The potential of summer-growing grasses to persist and produce out-of-season forage in the Victorian Mallee.

Anthony Whitbread[1] and Simon Craig[2]

[1]CSIRO Sustainable Ecosystems, Waite Precinct, Adelaide Email anthony.whitbread@csiro.au
[2] Birchip Cropping Group, Birchip Victoria, Email simon@bcg.org.au

Abstract

The purpose of this study was to investigate if subtropical pasture species could be established, grow and persist in the winter-dominant rainfall environment of the Victorian Mallee. Seven pasture species (6 grasses and one legume) were evaluated in a replicated small plot experiment at Hopetoun on a sandy loam with clay at depth and moderate subsoil constraints (EC > 0.5dS/m at 50 cm). The *Panicum maximum* cultivars (cvv.) of Petrie and Gatton, *P. coloratum* cv. Bambatsi and *Digitaria milanjiana* cv. Strickland established well and produced in excess of 1.0 t/ha of dry matter (DM) in spring-summer 2007/08 and 2008/09. *P. maximum* cv. Petrie produced the most DM in the establishment year 2006/07 (4.5 t/ha) and in excess of 3.3 t/ha over the summer 2009/10 in response to summer rainfall. *Bothriochloa bladhii* ssp. *Glabra* cv Swann did not establish well and did not recover while the patchy establishment of *Desmathus virgatus* cv. Marc shows potential to regenerate with a large seed set observed in February 2010. While subtropical grass species may hold promise as a summer growing pasture in the Mallee, the field results and modelling indicate that there is a short period of rapid growth in late spring and early summer corresponding with moisture availability and favourable soil temperatures. Consequently, in most years summer grasses have the potential to fill most of the early summer feed deficit, however, this is not likely extend to the late summer and early autumn periods.

Key Words

Tropical pastures, Mallee, feed deficit, modelling, pasture growth.

Introduction

Traditionally, wheat-sheep farmers of the Victorian Mallee have grown cereal crops and annual medic-based pastures during autumn, winter and spring to take advantage of the winter dominant rainfall pattern and low evaporation rates. This farming system often leaves a significant feed supply deficit for livestock industries over the summer and early autumn period which is filled by crop residues, conserved fodder or grain and volunteer weeds. These sown pastures do not take advantage of occasional summer rainfall and deep soil moisture carried over from winter and spring. Consequently it was hypothesised that summer-growing pasture species could be productive and reduce the summer feed deficit in the winter-dominant rainfall environment of the Mallee region. A species audit undertaken by Pengelly et al. (2006) identified several subtropical pasture species that may potentially fit in the farming systems of the Wimmera-Mallee region, especially under a climate scenario where significant summer rainfall events occur more frequently. Subtropical pastures have traditionally been grown in the summer-dominant rainfall zone of northern NSW and southern Queensland, and in recent years have found a niche in the northern Western Australian wheat belt. This paper presents field persistence and dry matter production results of 7 subtropical pasture species over 4 years along with a long term simulation analysis to assess the pattern and reliability of growth and its potential as a fodder source.

Methods

Field experiment

Six grasses (*Panicum maximum* Jacq. cvv. Petrie and Gatton, *P. coloratum* L. cvv. Bambatsi and AFT714, *Digitaria milanjiana* (Rendle) Stapf . cv. Strickland and *Bothriochloa bladhii* (Retz.) S.T. Blake subsp. *glabra* (Roxb.) B.K. Simon) and one legume (*Desmanthus virgatus* (L.) Willd cv. Marc) were chosen for evaluation in a replicated small plot experiment (4 replicates, plot size 25 x 3 m) at Hopetoun on a sandy loam with clay at depth and moderate subsoil constraints (EC > 0.5dS at 50 cm using 1:5 soil:water extract). Prior to sowing, a knockdown herbicide (1.5L/ha Roundup? PowerMax™) was applied. All species, were sown at 3kg/ha and 6kg/ha to identify the most successful sowing rate. The experiment was sown using a conventional seeder with rolling 'sheep feet' harrows on 10 November 2006. Because the seed of *B. bladhii* ssp. Glabra (cv. Swann) would not flow through the seeder it was broadcast by hand and then harrowed. Fertiliser was also applied at sowing (55kg/ha of Granulock Supreme Z (N11:P21.7:K0:S1)) and Buctril MA[?] (1.4L/ha) was applied on 24 February 2007 for control of common heliotrope (*Heliotropium europaeum*) and Caltrop (*Tribulus terrestris*). Afghan melons (*Citrullus lanatus*) were hand-weeded from the site. The plots were not grazed during the experiment and volunteer pasture growth during the winter months was not controlled. At the start of the 2009/2010 season (30 September 2009) all plots were slashed to ~ 5cm height with a mower and 25 kg/ha of N as urea was applied. Plant densities were assessed on 13 March 2007 and 13 March 2008 at 6 randomly selected points within each plot by counting the number of sown species on both sides of a 50 cm ruler. Plant counts were repeated on 30 April 2009 and January 2010 by counting plants within a 1 m^2 quadrat placed randomly at 3 locations within each plot. Total biomass of sown pasture was measured in 2-3 random quadrats in each plot in May 2007, March 2008, March 2009 and January 2010.

Modelling study

Using the sub-tropical grass model available in APSIM (http://www.apsim.info/apsim/publish/apsimui/types.xml#bambatsi), growth of *P. coloratum* cv. Bambatsi during the experimental period and over the longer-term (1955-2010) were simulated. For the simulation of the experimental period, soil water was set to 25 % of crop lower limit on 1 October 2006 (assumed to represent a relatively dry soil after the harvest of a cereal crop) with mineral N reset to the amount measured (77 kg/ha NO_3-N and 158 kg/ha NH_4-N in 0-1.3 m) prior to planting. The grass pasture was planted at 4 plants/m^2 on 10 November 2006 with an application of 6 kg/ha N. In the long-term simulation, the pasture was planted at 4 plants/m^2 at the start of the simulation (1 August 1955) and assumed remained at the same density (4 plants/m^2) throughout the simulation. Above-ground foliage was removed when dry matter (DM) exceeded 3 t/ha and surface residue were reset annually on 30 August to 1 t/ha to prevent the build up of surface residues influencing the simulation. For both simulations, meteorological data was sourced from the SILO database for Hopetoun (~10km away). Characterisation of the plant available water capacity (PAWC) and soil chemistry was undertaken at the site. The simulations assumed that there were no weeds at any time of the year, but soil moisture was reset to 25 % of crop lower limit annually on 30 Aug to more realistically represent the soil water available after winter.

Results

The majority of species germinated in late January/early February 2007 in response to 15mm of rain that fell on 20 January of that year. *B. bladhii cv.* Swann failed to germinate in 2007 and was not resown. *D. virgatus* cv. Marc was slow to emerge however a good population was eventually established. A series of frosts were recorded in July 2007 (e.g. -3.5^{o}C at 9am on 27 July 2007) and all species senesced shortly afterwards. November to March rainfall was 66 mm for 2006/07, 107 mm for 2007/08, 76 mm for 2008/09 and 176 mm for 2009/10 compared with the long term average of 73 mm (Table 1).

Table 1. Monthly rainfall (mm) and the long-term average (LTA) for Hopetoun.

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
2006										25	0	3	
2007	15	19	29	24	92	15	37	4	12	5	48	29	329

2008	29	0	1	13	30	16	29	7	4	6	24	36	195
2009	0	0	16	36	27	29	30	25	31	6	88	29	317
2010	18	13	28	26	29								
LTA	14	12	12	16	29	32	32	35	30	27	20	15	348

Plant numbers

In 2007 the 6 kg/ha sowing rate, had higher plant densities for *P. maximum* cv. Gatton, *P. coloratum* cv. ATF714 and *D. milanjiana* cv. Strickland which were 33 to 44 % higher than the 3 kg/ha sowing rate (Table 2). There was no difference in plant densities between the sowing rates for *P. coloratum* cv. Bambatsi, *D. Virgatus* cv. Marc or *P. maximum* cv. Petrie. Subsequent data collected in 2008, 2009 and 2010 showed no significant difference in plant density between the 2 sowing rates, but a high significant interaction between treatment and year (Table 3). From 2008 to 2009 plant density of all varieties declined with the exception of ATF714. From 2009 to 2010 no significant decline in plant density occurred for all varieties. In 2008 Gatton had higher plant densities than ATF714, however by 2009 and 2010 this difference had reversed. ATF714 had the most stable plant density over the 2008 to 2010 period and in 2009 and 2010 had higher plant than all other spp. The large decline in plant numbers from 2008 to 2009 indicates that there is probably low plant regeneration. No seed production or successful seedling recruitment was observed to have occurred, with the exception of Marc at any of the observation times.

Table 2. Plant densities of each sub-tropical species sown at two sowing rates (3 and 6 kg/ha) at Hopetoun assessed on March 2007.

Sowing rate	Gatton	Petrie	Bambatsi	ATF714	Strickland	Marc
3kg/ha	25	31	31	30	34	21
6kg/ha	36	44	37	40	48	24
Significance	P<0.05	NS	NS	P<0.05	P<0.05	NS

Table 3. Plant numbers (plants/m^2) present in March 2008, April 2009 and Feb 2010 for all varieties. Means followed by the same letter are not significantly different according to DMRT (P<0.05)

	Gatton	Petrie	Bambatsi	ATF714	Strickland	Marc
2008	23.4 a	15.4 bc	15.0 bc	10.8 cd	19.0 ab	16.3 bc
2009	4.7 ef	4.1 f	6.5 def	10.6 cde	2.5 f	2.1 f
2010	5.9 def	4 f	5.8 def	10.9 cd	2.3 f	1.8 f

Biomass

Significant differences in biomass were found between varieties at each sampling time but there was no difference in biomass between the two sowing rates in any of the years, hence the mean is presented. *P. maximum* cv. Petrie produced significantly more biomass than all the other varieties in 2007. *P. coloratum* cv. ATF714 produced the lowest biomass in all years despite having good plant density. Biomass production in 2008 and 2009 was generally low due to exceptionally dry and hot conditions experienced in January to March of 2008 and 2009. Good biomass for all spp in 2010 resulted from good rainfall received in November and December of 2009 and the application of 25 kg N/ha in September 2009. *D. milanjiana* cv. Strickland was not measured post 2008 as surviving plant numbers were low and variable between plots.

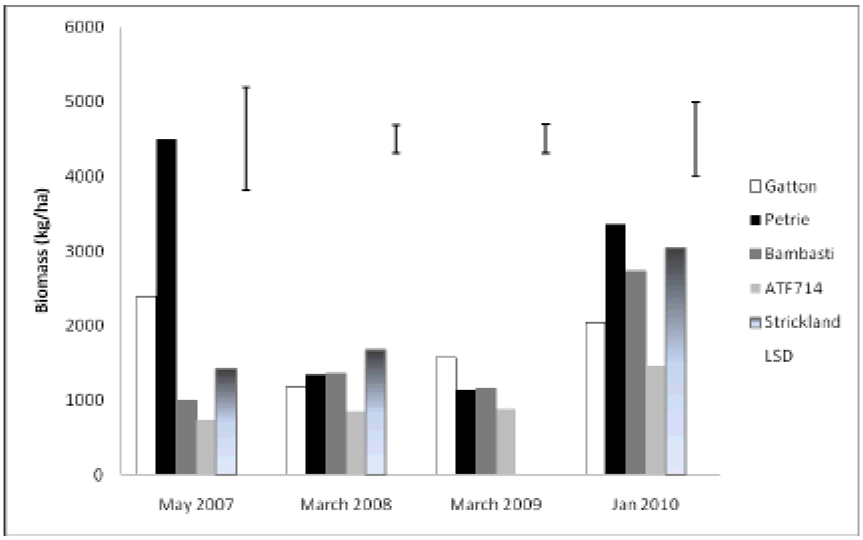

Figure 1. Aboveground biomass measured May 2007, March 2008, March 2009 and January 2010.

Prediction of pasture growth during experimental period

The seasonal pattern of simulated pasture growth was similar to the observed seasonal pattern, with the bulk of growth occurring September to December, intermittent growth during the warm months of January to March in response to rainfall and minimal growth March to August. Prediction of the accumulation of DM from the beginning of the growing season (October) until the date of a DM measurement was higher than measured in the 2 initial comparisons but overall, measured and observed data were very close. Data such as soil moisture and mineral N at the start of each growing season (October) was not collected in this study, but should be collected in future work in this area. The growth of volunteer medics during the winter period could also supply the summer growing pastures with N and should be considered in future studies.

Long term simulation

Simulated weekly pasture growth rate for 55 years shows peak pasture growth occurs in spring and early summer (September to December, Figure 2a) when soil moisture and temperature combine to provide favorable growing conditions. After December, pasture growth rate declines rapidly and remains low until April due to the low incidence of rainfall and higher evaporative loads. Between April and September, growth rate is negligible primarily due to low temperatures and frost events. Cumulative DM indicates a median of about 2000 kg/ha of DM produced per year (Figure 2b).

Table 4. Observed DM (kg/ha) and standard error of the mean (SEM) for harvest dates and predicted DM (kg/ha) for nominated start and finish dates.

Observed		Predicted	
Date of cut	DM (SEM)	Period of pasture growth	DM
27 May 07	1011 (173)	Oct06 to May 07	2015
17 Mar 08	1365 (200)	Oct07 to March 08	1820
24 Mar 09	1169 (125)	Oct08 to March 09	928
30 Nov 09	537 (164)	Oct 09 to Nov 09	611
21 Dec 09	2820 (796)	Oct 09 to Dec 09	2895
1 Feb 10	2736 (415)	Oct 09 to Jan 10	3311

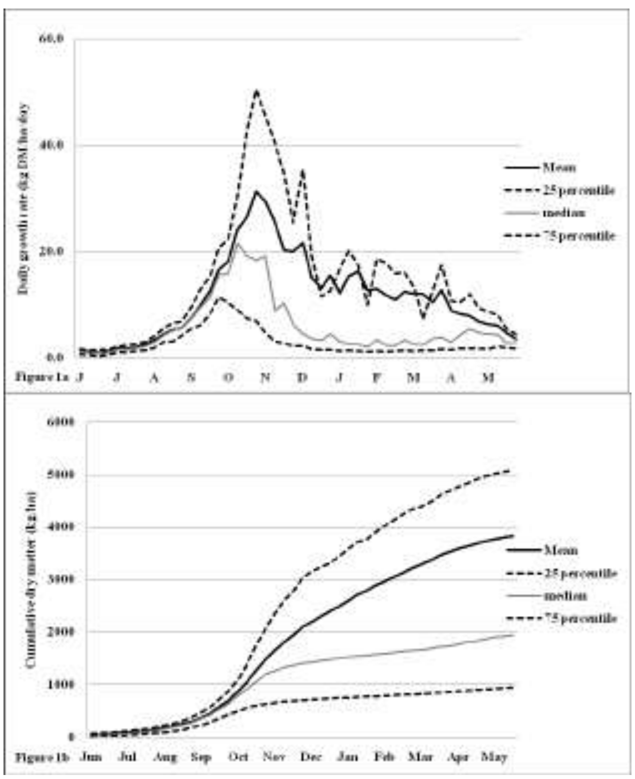

Figure 2. Simulated daily growth rate (Figure 2a) and cumulative DM (Figure 2b) of *P. coloratum* cv. Bambatsi throughout the year at Hopetoun. Heavy line = mean, Lighter solid line = Median and dotted lines = upper and lower quartiles for each week.

Conclusion

This is the first evidence that subtropical grasses can be productive in a Mediterranean mallee environment. Whether these species can recruit seedlings and persist in the medium to long term under grazing needs to be further investigated. While the simulation of pasture growth in this environment needs further validation against measured data, the pattern of pasture production shows a short period of rapid growth in late spring and early summer corresponding with moisture availability and adequate soil temperatures. Throughout the 55 years simulated, there were very few occasions of significant or sustained pasture growth between January and March. This reflects the low incidence of effective rainfall and high evaporative loads experienced in that period. As Lawes and Robertson (2008) concluded for a similar environment in Western Australia, perennial pasture may be best used tactically and may provide a handy but unreliable feed source in summer. This study suggests that while feed deficits are likely to be reduced in early summer they are still likely to be a problem in late summer and early autumn.

Acknowledgements

Thanks to Darryl Burdett for hosting of the trial for the past four years. This research formed part of the “Perennial Profit in the Mallee Wimmera” project funded by National Landcare Programme in partnership with the Mallee CMA and the EverCrop project of the Future Farm Industries CRC.

References

Lawes R and Robertson M (2008). Seasonal variability of Rhodes grass production in the northern West Australian wheatbelt. In “Global Issues Paddock Action. Proceedings of the 14th Australian Agronomy Conference. September 2008, Adelaide South Australia (http://www.regional.org.au/au/asa/2008/).

Pengelly BC, Hall E, Auricht G, Bennell M and Cook BG (2006). Identifying species and species mixes with potential for grazing systems in the Mallee-Wimmera. CSIRO Sustainable Ecosystems, Canberra. (87 pp). Report commissioned by the Birchip Cropping Group.