Grain & Graze 3 - Grazing Crops and Frost

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AIM

To assess the impact of (and interaction between) grazing and frost damage on the grain yield and quality of a range of winter and spring cereal varieties sown at two times of sowing.

TRIAL DETAILS

Property:	Gary Lang
Plot size & replication:	Complete Randomised Block design; 10m x 1.5m blocks; 11 Varieties x 3 Replications
Soil type:	Loamy Sand
Crop Variety:	**Winter Wheat:** Manning Wedgetail Currawong **Winter Barley:** Urambie **Winter Oat:** Eurabbie **Spring Wheat:** Forrest Magenta Mace **Spring Barley:** Oxford Hindmarsh **Spring Oat:** Bannister
Sowing Date:	Time of sowing 1; 23/04/2014. Time of sowing 2; 27/05/2014
Seeding Rate:	Wheat 75kg/ha; Barley 75kg/ha; Oats 90kg/ha
Fertiliser (kg/ha):	Pre - 100kg/ha DAP + 50kg/ha Urea
Paddock rotation:	2013 Barley
Herbicides:	Wheat Pre - 118g/ha Sakura + 250g/ha Diuron + 1.5L/ha Trifluralin Barley Pre - 2.5L/ha Trifluralin Oats Pre - 500mL/ha Metolachlor + 400g/ha Diuron
Insecticides:	Wheat/ Barley/ Oats Pre - 200mL/ha Bifenthrin
Tillage type:	Knife points and press wheels, 10 inch spacing
Stubble Characteristics:	Burnt Barley stubble

Randomisation

Time of Sowing 1

	Wheat														Barley								Oats				
	Magenta	Magenta	Mace	Mace	Manning	Manning	Forrest	Forrest	Wedgetail	Wedgetail	Currawong	Currawong			Hindmarsh	Hindmarsh	Urambie	Urambie	Oxford	Oxford			Bannister	Bannister	Eurabbie	Eurabbie	
Buffer	Manning	Manning	Wedgetail	Wedgetail	Currawong	Currawong	Magenta	Magenta	Mace	Mace	Forrest	Forrest	Buffer	Buffer	Urambie	Urambie	Oxford	Oxford	Hindmarsh	Hindmarsh	Buffer	Buffer	Eurabbie	Eurabbie	Bannister	Bannister	Buffer
	Currawong	Currawong	Magenta	Magenta	Forrest	Forrest	Wedgetail	Wedgetail	Manning	Manning	Mace	Mace			Oxford	Oxford	Hindmarsh	Hindmarsh	Urambie	Urambie			Bannister	Bannister	Eurabbie	Eurabbie	

Time of Sowing 2

	Wheat														Barley								Oats				
	Currawong	Currawong	Mace	Mace	Wedgetail	Wedgetail	Forrest	Forrest	Magenta	Magenta	Manning	Manning			Urambie	Urambie	Oxford	Oxford	Hindmarsh	Hindmarsh			Bannister	Bannister	Eurabbie	Eurabbie	
Buffer	Magenta	Magenta	Forrest	Forrest	Manning	Manning	Mace	Mace	Wedgetail	Wedgetail	Currawong	Currawong	Buffer	Buffer	Hindmarsh	Hindmarsh	Urambie	Urambie	Oxford	Oxford	Buffer	Buffer	Eurabbie	Eurabbie	Bannister	Bannister	Buffer
	Mace	Mace	Manning	Manning	Forrest	Forrest	Wedgetail	Wedgetail	Currawong	Currawong	Magenta	Magenta			Oxford	Oxford	Hindmarsh	Hindmarsh	Urambie	Urambie			Bannister	Bannister	Eurabbie	Eurabbie	

Note: Shaded = Grazed plot.

BACKGROUND

The use of crop grazing by mixed farmers can enable total farm productivity to be increased. The area of winter pasture required is reduced, as livestock spend some of their time grazing crops. This allows a greater percentage of the farm to be allocated to cropping for the same number of livestock. Or alternatively, a greater number of livestock can be run for the same area of crop/pasture.

To maximise the benefits from crop grazing, sowing some of the crop program early is critical to produce livestock feed in late autumn and early winter, when pasture is scarcest. However, most farmers in WA don't sow their cereal crops (utilising early-mid maturing spring cereal varieties) until May or early June. From a crop grazing perspective, this relatively late sowing date severely restricts both the amount of crop biomass available for grazing and the length of the grazing window.

To make use of early sowing opportunities, winter type cereals, with a vernalisation requirement for flowering, are needed when sowing in March and early-mid April, and late maturing Spring type cereals, with slow development, are needed when sowing from mid-April to early-May.

This project is part of the national GRDC funded Grain and Graze 3 project which is expected to run over 3 years, from 2014-2016.

METHODOLOGY

In additional to the grazing crops and frost trial at Wickepin, two additional grazing crops trial sites were established at Kojonup and Esperance. Results from these are included within this report.

Wickepin

A small plot trial was conducted on Gary Lang's farm, 15km NE of Wickepin. The experiment tested 11 varieties, 2 times of sowing, and +/- grazing. There were 3 replicates per treatment. Grazing of the grazed plots was simulated using an auto scythe, with a cutting height of 5cm. The first time of sowing was grazed twice (June 10 and July 15) while the second time of sowing was only grazed once (July 15). Quadrat cuts were used to determine the amount of edible biomass (plant material >5cm in height) available at each grazing. Plant development was monitoring using weekly Zadock scores from mid tillering through to anthesis. At anthesis heights of ten plants per plot were recorded. Three cuts per plot were taken at Z89 and used to calculate tiller number, sterility and harvest index. A small plot harvester was used to measure grain yield, screenings, hectolitre weight, 1000 seed weight and protein data. Temperature loggers were installed in each time of sowing at a canopy height of 600mm, and recorded minimum, maximum and temperature every 15 minutes. Six loggers were placed in each time of sowing, in grazed and ungrazed plots of Mace wheat, Hindmarsh Barley and Bannister oats.

Kojonup
A large plot (plots 12m wide x 200m long) trial was located on Waynne and Pip Crook's farm, 30km SSW of Kojonup. The experiment tested 7 varieties, 1 time of sowing (May 6) and +/- grazing. There were 3 replicates per treatment. Sheep grazed the grazed plots twice (June 25 to 27 and July 16 to 18), down to a height of approximately 5cm. Quadrat cuts were taken to assess crop biomass pre and post-grazing. A small plot harvester was used to measure grain yield.

Esperance
A large plot (plots 18m wide x 300m long) trial was located on David Cox's farm, 25km NE of Esperance. The experiment tested 7 varieties, 1 time of sowing (April 16) and +/- grazing. There were 4 replicates of the Urambie barley +/- grazing treatments, but only one replicate of all other treatments. Cattle grazed the grazed plots twice (June 4 to 17 and July 7 to 15), down to a height of approximately 5cm. A large combine harvester and weigh trailer were used to measure grain yield.

Rainfall
Table 1: Monthly rainfall (mm) at the Wickepin, Kojonup and Esperance trial sites in 2014.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Wickepin	0	0	7	25	72	24	62	54	36	36	5	0	321
Kojonup	0	22	2	11	136	53	113	70	57	61	16	0	540
Esperance	10	9	1	14	78	46	114	48	60	97	46	0	523

RESULTS & DISCUSSION

Wickepin
Edible dry matter production up to mid-July from the first time of sowing (23 April) was significantly greater than the second time of sowing (27 May) at Wickepin (Table 2). Oats were more productive than barley and wheat, and the "spring" varieties more productive than the "winter" varieties.

Table 2: The impact of variety and time of sowing on “edible” dry matter production (kg/ha >5cm in height) up to mid-July at Wickepin

	Time of Sowing	
Variety	**23-Apr**	**27-May**
Wheat		
Mace	822	116
Magenta	619	118
Forrest	561	82
Currawong	434	107
Wedgetail	459	114
Manning	285	133
Barley		
Hindmarsh	732	83
Oxford	522	85
Urambie	420	45
Oats		
Bannister	923	79
Eurabbie	805	80
Average	**599**	**95**
P-value	**<0.001**	
LSD (p=0.05)	**109**	

Grazing significantly delayed the date of flowering in the first time of sowing, but not the second time of sowing (Table 3). The delay in flowering was significantly longer in “spring” varieties (11 to 22 days) when compared to “winter” varieties (1 to 7 days). Early sowing enabled the late maturing wheat varieties (Forrest, Currawong, Wedgetail) to flower in the optimal mid-late September period. Early-mid maturing varieties (Mace, Magenta) also flowered at this time, but only when sown late, or sown early and grazed. When sown early but not grazed, they flowered in late August (a high frost risk period). The very late maturing Manning wheat always flowered in mid-late October, regardless of management.

Table 3: The impact of variety, time of sowing, and grazing on flowering date (Z65 for wheat, Z45 for barley and oats) at Wickepin

	Time of Sowing			
	23-Apr		**27-May**	
Variety	**Grazed**	**Ungrazed**	**Grazed**	**Ungrazed**
Wheat				
Mace	19-Sep	28-Aug	19-Sep	19-Sep
Magenta	19-Sep	29-Aug	23-Sep	23-Sep
Forrest	30-Sep	19-Sep	10-Oct	9-Oct
Currawong	23-Sep	19-Sep	3-Oct	3-Oct
Wedgetail	26-Sep	19-Sep	3-Oct	3-Oct
Manning	17-Oct	16-Oct	24-Oct	24-Oct
Barley				
Hindmarsh	29-Aug	11-Aug	4-Sep	2-Sep
Oxford	31-Aug	19-Aug	16-Sep	11-Sep
Urambie	31-Aug	26-Aug	12-Sep	11-Sep
Oats				
Bannister	9-Sep	22-Aug	11-Sep	10-Sep
Eurabbie	9-Sep	5-Sep	16-Sep	16-Sep
Average	16-Sep	5-Sep	23-Sep	22-Sep

Grazing reduced grain yield in both early and late sown crops, although the impact was less in late sown crops (Table 4). When sown early, the two earliest maturing cereal varieties (Mace wheat and Hindmarsh barley) suffered the most from grazing. This is most likely due to grazing removing initiating heads. In all varieties, except the very late maturing Manning wheat, early sown grazed crops yielded less than late sown ungrazed crops.

Table 4: The impact of variety, time of sowing, and grazing on grain yield (t/ha) at Wickepin

	Time of Sowing			
	23-Apr		**27-May**	
Variety	**Grazed**	**Ungrazed**	**Grazed**	**Ungrazed**
Wheat				
Mace	2.5	3.6	3.2	3.8
Magenta	2.6	4.1	3.7	3.8
Forrest	2.8	3.9	3.1	3.4
Currawong	3.3	3.9	3.9	3.7
Wedgetail	2.9	3.7	3.0	3.2
Manning	2.1	2.8	1.1	1.2
Barley				
Hindmarsh	2.8	4.6	3.7	4.2
Oxford	3.5	5.3	3.9	4.1
Urambie	3.1	3.4	3.3	3.6
Oats				
Bannister	3.0	4.1	4.1	4.5
Eurabbie	2.7	3.9	3.7	4.1
Average	2.8	3.9	3.3	3.6
P-value	**<0.001**			
LSD (p=0.05)	**0.4**			

Kojonup

Grazing did not have a significant impact on yield, but it did on grain quality at Kojonup (Tables 5 & 6). Small foreign seeds, ergot and screenings all increased under grazing. The increase in ergot and small foreign seeds suggests grazed crops contained more ryegrass than ungrazed crops. Weed numbers were not assessed.

Table 5: The impact of variety and grazing on grain yield (t/ha) at Kojonup

Variety	**Grazed**	**Ungrazed**
Calingiri	4.6	4.7
Currawong	5.2	5.1
Forrest	4.2	5.2
Magenta	4.1	4.6
Revenue	4.7	4.4
Scout	4.2	4.3
Wedgetail	4.3	4.6
Average	**4.5**	**4.7**
P-value	0.2	
LSD (p=0.05)	1.1	

Table 6: The impact of grazing on grain quality at Kojonup

	Grazed	Ungrazed	P-value	LSD (p=0.05)
Small Foreign Seeds (%)	0.7	0.2	<0.001	0.2
Ergot (cm)	5.8	2.4	0.005	1.8
Screenings (%)	2.7	2.1	0.005	0.3

Esperance

Grazing significantly reduced grain yield by 0.5 ton/ha at Esperance (Table 7). Insufficient replication made it impossible to determine if there was an interaction between grazing and variety, even though the data suggests the two spring barley varieties (Grange and Oxford) were least affected by grazing. Einstein wheat was the highest yielding ungrazed variety, while Oxford barley was the highest yielding grazed variety. Mace wheat was the lowest yielding grazed variety, and third lowest yielding ungrazed variety, showing there are far better options available when sowing early and grazing.

Table 7: The impact of grazing on grain yield (t/ha) at Esperance

	Grazed	Ungrazed	P-value	LSD (p=0.05)
Grain Yield	3.1	3.6	0.06	0.54

Table 8: The impact of variety and grazing on grain yield (t/ha) at Esperance

Variety	Grazed	Ungrazed
Wheat		
Mace	2.3	3.3
Currawong	2.8	3.2
Einstein	3.4	4.7
Revenue	3.1	3.7
Barley		
Grange	3.2	3.1
Oxford	3.5	3.5
Urambie	3.1	3.6
P-value	0.68	
LSD (P=0.05)	1.6	

Head loss in grazed barley was significantly less than in ungrazed barley at Esperance (Table 9). Varietal differences in head loss were large, with Urambie barley far worse than Grange and Oxford.

Table 9: The impact of variety and grazing on barley head loss (heads/m^2) at Esperance

Variety	Grazed	Ungrazed
Grange	12	30
Oxford	4	34
Urambie	62	81

CONCLUSION

In these experiments, cereal crops were sown 2 to 4 weeks earlier than standard district practise. This significantly increased the amount of crop biomass available for grazing in early to mid-winter. As an example, the increase in available biomass at Wickepin from early sowing was over 600% (599 vs 95 kg/ha). Clearly, if additional livestock production is a major priority from grazing crops, early sowing is a must.

Grazing did reduce grain yield in 2 out of the 3 experiments. Care must be taken when grazing to avoid inducing large and costly yield penalties. Based on other Grain & Graze research, we know that the timing and amount of crop biomass left when livestock are removed are key factors in determining the size of any yield penalty. In all 3 experiments, livestock were removed from crops in mid-July. We suggest this was either too late, or the amount of biomass remaining after grazing was too little. Confining crop grazing to just the month of June, when pasture availability is most limited, might be one way to reduce the risk of incurring yield penalties. Experimentation in 2015 will explore this.

Grazing did delay crop flowering, especially when crops were sown early and grazed for an extended period. Care needs to be taken when grazing early sown spring varieties with early-mid maturity as they rapidly reach Z30 and grazing can remove developing heads. Winter varieties can be sown as early as February and March without the worry of them rapidly reaching Z30, as this is controlled by their requirement for vernalisation.

The earlier maturing varieties of winter cereals such as Urambie barley and Currawong wheat appear to have a good fit when sown early in the medium and high rainfall zones. Ideally these would be sown in March or early April utilising early autumn rain and/or carryover subsoil moisture. The very late maturing winter cereals such as Revenue and Manning wheat appear to be unsuited to WA conditions due to the risk of moisture stress during grain fill.

Oxford, a high yielding, later maturing spring feed barley, appears to be an excellent option for sowing in mid-late April to provide grazing in early winter, and a high grain yield come harvest. To minimise the risk and size of any yield penalty, grazing could be confined to early winter (i.e. June).

High yielding, early-mid maturing spring cereal varieties such as Mace wheat and Hindmarsh barley should not be sown early with grazing used to hold back their development. Significant yield penalties are likely to occur with this strategy. A better strategy is to sow these in their normal sowing window (May) and graze very lightly in mid-winter (i.e. early July) if livestock feed is in short supply.

Although some varieties flowered during the high frost risk period, in 2014 no severe frost events were recorded at this time. Early assessment of frost data shows no significant results in terms of frost damage. Results from a more in-depth analysis of this data will be provided at a later date.

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