Crop sequences address agronomic constraints in a long term continuous cereal paddock

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Why was the trial/project undertaken?

The GRDC Low Rainfall Crop Sequencing project is identifying the effects that different break crops and rotations have on Mallee farming systems. Farmers have increasingly adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to greater yield and price fluctuations. Therefore, it is important to quantify the agronomic benefits that break crops can provide in Mallee cropping rotations so that farmers can be confident of the long term benefits of more diverse crop sequences.

How was the trial/project done?

In 2011, nine different break options were established along with a continuous wheat treatment. In 2012, a second break phase was implemented (2-year break) or the rotation was returned to wheat (1-year break). In 2013, all rotations were returned to either conventional wheat (var. Shield) or Clearfield wheat (var. Grenade). In 2014, all plots where again sown to wheat (var. Grenade).
Throughout the trial, agronomic management was varied for each individual rotation to help maximise the profitability of that rotation and to respond to particular issues in each option. For example nitrogen inputs, varieties, sowing dates or herbicide applications were varied depending on the level and type of agronomic constraints in each rotation.

Key Messages

- Legume crops consistently increased pre-sowing soil nitrogen in the year following the break.
- Two-year break phases that included a brown manure vetch phase have generally resulted in the highest pre sowing soil nitrogen levels in the subsequent wheat crops.
- One and two-year break phases reduce Rhizoctonia soil inoculum, however levels increase significantly following the first cereal crop.
- Two-year break treatments generally reduced brome grass populations in the cereal phase, however all rotations relied on Clearfield herbicides for brome grass control by the second wheat crop following the break.
- The benefits from extra soil water following some break phases in this trial have been variable and small.

Background

At the end of the millennium drought, broad-leaf crops made up only a very small proportion of the total area of sown crops in the low rainfall regions of south-eastern Australia. As a consequence the landscape is dominated by paddocks which have been in continuous cereal (often wheat) for many years. However these intensive cereal cropping sequences are declining in productivity due to agronomic constraints such as grassy weeds, declining soil nitrogen fertility and crop diseases. The Low Rainfall Crop Sequencing project commenced in 2011 to quantify the agronomic influences (including soil nitrogen, disease, soil water and grassy weeds) of 20 different rotations to provide farmers with information that will assist them to implement crop sequences that are more sustainable and profitable in the long term.

About the trial

The Mildura trial is located in the Millewa region of the Victorian Mallee. In 2011, nine different break options were established along with a continuous wheat. In 2012, a second break phase was implemented (2-year break) or the rotation was returned to wheat (1-year break). In 2013, all rotations were returned to either conventional wheat (var. Shield) or Clearfield wheat (var. Grenade). In 2014, all plots where again sown to Clearfield wheat (var. Grenade).

Over the first three years of the trial (2011-2013), agronomic management was varied for each individual rotation to help maximise the profitability of that rotation and to correct the agronomic constraints that emerged for that rotation. For example nitrogen inputs, varieties, sowing dates or herbicide applications were varied depending on the level and type of agronomic constraints in each rotation. Moodie *et al* (2013) provides details of the management practices applied prior to the 2014 season. However, in 2014 there were no clear signals to vary management, so all treatments received the same inputs, including Intervix herbicide to control brome grass and 23 kg/ha of nitrogen applied at sowing.

The trial has been intensively monitored for a range of agronomic parameters. Prior to sowing, soil fertility and root disease inoculum were measured in the topsoil while soil nitrogen and soil water were measured throughout the soil profile. The population of Brome grass was also monitored over the course of the trial.

Results

Soil Nitrogen

Including legume crops and pastures in the cropping sequence provided soil nitrogen benefits to the following wheat crop (Figure 1). Soil nitrate (0-60 cm) levels measured pre-seeding in 2012 were about 50 kg/ha N where vetch, chickpea and field pea had been grown in 2011 while for the non-cereal treatments (except for medic pasture) levels were 30 to 40 kg/ha. The biggest differences in pre sowing nitrogen was measured in 2013 where levels varied between 12 and 66 kg/ha. The two-year breaks which included vetch in the rotation had the highest amount of pre sowing nitrogen with 30 kg/ha of soil nitrate-nitrogen more than continuous wheat. Smaller nitrogen differences between treatments were observed at sowing in 2014 when all treatments had a wheat phase the year before. However, the vetch/canola and vetch/field pea rotations still had significantly higher nitrate-nitrogen levels than most other treatments.

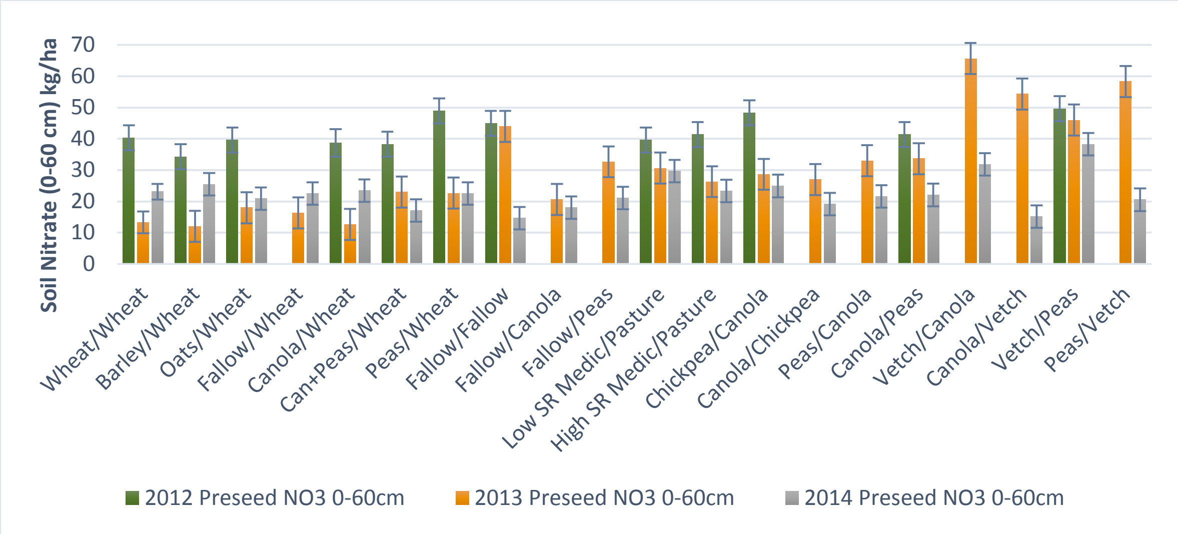

Figure 1. Soil nitrate (kg N/ha, 0-60 cm) measured prior to seeding in 2012, 2013 and 2014. Error bars represent the standard error of each treatment. Note: soil nitrate was measured for one treatment only to represent each crop type in 2012.

Root disease

Rhizoctonia is the most prevalent cereal root disease at the trial site. The inclusion of break phases in rotations resulted in lower pre-sowing soil inoculum than continuous wheat (Figure 2). Treatments that included canola as a break phase generally had the lowest Rhizoctonia inoculum levels prior to sowing in the next year. However, once the rotation was returned back to a wheat phase, pre sowing inoculum levels increased significantly. In 2014 where all treatments had been sown to a wheat crop in the previous year, pre sowing soil inoculum levels were high and varied little compared to the differences measured between rotations in the previous two seasons (Figure 2).

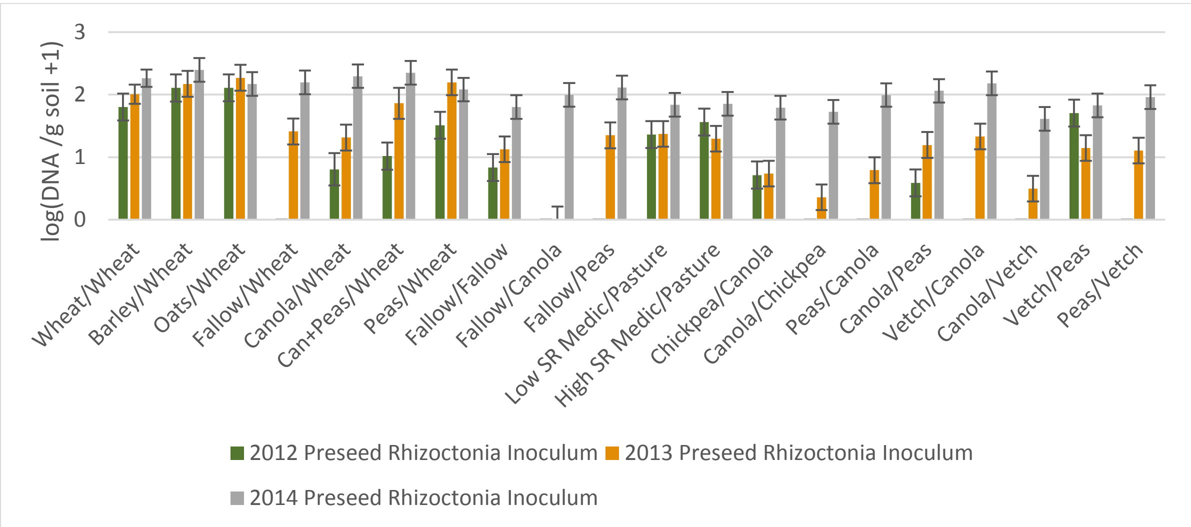

Figure 2. Rhizoctonia inoculum measured prior to seeding in 2012, 2013 and 2014. Error bars represent the standard error of each treatment. Note: inoculum was measured in one treatment only to represent each crop type in 2012.

Brome Grass

Crop sequences that included two-year break phases generally had fewer brome grass weeds in 2013 and 2014 when all rotations were sown to wheat (Figure 3). The exceptions here were the pasture treatments where brome grass control relied only on 'spray topping'. Winter cleaning pastures with group 'A' herbicides, such as where applied to the other break crop options, would likely have prevented the proliferation of brome in the pasture treatments.

Crop sequences that included a one-year break phase failed to reduce the brome grass numbers relative to the continuous wheat treatment for longer than one season. As a consequence both the one-year break and continuous cereal rotations relied on the application of Clearfield herbicides to manage the brome grass population. The weed population in these options were minimised by the 2014 harvest following two applications of Intervix, however at this intensity of application, the onset of resistance to Clearfield herbicides is likely to be rapid.

The two-year break treatments also required an application of Clearfield herbicide in 2014 as a brome grass population of 10-40 plants m^2 had established in the second wheat crop. This shows that where a high weed population is present (a seedbank of 150 brome plants m^2 was present at the beginning of the trial) a longer break crop phase of three or more years may be required to adequately reduce the weed seed bank. Alternatively, break phases need to be implemented before weed numbers reach high levels and/or integrated weed management tactics in the cereal phase (e.g. harvest weeds seed control) need to be combined with the use of break phases over the cropping sequence.

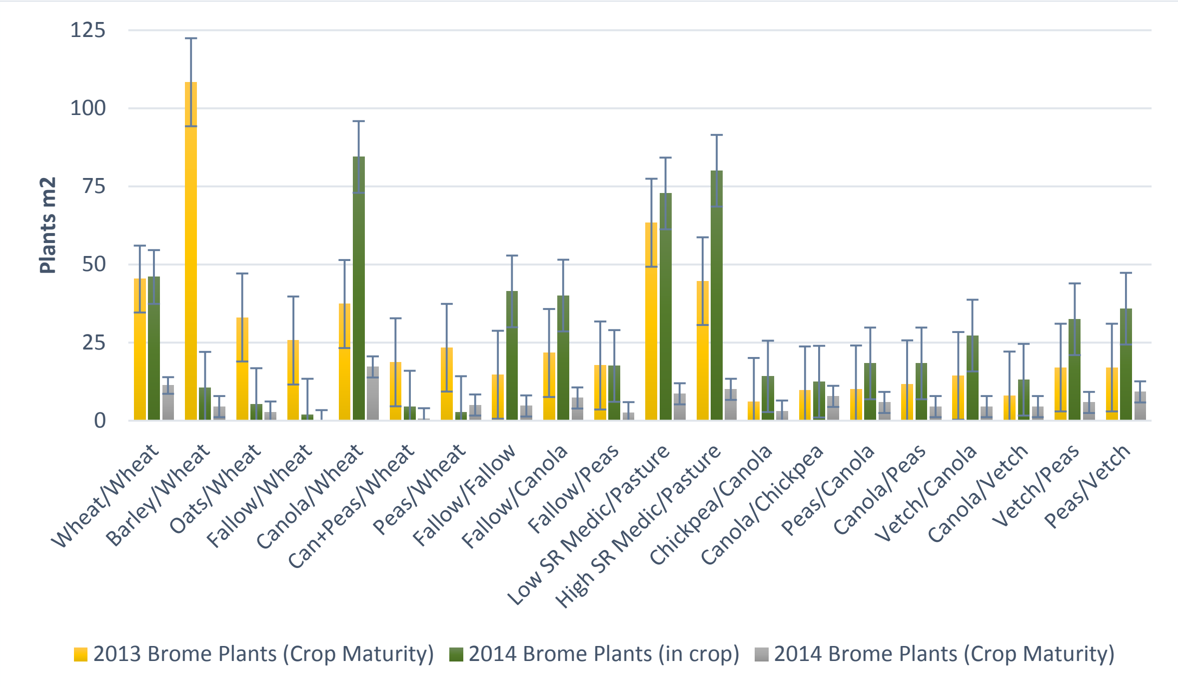

Figure 3. Brome grass (plants m^2) measured at crop maturity in 2013 and in crop and at crop maturity in 2014.

Soil Water

Soil water benefits of break crops and rotations has been variable. For example, prior to sowing in 2012, there were no major differences between any treatments as approximately 30 mm of soil water accumulated from abundant summer rainfall regardless of the treatment. Therefore a fallow did not store any additional water because the profile filled anyhow. However prior to sowing in 2013, the fallow had approximately 28 mm more water than continuous wheat and all other treatments were in between these two extremes. In 2014, no differences were measured between any of the treatments which had all been sown to wheat the previous year.

Implications for commercial practice

In this trial, a two-year break phase was generally more effective at alleviating agronomic constraints than a one-year break phase. The benefits of increasing soil nitrogen, reducing Rizoctonia inoculum and soil water were significant following the break phase but were generally short lived across the rotation. However the impact of the different crop sequences on the brome grass population was evident in the final year of the trial. At this site where the brome grass population was high (150 plant m^2) at the commencement of the trial, even a two-year break phase did not appear to be adequate to maintain low weed numbers in the long term. Therefore further research is required to determine how break phases can be implemented in conjunction with other weed control tactics across the wider crop sequence.

Links and references

Moodie, M. Wilhelm, N. Telfer, P and McDonald, T (2013). Mallee crop sequences influence soil nitrogen, Rhizoctonia and Brome grass. *Mallee Sustainable Farming Results Compendium 2013*. www.msfp.org.au/research

Moodie, M. Wilhelm, N. Lawes, R*. Telfer, P and McDonald, T (2014). Two year breaks profitably reduce agronomic constraints. Mallee Sustainable Farming Results Compendium 2014*. www.msfp.org.au/research

Acknowledgements

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