Grain yield of wheat following winter grazing in a low rainfall environment

Latta R
South Australian Research and Development Institute. PO Box 31 Minnipa SA (5654) Australia; roy.latta@sa.gov.au

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Introduction

Cereal, largely wheat (*Triticum aestivum* L.), production is the primary enterprise of most dryland farms in the low rainfall winter rain dominant zone of southern Australia. Sheep (*Ovis aries* L) are used on a majority of those farms to graze pastures, grown in rotation with the wheat crops, and during the dry summer crop stubbles (Ewing *et.al*., 2005). A major constraint to the sheep enterprise is the scarcity of sheep feed from April to July when supplies of stubbles and pasture residues are exhausted, annual pastures take time to establish and feed demand is high due to lambing. There is interest in the potential for vegetative cereal crops to provide high-quality green feed during this period.

Recent research including whole farm biophysical (Moore, 2009) economic modelling (Doole *et.al*., 2009) and field based studies (Virgona et.al., 2006) have suggested that spring wheat does not provide a production or economic benefit in regions with annual rainfall below 350 mm. This assessment is based on the contention that the number of seasons that allow wheat establishment to occur early enough to produce worthwhile biomass, with consideration of the probability of frost and the need to graze prior to stem elongation, in this low rainfall zone is limited to a point considered unviable. In the medium to high rainfall zones they recommended longer season winter wheat to allow early seeding to increase the winter biomass while reducing the frost risk. This has been shown to support increased stocking rates with acceptable grain yield reductions, although this depends on the timing of defoliation plus the seasonal conditions.

This study evaluated the impact of defoliation timing on both spring and winter wheat grain yield over 3 seasons in the low rainfall grainbelt of southern Australia to better support an integrated mixed farming system.

Materials and Methods

Three years of trials were carried out on Minnipa Agricultural Centre (Latitude 32.833 S, Longitude 135.150 E) on an alkaline red calcareous sandy clay loam pH 7.8 (CaCl).

Experiments were sown with wheat varieties on 24 June 2005, 12 May 2006 and 16 May 2007 (Table 1). All plots in all 3 years received 11 kg/ha of N and 12 kg/ha of P at seeding. Pre seeding, Sprayseed^{R} (135g/L paraquat, 115g/L diquat) at 1 L/ha was applied on 6 June 2005 and 9 May 2007. In 2006, glyphosate (460 ml/L a.i.) at 1 L/ha was applied on 12 May. No post-emergent chemicals were applied.

Table 1. Wheat varieties and seeding rates (kg/ha) sown at Minnipa in 2005, 2006 and 2007

	Seeding rate (kg/ha)*		
Variety	2005	2006	2007 (2)
Wyalkatchem	48	69	57
Yitpi	48	65	59
EGA Wedgetail	48	65	58

Plot sizes in all years were 24 m x 1.8 m. In 2005 and 2006 the plots were split in half for plus and minus mowing and grazing respectively, with the defoliated half of the replicate randomly allocated. In 2007 each treatment was allocated its individual plot, i.e., no split plots. Both sites were fully randomised blocks with 3 replicates in 2005 and 4 replicates in 2006 and 2007.

Plant establishment and biomass measurements were collected from 4 x 1 m rows with the biomass estimated after drying samples for 48 hours at 70^0C. Grain yields were calculated from machine harvesting whole plots, with grain samples retained for grain protein contents, test weights and screening percentage estimates.

In 2005 the plant establishment and biomass measurements, and mowing treatments, were carried out on 12 September (Zadock's growth scale 34-36). Grain yields were collected on 13 December. In 2006 plant establishment and biomass measurements were collected on 19 July (Zadock's growth scale 13-15) followed immediately with grazing at a rate of 227 Dry Sheep Equivalent (DSE)/ha on half of each replicate for 24 hours. Grain yield was collected on 23 October. In 2007 plant establishment and biomass measurements and mowing were completed on the 17 July (Zadock's growth scale 23-25) with grain yields collected on the 6 November.

Results and Discussion

The study measured the impact of defoliation at 3 different growth stages on the grain yield of an early and mid season spring wheat, and a longer season winter wheat over three seasons, two of which had growing season rainfall below 100 mm. It tested the opportunity to utilise wheat herbage to help fill the winter feed gap with a rapid defoliation.

Growing season rainfall (long term April-September 250 mm) was deficient in 2006 and 2007 with 97 and 87 mm respectively (Table 2).

Established plant numbers were similar between treatments in all years, and reflected the increased seeding rates in 2006 and 2007 (Table 3). Biomass at the time of defoliation was similar between cultivars in 2005 and 2006 but in 2007 Wyalkatchem produced less than Yitpi, and Yitpi less than Wedgetail. The biomass reflected the growth stage at time of defoliation, 2005 GS 34-36, 2006 GS 13-15 and 2007 GS 23-25.

As expected and reported previously (Virgona et.al., 2006), grazing post stem elongation resulted in loss in grain yield in the earlier maturing spring wheats but was not the case with the longer season variety Wedgetail with 61 mm of rain in September 2005. Defoliation pre-stem elongation with either a very intensive grazing or a mechanical mowing did not result in any yield loss in the 2006 and 2007 low rainfall seasons in any of the cultivars (Table 3). However, Wedgetail grain yields in 2006 and 2007 reflected the very dry spring periods. The only impact of defoliation on screening percentage or test weight was in 2005 when the screening percentage of Wyalkatchem was increased from 2.6 to 5.4% by defoliation.

Table 2. Rainfall (mm) at Minnipa Agricultural Centre in 2005, 2006 and 2007

Minnipa	Jan	Feb	Mar	Apr	Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2005	8	2	1	5	8	66	31	31	61	28	24	22	286
2006	25	20	50	15	22	19	37	3	1	0	20	9	221
2007	13	0	66	17	13	14	23	14	6	5	18	52	241
Mean*	13	17	16	18	37	46	48	46	34	27	22	20	345

* 1915 – 2009 average rainfall at Minnipa.

Table 3. Cereal establishment (plants/m^2) biomass (tDM/ha) grain yield (t/ha) and protein content (%) in 2005, 2006 and 2007

Variety	Establishment	Biomass	Grain yield (t/ha)		Protein (%)	
2005	plants/m^2	tDM/ha	mown	unmown	mown	unmown
Wyalkatchem	111	0.7	0.7	1	13.3	12.8
Yitpi	115	0.6	0.7	1	14	13.9
Wedgetail	114	0.6	0.8	0.9	14.2	14
lsd (*P*=0.05)	nsd	nsd	0.16		0.3	
2006	plants/m^2	tDM/ha	grazed	ungrazed	grazed	ungrazed
Wyalkatchem	157	0.24	0.56	0.65	14.3	15.1
Yitpi	151	0.21	0.56	0.67	14.7	15
Wedgetail	153	0.19	0.42	0.45	16.4	16.5
lsd (*P*=0.05)	nsd	nsd	0.13		0.6	
2007	plants/m^2	tDM/ha	mown	unmown	mown	unmown
Wyalkatchem	144	0.3	0.9	1.1	13.5	13.1
Yitpi	147	0.4	0.9	1	14.5	15.2
Wedgetail	144	0.5	0.4	0.4	16.8	17
lsd (*P*=0.05)	nsd	0.1	0.17		0.7	

The results suggest there is an opportunity to graze spring wheat for a very short period pre-stem elongation with only minimal loss in grain yield. There was no measure of biomass utilisation to estimate the value in livestock production, and it could be assumed that the defoliation in 2006 at the 3 to 5 leaf stage (0.2 tDM/ha) would provide minimal livestock forage benefits and present soil protection risks. However 0.4 – 0.5 t/ha of biomass at early tillering would provide 1-200 kg/ha of high value forage in a period of low feed availability, thus improving the viability of the mixed farming system while maintaining adequate groundcover.

References

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