Break crops pay in the Victorian Mallee

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Abstract
In the Victorian Wimmera and Mallee, the area sown to broad leaf break crops has declined dramatically in response to their perceived high risk and poor profitability in drought years. However, removing break crops from crop sequences has reduced flexibility in the management of weeds, diseases and nutrition. An experiment was established in 2009 to identify low risk, profitable break crops and end-uses (grain, hay, brown manuring) and quantify their benefits to subsequent wheat crops. At a site near Hopetoun in the Mallee region of NW Victoria on two soil types, three different broad-leaf break crops, wheat and long-fallow were grown in 2009 or 2010 and followed by wheat in 2010 and 2011.

Despite sometimes being less profitable than continuous wheat in the year in which break crops were grown, this experiment demonstrated that crop sequences involving a broadleaf break crop were more profitable than continuous wheat. Wheat grown after juncea canola, peas and vetch (sand soil) and vetch and peas (clay soil) yielded more than continuous wheat. Crop sequences will be most profitable when break crops are grown in order to solve agronomic problems in continuous cereals (grass weeds, root disease, low soil N). The risk of losing money on break crops can be greatly reduced if growers make their crop selection based on the amount of soil water, nitrogen and timing of the autumn break, and if inputs are kept to a minimum and applied in response to favourable conditions (e.g. in-season top-dress and fungicides) and end use selection based on seasonal conditions (e.g. cut for hay in a poor season).

Key Words
Break crops, crop sequence**,** crop rotation, profitability, water-use efficiency

Introduction

In the Victorian Wimmera and Mallee region, the area sown to broadleaf break crops declined dramatically in response to the Millennium drought. During this period, grain legume and oil seed production declined as a percentage of wheat and barley production by a third from 27% in 2000 to 9% in 2009 (ABARE 2012). This was a rational response by farm managers given the high risk and poor profitability of many break crops in drought years. However, this strategy has put pressure on selective grass weed herbicides and has increased root disease inoculum and reduced soil N fertility. This has resulted in higher production costs for cereals, and reduced cereal crop yields, particularly in more favourable growing seasons (e.g. 2010 and 2011).

The aim of this experiment was to identify low risk, profitable break crops and end-uses (grain, hay, brown manure) and quantify their benefits to subsequent wheat crops. Results from the 2011 growing season are used to demonstrate first and second year break crop effects on subsequent wheat crops on two soil types at Hopetoun, Victoria. Taking advantage of three years of trial data, rotation based mean gross margins (GM) are presented incorporating 2009 break crop effects.

Methods

The experiment was established on two sites 2 km apart and 13 km south of Hopetoun in north western Victoria. The 'sand' site was sand over sandy loam (Chromosol) and the 'clay' site a clay loam over a medium clay with subsoil constraints (Calcarosol). Both soil types are typical to the region. The sand site lies on top of an east west dune while the clay site was located on a low lying flat. Both sites were established in 2009 in paddocks that had produced a commercial wheat crop in the previous season. Rainfall distribution at Hopetoun is Mediterranean with an average of 230 mm falling during the growing season (April to October) and 112 mm during the summer fallow period (November to March).

Plots (2.1 x 28 m) were arranged in a split block randomised design with a whole plot of break crop year and a split plot of break crop type, with four replicates. Three different areas were established to allow phasing of the experiment. The first area (Block A) was planted to break crops in 2009 followed by wheat in 2010 and 2011. The second area (Block B) was sown to wheat in 2009, break crops in 2010 and wheat in 2011. The third area (Block C) was sown to wheat in 2009 and 2010, and to break crops in 2011. Blocks A, B and C will all be sown to wheat in 2012.

Break crops chosen for the experiment were canola *(brassica napus)* /juncea canola *(brassica juncea)*, vetch *(vicia sativa)* and field peas *(pisum sativum)* with fallow ('long' starting 1 June and 'short' starting 1 September) and continuous wheat used as controls. To test the economic returns of different end uses, half of each of the plots in Block A (2009 Break crops), Block B (2010 break crops) and Block C (2011 break crops) were cut for hay at an appropriate time for each crop (biomass cut at approximately 10 cm above ground level and removed from plots) and for vetch half of each plot was brown manured. The remaining plot area was machine harvested for grain yield and the grain was analysed for quality (protein, oil, moisture, and screenings). The total amount of N fixed from legume crops was derived from shoot data (N^{15} analysis) by assuming plant N was partitioned 67 % above-ground, 33 % below-ground.

Plant available water (PAW) and soil mineral N was measured at sowing and harvest by taking two soil cores per plot (segmented into layers to a depth of 1.3m) on 22 April 2009, 12 November 2009, 30 March 2010, 14 December 2010, 29 March 2011 and 7 December 2011. On 30 March 2010 and 31 March 2011 soil cores were taken to a depth of 10 cm and were tested for DNA levels of soil-borne disease inoculum (Predicta B testing). Sowing details for the three years of the experiment are listed in Table 1.

Table 1. Sowing details for Block A (2009 breaks), Block B (2010 breaks) and Block C (2011 breaks).

	Block A (2009)		Block B (2010)		Block C (2011)	
Crop type	Variety	Sowing date	Variety	Sowing date	Variety	Sowing date
Canola	43C80	30 April	-	-	Hurricane	28 April*
Juncea canola	Sahara CL	30 April	Oasis CL	29 April	-	
Peas	Young	12 June	Morgan	2 June	Twilight	1 June
Vetch	Morava	30 April	Morava	29 April	Morava	28 April*
Wheat	Young	30 April	Correll	29 April	Correll	28 April
Fallow	-	-	-	-	-	-

*Due to mouse damage, canola was re-sown at the clay site on 10 June.
*Due to hare damage vetch at the clay site was re-sown on 1 June.

Wheat cv. Correll was sown in late April in each of the years following break crops and managed in accordance with district practice. Consistent rates of N fertiliser (Sand 21kgN/ha and Clay 46kgN/ha) were applied by top-dressing during stem elongation on each wheat crop following the break crops. The N rate was selected to reflect farmer attitudes to input risk and using Yield Prophet® such that there was >50% probability of a 2-for-1 return on investment in N fertiliser at the time of application.

Gross margins were calculated for Block A for each crop and end-use in 2009 and for wheat in 2010 and 2011. Hay prices in 2009 were assumed to be $200/t for vetch, peas, canola and mustard, $150/t for wheaten hay. Grain prices used were $214/t for H2 wheat, $184 for APW and $144/t for AGP. The variable costs used to calculate the gross margins include cutting $40/ha, bailing $30/t, urea $650/t and MAP $780/t.

Results

At the sand site, fallow in 2010 reduced mineral N relative to peas and wheat when measured in March 2011 (Table 2), probably due to leaching during the wet growing season and summer of 2010. There was no significant effect ($P>0.05$) of crop type on the amount of mineral N in the soil prior to sowing at the clay site in 2011. Wheat grown in 2011 yielded more ($P<0.05$) where broadleaf break crops had been grown in 2010 at the sand site (Table 2). At the clay site wheat following vetch and peas yielded more than wheat following wheat, fallow and juncea canola. At the clay site wheat grown following juncea canola and fallow had higher protein % than continuous wheat. At either site there was no significant effect ($P>0.05$) of break crop end-use (e.g. hay, grain or brown manure) on soil N, yield or protein.

In the second year after a break crop at the sand site, wheat grown two years after vetch or peas yielded more than wheat grown two years after canola, juncea canola, wheat or fallow. Wheat grown two years after vetch yielded 0.5t/ha more than wheat grown two years after peas (Table 2), reflecting the greater amount of atmospheric N fixed by vetch in 2009 (58 kg N/ha and 30kg N/ha at the sand site by vetch and peas respectively). At the clay site there were no significant differences (P>0.05) in yield, reflecting the higher N fertility of that site (Table 2).

In general, yields were higher after legumes (vetch and peas) and there was no difference between wheat yield grown after brassicas, fallow or wheat. Wheat following vetch has consistently been the highest yielding treatment in this experiment, again reflecting the high levels of atmospheric N fixation, which in 2010 was measured at 77 kg N/ha for vetch vs. 48kg N/ha for peas at the clay site, and 132 kg/ha N for vetch vs. 124 kg/ha N for peas at the sand site. The greater levels of N fixation by vetch are probably because of its longer growing season and greater dry matter accumulation. However, vetch tends to use more water than peas - PAW on March 2011 at the sand site was 113 mm following vetch vs. 136 mm following peas (P<0.05) and at the clay site 73 mm following vetch vs. 134 mm peas (P<0.05). In a drier growing season than those experienced in 2010 and 2011, wheat grown following peas and fallow may have yielded more than wheat grown on vetch.

Nitrogen availability following the different break crops is the dominant factor determining yield of subsequent wheat crops in this experiment. Consequently, results have been influenced by the chosen N strategy for subsequent wheat crops based on farmer tolerance of input risk. However, use of this strategy has made our results more likely to reflect farmer experience, and is vindicated by grain proteins in excess of the maximum quality segregation of 11.5% (Table 2). Root diseases (crown rot, take-all, rhizoctonia), although measured at significant levels using DNA techniques prior to sowing in 2010 and 2011, did not appear to adversely affect yield, and grass weeds were able to be adequately controlled in the continuous wheat treatments.

Table 2. Pre-sowing soil mineral N kg/ha March 2011, mean 2011 wheat grain yield t/ha and protein % following 2010 and 2009 break crops at the sand and clay site.

	Sand			**Clay**		
	Sowing Soil Mineral N (kg/ha)	Grain Yield (t/ha)	Grain Protein (%)	Sowing Soil Mineral N (kg/ha)	Grain Yield (t/ha)	Grain Protein (%)
2010 Crop						
Juncea canola	80	3.0	12.0	226	3.3	12.8
Peas	88	3.0	11.6	209	4.0	12.7
Vetch	79	3.4	11.6	203	4.0	12.7
Wheat	89	2.5	11.5	245	3.6	12.4
Fallow	68	2.5	11.6	238	3.1	13.2
lsd(P<0.05)	14	0.4	NS	NS	0.4	0.4
2009 crop						
Canola		2.4	9.8		2.9	12.4
Juncea canola		2.3	9.3		2.9	12.3
Peas		2.5	10.3		2.7	12.7
Vetch		3.0	10.1		3.0	12.6
Wheat		2.3	9.9		2.8	12.4
Fallow		2.3	9.9		2.6	12.8
lsd(P<0.05)		0.2	0.4		NS	0.04

At the clay site pea hay in 2009 followed by wheat in 2010 and 2011 had the highest mean gross margin (Figure 1). At the sand site, canola grain, pea hay and vetch hay followed by wheat were more profitable than continuous wheat or fallow followed by wheat (Figure 1). Pea hay and grain and canola grain followed by wheat were more profitable than continuous wheat ($500/ha) or fallow followed by wheat ($570/ha). Vetch hay has been more profitable than brown manure because of the income generated from hay, and similar wheat yield following each of these treatments. Peas for hay were more profitable than peas for grain at both the sand and clay sites. However, this result is sensitive to the nominated prices for hay and grain.

Canola grain followed by wheat has been a particularly profitable crop sequence. This has been because of the profitability of canola itself during the years in which the trial has run (all of which have featured stored soil water at sowing, early autumn breaks and high canola prices), not because of increased wheat yield following canola, which is contrary to the findings of Angus *et al.* (2011) and Seymour *et al.* (2012) who found a 0.8 t/ha and 0.4 t/ha increase in wheat yield following canola, compared to continuous wheat. This outcome may have been different if seasons over which the experiment was conducted had featured dry starts, late breaks and poor prices. Wheat-on-wheat over the three years was still profitable, despite having the lowest gross margin; this is largely due to high yields and high return in 2010.

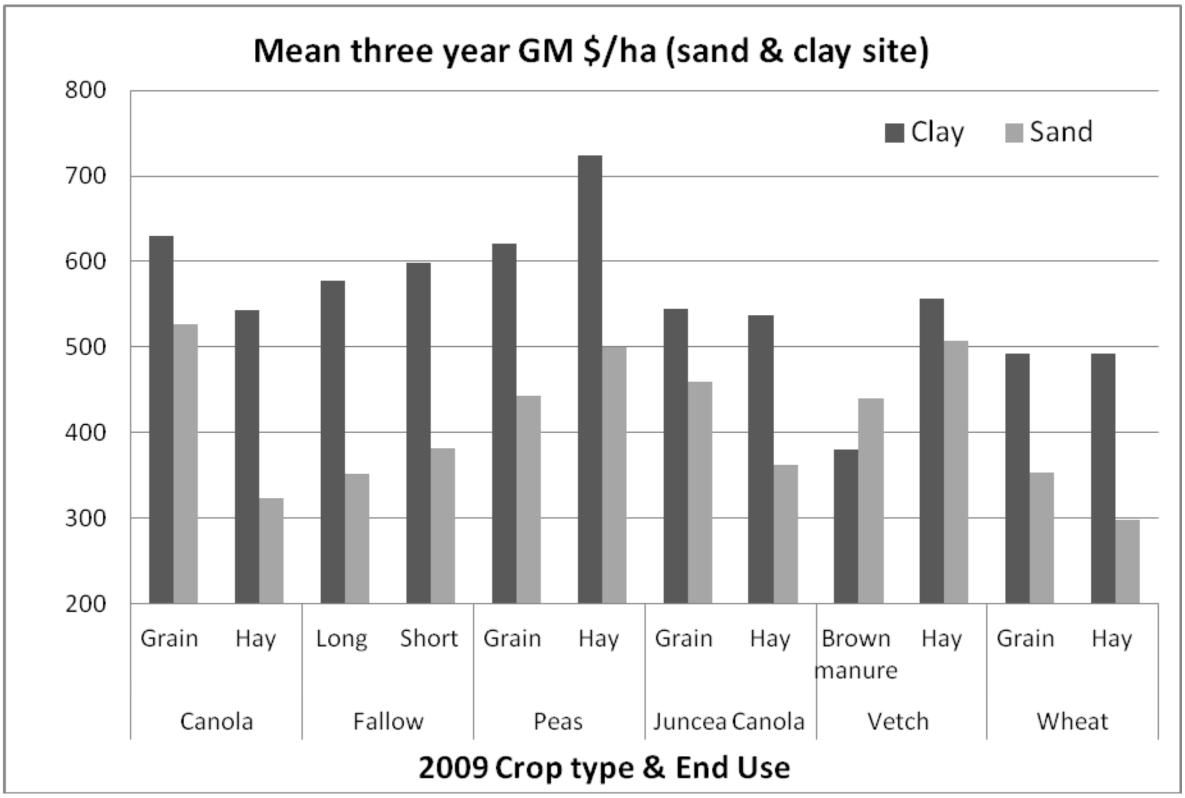

Figure 1. Mean three year gross margin $/ha with crop type and end use grown in 2009 followed by Correll wheat in 2010 and 2011 at the clay and sand sites.

Conclusion

This experiment clearly shows that crop sequences involving a broadleaf break crop grown in 2009, were more profitable than continuous wheat. Crop sequences will be most profitable when break crops are grown in order to solve agronomic problems in cereal production (grass weeds, root disease, low N). The risk of losing money on break crops can be greatly reduced if growers remain flexible with their crop selection, and make final decisions on crop type based on amount of soil water, N and timing of the autumn break. Profitability can be further increased if inputs are kept to a minimum and applied in response to favourable conditions (e.g. top-dress N on canola based on Yield Prophet®). End-use should also be selected to match seasonal conditions (e.g. cut for hay in a poor season).

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