Adapting to climate change with crop sequences

RESEARCH

Roy Latta and Ian Richter
SARDI, Minnipa Agricultural Centre

Australian Government
Department of Agriculture, Fisheries and Forestry
GRDC Grains Research & Development Corporation
SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 333 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 3.8 t/ha (W)
Actual: 3.6 t/ha
Paddock History
2010: Wheat
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam over light clay
Soil Test
Total N (0-60 cm) <40 kg/ha
Colwell P 22 mg/kg
Pest and Diseases
Project key outcome: control grass weeds and cereal borne root diseases
Plot Size
40 m x 1.5 m x 3 reps
Yield limiting factors
Powdery mildew on annual medics
Environmental Impacts
Soil Health
Project aims to recommend options to improve;
- soil nutrients and groundcover
- reduce disease levels and chemical use

Key messages

- **Well managed continuous wheat produced a yield of 3.6 t/ha in 2011, a decile 5 year.**
- **Oats produced up to 9 t dry matter (DM)/ha as a hay crop.**

Why do the trial?

To determine the comparative performance of alternative crops and pastures as pest and disease breaks in an intensive cereal phase.

In low rainfall regions of south-eastern Australia broad-leaf crops make up only a very small proportion of the total area of sown crops. In light of increasing climate variability farmers have adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to greater yield and price fluctuations. However, there is an identified need for non-cereal options to provide profitable rotational crops, disease breaks and weed control opportunities to sustain cereal production. The current "break crop" is often a poor performing volunteer annual grass dominant pasture. They are often havens for cereal pests and disease and seen as having a negative impact on subsequent cereal grain yield and quality.

How was it done?

2011 was the first year of a 4 year rotation trial, comparing a 2 year phase of alternative break crops followed by 2 years of wheat with a continuous wheat phase. The site is described as a red sandy loam over light clay pH 7.9 ($CaCl_2$). Boron and chloride levels were measured as providing a constraint to root development at 70-80 cm. Total soil N (0-60 cm) was less than 40 kg/ha, Colwell P 22 mg/kg (0-10 cm) was assessed from soil collected on 22 March 2011.

The break crops were sown on 2 May, apart from an earlier simulated regenerating medic pasture sown on 1 April, in plots of 40 x 1.5 m replicated 3 times. The 40 m plots were split into 2 x 20 m sub plots where the treatment was considered a dual purpose option, i.e. grazing or hay production, hay or grain production or graze and grain production. The continuous wheat treatment was sown on 13 May. To prepare the site broad spectrum knockdown sprays were applied on 24 December 2010, 2 March and 2 May 2011. Table 1 presents the crop type and species sown, seeding and fertiliser rates along with in-crop management.

There was no broad-leaf herbicide applied, all broadleaf crops and pastures received a bare earth insecticide treatment at the time of sowing, 2 May.

Measurements collected included; site soil chemistry analysis, plant establishment, biomass production at times selected for grazing and hay production (both simulated with mowing) and the grain yields from field crops. Samples were collected from 8 x 0.5 m rows = 1 m^2 within each field crop plot and 5 x 0.1m^2 quadrats = 0.5 m^2 within each pasture plot. Grain yields were measured with a Kingaroy plot harvester with grain samples retained for quality testing. Comparative soil water contents were also collected post harvest.

Plant establishment was satisfactory and representative of sowing rates. The oats and pea and canola mixture had produced adequate food on offer for grazing by 1 July following the May seasonal break and 2 May sowing. The simulated regenerated medic treatment also produced adequate biomass by July but was sown too late to take full advantage of the March rainfall events and only commenced germination in mid April.

The oats, with 50 kg/ha of applied urea, achieved a growth rate of 73 kg DM/ha/day from 1 July to 11 August, vetch and oats 45, medic 36. Total cumulative figures of 4.9 t/ha (oats) 3.7 (annual medic) and 3.6 (vetch & oats) were less than the measured hay production of 9.4, 4.5, 5.9 and 7.2 t/ha respectively.

Table 1 Crop type and species, seeding rate (kg/ha), fertiliser (units N & P/ha) and in-crop herbicides for grass control

	Cultivar	Seeding rate	Fertiliser	Herbicide
Wheat	Mace	60	35 & 13	Pre-em Treflan® Post-em Hoegrass®
Annual medic	Jaguar/Angel	5	12 & 13	Pre-em Treflan® Post-em Leopard®
Regen. medic	Angel	5		Post-em Leopard®
Oats	Winteroo	40	35 & 13	[1]Broad spectrum 26 September
Vetch & Oats	Rasina & Winteroo	10 & 15	12 & 13	Broad spectrum 26 September
Fallow				Broad spectrum 7 July, 19 October
Field pea	Twilight/Morgan[2]	80	12 & 13	Pre-em Treflan® Post-em Leopard®
Canola	Tarcoola	2	35 & 13	Pre-em Treflan® Post-em Leopard®
Pea & canola	Morgan & Tarcoola	40 & 1	12 & 13	Pre-em Treflan® Post-em Leopard®
Hedysarum	Wilpena	5	12 & 13	Pre-em Treflan® Post-em Leopard®

[1] The broad spectrum treatment includes glyphosate. [2] Forage type field pea

Table 2 Plant establishment (plants/m²) biomass (t DM/ha) grain yields (t/ha) and volumetric soil water contents (mm, 0-1 m) in 2011

	Establishment	Biomass (t DM/ha)					Grain (t/ha)	H_2O (mm)
	(plts/m²)	Grazing				Hay		
	27 May	1 July	11 Aug	19 Sept	31 Oct	19 Sept	28 Oct	15 Nov
Mace	119[1]						3.6[3]	139
Jaguar	123		2.8	[2]	0.9	4.5	0.1	134
Angel	123		2.1	[2]	0.1	2.9	<0.1	134
Regen. medic	111	0.7	2.2	[2]	0.2	3.8		162
Winteroo	95	0.6	3.6	0.5	0.2	9.4		164
Vetch & oats	111	0.4	2.3	0.6	0.4	7.2		163
Twilight	36					6.1	1.8	157
Morgan	33					5.4	1.3	163
Tarcoola	31	0.4					1.4[4]	151
Pea & canola	49	0.6		5.1	0.1	5.9		162
Wilpena	26			3	1.8			130
Fallow								184
Annual Rye grass	50							
Barley grass	7							

[1] Establishment count delayed until 10 June due to later sowing date. [2] Infestation of powdery mildew limited annual medic spring biomass production. [3] Wheat harvest delayed until maturity, 14 November .[4] Grain yield for crops both mown (on 1 July) and unmown were 1.4 t/ha

The 5.5 t/ha (pea & canola) from mowing was similar to the 5.9 t/ha hay cut. The mown medic pastures did not recover well after 11 August with levels of powdery mildew evident.

Wheat yield at 3.6 t/ha achieved an estimated water use efficiency (WUE) of 19 kg/ha/mm of plant available water, a protein content of 10.6% but with 12% screenings. Pea yields of 1.3-1.8 measured a WUE for 7.5 to 11 for the Morgan and Twilight pea respectively. Canola yielded <0.5 t/ha, 43% oil and a 24% harvest index. The Jaguar medic produced 0.1 t/ha of medic seed harvestable with open front header as opposed to the Angel with <10 kg/ha.

Indications were that the biennial pasture Sulla (Wilpena), the late sown medics and the wheat had less soil water in the 0-1 m soil profile than the other crops with the fallow treatment having the most water present in the profile.

What does this mean?

2011 was a decile 5 year with the continuous wheat producing excellent water use efficiency figures. In year 1 of the 4 year study the alternative "break crops" showed their specific attributes; the biomass production from oats and the early production of regenerating annual medic, when coupled with an early break.

The other opportunities measured were:

- The potential to harvest worthwhile amounts of Jaguar medic pod from an ungrazed pasture.
- Canola as an early feed resource with no grain yield loss resulting from the defoliation.
- Sulla with a green feedbase at the pre stubble November/ December period of feed deficit.
- No measured benefit in the use of mixtures as opposed to the monocultures.
- Twilight out yielded Morgan in grain produced, and although an earlier maturing cultivar, Twilight produced similar biomass in 2011.

The relative benefits of the crops for cereal weed and disease control will be measured through emerging weed numbers and soil borne disease levels in 2012, 2013 and 2014.

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Treflan – registered trademark of Dow Agrosciences, Hoegrass – registered trademark of Bayer Cropscience, Leopard – registered trademark of Farmoz.