Dual-purpose barley as a risk management tool for mixed livestock enterprises in Western Australia

Bennett, Sarita Jane and Low, Susan Gai

Curtin University, GPO Box U1987, Perth WA 6845 http://oasisapps.curtin.edu.au/staff/profile/view/Sarita.Bennett, Sarita.bennett@curtin.edu.au

Abstract

Dual-purpose cereals provide the opportunity to graze a crop during the vegetative phase, yet still harvest the grain at the end of the season. They can also help to spread frost risk by delaying flowering to later in the growing season. The aim of the experiment was to determine the benefits of a dual purpose barley in relation to livestock feed and risk mitigation, and whether a malting variety can also be used for dual-purpose use. A simulated grazing experiment was conducted in Perth over the 2015 growing season, using four varieties of barley (both malting and feed) with four treatments; control, early July graze, early August graze and grazing at both dates. All varieties were found to respond in a similar way to grazing with a reduction in grain yield from all grazing treatments. The greatest loss of grain yield was in the grazed twice and early August grazed treatment, with the commencement of flowering being delayed up to five weeks following grazing. However, the early August grazed treatment provided nearly four times as much vegetative biomass as the early July grazed treatment and therefore it is suggested that this treatment may provide the greatest economic benefit from including livestock grazing in the system.

Keywords

Frost, supplementary feed.

Introduction

The proportion of land used for cropping in Australia's mixed-farming agricultural zone has increased since 1995 and the proportion of pastures has decreased, along with animal numbers (Bell and Moore 2012). With increasing meat and wool prices and a decrease in cereal prices in the last 2 years, plus an increasingly variable climate there is a drive by farmers to diversify on-farm enterprises to spread risk across the system. Dual-purpose cropping is a method of grazing a cereal crop during the vegetative stage before leaving the crop to flower and set seed as normal. There are a number of clear advantages from grazing a cereal crop including; providing feed for animals during the winter months when pasture growth is slow, reducing the amount of vegetative material thus potentially reducing the amount of water used during this period, saving water for later in the season when it can be limited, and changing the flowering period to later in the season to potentially avoid the frost window (Bell et al. 2014). Current recommendations are that animals should be removed before plants complete stem elongation (Anon. 2009) to ensure that grain yield is not compromised. However there are a number of unanswered questions - what is the yield penalty when animals are used for grazing at set times (so that a feed management plan can be used), is there is a difference between malting and feed varieties in amount of feed available and final grain yield, and is grain quality compromised when crops are grazed? The aim of this paper, addressing the conference theme of 'doing more with less', is to investigate the benefits of the use of dual-purpose barley using both feed and malting varieties across the cropping-livestock enterprise.

Methods

Four varieties of barley were sown at the Curtin University Field Trials Area, Perth (32°00'42. 71" S 115°53'24. 23" E, 730 mm 2015 GSR) on 5 May 2015 for a dual-purpose grazing experiment, with four treatments; an early graze, a later graze, two grazes and an un-grazed control. Varieties were chosen across both feed and malting classifications and were; Bass (malting), Yagan (feed), Lockyer (feed) and Baudin (malting). The experiment was sown as a two-block split-plot design with 7 rows of each variety sown at 120 plants/m^2 and with a 25 cm row spacing. Each block was 8 m long, with each variety of 7 rows divided randomly into four treatment plots of 1.5 m by 7 rows, with 1 m guard rows at each end.
The first cut was taken on 2 July 2015, and the 2nd cut on the 5 August 2015, cutting the middle five rows of each variety to 5 cm using grass cutters to simulate grazing. The treatment with 2 cuts was cut on both of these dates. The cut material was weighed, dried in an oven at 60°C for 6 days and re-weighed – this material

will be analysed for nutritive value. A sample of the cut material was weighed, dried at 80°C for 6 days and re-weighed to calculate the moisture content of the sample.

From the 2 July 2015 until harvest Zadoks (Zadoks et al. 1974), plant height and tiller number were recorded every four weeks on five randomly selected plants within each plot; 1 plant in each of the middle give rows, with the final measurement taken on 14 October 2015. A final harvest was taken on 19 November 2015 of the five middle rows of each plot. Grain was threshed, harvest index and yield calculated. A sample of the grain was analysed for protein percentage using the method described in AFIA Laboratory Manual Method 1.4R (AFIA 2014)

Data analysis
Data was analysed using Genstat 18th Edition (VSNI Ltd). Tests for normality and homogeneity of variance were conducted prior to analysis of the data. All data was found to be normal.

Results

Growth stage of treatments through growing season
Using the median value of five plants in each plot, the growth stages of the barley varieties were found to be delayed by grazing. At the first cut on 2 July all varieties were at stem elongation and at the 2nd cut on 5 August Bass, Baudin and Lockyer were still at stem elongation, whereas Yagin had progressed to early anthesis. Plots grazed on 2 July were all at stem elongation. By 26 August the control plots of Yagin were at late booting, and Bass, Baudin and Lockyer at anthesis. In contrast Cut 1 plots grazed on 2 July were all at early booting, and Cut 2 and Both Cuts plots grazed on 5 August were pre-Z39 and still at stem elongation. Cut 2 and Both Cuts treatment plots did not reach anthesis until mid-September.

Table 1. Analysis of variance of variables recorded for food and feed components in dual-purpose barley

Variable	Variety			Treatment			variety x treatment		
	df	F-ratio	F pr.	df	F-ratio	F pr.	df	F-ratio	F pr.
Height									
2-Jul	3	216.46	<0.01	3	1.48	ns	9	4.08	<0.01
5-Aug	3	48.4	<0.01	3	79.22	<0.01	9	1.13	ns
26-Aug	3	13.58	<0.01	3	78.00	<0.01	9	5.08	<0.01
16-Sep	3	25.16	<0.01	3	82.48	<0.01	9	3.08	<0.01
14-Oct	3	26.29	<0.01	3	26.51	<0.01	9	1.26	ns
Total Biomass	3	0.19	ns	3	48.78	<0.01	9	0.49	ns
Grain yield	3	4.4	<0.05	3	13.91	<0.01	9	0.56	ns
%Crude protein	3	3.21	0.05	3	0.56	ns	9	0.37	ns

ns – not significant

Plant vegetative characteristics
Plant height was significantly affected by grazing treatment in all varieties at all dates, with all grazed treatments having shorter plants at harvest (Table 1). There was also a significant difference between varieties with Lockyer significantly taller at all measurement dates (df = 3, p = <0.01) and a significant interaction between variety and treatment as varieties responded differently in their recovery from grazing. Figure 1 shows plant height in Lockyer as an example of the impact of the grazing treatments over the growing season.

Plant biomass available as a feed resource was significantly different between treatments (df = 3, F = 48.78, p=<0.001), but there was no significant difference between varieties, with the amount of feed available in each treatment showing limited variation. Tukey's post-hoc tests showed that the greatest biomass was available in the 2nd graze on 5 August (451.1 t/ha), followed by the combined biomass of the two cut treatments (261.1 t/ha), and then the 1st cut on 2 July (117.9 t/ha). Moisture content of the grazed material was on average 90% on 2 July and 86% on 5 August.

Grain yield and quality
Grain yield was found to be significantly different between treatments (df = 3, F = 13.91, P<0.01), and between varieties (df = 3, F = 4.4, P<0.05) with the control plots having a significantly higher grain yield in all varieties, and the treatment plots grazed twice having the lowest yields, following Tukey's post-hoc tests (Figure 2). Bass and Yagan had significantly lower grain yields than Lockyer, with Lockyer out yielding the other varieties in the 5 August graze in particular.

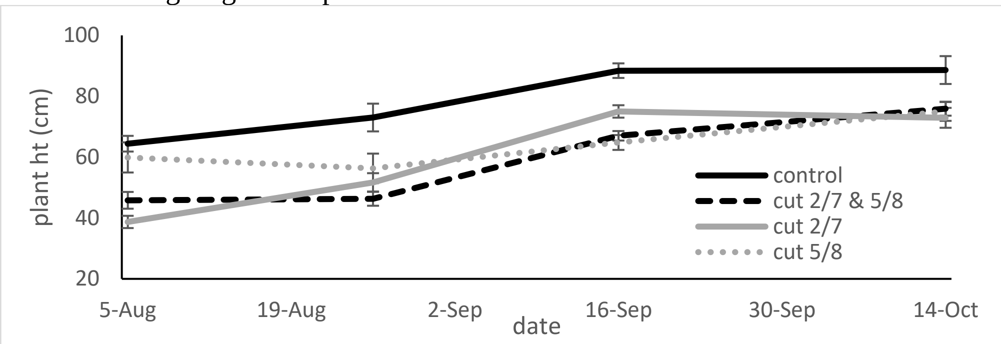

Figure 1. Plant height of Lockyer barley under different simulated grazing treatments over the growing season from the date of implementation of the first grazing treatment.

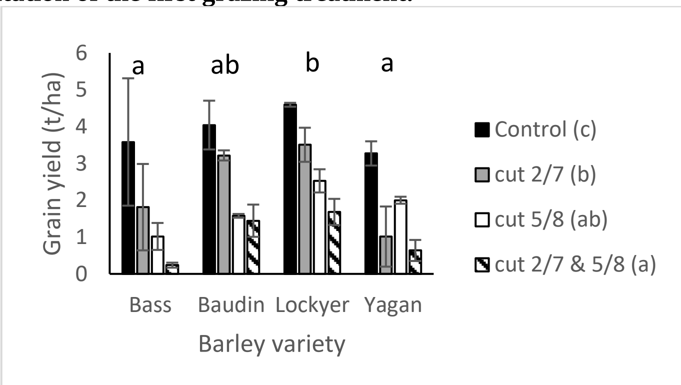

Figure 2. Grain yield of barley varieties grazed once or twice during the growing season. Tukey's post-hoc tests for variety shown above graph, and for treatment shown in legend, with different letters being significantly different.

Percentage crude protein (%CP) showed no significant differences between grazing treatments or the interaction between grazing treatment and variety. A significant difference was found between varieties with Yagan recording the lowest %CP (9.75%), and Bass the highest %CP of 12.58%. Baudin grain therefore met the receival standards for MALT1 from all treatments with %CP of 11.83 to 10.48%, whereas the %CP of Bass grain from the control treatment was greater than the maximum of 12.8% (MALT2), and would therefore potentially be downgraded to feed. The grazed treatments of Bass were all between 11.5 and 12.8% (MALT2) (cbh.com.au).

Discussion
Grazing at set times, as conducted in this experiment, with grazing simulated at the beginning of July and the beginning of August, following an early sowing at the beginning of May, resulted in an early July graze (cut 1), that was within the recommended grazing period for dual purpose cereals (Anon 2009), and an early August graze (cut 2) where all varieties except Yagan were still at stem elongation. Grain yield was compromised by grazing as has been shown by a number of authors including Frischke et al. (2015) in wheat and barley, and particularly in the later graze, or when two grazes are imposed. However quality was not significantly affected by grazing during the growing season, and a number of clear benefits were shown; delaying the flowering window and providing feed for animals at a time when feed can be scarce due to the low winter temperatures. Maturity length was the biggest contributor of effect of grazing on yield, rather than variety type (malt or feed), providing the opportunity to graze malting varieties and still obtain malting grades. However, in the current market the price for feed and malt varieties is comparable (glencoregrain.com.au) increasing flexibility for farmers, but not providing the benefits of growing malting varieties. Yagan as a very early maturity type is not suitable for use in a dual-purpose system (Paynter and Trainor 2016), whereas Bass and Baudin with a medium maturity length, and Lockyer as a long-season

variety provide more options in a mixed farming system depending on location. In a high rainfall environment in WA, where this experiment was conducted, Yagan was still constrained by maturity length, although screenings were not an issue in any variety (data not presented).

In a growing season with an early break, these benefits enable farmers to sow earlier to maximise the use of early winter rains, but reduce the risk of frost impacting on grain yield by delaying flowering. One of the management options suggested for spreading frost risk is to stage sowing dates over a 3 to 6 week period (Anon 2016). Grazing crops provides the same management outcome using time of grazing to spread the flowering window. The flowering window was delayed by up to 5 weeks into mid-September following grazing. In an environment where the potential for damaging frosts is widening, spreading risk by spreading the flowering window across the farm is recommended.

The benefits to the livestock enterprise are harder to quantify, but dual-purpose cereals provide animals with a green winter feed source at a time when pasture growth can be slow and there may be feed gaps in the system. The amount of feed available in early August was almost four times that available in early July (cut 1), and almost double that of the plots that were grazed twice in the growing season. It can be argued that the final yield reduction in the plots that were grazed twice or grazed once in August compromised the amount and quality of the final yield, but the value of the grain versus the value of the feed will vary depending on the demands and requirements of the farm enterprise. In a review on the evolution of crop-livestock integrated systems in Australia, Bell et al. (2014) calculated that the median benefit of grazing dual purpose wheat crops was around 25% and in 30% of the studies investigated was more than 75%. Interestingly the impact of livestock price to grain price had little impact, and the benefit to the livestock more than compensated for the reduced grain yield. It is therefore suggested that in a mixed farming system, where livestock are a significant component of the system, the value of the feed resource from the barley up to early August, although resulting in a significant reduction in grain yield, may provide the best economic returns, even when grazing malting varieties, and particularly in years when winter pasture is limited.

Conclusion

In conclusion, there was a reduction in grain yield, but no quality penalty in terms of % crude protein across all varieties in response to grazing, with the greatest reduction occurring in the treatments that were grazed early August, or were grazed twice. Yagan, the early maturity variety, showed the biggest penalty and is not recommended for dual-purpose use. Imposing grazing treatments delayed the flowering window by up to 5 weeks, reducing the risk of frost damage during flowering. The amount of biomass available for grazing was greatest in the early August grazing treatment and is almost four times greater than that available in the first grazing treatment in early July. It is suggested that the amount of vegetative biomass available for livestock more than compensates for the reduction in grain yield.

References

AFIA (2014). AFIA - Laboratory Methods Manual. Publication No. 03/001. Australian Fodder Industry Association Ltd. Melbourne, VIC.

Anon (2009). Dual-purpose crops. GRDC Fact Sheet. Canberra, ACT.

Anon (2016). Managing frost risk. Northern, southern and western regions. GRDC Grownotes. Canberra, ACT.

Bell LW and Moore AD (2012). Integrated crop-livestock systems in Australian agriculture: Trends, drivers and implications. Agricultural Systems 111, 1-12.

Bell LW, Moore AD and Kirkegaard JA (2014). Evolution in crop–livestock integration systems that improve farm productivity and environmental performance in Australia. European Journal of Agronomy 57, 10-20.

Frischke AJ, Hunt JR. McMillan DK and Browne CJ (2015). Forage and grain yield of grazed or defoliated spring and winter cereals in a winter-dominant, low-rainfall environment. Crop and Pasture Science 66(4), 308-317.

Paynter B and Trainor G (2016). 2017 barley variety sowing guide for Western Australia. DAFWA South Perth, WA.

Zadoks JC, Chang TT and Konzak CF (1974). A decimal code for the growth stages of cereals. Weed Research 14 (6), 415-421.