New tall fescue cultivars for medium to low rainfall environments in southern Australia

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Abstract

The unreliable persistence of traditional cultivars has led to tall fescue (*Festuca arundinacea* Schreb syn *Lolium arundinceum* Schreb, S.J Darbyshire) being identified for improvement in low to medium rainfall environments (400-750 mm) in southern Australia. Three synthetic cultivars of tall fescue Summer Active 1 Summer Active 2 and Winter Active were developed in 2006/2007. The production and persistence of these three synthetic tall fescue cultivars are being evaluated against commercial cultivars of tall fescue at a total of 5 sites in Victoria (2), southern NSW (2) and northern NSW (1). Although this evaluation will continue until 2013, this paper presents establishment and some initial dry matter production and persistence data for 2009–2011. At all sites, establishment of all tall fescue cultivars was satisfactory (average of >90 plants/m^2). The ranking of tall fescue cultivars for total herbage production (t DM/ha) varied across site and year, but SA1 and SA2 were as productive as the highest yielding summer active cultivar Quantum II MaxP. Due to favourable summer conditions in 2010 and 2011 persistence of tall fescue at the Victorian and the northern NSW sites has remained steady. At the southern NSW sites where severe drought and high temperatures were experienced in the first spring/summer after sowing, there was a dramatic decline in basal frequency of all tall fescue cultivars. Averaged across cultivars and these two sites, frequency declined from 81% (year 1) to 6.5% (year 2). Although frequencies increased slightly (3% at one site) in year 3, none of the tall fescue cultivars have adequate frequencies (all <25%) to sustain production.

Introduction

Cultivars of the main cultivated, introduced temperate (C3) perennial grasses, tall fescue (*Festuca arundinacea* Schreb syn. *Lolium arundinceum* Schreb, S.J. Darbyshire), phalaris (*Phalaris aquatica*), cocksfoot (*Dactylis glomerata*) and perennial ryegrass (*Lolium perenne*) have often failed to persist under grazing in low to medium rainfall environments (up to 750 mm in northern NSW). This is a result of a combination of poor adaptation of commercial cultivars to the environment and inadequate management (Bennett *et al.* 2003). For temperate perennial grasses to be successful in these low to medium rainfall environments, characteristics such as varying levels of summer activity, drought tolerance and persistence under grazing will need to be incorporated into new cultivars (Harris *et al.* 2008).

Tall fescue was identified as one of several species with potential for improvement for the low to medium rainfall environments as it is broadly adapted, has distinctive advantages for particular environments, has varying degrees of summer activity and a commercial market (Harris *et al*. 2008). Tall fescue is adapted to a wide range of soil types including those that are moderately acidic, saline and of medium fertility and is more tolerant of waterlogging than cocksfoot (Easton *et al.* 1994). Tall fescue has been traditionally sown in high altitude tableland regions with high rainfall (>750 mm). The use cultivars associated with low summer activity has broadened the area of adaptation of tall fescue into summer dry, short growing season regions (Reed *et al.* 2004).

From 2004 to 2006, 115 accessions, experimental varieties and cultivars of tall fescue with varying degrees of summer activity were screened on the North West Slopes of NSW. The main objective of this evaluation was to identify material to develop a drought tolerant cultivar that was responsive to summer rain and more persistent if not more productive than existing commercial cultivars in low to medium rainfall environments.

Three endophyte-free synthetic cultivars of tall fescue were developed in 2006/2007. Two of the tall fescue synthetics – Summer Active 1 (SA1) and Summer Active 2 (SA2) were based on select East Sardinian accessions that exhibited improved persistence, greater year-round production, enhanced summer production and increased winter production compared to that of the control cultivars. The third synthetic variety – Winter Active (WA) was based on persistent North African accessions that had a similar overall yield to the controls, but with greater winter production and an ability to maintain green leaf over summer with limited growth over summer (Harris *et. al.* 2008).

This paper reports the preliminary data (2009 to 2011) from 5 experiments designed to evaluate the production and persistence over a range of environments of these new varieties of tall fescue compared to the commercial cultivars.

Methods

The three synthetic cultivars of tall fescue (SA1, SA2 and WA) and commercial cultivars (Flecha MaxP, Quantum II MaxP, at all sites, Au Triumph, Demeter, Jesup MaxP, Prosper, Resolute at 3 sites and Fraydo at 2 sites) were evaluated at a total of 5 sites in Victoria (Bealiba, Eversley), southern NSW (Beckom, Trungley Hall) and northern NSW (Inverell). These sites cover the continuum of rainfall patterns experienced in the low-medium rainfall environment target regions; summer dominant (Inverell), uniform rainfall (Beckom, Trungley Hall) and winter dominant (Bealiba, Eversley). The two Victorian sites were on sandy soils over medium clay and were the most acidic of the 5 sites (Eversley pH_{CaCl2} 4.0 and Bealiba pH_{CaCl2} 4.6) in the top 10 cm of the soil. The soil at the Beckom site was also a sandy loam with a pH_{CaCl2} of 4.8. The site at Trungley Hall was located on a grey clay soil with a pH_{CaCl2} of 5.1. The Inverell site was the least acidic at 5.4 $_{pHCaCl2}$ and was located on a red clay loam.

In addition to the tall fescue cultivars, new cultivars and commercial cultivars of cocksfoot and phalaris are also being evaluated at these sites, but are reported in separate papers (Clark *et al.* 2012 and Culvenor *et al.* 2012).

The experiments at all sites were sown in autumn-winter 2009. The experiment at Inverell failed to establish due to drought and was re-sown in autumn 2010. Each site consists of a randomised block with 4 replicates. Plot size varied at each site; 5 x 1.5 at the Victorian sites, 6 x 2 m at the southern NSW sites and 6 x 2.5 m at the northern NSW site. The tall fescue was sown at 12 kg/ha with subterranean clover (*Trifolium subterranean)* (4 kg/ha).

At each site measurements were: establishment density (8-12 weeks after sowing), basal frequency in autumn/winter (two fixed 1 m^2 quadrats per plot) and herbage mass and pasture composition assessed using Botanal and calibrated visual assessment at least once each season. After each herbage mass assessment the plots were grazed or mown. Data were analysed using analysis of variance and least significant difference calculated at the 5% level.

Results

The first year of the evaluation (2009) was dry, with all sites except for Eversley having below average rainfall. However, all sites in years 2 and 3 (2010 and 2011) had above average rainfall (Table 1).

Table 1. Annual rainfall (mm) for all sites over the experimental period compared to the long-term average (LTA)

	Bealiba	Eversley	Beckom	Trungley Hall	Inverell
2009	428	599	330	447	539
2010	740	852	594	749	889
2011	700	661	632	702	1088
LTA	479	599	460	520	700

At all sites establishment of the tall fescue cultivars was satisfactory (average of >90 plants/m^2) (Table 2). There were significant differences in establishment within sites but there is no clear pattern of tall fescue cultivar performance. There were also differences in establishment between the sites with much higher establishment of all cultivars at the Eversley site.

Table 2. Establishment (plants/m2) of tall fescue cultivars at 5 evaluation sites in Victoria and NSW. A dash denotes that the cultivar was not sown at that site.

	Bealiba	Eversley	Beckom	Trungley Hall	Inverell
Au Triumph	203	354	-	-	99
Demeter	163	240	-	-	141
Fraydo	-	-	242	106	-
Flecha MaxP	260	415	270	128	170
Jesup MaxP	241	344	-	-	133
Prosper	142	248	-	-	138
Quantum II MaxP	196	291	189	93	201
Resolute	218	454	-	-	160
Summer Active 1	170	238	169	68	173
Summer Active 2	187	270	208	75	175
Winter Active	203	380	176	84	159
Average	198	323	209	92	155
LSD (P=0.05)	58.8	72.8	86.4	35.9	33.8

At the southern NSW sites where drought and high temperatures were experienced in the first spring/summer after sowing, there was a dramatic decline in basal frequency of all tall fescue cultivars. Averaged across cultivars and the two sites (Beckom and Trungley Hall) frequency decreased from 81% in year 1 to 7% in year 2. Although frequencies increased slightly (3% at one site) in year 3, all of the tall fescue cultivars at the southern NSW sites have inadequate frequencies (all <25%) to sustain production. This decline in basal frequency corresponded with very low herbage yields. At the Victorian sites average basal frequency remained relatively steady across the years 1, 2 and 3 (Bealiba – 64, 54 and 62%, Eversley – 79, 80 and 83% respectively). Only one year of basal frequency data was available from the Inverell site, of over 90%, due to the favourable summer conditions in 2010.

Average total herbage production (t DM/ha) was highest at Eversley and lowest at the southern NSW sites (Table 3). Average total herbage production was high at Inverell although this only represents two years production. The low herbage production at Beckom and Trungley Hall reflects the decline in basal frequency reported above.

The ranking of the three synthetic tall fescue cultivars for herbage production, varied across site and year (Table 3). SA1 and SA2 had the highest production averaged across sites of all cultivars, but were not significantly different from Quantum II MaxP. When averaged across sites the WA entry had the lowest herbage production.

Table 3. Total herbage production (t DM/ha) of tall fescue cultivars over 3 years at 4 sites (Bealiba, Eversley, Beckom and Trungley Hall) and 2 years at Inverell. A dash denotes that the cultivar was not sown at that site.

	Bealiba	Eversley	Beckom	Trungley Hall	Inverell
Au Triumph	9.5	22.5	-	-	14.8
Demeter	7.4	16.6	-	-	14.6
Fraydo	-	-	1.5	4.5	-
Flecha MaxP	8.4	20.8	3.2	5.9	12.4
Jesup MaxP	9.8	18.8	-	-	13.0
Prosper	8.4	17.2	-	-	8.1
Quantum II MaxP	10.6	21.7	2.3	4.2	16.1
Resolute	9.2	17.5	-	-	14.0
Summer Active 1	11.3	21.7	3.7	6.3	16.9
Summer Active 2	12.1	22.2	2.2	5.6	16.5
Winter Active	8.2	19.1	0.9	2.9	11.8
Average	9.5	19.8	2.3	4.9	13.8
LSD (P=0.05)	1.52	2.43	2.23	2.48	1.38

Conclusion

This paper reports 3 years preliminary data (2009 to 2011) from 5 experiments designed to evaluate the production and persistence over a range of environments of new synthetic cultivars of tall fescue compared to the commercial cultivars.

At the southern NSW sites where severe drought and high temperatures were experienced in the first spring/summer after sowing, there was a dramatic decline in basal frequency of all tall fescue cultivars over the first summer. At these sites by year three of the evaluation none, of these tall fescue cultivars had adequate frequencies to sustain production, which was reflected in the low total herbage production. These sites represent the limit (with respect to rainfall and summer temperature) for tall fescue use. These preliminary results suggest that tall fescue may not be suited to low summer rainfall areas of southern NSW. At the Victorian and northern NSW sites the ranking of the three synthetic tall fescue cultivars for herbage production varied across site and year, but SA1 and SA2 were at least as productive as the highest yielding summer active cultivar Quantum II MaxP, indicating they are suitable for these environments. When averaged across sites the WA cultivar had the lowest herbage production, indicating that the selection within the North African germplasm failed to produce a more persistent cultivar for low rainfall, summer dry areas.

The high rainfall and mild temperatures over summer in 2010 and 2011 did not result in more stressful moisture by temperature conditions than normally experienced at the evaluation sites making it difficult to evaluate the cultivars for persistence and production. These experiments will continue until 2013 to further monitor persistence and production. At the end of this evaluation period it is anticipated that one of the synthetic cultivars is highly likely to proceed to commercialisation.

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References

Bennett SJ, Ayres J, Dear BS, Ewing M, Harris C, Hughes SJ, Mitchell M, Moore GA, Nie Z, Reed KFM, Sandral GA, Slattery J, Snowball R (2003) Perennial pastures for the recharge areas of southern Australia. Scoping Document No. 1. CRC for Plant-Based Management of Dryland Salinity, Crawley.

Clark S, Culvenor R, Gardner M, Harris C, Hayes R, Li G, Nie Z, Norton M, Clark B (2012) Novel cocksfoots for SE Australia – Establishment and production. In 'Proceedings of the 16th ASA Conference, Armidale' (Eds ???). pp xxx

Culvenor R, Clark S, Li G, Gardner M, Harris C, Hayes R, Nie Z, Norton M (2012) Evaluating new phalaris populations for lower rainfall margins in SE Australia. In 'Proceedings of the 16th ASA Conference, Armidale' (Eds ???). pp xxx

Easton HS, Lee CK, FitzGerald RD (1994) Tall fescue in Australia and New Zealand. *New Zealand Journal of Agricultural Research* **37,** 405-417.

Harris CA, Clark SG, Reed KFM, Nie Z, Smith KF (2008) Novel *Festuca arundinacea* Shreb. and *Dactylis glomerata* L. germplasm to improve adaptation for marginal environments. *Australian Journal of Experimental Agriculture* **48**, 436-448.

Reed KFM, Clement SL, Feely WF, Clark B (2004) Improving tall fescue (*Festuca arundinacea*) for cool season vigour. *Australian Journal of Experimental Agriculture* **44**, 873-881.

