# Mallee crop sequences influence soil nitrogen, Rhizoctonia and Brome grass

Michael Moodie[1], Nigel Wilhelm[2], Peter Telfer[2], Todd McDonald[1]
[1]Mallee Sustainable Farming Mildura; [2]SARDI Waite campus Adelaide

## Why was the trial done?

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 done?

In 2011, nine different break options were established and compared against 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) which was placed on rotations where brome grass had built to concerning levels. Treatments in 2013 were also sown at two different times depending on the grass weed risk. Treatments had different levels of nitrogen applied throughout the growing season depending on rotational history and yield potential. Throughout the trial, agronomic factors including soil nitrogen, soil disease, plant available water and weeds have been intensively monitored.

## Key Messages

- Including legume crops and pastures in rotations increases soil nitrogen even two years after the legume break was grown.
- Brown manure vetch has proven to be the best break phase for increasing soil mineral nitrogen.
- Crop sequences have had small and variable effects on plant available soil water.
- Rhizoctonia inoculum levels are highest following cereal crops and high Rhizoctonia levels have corresponded with poor root health. Canola decreased inoculum levels to levels similar to a fallow.
- High brome grass numbers re-emerged two years after a one year break.

## Acknowledgements

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## Background

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 and the landscape is dominated by paddocks which have been in continuous cereal (often wheat) for many years now. Farmers need break phase options as grassy weeds, cereal diseases and pests start to severely restrict productivity in continuous cereal paddocks. This project is quantifying the agronomic influences (including soil nitrogen, disease, soil water and grass weeds) of 20 different rotations to provide farmers with information that will assist them to implement crop sequences that are sustainable and profitable in the long term.

## About the trial

This trial is located 30 km west of Mildura and was established in 2011 on a low fertility sandy soil where over 10 cereal crops had been grown continuously and brome grass was an emerging issue. 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). As summary of each treatment and the key agronomic management practices in 2013 are provided below in Table 1.

**Table 1: List of treatments (rotations) implemented in the Mallee Crop Sequencing Trial**

| Break phase | First year phase (2011) | Second year phase (2012) | [a]2013 Crop | [b]Sowing | N Applied in 2013 kg N/ha |
|---|---|---|---|---|---|
| **2 Years** | Canola, TT | Chickpea | Wheat | Early | 20 |
| **2 Years** | Canola, TT | Peas | Wheat | Early | 20 |
| **2 Years** | Canola, TT | Vetch | Wheat | Early | 9 |
| **2 Years** | Chickpea | Canola, TT | Wheat | Early | 20 |
| **2 Years** | Fallow | Canola, CL | Wheat | Early | 31 |
| **2 Years** | Fallow | Fallow | Wheat | Early | 20 |
| **2 Years** | Fallow | Peas | Wheat | Early | 20 |
| **2 Years** | Medic Pasture, High seed rate | Pasture, volunteer | Wheat | Early | 9 |
| **2 Years** | Medic Pasture, Low seed rate | Pasture, volunteer | Wheat | Early | 9 |
| **2 Years** | Peas | Canola, TT | Wheat | Early | 20 |
| **2 Years** | Peas | Vetch | Wheat | Early | 9 |
| **2 Years** | Vetch | Canola, TT | Wheat | Early | 9 |
| **2 Years** | Vetch | Peas | Wheat | Early | 9 |
| **1 Year** | Barley | Wheat | [Ix]Wheat CL | Early | 31 |
| **1 Year** | Canola CL | [Ix]Wheat CL | Wheat CL | Early | 31 |
| **1 Year** | Canola/Pea Mix | Wheat | [Ix]Wheat CL | Early | 20 |
| **1 Year** | Oats | Wheat | [Ix]Wheat CL | Late | 31 |
| **1 Year** | Peas | Wheat | [Ix]Wheat CL | Early | 20 |
| **1 Year** | Fallow | Wheat | [Ix]Wheat CL | Early | 20 |
| **None** | Wheat | [Ix]Wheat CL | Wheat CL | Late | 31 |

[a]Wheat (var: Shield) or Clearfield Wheat (Wheat CL) (var: Grenade)

[b]Early Seeding: Sown dry on the 15$^{th}$ of May; Late seeding: Sown 28$^{th}$ of May following a rain

[ix]Intervix applied to the Clearfield wheat

The trial has been intensively monitored for a range of agronomic parameters. Prior to sowing soil fertility and root disease inoculum is measured in the topsoil (0-10 cm) while soil nitrogen and soil water are measured throughout the soil profile (0-120 cm). The population of Brome grass is also assessed through measuring the seed bank prior to seeding and in 2013 plant and panicle density was measured in crop. The root health of each treatment was also measured in August 2013. Dry matter production and grain yield and quality have also been measured each season.

## Results

Including legume crops and pastures has provided clear soil nitrogen benefits (Figure 1). Pre-seeding in 2012, 0-60 cm nitrate levels were 48-50 kg/ha where vetch, chickpea and field pea had been grown in 2011 while for the non-cereal treatments (except for medic pasture) levels were 30 – 41 kg/ha. In 2013, pre-seeding 0-60 cm soil nitrate levels were above 20 kg/ha where a legume break phase had been included over the previous two years while levels where no legume break was included were below 20 kg/ha. Brown manure vetch has proven to be the best break phase for boosting soil nitrate levels. In 2012, 0-60 cm soil nitrate levels were highest under vetch and in 2013 the four rotations where brown manure vetch had been included also had the highest soil nitrate levels.

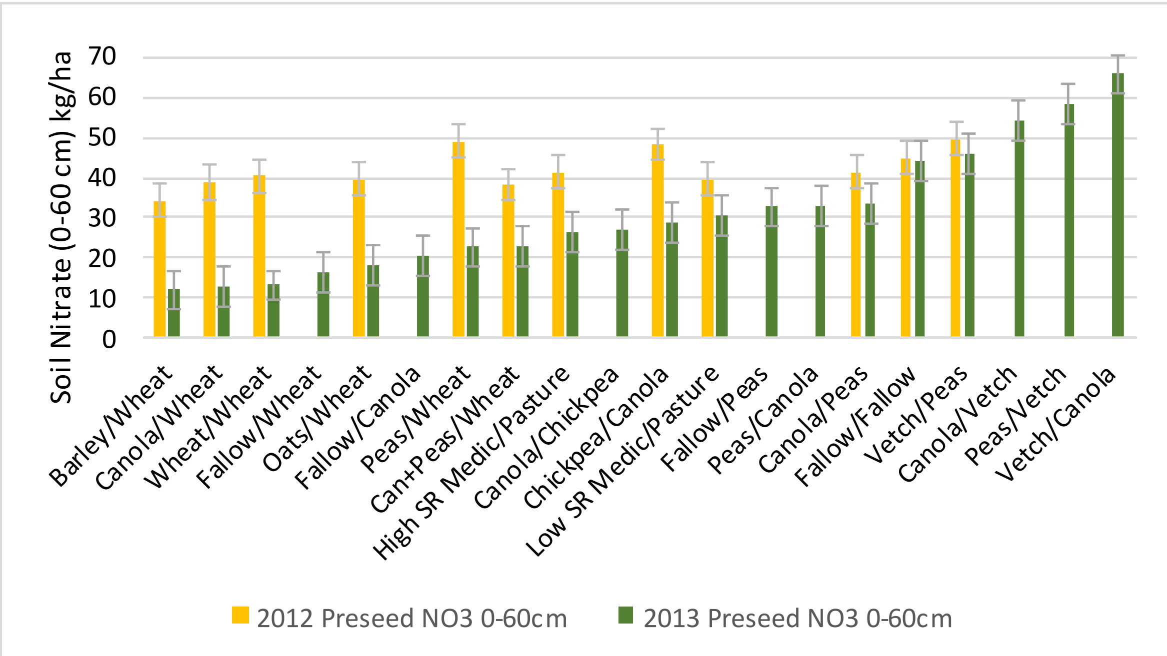


**Figure 1**. 0-60 cm soil nitrate (kg/ha) measured prior to seeding in in 2012 and 2013. Error bars represent the standard error of each treatment. Note: soil nitrate was only measured for each crop type in 2012 and not for each treatment.

The 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 because approximately 30 mm of soil water accumulated from abundant summer rainfall regardless of the treatment. 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. All other options were in between these two extremes.

Rhizoctonia is the most prevalent cereal root disease at the trial site with inoculum levels increasing where cereals were grown in 2011 and 2012. Where wheat grown in 2013 followed wheat in 2012, the soil inoculum levels pointed to a high risk of Rhizoctonia infection where yield losses of 10 – 50% were possible. Subsequently, the health of roots was scored for all treatments in August 2013. As shown in Figure 2, crown roots were healthier (low root health score) following a break phase in 2012 while crown root health was poorer (high root health score) following wheat in 2012. Rotations had much less influence on the root health score of seminal roots.

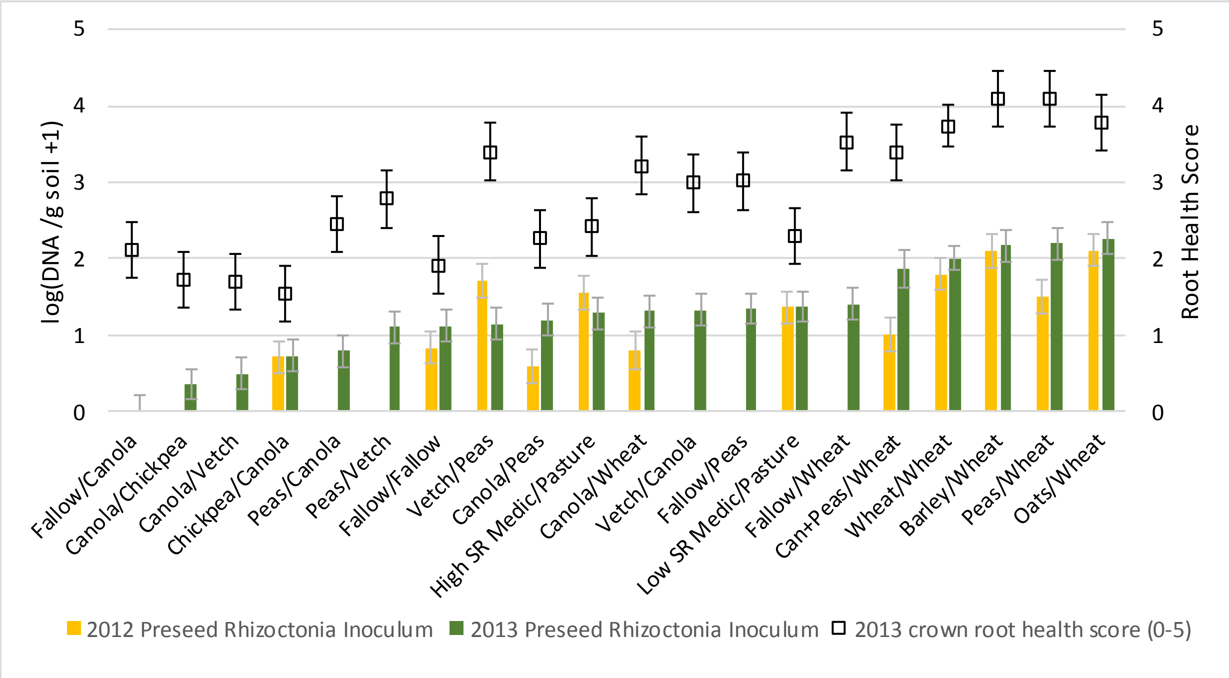


**Figure 2**. Rhizoctonia inoculum measured prior to seeding in in 2012 and 2013 on the left hand y-axis and the root health score (1-5) measured in August 2013 on the right hand y-axis. Error bars represent the standard error of each treatment. Note: inoculum was only measured for each crop type in 2012 and not for each treatment.

In crop brome grass was monitored in 2013. The brome grass weed burden was scored for each treatment in early July which showed that high brome grass numbers had re-emerged in 2013 following only a one year break in 2011. Subsequently Clearfield herbicide was applied to these treatments. Brome grass density (plants per m$^2$) and panicle number (m$^2$) were then assessed prior to harvest (Figure 3). All two year breaks had low weed pressure at harvest with the exception of pastures which had only been spray-topped previously. However, where pastures had received a grass selective herbicide plus spray-topping grassy weed pressure appeared to be much lower (data not shown). Figure 3 also shows the benefits of Intervix applied in 2013 suppressing brome grass density and panicle number at crop maturity despite high brome grass numbers (eg. peas/wheat or oats/wheat).

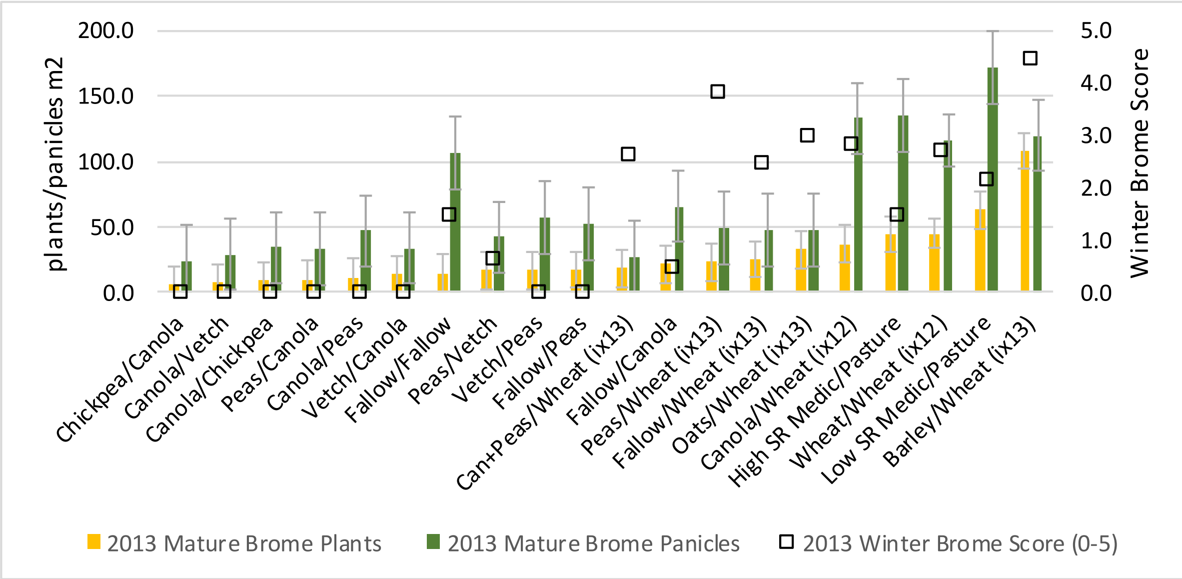


**Figure 4**. Brome grass severity score on right hand y-axis (0 Very low brome pressure – 5 Very high Pressure) measured on the 8th of July 2013 and brome plants and panicles per $m^2$ measured immediately prior to harvest on left hand y-axis. Error bars represent the standard error of each treatment.

ix13: Intervix applied in 2013; ix12 Intervix applied in 2012

## Implications for commercial practice

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. The Mallee Crop Sequencing trial has now been running for three seasons and so far is has shown that:

- Including legume crops and pastures in rotations increases soil nitrogen even two years after the legume break was grown.
- Brown manure vetch has proven to be the best break phase for increasing soil nitrate.
- Crop sequences have had small and variable effect on plant available soil water.
- Rhizoctonia inoculum levels are highest following cereal crops and high Rhizoctonia levels have corresponded with poor root health.
- High brome grass numbers re-emerged two years after a one year break.

In 2014 the site will again be sown to wheat to monitor any continuing effects of these rotations on cereal production.