Adding value through pasture and fodder break crops- is the current break crop broken?

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Abstract
Identifying suitable break crop rotations is becoming a major challenge for farmers and advisors in southern Victoria. Canola has traditionally been the main break crop used, but the high input costs, establishment challenges and dry finishes makes it high risk. There is also perception canola yields are declining with its repeated use in the rotation. Weeds, especially annual ryegrass, emerging herbicide resistance, root diseases and the depletion in soil nitrogen are major reasons for seeking alternative break crops to canola. The complexity of rotation selection means that there is no 'recipe' that can be applied broadly. Preference, specific problems to be solved and opportunity need to be considered when making these decisions. Due to this, and the long term nature of some rotational benefits, the problem to be focused upon in this paper will be weeds and the use of pasture and fodder rotations to control weeds and drive down the weed seed bank. Fodder conservation is a practical option for growers in the high rainfall zone of southern Australia. The area still has a vibrant livestock industry and Victoria's largest dairy region is close by. The market for fodder (both hay and silage) exists and is likely to grow. Three years of field experiments have shown that alternative rotations that allow weed removal through grazing or fodder have the ability to reduce weed numbers by 80-90% in two years whilst producing large amounts of feed and in some cases fix nitrogen.

Key words
Rotations, legumes, grazing, south-west Victoria, crop sequencing

Introduction

Finding alternative break crops to canola and determining the appropriate place and application of these alternatives is critical to the longevity of cropping in Southern Australia. Break crops are generally described as a crop grown as an alternative to cereals, usually a broadleaf, for control against weeds and disease. Grain legumes such as peas and beans have been the focus of promising crop sequencing research in recent years, with more suitable varieties being bred and refined management strategies making this break crop more profitable and less risky. The Pastures in Crop Sequencing work concentrates on the role of pastures and fodders in a crop rotation, given the abundance of mixed farming enterprises and the opportunities available in certain regions (dairy etc.).

Three significant variables that influence the type of fodder break crops that may be appropriate at any point in time are **preference** toward livestock, the **problems** that need solving and the prevailing conditions or **opportunities** when the choice needs to be made. There are numerous combinations of species, applications and desired benefits from the break crop phase. This creates a complexity because there is a multitude of 'right answers' depending on an individual farming circumstance. Rotation length and sequencing of break crop options need to be considered, with analysis focusing on the net benefits over time and not simply one crop. Weed control using an Integrated Weed Management (IWM) approach will be the focus of this paper.

Spotlight on weeds

The most common approach to weed control has been to focus on knockdown herbicides early in the season and herbicides mid-season (pre or post emergent). However over the life of this research, our thinking has moved from early and mid-season weed control to also consider control of the weeds later in the season.

Management options early in the season are fairly straight forward and still seem to be quite reliable. It is the late germinating weeds, the ones that strike and mature after the opportunity for in crop herbicide has passed that seem to be carrying over. These late germinating weeds are missing traditional control methods

in the conventional rotation, but have set seed by the time the crop is ready to be harvested. In the continuous cropping rotation adopted, we are selecting for late germinating weeds, leaving ourselves with limited options as to how to remove these weeds from the system.

Seed set control relies on intercepting the seed production of weeds that have survived earlier attempts at control (McGillon and Storrie 2006). Therefore the timing of a seed removal operation is more critical than the method of seed removal, and the use of multiple seed removal tactics will ensure better control.

Method

Numerous trials have been conducted in the past six years where weed populations have been measured. These include tactics applied at pre break (grazing, autumn 'tickle', stubble burn) and in season (time of sowing, species, sowing rate, grazing, fodder conservation, manuring and summer fodder crops). This paper focusses on annual ryegrass (ARG) and three of these tactics;

- Sowing rate
- Duration of break crop
- Species used (and the associated management options these species lend themselves to).

Weeds have been measured six weeks after sowing for three consecutive years across treatments, replicated four times. The trial has been designed as a three way factorial, with sowing rate of fodder crop (common, double and triple), duration of break (1, 2, 3 years) and the species of break crop (clovers, oats, ryegrass, peas, lucerne and nil).

Results and discussion

Weed populations are dynamic and can fluctuate markedly from year to year. This is the result of dormancy strength conferred at seeding, fluctuations in temperature and moisture over summer, timing of the autumn break, predation, depth of burial and if it is grazed (Grundy 2003). In order to conclude that a treatment has altered a population, the results need to be compared to a control treatment. In addition weed populations are often uneven across a site which means there can be large variability even within replicates of the same treatment. This means statistical significance is often not measured, even if the differences appear large. Therefore readers are encouraged to proceed with caution when interpreting results.

Competition arising from sowing rate

There was no significant difference on weed populations or dry matter production at double or triple sowing rates compared to the recommended sowing rate (Table 1). The current 'common' sowing rate of species appears sufficient to provide competition to weeds and optimum dry matter production.

Table 1. Change in annual ryegrass (ARG) populations from June 2012 to June 2013 under three different species sown at common, double and triple sowing rate. Weed numbers are not significant at p=0.05

Species	Sowing rate (kg/ha)	Establishment (pl/m2)	Dry matter (kg/ha)	ARG 2013 (pl/m2)	Change in ARG numbers after one year
Balansa clover					
Common	6	113	5176	19	-89%
Double	12	202	5812	34	-78%
Triple	18	248	4031	19	-90%
Peas					
Common	100	43	5637	23	-89%
Double	200	74	6393	25	-82%
Triple	300	81	4785	26	-81%
Forage oats					
Common	100	187	8802	56	-82%
Double	200	279	7824	23	-91%
Triple	300	447	9681	33	-89%

These results support other pasture research (Burge and Nie 2012) that shows that the only advantage to higher sowing rates is achieving ground coverage faster. A higher sowing rate does not necessarily translate to more dry matter production, or as shown here, a greater reduction in weed populations. If looking to sow at lower rates than recommended, there is a risk that the weed competition may not be sufficient due to low crop numbers and could encourage weed growth.

Duration of break crop
Seed bank dynamics are different between annual ryegrass and wild radish. McGowan (1970) found that with ARG, you could expect 75-85% germination on the first couple of rain events in autumn. Most of the remaining seeds will germinate after June, with about five per cent carrying over to germinate the following year. The weeds we are allowing to go through in a conventional crop (allowing late season weeds to set seed) is almost selecting for weeds that we will never control with pre sow or early in crop tactics. With this in mind, stopping seed set is critical but different thinking needs to be applied to ARG and WR.

Wild radish seed banks appear to be far more difficult to run down due to dormancy and longevity of the seed. Cheam (1996) reported that up to 70% of WR seeds are still dormant at the start of the cropping season, making early season management ineffective on the majority of the population. Continual control of WR should be at the forefront of management decisions to prevent turning a small manageable problem into a bigger one that forces a management change rather than gives a choice.

Focusing on results for ARG at Lake Bolac (Figure 1) suggests that a one year fodder break crop like Balansa clover can reduce ARG by up to 85% (>160 to <25 pl/m^2) when weeds were measured in June (at crop establishment). This high level of control is coming from successful pre sowing and early in crop management, so is it the late season weeds that are causing weed numbers the following year? The first year back in crop was TT canola which appears to have maintained low weed numbers quite well. How will this line look after a second year of crop? Have we achieved enough with a one year break?

Weeds were reduced further after a second year in break crop (Balansa clover), with the same principle, stopping weed seed set using grazing and fodder conservation options. Although there are still weeds present in June after two years of a pasture break, numbers were down to 5 plants per square metre (Figure 1).

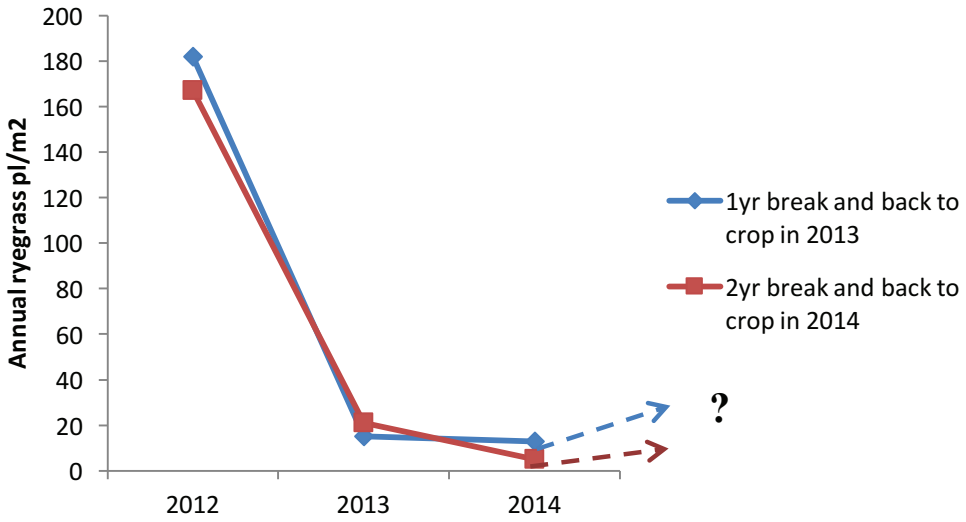

Figure 1. Change in annual ryegrass (ARG) numbers (measured in June) using Balansa clover as a break crop for one year and back to crop compared to two years in the pasture break

Deciding on a break crop species
A range of species were tested, with different species having different growth characteristics and management options. Table 2 displays fodder production, end use and impact on ARG numbers at Lake Bolac. General observations are:

- Oats and ryegrass grow rapidly and compete well early in the season as well as providing a lot of dry matter later in the season
- Annual clovers (Persian, Arrowleaf, Balansa) have been slow to start but bulk up very quickly in spring to provide late competition and high amounts of dry matter
- Lucerne and sub clover were slow and produced little in the first year but came back in the second and third year very quickly and provided great competition throughout the season
- Sowing nothing and allowing weeds to grow (but managed through the season so no seed set) was included, as a low cost option that still produced feed and allowed weed control that wouldn't normally be available in a cash crop.

Different fodder species also allow different options for chemical weed control in-crop so a pasture species can be chosen not just on the basis of its competitiveness, biomass production or potential for N fixation, but also on the chemistry it offers. Rotating herbicide groups and modes of action is a critical part of any IWM strategy.

Table 2. Dry matter production from different species and change in annual ryegrass (ARG) numbers at Lake Bolac 2012-2014 (weeds measured in June)

Species	Dry matter 2012 (kg/ha)	Fodder removal	Change in ARG numbers after 1 year fodder break	Dry matter 2013 (kg/ha)	Fodder removal	Change in ARG numbers after 2 year fodder break
Annual clover[1]	5027	Silage	-87%	5026	Graze, silage	-92%
Sub clover	2416	Graze	-89%	2463	Silage	-93%
Lucerne	1794	Graze	-88%	3035	Graze, silage	-90%
Peas	5434	Hay	-84%	6913	Hay	-96%
Oats	6110	Silage	-87%	10372	Graze, silage	-93%
Ryegrass	5272	Silage	-89%	7753	Silage, graze	-83%
Nothing sown	3138	Graze	-78%	4625	Graze	-91%

[1]Species included Arrowleaf, Balansa and Persian clover

Adding value through break crops

Moving away from continuous cropping does not have to mean sacrificing production or income from that paddock. Utilising a pasture or fodder in the short term can help solve problems in a cropping system (weeds or poor soil structure), provide an opportunity (grazing, fodder conservation or fixed nitrogen) with a vast range of options to cater for the preference of the farmer. There are many mixed farming operations with weed problems and livestock to feed, yet are seeking the ideal break crop in the form of a harvestable grain. Why not grow fodder as the break crop? Project work in 2015 will focus on completion of field trials (4 years of data collection on soil parameters, weeds and yield (DM and grain), as well as factoring in feed values, costs and gross margin to complete the picture.

Take home messages

- Rotations are complex and depend on preference, the problem and opportunities- there is no 'right way'
- The break species can be selected for multiple benefits including grazing value, fodder conservation, nitrogen fixation and improving soil conditions
- If weeds are the problem, focus on targeting the weeds that come late in the season, these are the ones getting through in a continuous crop rotation
- Annual ryegrass can be reduced by up to 90% in two years by stopping weed seed set through fodder removal, whilst providing ample fodder.

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