Break crops in cropping systems: impacts on income, nitrogen and weeds

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Key points

- Recent trials have shown crop sequences that include a brassica or legume break crop can be as profitable as, and in many instances more profitable than, continuous wheat. For instance, the most profitable cropping option at Yarrawonga during 2012 was clover hay.
- In 2013, all 2012 break crop and cereal treatments will be sown to wheat. Single year and multiple year gross margin comparisons will be made.
- The relationship between legume dry matter (DM) production and nitrogen (N) fixation found in previous studies was consistent with the results from the current trial. In most cases during 2012, higher legume DM production resulted in greater amounts of nitrogen being fixed.
- Strategic timing of operations, such as hay cutting and brown manuring, provide opportunity for improved weed control when compared with harvesting crops for grain.
- While options such as brown manuring have negative gross margins in the first year, the reduction in weed control costs and nitrogen input costs can pay off over the cropping sequence through increased profitability of subsequent wheat crops, particularly if resistant weed populations are an issue.

Background

The ability of pulse and brassica break crops to support increasing yields in subsequent wheat crops is well documented. These yield improvements arise through break crop effects on beneficial soil biology, enhanced nutrient availability, soil structural characteristics, soil moisture carryover, and/or the control of cereal diseases and insect pests.

During 2012, a trial was established at Yarrawonga South to address the renewed interest of farmers in the Riverine Plains area in growing break crops, and to help identify which break crop best fits their situation.

Key factors worthy of considering to assess crop choice and end use include herbicide-resistant weed populations, soil nitrogen concentrations and soil moisture content. The consequent economic impact depends on what influence each of these factors has on input costs (herbicides and fertiliser), income (yield and quality) and therefore gross margins.

This report details results from the first year of the trial (2012). During 2013 (year two), all treatments will be sown to wheat. Soil available nitrogen, soil moisture, yield and grain quality will be used to assess the net effect of different cropping sequences.

Aim

To determine the effect of different cropping sequences containing break crops (legumes or canola) with different end uses (grain harvested, hay cutting or brown manuring) to those with continuous cereal crops (grain harvested) in terms of income, weeds and nitrogen dynamics. The potential growth, yield and the amount of nitorgen fixed by commercial pulse crops in the Riverine Plains will be measured to determine the potential nitrogen benefits for following wheat crops.

Method

The trial was sown on the Inchbold family property at Yarrawonga South. Table 1 summarises the details of the treatments sown. Sowing was carried out on both 4 May 2012 and 1 June 2012.

Soil tests were taken at the start of 2012 to determine starting soil characteristics. Soil pH (0–10cm) ranged between 5.3–5.9 ($CaCl_2$) across the site and increased with depth. Colwell P (0–10cm) ranged from 9–22 and soil mineral nitrogen was 40–50kg N/ha in the top 60cm of soil.



TABLE 1 Trial treatments at Yarrawonga South 2012

Species	Variety	Sowing rate (kg/ha)	Sowing date
Lupins	Jenabillup	80	4/05/2012
Faba beans	Rana	160	4/05/2012
Field peas	Oura	130	1/06/2012
Chickpeas	Slasher	130	1/06/2012
Arrowleaf clover	Zulu	8	4/05/2012
Sub-clover	Antas	8	4/05/2012
Vetch	Morava	40	4/05/2012
Wheat nil fertiliser	Young	90	1/06/2012
Wheat + N fertiliser*	Young	90	1/06/2012
Canola nil fertiliser	Tawriffic	3	4/05/2012
Canola + N fertiliser*	Tawriffic	3	4/05/2012

* Topdressed as per local practice (180kg/ha urea)

During 2013, each plot will be soil tested before sowing to assess the impact of treatments on starting available soil nitrogen.

Eleven treatments were sown with MAP @ 80kg/ha in plots 20m x 1.42m, and replicated four times in a randomised block design. Pulses were inoculated with standard peat inoculant and treatments were grown according to best management practice. Both the wheat and canola + nitrogen fertiliser treatments received a total of 180kg/ha of urea during the growing season.

The field pea, sub-clover, arrowleaf clover and vetch treatments were each split in half, with one half brown manured and the other half cut for hay. Hay cut yields were calculated at 70% of peak biomass DM values. The faba bean, chickpea, wheat and canola treatments were harvested for grain at physiological maturity. The lupin treatment was sprayed out before seed set due to excessive bird damage (which made harvest unviable). Weeds such as soursob, ryegrass and marshmallow were an issue in some plots and were removed by hand.

Legume treatments were sampled at early–mid pod fill to coincide with around the time of peak biomass accumulation. Plant samples were collected to determine dry matter (DM) and estimate inputs of fixed nitrogen using a 15N-based technique.

Yield and gross margin comparisons were made between first-year break crops and wheat treatments to see if break crops could be profitable in their own right when compared with high and low nitrogen input wheat in a single year. Following the 2013 season, two-year average gross margins will be calculated to assess the impact of break crops over time in the Riverine Plains area.

Results and discussion

Flooding rainfall preceded the 2012 growing season, with more than 300mm recorded during late February–early March. This rainfall provided excellent subsoil moisture at sowing. However, the site received a total of 213mm growing season rainfall (GSR), which was below average. The wet starting conditions allowed crops to establish well with the exception of the lupins, which were severely damaged by birds.

There was a positive relationship found when legume treatments were sampled for peak biomass between legume shoot DM and the amounts of nitrogen fixed (see Table 2). In most cases, more legume DM resulted in an increased amount of nitrogen fixed.

Previous studies have shown that the percentage of nitrogen fixed by most legumes in south-eastern Australia appears to range between 60–90% of total plant nitrogen and the amount of nitrogen fixed tends to be related to biomass production (15–25kg of nitrogen fixed per tonne of shoot DM).

Provided there are adequate numbers of effective rhizobia in the soil and the concentrations of soil mineral nitrogen are not too high, the amount of nitrogen fixed will largely be regulated by legume growth rather than by the percentage of nitrogen fixed.

Well nodulated: Pulse crops in the trial nodulated well.

TABLE 2 Nitrogen fixation results for legumes sampled at peak biomass

Treatment	Mean shoot DM (t/ha)	Shoot N (kg N/ha)	% N fixed	Shoot N fixed (kg N/ha)	Shoot N fixed (kg N/t DM)	^Total N fixed (kg N/ha)
Vetch	5.1	120	79	95	19	141
Arrowleaf clover	6.1	100	81	80	13	138
Faba beans	5.3	105	82	85	16	129
Sub-clover	5.8	99	69	69	12	118
Field peas	4	93	64	58	15	86
Chickpeas	2	37	65	24	12	50
Lupins*	0.6	20	82	16	25	21
P-value	(<0.05)	<.001	<.001 NS	<.001	<.001	<.001
LSD	1.21	22	15	17	4	27

* Lupins were severely affected by bird damage and were not harvested.
^ Total nitrogen fixed (kg N/ha) estimates for the amount of nitrogen fixed from both the shoots and roots. Determined using root factors obtained from previous N fixation studies.

The vetch produced the most total plant fixed nitrogen (141kg N/ha) followed by the arrowleaf clover (138kg N/ha), faba beans (129kg N/ha) and sub-clover (118kg N/ha). These results were significantly higher than the field peas (86kg N/ha) and chickpeas 50kg N/ha) (see Table 2). Soil tests at the start of 2013 will help to identify what the net nitrogen effect the different legume treatments have on subsequent nitrogen availability for following wheat crops.

The clover and chickpeas treatments did not appear to fix nitrogen as efficiently as the other legumes with only 12–13kg fixed N/t shoot DM compared with the faba beans and field peas fixing 15–16kg fixed nitrogen per tonne of shoot DM or the 19 kg fixed nitrogen per tonne of shoot DM for the vetch (see Table 2). This may have been the result of a later than ideal timing of peak biomass sampling in the clovers (sampling closer to senescence can result in reduced nitrogen in the leaf as nitrogen is exported for seed production).

The chickpeas have less DM production than most other pulses and therefore less nitrogen was estimated to be fixed in these treatments (see Table 2). However, while chickpeas have less potential to produce as much biomass as species such as field peas and clovers, they do offer the potential to be a high value grain crop in years when grain markets favour high prices.

TABLE 3 Comparisons of grain yield, hay cut and brown manure yield, income, variable costs and gross margins near Yarrawonga during 2012

Treatment	Grain or hay yield (t/ha)	Gross income ($/ha)	Total variable costs ($/ha)	Gross margin ($/ha)
Arrowleaf clover hay cut	4.3	1324	229	1095
Sub-clover hay cut	4.0	1252	229	1023
Wheat + N	4.8	1310	323	987
Wheat - N	4.1	1066	215	851
Faba beans	3	1170	347	823
Canola + N	2.2	1206	415	791
Canola - N	1.8	965	307	658
Vetch hay cut	3.5	815	224	571
Chickpeas	1.7	799	265	534
Field pea hay cut	2.8	614	244	371
Arrowleaf clover BM	0	0	170	-170
Sub-clover BM	0	0	170	-170
Vetch BM	0	0	185	-185
Field pea BM	0	0	185	-185

Note: Grain and hay prices used in the calculations were current at the time of harvest. Variable costs were based on local practice and prices. These figures are estimated as a guide only.



The arrowleaf clover hay cut provided the highest gross margin due to the combination of high DM yields and high hay prices (see Table 3). This was followed by the sub-clover hay cut treatment and then the wheat plus fertiliser treatment. The clover hay treatments have multiple advantages for the average two-year gross margins because they potentially start with higher soil nitrogen, better weed control and higher soil moisture due to an early termination.

Above-average prices and yields were achieved for most grains; in particular wheat, faba beans and canola, which resulted in excellent gross margins for 2012. Wheat yields showed a nitrogen response with a significant difference between the plus nitrogen fertiliser treatment (4.84t/ha) and the nil treatment (4.07t/ha). There was no significant difference between canola yields +/- nitrogen.

Brown manuring provides opportunities to: maximise nitrogen carryover, deliver strategic herbicide knockdown for optimal weed control and optimise stored soil moisture. In certain situations it can provide the opportunity to rotate herbicide chemical groups to allow for a more effective reduction in problem weed populations. This is particularly relevant given the growing herbicide-resistant weed populations in many cropping areas.

Brown manuring can be timed according to the timing of weed seed set of the main target species. This timing often coincides with maximum nitrogen accumulation in the plant prior to the crop exporting nitrogen in grain development.

During 2013, gross margins in the subsequent wheat crop will be calculated on a single-year basis. Average gross margins will also be calculated for the two-year rotation. After year one, the clover treatments appear to be the most profitable. The 2013 season will help to identify the net effect of these cropping sequences in the given years.

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