0.05$) in total cumulative sward yield of any of the perennial grass treatments at either site (Fig. 1b). However, ignoring the production of weeds and legume species, phalaris was the most productive of all the perennial grass species. Tall fescue was the least productive species although cv. Fraydo was not significantly different from cocksfoot cv. Currie at either site. Phalaris produced 97% and 138% more biomass than tall fescue cv. Fraydo at Cootamundra and Wagga Wagga, respectively (Fig. 1a).

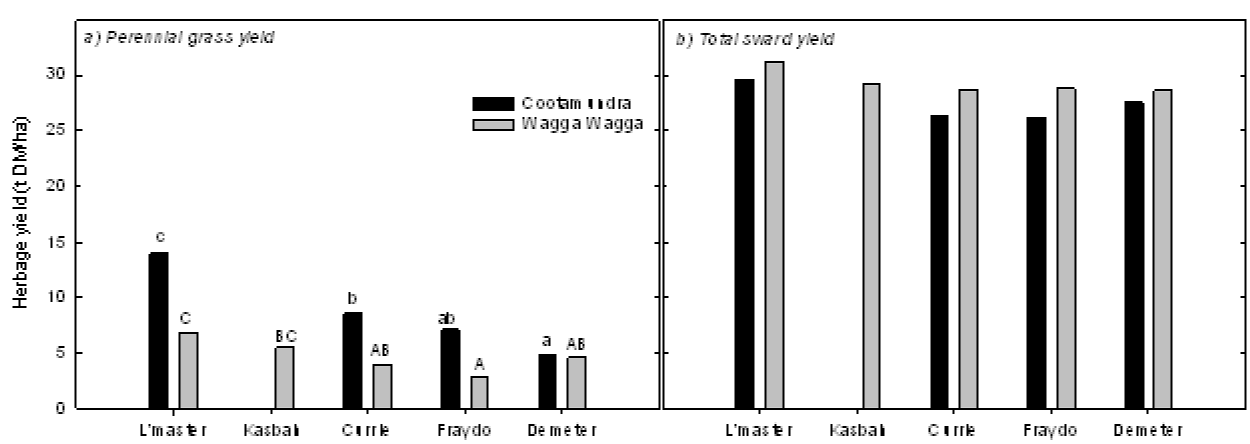

Figure 1. Cumulative herbage mass (t/ha) measured between 2004-08 of a) sown perennial grasses only and b) total yield of perennial grass swards grown at Cootamundra and Wagga Wagga. Bars denoted with the same letter were not significantly different at *P* = 0.05.

Averaged across 7 samplings within a 12-month period, values for cocksfoot were generally amongst the highest for each of the herbage quality parameters measured (Table 2). There was no significant difference between the quality of phalaris cv. Landmaster herbage and that of tall fescue cv. Fraydo, with the exception of ash content which was lower in cv. Fraydo. A more detailed description of the within-season differences in herbage quality of the various species is given by Hayes et al. (2010b).

Table 2. Mean crude protein (%), dry matter digestibility (%), metabolisable energy (MJ/kg DM), neutral detergent fibre (%), acid detergent fibre (%) and ash content (%) values for 4 perennial grass treatments grown at Cootamundra, sampled on 7 occasions between 2005-2006.

Values within rows followed by the same letter were not significantly different at *P* = 0.05.

Quality parameter	Phalaris (cv. Landmaster)	Cocksfoot (cv. Currie)	Tall fescue (cv. Demeter)	Tall fescue (cv. Fraydo)
Crude Protein	14.6 ^{a}	16.2 ^{b}	14.7 ^{ab}	13.5 ^{a}
Dry Matter Digestibility	71.7 ^{ns}	73.2 ^{ns}	70.9 ^{ns}	72.4 ^{ns}
Metabolisable energy	10.6 ^{ab}	10.7 ^{ab}	10.4 ^{a}	10.9 ^{b}
Neutral Detergent Fibre	46.2 ^{a}	49.0 ^{bc}	50.0 ^{c}	46.9 ^{ab}
Acid Detergent Fibre	24.7 ^{ab}	26.0 ^{b}	26.1 ^{b}	24.1 ^{a}
Ash Content	10.0 ^{bc}	10.3 ^{c}	9.5 ^{ab}	8.9 ^{a}

Discussion and conclusion

In contrast to previous research, this study highlighted the considerable risk to production for farmers considering sowing tall fescue in medium-low rainfall cropping environments. There is little doubt Mediterranean cultivars of tall fescue and cocksfoot such as Fraydo and Kasbah provide increased persistence in summer-dry environments than their summer-active counter-parts. However, cv. Fraydo only produced 51% and 42% of the herbage produced by phalaris despite maintaining a similar basal frequency. Given the very small differences in herbage quality between the two species there is very little incentive to promote tall fescue in drier cropping regions where phalaris is a viable option. Clearly, this study only examined the performance of one Mediterranean cultivar of tall fescue and so it is possible that other tall fescue cultivars may perform differently to cv. Fraydo. However, Reed et al. (2008a) found cv. Fraydo to be the most productive tall fescue cultivar in a study that evaluated 11 cultivars and 12 accessions of tall fescue and in that study no other line of tall fescue had significantly greater plant frequency than cv. Fraydo at the end of the experiments. On the basis of this evidence it is reasonable to assert that no tall fescue cultivar that is currently available would have been likely to perform substantially better than cv. Fraydo in the current study. Given the large differences in productivity between Landmaster phalaris and Fraydo tall fescue, any future tall fescue cultivar would need to demonstrate substantial improvements over existing cultivars before they could be considered viable alternatives in medium-low rainfall cropping environments.

The yield difference between phalaris and tall fescue is larger than previously reported (Reed et al. 2008a; 2008b). This could be due to harsher seasonal conditions experienced during the current study, but could also be due to the use of cv. Landmaster phalaris as the control rather than cv. Australian as in the previous studies. However, had phalaris cultivars such as Sirolan or Sirocco been used in the current study instead of Landmaster, it is possible that the yield difference between phalaris and tall fescue would have been even greater. Landmaster phalaris was selected from sites with shallow acid soils so alternative cultivars may be better adapted to hotter and drier environments, such as Wagga and Cootamundra (Oram et al. 2009). More research is required to quantify the drought tolerance of different phalaris cultivars.

In contrast to tall fescue, cocksfoot offers at least two desirable attributes that could add value to a phalaris-based pasture. Firstly, our study demonstrated cocksfoot to have desirable herbage quality attributes relative to phalaris, particularly in terms of increased crude protein. Secondly, previous studies (such as Reed et al. 2008b) have shown an increased ability of cocksfoot to recruit seedlings, offering cocksfoot-based pastures an alternative mechanism to cope with drought. Kasbah cocksfoot showed great potential for drought survival at one location. Our study shows there may be more merit in pursuing summer dormant cocksfoot cultivars for medium rainfall drought-prone environments rather than pushing tall fescue too far beyond the high rainfall zone.

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