Summer production of alternative species in comparison to perennial ryegrass and white clover for high input pasture systems

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Abstract
The increase in irrigable land in the Midlands region of Tasmania presents an opportunity to increase animal production, whether it is lamb, dairy or beef. However, challenges including low rainfall (<650 mm annual average rainfall, high amounts of irrigation are required to maintain soil moisture), high summer temperatures (days >27°C) and duplex winter wet soils in this region put into question the suitability of the traditional intensive pasture base of perennial ryegrass *Lolium perenne* and white clover *Trifolium repens*. This study evaluated the performance of alternative grass and legume species under high input management for diversifying the feedbase in this region. The experiment was sown with 29 pasture treatments consisting of mixed swards and monocultures of 5 grass species (perennial ryegrass, tall fescue *Festuca arundinacea*, coloured brome *Bromus coloratus*, cocksfoot *Dactylis glomerata* and phalaris *Phalaris hybrid*) and 4 legume species (white clover, red clover *Trifolium pratense*, strawberry clover *Trifolium fragiferum* and Caucasian clover *Trifolium ambiguum*). The experiment was fully irrigated and nitrogen was applied at 40 kg N/ha following each harvest event. Dry matter (DM) yield was assessed at six defoliation events between November 2014 and April 2015. Perennial ryegrass and coloured brome were the best performed grasses, with coloured brome only significantly ($P<0.05$) lower than perennial ryegrass on one of the six harvest dates. The addition of the 4 clover cultivars to each of the 5 grass swards made no significant difference to yield except where white clover was in combination with phalaris. This study highlights the potential of coloured brome as an alternative to perennial ryegrass in high input systems although its tolerance of waterlogging, typical in the Midlands region requires further evaluation.

Keywords
Coloured brome, tall fescue, cocksfoot, phalaris, red clover, DM yield

Introduction
Recent and ongoing irrigation expansion in the Midlands region of Tasmania has led to an increase in intensive grazing systems. In an area once most suited to wool and cereal production, high input pastures for finishing lambs and dairy farming are now seen as economically viable enterprises. These intensive grazing systems will require greater flexibility in their feedbase for a few reasons. As rainfall is more variable a diverse feedbase containing multiple species may help to fill feed gaps and withstand prolonged periods of moisture stress where irrigation needs to be prioritised. In addition, the shallow duplex soil type provide challenges with pugging and pasture growth in waterlogged areas than in traditional dairy regions. The productivity and nutritive value of alternative grasses and legumes under irrigation in these areas is unknown. There are some existing and novel species/cultivars available that could provide good production while adding flexibility to the grazing resource. These include: summer active cocksfoot cv. Megatas, coloured brome cv. Exceltas, tall fescue cv. Quantum II MaxP, Caucasian clover cv. Kuratas, strawberry clover cv. Palestine and stoloniferous red clover cv. Rubitas. Of particular interest is the seasonal production of the new cultivars developed by the Tasmanian Institute of Agriculture (TIA), coloured brome and stoloniferous red clover under input irrigation and high N input systems, as these two cultivars have not been evaluated under such conditions previously. Studies by Hall and Hurst (2012) and presented by Hackney *et al*. (2007) indicated that coloured brome cv. Exceltas could match and even surpass the DM production of perennial ryegrasses grown under dryland conditions. This study evaluated the seasonal production of alternative grasses and legumes in monoculture and mixed swards in comparison to perennial ryegrass/white clover under irrigation and high nitrogen input in Midlands region of Tasmania.

Methods

The trial site was established in 2014 at Cressy (41° 43'S, 147° 03'E) in Northern Tasmania where the mean annual rainfall is 628 mm and the elevation 147 m. The soil is a brown chromosol, and can be described as duplex with a heavy clay subsoil. The trial was sown in April 2014 with an Ojyard cone seeder into a shallow cultivated seed bed, prepared over 12 months from a previously degraded pasture. The experiment was a randomised block design with four replicates with plot sizes 3 m x 1.5 m. Pasture cultivars were sown as both monocultures and in mixed swards, using all the grass/clover combinations. Sowing rate for each cultivar was dependant on seed size and if sown as a monoculture or in a mix (Table 1). Growing season rainfall (November 2014 – April 2015) was 152.5 mm plus an additional 665 mm of irrigation applied to make the study fully irrigated. Plots received 40 kg/ha of nitrogen following each harvest. Maintenance levels of phosphorus and potassium were applied at 42 kg P/ha and 169 kg K/ha respectively. Weeds and pests were controlled as required, although in some plots volunteer grass, legume and broadleaf weeds became difficult to manage as a result of slow or poor establishment of the sown species.

Plots were cut twice during establishment in early spring, prior to dry matter (DM) evaluation at 6 harvest events between November 2014 and April 2015. Defoliation interval was between 26 and 34 days depending on growth rates. Dry matter (DM) yield was assessed across all pasture treatment plots by quadrat cuts (2 per plot) when the perennial ryegrass plots had reached the three leaf regrowth stage. Plants were defoliated to 5cm using hand shears and following collection the residual plot area was mown to 5cm. Pasture samples were botanically separated into the individual cultivars planted, with weed and non-sown species removed. Samples were oven dried at 56 °C for 48 hours to determine DM yield. The yield data were analysed assuming a randomised block design using Proc Mixed software of the SAS System version 9.3 [SAS Institute Inc. 2014. SAS/STAT ® 13.2 User's Guide. Cary, NC: SAS Institute Inc]. Each harvest time was analysed separately. Differences and associated 95% confidence intervals of predicted means were calculated using Proc Plm software of the SAS System version 9.3 [same ref as above] and P values adjusted for multiplicity using simulation. The half-width of the confidence interval was used to identify homogeneous pairs of predicted means (Westfall *et al*., 1999).

Table 1: Sowing rates (kg/ha) of pasture cultivars in monoculture (mono) and mixed swards

Grasses	Mono	Mixed	*Legumes*	Mono	Mixed
Perennial ryegrass *cv. Base*	15	12	White clover *cv. Bounty*	6	3
Coloured brome *cv. Exceltas*	20	12	Red clover *cv. Rubitas*	6	4
Cocksfoot *cv. Megatas*	5	3	Strawberry clover *cv. Palestine*	6	3
Tall fescue *cv. Quantum II MaxP*	12	10	Caucasian clover *cv. Kuratas*	6	4
Phalaris *cv. Advanced AT*	5	3			

Results

There were significant ($P<0.05$) differences between the yields (t DM/ha) of the 5 perennial grasses sown in monoculture at different harvest times (Table 2). Perennial ryegrass was the best performed grass, yielding equal to or significantly higher than all other grasses at each harvest time. Coloured brome also performed well and only differed from perennial ryegrass at the January 2015 cut. Cocksfoot and tall fescue yielded significantly less than perennial ryegrass at the January 2015 cut. Except for the first cut in November 2014, the yield of phalaris was significantly ($P<0.05$) lower than perennial ryegrass and coloured brome at each harvest thereafter. White clover was the best performed legume in monoculture, significantly ($P<0.05$) out yielding other clovers except red clover on 3 harvest dates and strawberry clover in November 2014. Caucasian clover performed poorly throughout. The inclusion of the white clover in the phalaris mixed swards had a positive effect of DM yields, significantly higher ($P<0.05$) in the later cuts (Table 2). However, there appeared to be no significant ($P<0.05$) response in yields with the inclusion of white clover, or any other clover in mixed swards consisting of perennial ryegrass, coloured brome, cocksfoot or tall fescue.

Discussion

Perennial ryegrass was the best performed perennial grass in this study and is the foundation of the majority of intensive pastures in Tasmania. However, the production of coloured brome was quite similar and was only significantly less at one of the harvest dates. The suggestion of the brome species as an alternative to perennial ryegrass was raised by Slack *et al*. (2001) who showed prairie grass *Bromus willdenowii*

outperformed perennial ryegrass under high temperatures providing the defoliation interval was extended. High daytime temperatures during summer are a characteristic of the Midlands region, compared with other areas of Tasmania. Many of the lower lying soils in the Midlands region are duplex and prone to waterlogging. Bromes including grazing brome *Bromus stamineus* cv. Grasslands Gala have poor tolerance of waterlogged soils (Stewart, 1992; Stewart 1996). The potential of coloured brome on such soils, although listed by Hall and Hurst (2013) as moderate, has yet to be fully evaluated. On free draining soils or in areas where summer irrigation may not always be available, coloured brome provides an animal friendly alternative to perennial ryegrass as suggested by Hall and Hurst (2012).

Table 2: Predicted means of dry matter yield (t DM/ha) of mixed and pure pasture swards across harvest dates.

Pasture treatments	**5/11/14**	**9/12/14**	**7/1/15**	**5/2/15**	**5/3/15**	**31/3/15**	**TOTAL**
Growing days	28	34	29	29	29	26	
Grass comparisons							
Phalaris	1829^{a}	1192^{b}	1022^{c}	515^{b}	649^{b}	647^{b}	5854
Perennial ryegrass	2673^{a}	2250^{a}	2856^{a}	2215^{a}	2552^{a}	1644^{a}	14190
Coloured brome	2604^{a}	2408^{a}	1883^{b}	2220^{a}	2783^{a}	1466^{a}	13364
Cocksfoot	2286^{a}	1726^{ab}	1977^{b}	1888^{a}	2664^{a}	1334^{ab}	11874
Tall fescue	2133^{a}	1627^{ab}	1667^{bc}	1986^{a}	2440^{a}	1436^{a}	11288
Clover comparisons							
White clover	1689^{a}	1406^{a}	1784^{a}	1300^{a}	1878^{a}	1020^{a}	9077
Caucasian clover	86^{b}	38^{b}	120^{c}	49^{c}	111^{c}	87^{b}	490
Strawberry clover	1669^{a}	289^{b}	363^{bc}	326^{bc}	546^{bc}	257^{b}	3449
Red clover	1601^{a}	594^{b}	937^{b}	887^{ab}	965^{b}	497^{ab}	5480
Phalaris comparisons							
Phalaris	1829^{a}	1192^{a}	1022^{a}	515^{ab}	649^{bc}	647^{b}	5854
Phalaris/White clover	2222^{a}	1014^{a}	1129^{a}	1038^{a}	1980^{a}	1494^{a}	8876
Phalaris/Caucasian clover	1921^{a}	1216^{a}	644^{a}	192^{b}	262^{c}	154^{b}	4383
Phalaris/Strawberry clover	1891^{a}	812^{a}	742^{a}	362^{ab}	674^{bc}	437^{b}	4918
Phalaris/Red clover	2315^{a}	957^{a}	888^{a}	710^{ab}	1144^{b}	734^{b}	6747
Perennial ryegrass comparisons							
Perennial ryegrass	2673^{a}	2250^{a}	2856^{a}	2215^{a}	2552^{a}	1644^{a}	14190
Perennial ryegrass/White clover	2883^{a}	2127^{a}	2687^{a}	1966^{a}	2448^{a}	1590^{a}	13700
Perennial ryegrass/Caucasian clover	2602^{a}	2247^{a}	2789^{a}	2291^{a}	2536^{a}	1356^{a}	13821
Perennial ryegrass/Strawberry clover	2691^{a}	2289^{a}	2764^{a}	2041^{a}	2539^{a}	1569^{a}	13892
Perennial ryegrass/Red clover	2836^{a}	2319^{a}	2479^{a}	2093^{a}	2801^{a}	1707^{a}	14235
Coloured brome comparisons							
Coloured brome	2604^{a}	2408^{a}	1883^{a}	2220^{a}	2783^{a}	1466^{a}	13364
Coloured brome/White clover	3058^{a}	2428^{a}	1852^{a}	1985^{a}	2782^{a}	1871^{a}	13977
Coloured brome/Caucasian clover	2593^{a}	2301^{a}	1809^{a}	2066^{a}	2662^{a}	1450^{a}	12873
Coloured brome/Strawberry clover	3122^{a}	2422^{a}	2084^{a}	2028^{a}	2712^{a}	1637^{a}	14005
Coloured brome/Red clover	3099^{a}	2259^{a}	1917^{a}	1887^{a}	2950^{a}	1717^{a}	13829
Cocksfoot comparisons							
Cocksfoot	2286^{a}	1726^{a}	1977^{a}	1888^{a}	2664^{a}	1334^{a}	11874
Cocksfoot/White clover	2580^{a}	1780^{a}	2052^{a}	2127^{a}	2826^{a}	1543^{a}	12908
Cocksfoot/Caucasian clover	2397^{a}	1797^{a}	2285^{a}	2340^{a}	2874^{a}	927^{a}	12619
Cocksfoot/Strawberry clover	2747^{a}	1963^{a}	2060^{a}	2036^{a}	2663^{a}	1548^{a}	13017
Cocksfoot/Red clover	2096^{a}	1753^{a}	2069^{a}	2069^{a}	2815^{a}	1345^{a}	12146
Tall fescue comparisons							
Tall fescue	2133^{a}	1627^{a}	1667^{a}	1986^{a}	2440^{a}	1436^{a}	11288
Tall fescue/White clover	2781^{a}	1945^{a}	1917^{a}	1980^{a}	2760^{a}	1646^{a}	13028
Tall fescue/Caucasian clover	2395^{a}	1725^{a}	1719^{a}	1768^{a}	2561^{a}	1464^{a}	11631
Tall fescue/Strawberry clover	2181^{a}	2002^{a}	1951^{a}	2209^{a}	2693^{a}	1628^{a}	12664
Tall fescue/Red clover	2431^{a}	1971^{a}	1937^{a}	1703^{a}	2544^{a}	1422^{a}	12008
95% CI half-width	1165	795	724	682	779	748	

Note: 95% CI half-width was estimated using simulation (see text). Letters indicate significant (P<0.05) differences between pasture treatments within each group of comparisons.

In this study phalaris produced significantly less than other grass cultivars, particularly from January onwards. This could partially be explained by Advanced AT being a winter active cultivar of phalaris (Culvenor, 2009) with a low level of summer dormancy. The continuation of the current study for the remainder of 2015 will show the seasonal production of phalaris during winter. However, it is unlikely that the annual production phalaris could match perennial ryegrass under these conditions and the full value of this cultivar is under dryland conditions in this region. The semi erect growing nature of this cultivar provided an open canopy for the growth of clovers. This is reflected in the yields of phalaris/white clover being significantly higher than the phalaris monoculture in the latter harvest dates. This was not observed in any of the other grass/legume mixed swards. The grasses quickly became dominant, reaching canopy closure and being very competitive against the clover under the high nitrogen applications. In monoculture, white clover was the highest performing clover, while the sowing time (April) was not favourable for Caucasian clover resulting in very slow establishment and strong competition from broadleaf weeds and grass weeds. Spring sowing Caucasian clover is recommended in this climatic region (Hall and Hurst, 2013).

Conclusion

Results from this study show that perennial ryegrass has confirmed its position as the most productive perennial grass species under a high input irrigation system in a cool temperate environment. However, coloured brome has shown to have the potential to be a viable alternative in this environment. These results reflect a snapshot of each cultivars performance over one summer. The continuation of this study over a much longer period of time will provide a clearer picture of each species full potential. The promising performance of the new species, coloured brome vs perennial ryegrass at this site indicates there is a need to compare these grasses across a wider range of environments, especially those with warmer summers, where the summer growth of perennial ryegrass is compromised by the heat.

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