LEADA

Lower Eyre Agricultural Development Association

*Presents*

# The Lower Eyre Peninsula Farming Expo

## 9 March 2017

Marble Range Community and Sporting Complex, Wangary


***Wish to acknowledge the support from the following Organizations to help make this event and all our trials possible***

GRDC Grains Research & Development Corporation

Australian Government

Government of South Australia Eyre Peninsula Natural Resources Management Board

Regional Landcare Facilitator

***Our Vision:*** *LEADA is committed to providing support and attracting research activity to the Lower Eyre Peninsula. It is driven by local issues and the search for solutions that suit local systems.*

***Our mission*****:** *A grower group that specifically addresses issues and solutions to improve farming systems in your area.*

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# PROGRAM FOR THE DAY

| | |
|---|---|
| **7.30 am** | **Registration and Breakfast** |
| **8:30 am** | **Welcome**<br>**Bruce Morgan**, Chair, LEADA |
| **8:35 am** | **Andrew Ware** (SARDI) – Lower Eyre Peninsula Trial Updates |
| **9.00 am** | **Mark Modra** (GRDC) – GRDC Update – directions and changes |
| **9.10 am** | **Keynote Speaker**<br>**Rick Bieber,** (No Till Farmer South Dakota USA) – Improvements to soil health through cover cropping and integrated livestock management to improve farm profits |
| **10.05 am** | **John Richardson,** (LEADA) – Stubble Management Project survey |
| **10.15 am** | **Morning Break** |
| **10.45am** | **Keynote Speaker**<br>**Mark Branson,** (Owner Manager, Branson Farms, Stockport SA) – Precision Farming practices – the use of digital technology |
| **11.40am** | **George Pedler** (George Pedler Ag) – Canola : Direct Heading |
| **12.00 noon** | **Michael Nash** (SARDI) – Russian Wheat Aphid and Snails Update |
| **12.30pm** | **Brett Masters / Andrew Harding** (PIRSA) – Soil Acidity Update |
| **1.00pm** | **Rosemary Bartle,** (Rabobank) – Succession Planning |
| **1.20pm** | **Bruce Morgan,** (LEADA)<br>**Wrap up and thanks**<br>LEADA Committee |
| **1.30pm** | **Lunch *and static displays*** |

**Lunch time displays**

- DEWNR – fox management, rabbit control and invasive perennial grasses.
- PIRSA – pH machine on display with Andrew Harding available for discussion at 2.00pm

**Afternoon Field Trip – Cover Crops with Rick Bieber – Bruce Morgan's Property**

## THANKS TO OUR 2016 SPONSORS

# CONTENTS

# Chairman's Introduction

**Bruce Morgan**

Welcome all members, sponsors, industry professionals and guests to another year of LEADA research and extension.

2016 across Lower EP saw above average growing season rainfall; which resulted in above average yields for many, although rain during harvest time for some, resulted in downgrading of grain. Low grain prices were a concern to all producers, but all in all most farmers were happy with the season.

LEADA continued to focus on attracting funding for research and extension across Lower EP in 2016. A strategic review of research priorities for the region directed project proposals into increasing Lupin profitability and continuing soil amelioration work, amongst many others.
LEADA had a productive 2016 with continuation of our major GRDC Stubble Management project with a focus on chemical rates for ryegrass control. We continue to support the New Horizons trial site looking at the value of treatment of sub soil constraints.

LEADA was successful in gaining some new grants that are in full swing currently:

- EPNRM Sustainable Ag Grant – Understanding Crop Production for Women Program – Series of five workshops.
- National Landcare Program to case study treatment for low pH soils.

LEADA continues to offer small grants for members and last year contributed funds to assist 5 projects across the region.

The LEADA committee welcome new member Sam Ness to the Committee and thank Helen Lamont, Executive Officer / Regional Landcare Facilitator for her work over three years with LEADA.

We are now looking forward to a positive 2016. Thank you to our ongoing sponsors and funders, thanks to the ongoing support from PIRSA through SARDI and Rural Solutions SA delivery. Thank you to the ongoing relationship with Eyre Peninsula Natural Resources Management and thanks to LEADA committee for their support and input.

Bruce Morgan

Chair

# MONITORING OF THE NITROGEN (N) FERTILITY OF KEY LOWER EYRE PENINSULA SOILS

**Blake Gontar[1], Therese McBeath[2], Andrew Ware[1], Stasia Kroker[2] and Vadakutta Bupta[2]**

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**[2]Agriculture and Food, CSIRO, Waite Campus**

## Background

The best management practice for nitrogen (N) will depend on the specific combination of soil, season, crop and grower preference for yield vs. profit maximisation. As cropping systems continue to intensify on the Lower Eyre Peninsula (LEP), the pressure to manage N fertiliser for the most efficient outcome grows in parallel.

At the moment, the estimated N losses have been managed through high inputs of N relative to yield potential. Growers perceive that they are operating at low N use efficiency, particularly on the waterlogging-prone duplex soils, and recent LEADA trials support this notion with fertiliser use efficiency or the amount of extra N exported in a crop generally less than 50% of the fertiliser N applied.

In 2016 we utilised a paddock monitoring protocol developed in 2015 to make assessments that would enhance our understanding of the relative differences between LEP soil types in their N use efficiency. The components of N use efficiency that measured included the ability of the soil to supply N through mineralisation and the mineral N readily available to the crop at sowing. In 2016 we focussed on a smaller set of soils where there were some gaps in our understanding following the assessments made in 2015.

## Aims

1. To develop estimates of the ability of LEP soil types to supply N to crops from the soil.
2. To quantify nitrogen use efficiency on key Lower EP soil types.

## Methods

We identified six wheat paddocks for monitoring to represent three key cropping soil types (loam over clay at Wanilla, gravelly sand over loam at Wangary and deep clay at Cummins) on LEP. We monitored two paddocks for each soil type; wheat following canola and wheat following a legume. At the beginning of the growing season, and prior to sowing we collected replicate core samples to approximately 80 cm depth along a fixed transect from each paddock.

Pre-sowing soil samples were analysed for properties that are not related to N nutrition but might constrain crop productivity (soil water, phosphorus (P) nutrition, pH and salinity (EC)). In addition the soil organic C:N ratio, microbial biomass C and N, N supply potential (NSP) and mineral N were measured.

The microbial quotient is used to identify whether there is likely to be a limitation to the turnover of microbial biomass which could reduce the supply of available N to crops.

The microbial quotient (%) was calculated as $\frac{Microbial\ Biomass\ C}{Total\ Organic\ C} \times 100$

The NSP is an estimate of the amount of N a soil will supply to a crop in a growing season. It is a combination of N mineralised in a 21 day aerobic incubation (approximate number of days with optimal conditions for N mineralisation in a growing season) and the proportion of microbial biomass N which is assumed to become available from microbial turnover over a growing season in the top 10cm of soil.

During the growing season plants on the same transect were sampled at first node and anthesis to measure biomass and N nutrition, and at maturity for grain yield, harvest index and protein.

Several of the measurements were utilised to calculate the N use efficiency as a % of N available to wheat crops grown on these soil types including grain yield and grain N (in protein) to calculate the N yield or N export from the paddock, fertiliser N input (at 0.5 of added based on the maximum fertiliser N efficiency measured on LEP N response trials), pre-sowing mineral N (in the rooting zone below 10cm) and the NSP.

N use efficiency (%) = $\frac{Grain\ Yield\ x\ Grain\ N}{Fertiliser\ N \times 0.5 + Pre{-}sowing\ mineral\ N\ (0{-}60cm) + Nitrogen\ Supply\ Potential} \times 100$

**Results**

The soils monitored varied both between soil types and within soil pairs, in pH and salinity. Soil types varied from acidic through to alkaline with salinity levels below most crop thresholds (Table 1).

**Table 1. 2015 residue type and grain yield, and pH and salinity (EC) characteristics of each 2016 sampling transect.**

| Soil Type | 2015 Residue | 2015 Yield (t/ha) | pH ($H_2O$) | EC (1:5) (dS/m) |
|---|---|---|---|---|
| Loam over clay | Canola | 1.7 | 5.91 | 0.47 |
| -Wanilla | Lupin | 1.0 | 5.06 | 0.29 |
| Gravel sand over loam | Canola | 1.9 | 5.17 | 0.13 |
| -Wangary | Lupin | 1.2 | 6.03 | 0.19 |
| Deep clay | Canola | 2.6 | 8.26 | 0.24 |
| -Cummins | Bean | 2.2 | 8.19 | 0.27 |

For each soil type there was a very similar amount of pre-sowing profile soil water (Table 2) indicating that the soil type pairs were well matched for texture. Generally a C:N in the range of 11-13 is considered to support optimal N mineralisation from organic matter for crop uptake and these soils generally had a C:N within the optimal range. The microbial quotient represents the relationship between the microbial biomass carbon and the total organic carbon pool. A microbial quotient in the range of 3-5% is required for sufficient microbial turnover, a process which releases nutrients (Gonzalez-Quinones, 2011). Both the Wanilla and Wangary soils had a microbial quotient of less than 3%. The higher yielding Cummins soil had higher DOC and microbial quotient supporting higher levels of microbial biomass and N supply potential.

**Table 2. 2016 pre-sowing soil test results from LEP 2016 wheat monitoring transects.**

| Soil Type | 2015 Residue | 2016 soil water (mm/0.9 m) | Total C:N | DON (µg N/g soil) | DOC (µg C/g soil) | Microbial Biomass C (µg/g soil) | Microbial Quotient (%) |
|---|---|---|---|---|---|---|---|
| Loam over clay | Canola | 201±8 | 14.3±0.7 | 7.9±2 | 36.0±3.3 | 393±24 | 1.52±0.10 |
| -Wanilla | Lupin | 215±18 | 13.4±0.2 | 3.9±2.2 | 33.6±2.5 | 275±33 | 1.05±0.06 |
| Gravel sand over loam | Canola | 102±17 | 12.5±0.4 | 3.0±1.1 | 29.6±3.1 | 234±30 | 1.59±0.16 |
| -Wangary | Lupin | 110±4 | 10.8±0.8 | 18.3±5.5 | 28.9±2.4 | 273±39 | 1.85±0.21 |
| Deep clay | Canola | 217±13 | 11.9±0.5 | 15.3±2.6 | 57.5±4.6 | 614±56 | 4.54±0.15 |
| -Cummins | Bean | 211±6 | 11.6±1.0 | 23.2±3.5 | 58.7±3.4 | 654±87 | 4.41±0.26 |

Wheat variety and fertiliser N inputs were not constant across sites or within soil types and the details are given in Table 3. The varieties within a soil type pair did not vary in their maturity date and the sowing dates were closely matched (Table 3).

**Table 3. Monitoring site management details including wheat variety and fertiliser N application**

| Site | Residue | Variety | **Sow Date** | Seeding N (kg/ha) | In Crop N (kg/ha) | No. of Apps | Total Fert N (kg/ha) |
|---|---|---|---|---|---|---|---|
| Wanilla | Canola | Wyalkatchem | 6 May | 16.2 | 63.6 | 3 | 79.8 |
| | Lupin | Emu Rock | 7 May | 16.2 | 63.6 | 3 | 79.8 |
| Wangary | Canola | Wyalkatchem | 19 May | 33.6 | 78.2 | 2 | 111.2 |
| | Lupin | Emu Rock | 18 May | 33.6 | 64.4 | 2 | 98.0 |
| Cummins | Canola | Trojan | 4 May | 32.8 | 105.8 | 3 | 138.6 |
| | Bean | Cobra | 6 May | 35.8 | 82.8 | 2 | 118.7 |

In-crop monitoring of crop N status indicated that at Wanilla plants were deficient for N and marginal for P at GS31 according to published thresholds (Table 3), while plants were adequate for N and P at the other sites. There wasn't a consistent effect of a legume residue causing a higher tissue N content, biomass or grain yield in the subsequent wheat crop, but protein was always higher following a legume for a given soil type (Table 3).

**Table 4. Plant assessments including first node (GS31) N and P content (%), anthesis N content (%w/w), anthesis biomass (GS65, t/ha) and grain yield (t/ha) and protein (%) at maturity ± standard error.**

| Soil Type | Residue | GS31 P (% w/w) | GS31 N (%w/w) | GS31 biomass (t/ha) | #GS65 N (% w/w) | GS65 biomass (t/ha) | Grain Yield (t/ha) | Protein (%) |
|---|---|---|---|---|---|---|---|---|
| Loam over clay | Canola | 0.21±0.02 | 2.25±0.10 | 0.90±0.14 | 0.98±0.02 | 5.12±0.34 | 3.29±0.15 | 8.70±0.07 |
| -Wanilla | Lupin | 0.29±0.02 | 2.58±0.05 | 1.15±0.15 | 1.18±0.15 | 6.05±0.55 | 3.87±0.42 | 9.28±0.32 |
| Gravel sand over loam | Canola | 0.48±0.03 | 3.50±0.11 | 1.09±0.18 | 1.20±0.09 | 6.37±0.32 | 4.26±0.30 | 10.50±0.32 |
| -Wangary | Lupin | 0.42±0.00 | 3.85±0.12 | 0.62±0.05 | 1.95±0.04 | 5.35±0.26 | 4.30±0.20 | 12.73±0.18 |
| Deep clay | Canola | 0.28±0.08 | 3.60±0.30 | 0.94±0.08 | 1.70±0.05 | 7.61±0.42 | 5.85±0.22 | 9.08±0.12 |
| -Cummins | Bean | 0.27±0.04 | 3.48±0.16 | 1.08±0.04 | 1.40±0.05 | 7.40±0.30 | 5.61±0.10 | 10.70±0.15 |

*whole shoot late tillering deficient N% <3.08 and P% <0.18-0.22, #anthesis- critical values at anthesis in development by Sadras et al. ±standard error

Within each soil type there was a lack of effect of legume residue increasing N supply potential compared with canola residue (Table 4). In particular the lower microbial quotient at Wanilla after lupins would have contributed to the lack of effect of legume residue. This likely reflects the low yields of 2015 lupins at Wanilla and Wangary and the high level of N export in the high yielding beans at Cummins reducing the legume N effect for subsequent crops.

Generally, low NUE was once again a feature of LEP wheat production in this audit. No rotation/soil type produced better than 50% NUE (Table 5). This likely reflects the nature of N loss on LEP soil types, particularly during an above-average rainfall year and one in which there were distinct wet periods characterised by runoff and waterlogging. NUE was surprisingly low on the Cummins soil type, perhaps reflecting the high levels of pre-sowing soil mineral N and NSP combined with the highest inputs of fertiliser (Table 5). This highlights the potential benefit of incorporating a measure of NSP, not just starting soil mineral N, to be able to adjust fertiliser rates to reach yield potential while accounting for soil N supply (Gupta 2016). It is interesting to speculate whether smaller amounts of N at similar application times on the Cummins soil type may have produced similar yields.

The higher NUE at Wangary, on deeper gravel soils reflects the yield potential of these soils in a good spring where rainfall is sufficient to allow the crop to fill grain effectively. Low NUE in the lupin stubble versus canola stubble at this site may be a result of high levels of soil mineral N at sowing in the lupin stubble (above average February rains may have accelerated mineralisation in this scenario) (Table 5), followed by heavy winter rainfall potentially leaching much of this out of reach before the crop was at a stage to utilise it.

The paddocks at Wanilla operated at the lowest NUE, these paddocks were the most constrained by waterlogging limiting yield potential, combined with pre-sowing soil mineral N levels in excess of 100 kg/ha, and NSP of 40-50 kg/ha. However, the fertiliser N inputs had been moderated and were the lowest of the three soil types (Table 5).

**Table 5. Components of N use efficiency, NUE; N yield from grain (kg/ha), fertiliser N applied (kg/ha), sowing soil mineral N (to 60-80cm) and N supply potential, NSP (kg/ha/decile 5 growing season) ± standard error.**

| Soil Type | Residue | *N Yield (kg/ha) | Fertiliser N (kg/ha) | Soil Mineral N (kg/ha) | NSP (kg N/ha/ <average season) | NSP (kg N/ha/ >average season) | NUE (% of N available) |
|---|---|---|---|---|---|---|---|
| Loam over clay | Canola | 49.78 | 79.8 | 105±7 | 49±10 | 77±12 | 22.63 |
| -Wanilla | Lupin | 62.30 | 79.8 | 129±16 | 38±6 | 57±9 | 27.82 |
| Gravel sand over loam | Canola | 77.79 | 111.2 | 42±6 | 29±7 | 46±12 | 54.53 |
| -Wangary | Lupin | 95.20 | 98.0 | 103±13 | 38±14 | 57±19 | 45.95 |
| Deep clay | Canola | 92.38 | 138.6 | 105±6 | 57±12 | 101±19 | 33.85 |
| -Cummins | Bean | 104.39 | 118.7 | 129±5 | 54±14 | 100±26 | 36.53 |

*N Yield (kg N/ha) is N exported from the paddock; Grain wt (kg/ha) x Grain N (kg N/ha). NUE calculation is given in methods.

This audit again demonstrated the challenge for determining the most efficient N strategy on waterlogging-prone soils. In 2016, there were several waterlogging events that would have led to N loss and periods where crop root access to N was constrained, contrasting with 2015 where there was a lack of finishing rainfall reducing yield potential and low NUE. The audit further suggests pre-sowing soil mineral N and NSP levels could be used for formulating more efficient fertiliser N application strategies.

**Conclusions**

Surprisingly wheat paddocks following legumes did not operate at a higher NUE than those following canola for a range of reasons. Working through the components of NUE to understand how to better manage fertiliser inputs according to soil type and management factors remains an opportunity for LEP paddocks.

**Reference**

Gonzalez-Quinones, V. et al. (2011). Soil microbial biomass-interpretation and consideration for soil monitoring. Soil Research. 49: 287-304.

Gupta, V.V.S.R. (2016). Biological factors influence N mineralization from soil organic matter and crop residues in Australian cropping systems. 7$^{th}$ International Nitrogen Fixation Conference. Melbourne, Australia. http://www.ini2016.com/1456

**Acknowledgements**

Thanks to the grower collaborators for the provision of access for sampling and for information to allow us to complete the audit and to Willie Shoobridge for technical assistance. GRDC and LEADA have provided funding for the monitoring through the Stubble Retention Initiative (project LEA00002).

# CANOLA AGRONOMY AND PHENOLOGY TO OPTIMISE YIELD

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**GRDC project code: CSP00187**

**Keywords**

- Canola, variety, phenology, risk management.

**Take home messages**

- Improved knowledge of how canola varieties develop in differing regions and the drivers behind development will assist growers in choosing the correct variety for a particular sowing opportunity.
- The development of site specific optimal flowering windows, where the balance between plant growth and frost and heat risks are accounted for, will allow growers and advisors to match canola variety selection with sowing opportunities.

**Background**

Research to better understand to yield drivers of canola in eastern Australia commenced in 2014, and continued in 2015 and 2016 focusing on improving the profitability of canola as part of the Optimised Canola Profitability (OCP) project. The research is targeted at low to medium rainfall zones of Eastern and Southern Australian cropping regions and is a collaboration between a collaboration between CSIRO, NSW DPI and GRDC, in partnership with SARDI, CSU, MSF and BCG. The project links closely with similar GRDC supported projects in Western Australia and high rainfall zones (HRZ).

**2016 Season**

The 2016 season in South Australia was typified by average to above average rainfall in most of the cropping region between April and August and then significantly higher than average rainfall in September and October. Average daily temperatures (daily maximum minus daily minimum divided by two) tended to be average to slightly warmer than normal between April and August and then considerably below average in September and October. Solar radiation was lower than normal (about 8% below average figures) placing 2016 as having one of the lowest cumulative totals of solar radiation for the growing season on record.

All of these factors had an effect on canola yields observed in 2016, challenging some of the results gathered by this project in previous years.

## 2016 Results

Similar to 2014 and 2015, in 2016 three time of sowing (TOS) x variety experiments were conducted at Yeelanna (Lower EP), Hart (Mid North) and Lameroo (Murray Mallee), with grain yields shown in table 1.

**Table 1**. Grain yields (t/ha) from TOS x variety experiments conducted Yeelanna, Hart and Lameroo in 2016.

| Variety | Yeelanna | | | Hart | | | Lameroo | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8 April | 20 April | 6 May | 15 April | 2 May | 16 May | 13 April | 28 April | 12 April |
| 44Y89CL | 3.11 | 3.76 | 2.99 | 2.16* | 2.67 | 2.83 | 2.11 | 2.41 | 1.83 |
| 45Y88CL | 3.86 | 3.22 | 3.77 | 2.36* | 2.81 | 3.08 | 2.01 | 2.19 | 1.53 |
| Archer | 3.72 | 3.87 | 3.43 | 2.80 | 3.17 | 3.05 | 2.14 | 1.86 | 1.27 |
| ATR_Gem | 2.72 | 2.78 | 3.40 | 1.69* | 2.47 | 2.31 | 2.04 | 1.74 | 1.24 |
| ATR_Stingray | 2.11 | 2.89 | 2.42 | 2.00* | 2.77 | 2.92 | 1.24 | 1.82 | 1.38 |
| Hyola559TT | 3.45 | 3.49 | 3.78 | 2.47* | 3.03 | 3.05 | 2.18 | 2.31 | 1.61 |
| Hyola575CL | 2.91 | 4.04 | 4.45 | 1.98* | 2.58 | 2.61 | 1.71 | 1.87 | 1.67 |
| Hyola750TT | 3.53 | 3.42 | 3.20 | 2.23* | 2.81 | 2.39 | 2.09 | 1.65 | 1.17 |
| Nuseed_Diamond | 3.35 | 4.19 | 4.36 | 1.94* | 2.08 | 3.26 | 1.80 | 2.74 | 1.76 |
| Average | 3.20 | 3.52 | 3.53 | 2.18* | 2.71 | 2.83 | 1.92 | 2.06 | 1.50 |
| lsd 5% (TOS) | 0.16 | | | 0.18 | | | 0.17 | | |
| lsd 5% (variety x TOS) | 0.47 | | | 0.53 | | | 0.52 | | |
| p (variety x TOS) | <.001 | | | <.001 | | | 0.03 | | |
| GS Rainfall (Jan-Mar) | 449 mm (71mm) | | | 330mm (62mm) | | | 300mm (47mm) | | |

* Yield adjusted to account for bird damage

These data show that the 2nd and 3rd sowing times at Yeelanna and Hart and yields in TOS1 and TOS2 at Lameroo resulted in the highest yields in 2016. This is reflects the cooler and wetter finish to the season experienced in 2016.

The 2016 experiments showed that short season variety Nuseed Diamond sown at TOS3 giving the highest grain yields at Yeelanna and Hart. Longer season variety, Archer yielded well in TOS1, but failed to match the yields of Nuseed Diamond sown late.

It should be noted that early flowering varieties sown early suffered from higher levels of upper canopy blackleg and sclerotinia infection than later sowings. See paper at this update by Marcroft et al.

Given that experiments in previous years have demonstrated considerable benefits from sowing early, results from 2016 raise the question of how yields can be maximised in every season. 2016 was a usual year from an historical sense of the grain growing regions of South Australia, but demonstrated how vitally important it is to capitalise on the opportunities of late season rainfall.

The answer lies with gaining a better understanding of what triggers varietal development in canola and then using that information coupled with historical climate data for a particular locality to choose a variety that will perform to its maximum potential for the planned sowing window.

**How do canola varieties develop and why is it important?**

The most common and easily recognised stages of canola development are emergence, green bud, flowering, podding and maturity. To determine when to move from one growth stage to another plants respond to environmental signals such as temperatures.

It is important that canola flowers within a particular window, to avoid the high risk of winter frosts at one end of the season and risks of high temperature heat stress at the other. If planned sowing rains occur in a particular month you can match your varieties maturity to ensure you flower inside the optimum window every year. An understanding of phenology for different varieties allows specific variety selection to ensure flowering occurs at the optimum time, and the risk of crop loss is reduced.

The development of canola crops is largely driven by temperature (thermal time), but is also affected by vernalisation and photoperiod to differing degrees in different varieties.

**Thermal Time**

Day degrees are the units of a plants biological clock. They are a way of combining time and temperature into a single number. To calculate the thermal time target for a plant's development stage you accumulate the day degrees until a specific target is reached, e.g. variety X accumulates 1000 degree days between emergence and flowering.

**Vernalisation**

Vernalisation can be described as a low temperature promotion of flowering. For canola if the average temperature is 2 degrees or below, then one vernal day is accumulated, no vernal days are accumulated if the average temperature is below 0 or greater than 15. Between 2 degrees and 15 degrees only a proportion of a vernal day is accumulated.

There are two types of vernalisation, obligate and facultative.

Obligate vernalisation is the need for a plant to accumulate cold days before the day degree calculation can begin. This typically drives the development of winter type canola varieties.

Facultative vernalisation occurs in both spring and winter type canola. It simply means the more cold days the plant accumulates between sowing and floral initiation (stage before green bud) the lower the thermal time target required.

**Photoperiod (Day length)**

Photoperiodism, is the response of plants to increasing or shortening day lengths. Long day plants (canola) respond to increasing day length. As you move from winter to summer the days lengthen and the crop requires fewer day degrees to move between growth stages so flowers earlier.

Once the drivers of phenological development for a particular variety are understood they can be used in models, such as APSIM, to determine how they will grow and develop in a particular environment. But to maximise yield, as discussed previously, an optimal flowering window for that environment needs to be developed and then an optimal sowing date for the variety extrapolated.

**Optimal flowering period (OFP) for canola in South Australia**.

Crops which flower too early may have insufficient biomass or frost damage, while late flowering increases heat and water stress. Despite its importance, OFPs for canola have not been comprehensively defined for canola across eastern Australia's cropping zone, especially for crops sown prior to the traditional sowing window (late April to early May). Identifying the OFP is a first step to establish appropriate variety by sowing date combinations to optimise yields in different environments.

Figure 1 shows how APSIM modelling can be used to develop an OFP for an example environment, where flowering ideally occurs when frost and heat stress risk are minimised. Once this is known the ideal sowing date can be generated for a variety based on historical meteorological data and knowledge of the drivers of the variety's phenological development.

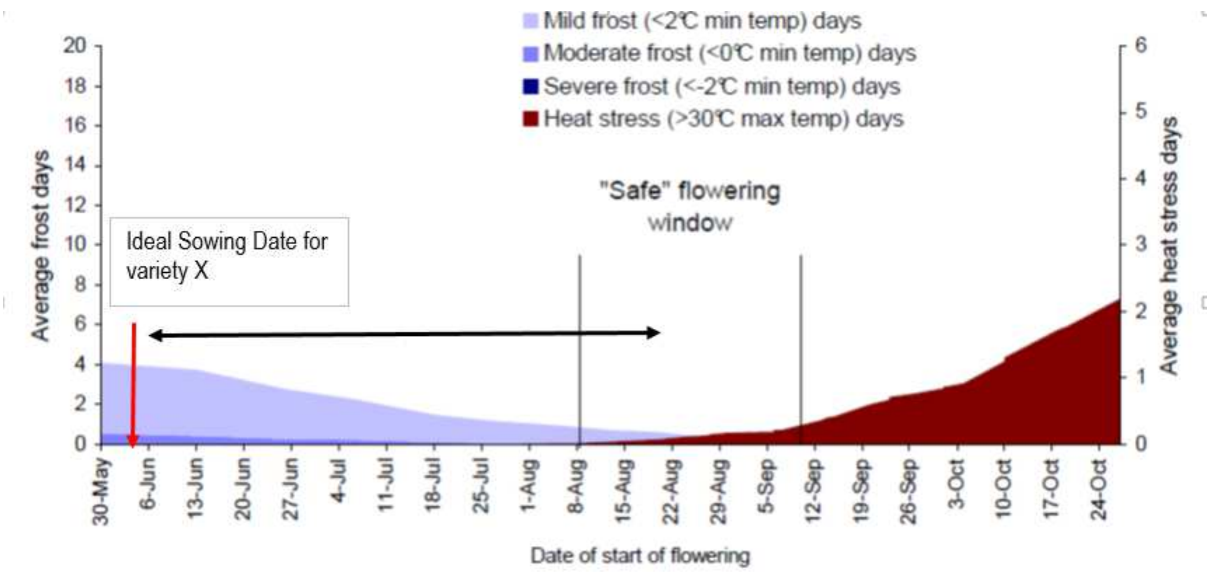


**Figure 1**. Example of how an optimal flowering period is generated and then an ideal sowing date is developed for an example environment.

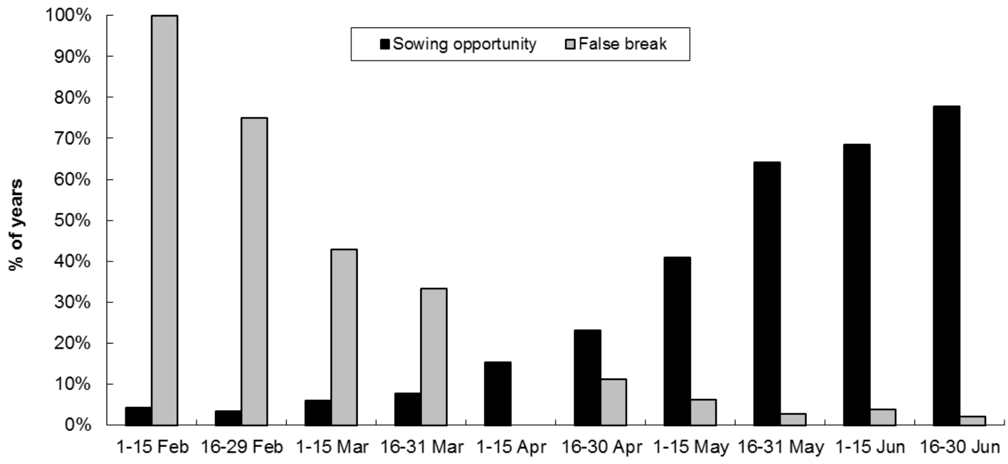


**Figure 2 Hart Sowing opportunities:** For fortnightly periods the frequency of years with a sowing opportunity (i.e. rainfall > pan evaporation over 7 days) and the likelihood of a false break with no further effective rain (i.e. rainfall < pan evaporation over 7 days) in the subsequent 6 weeks.

Figure 2 shows how, once an optimal sowing date for a particular variety is known then historical meteorological data can be used to determine how likely a sowing opportunity within the optimal window occurs for that location.
The development of optimal flowering windows for South Australia is now well advanced and an increased understanding on the phenological drivers of recently released canola varieties is also being updated into crop models such as APSIM, meaning that growers and advisers will shortly have access to techniques that offer the potential improve canola productivity in their region.

**Conclusion**
The grain yields achieved in field experiments conducted at Yeelanna, Hart and Lameroo in 2016 showed that having the correct variety x time of sowing combination enabled yields to be maximised.

An increased understanding of how a canola variety develops can be used in combination with the development of optimum flowering windows for a particular location so that optimal sowing times can be generated.

**Useful resources**
https://grdc.com.au/Resources/GrowNotes

**Acknowledgements**

This work is a component of the 'Optimised Canola Profitability' project (CSP00187) a collaboration between NSW DPI, CSIRO and GRDC in partnership with SARDI, CSU, MSF and BCG.

Thank you the numerous South Australian growers and Hart Field Site group for making their land available for the field trials and to the technical officers of the SARDI New Variety Agronomy group for their assistance in conducting the field trials.

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# LUPIN AGRONOMY AND CANOPY MANAGEMENT ON THE LOWER EYRE PENINSULA

**Jacob Giles,** SARDI Port Lincoln

**Key Findings**

- New variety PBA Jurien yielded the highest and was also the first to flower, Jindalee yielded the lowest and was last to flower.
- All varieties performed the best when sown early May.
- Choice of variety becomes less important as TOS is pushed into late May/ early June.
- Ideal sowing rate (for PBA Jurien) was found to be 100kg/ha or 65pl/m² with significant losses resulting if rates dropped below 80kg/ha or 50pl/m².
- If sowing is early, rates as high as 120kg or 80pl/m² may have negative yield effects.
- Higher sowing rates become more critical as time of sowing becomes later.
- Use of PGR'S with the current lack of knowledge will most likely have a detrimental effect on yield, however potential is apparent.

Lupins are grown on the LEP over acidic sandy soils that pre-dominate the growing region south of Cummins. However, the extent to which lupins are grown as part of farming systems on the LEP is becoming restricted. Low gross margins have formed the basis for alternative growing options such as tighter rotations of existing crops, pastures and the extension of more profitable pulses such as field pea and faba beans into areas where previously not grown.

Lupins are utilized as a disease break, for their N-fixing ability and have proved handy as a tool to combat ryegrass. While these three traits are highly valued in farming systems on the LEP, as long as gross margins remain low, the time and effort put towards developing lupins as a crop will remain minimal. The trials below look at several issues surrounding lupins, but all aimed towards the same driving factor of yield.

If the determining factors of yield could be pin pointed and worked upon as extensively as they have been for other crops such as cereals, perhaps yields becoming more consistent would provide an incentive to grow lupins, even if prices remained average. This is the purpose of experimenting with varying time of sowings, at different sowing rates with several varieties. However an early sown crop, or any Lupin crop for that manner has its issues. Large bulky crops that look promising half way through a growing season will be harvested with poor yields resulting and often with no real answer as to why. Plant Growth Regulators, (PGR's) amongst other treatments were trialled in an attempt to understand this issue in the canopy management trial.

Germination, early vigour, biomass, lodging, harvest index and maturity are all linking factors to yield. These factors contributed to the design and outcome of the following trials.

- **time of sowing x variety**
- **time of sowing x sowing density**
- **canopy management**

**How was it done?**

All three trials were sown as a complete randomised split plot block design. Plots measured 2 m x 10 m. The following varieties were sown for the time of sowing x variety trial:

- PBA Gunyidi
- PBA Barlock
- PBA Jurien
- Mandelup
- Jindalee
- Jenabillup

Time of sowing x variety was sown to PBA Jurien while the canopy management trial contained Mandelup. Across all trials, seed was treated with Rovral at recommended rates. Seed was inoculated with Group G inoculum just prior to sowing. Glyphosate at 2L/ha, Trifluralin at 2L/ha, 75ml/ha Oxyflourfen 240g/L, Simazine 900 at 1.1kg/ha was applied along with Lorsban 500 to allow unhindered establishment and prevent confounding results, (pests and weeds). Sowing took place into a moist seedbed across all 3 times of sowing, with 100kg MAP applied. The trials were sown into acidic red sand over ironstone clay loam. All TOS were sown into a moist seed bed.

Prior to canopy closure clethodim was sprayed twice to combat annual ryegrass at a rate of 0.5L/ha (with Activ Oil @ 1%). The trial was direct headed with minimal grain loss resulting from pod shatter. Some disease was present upon harvest. This was minimal and not thought to incur a confounding loss of yield.

Canopy management trial received treatments at 2 stages. The first at 8 nodes, or a well developed plant but also well premature to bud initiation. The other, at bud initiation, when flower buds were just visible at the top of the primary stem but still yet to open.

**Seasonal outlook**

**Table 1: Monthly rainfall 2016**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Monthly** | 10.9 | 85.4 | 12.0 | 32.2 | 90.2 | 112.4 | 74.8 | 49.0 | 78.4 | 43.4 | 15.2 | 29.2 | **633.1** |
| **GSR** | | | | 32.2 | 122.4 | 234.8 | 309.6 | 358.6 | 437.0 | 480.4 | | | **480.4** |

As is well known, the growing season of 2016 was exceptional, but also very different. A warmer than average winter, paired with consistent rainfall ensured good establishment and development into flowering. As the onset of spring approached, temperature averages decreased, and the rainfall continued (September 78.4mm, October 43.4mm), allowing for a long slow finish.

**Results**

**TOS x variety**

Germination was generally good, however PBA Barlock did see a significantly lower establishment than other varieties as seen in Table 2. For this reason I will not discuss PBA Barlock to any great extent. Establishment at later sowing times remained successful despite cold, wet conditions.

**Table 2: Establishment rate, variety x TOS**

| Establishment (pl/m²) | TOS | | | |
|---|---|---|---|---|
| **Variety** | **4th May** | **19th May** | **7th May** | **Average** |
| Jindalee | 47 | 47 | 51 | 48 |
| PBA Barlock | 32 | 38 | 26 | 32 |
| PBA Gunyidi | 45 | 37 | 40 | 41 |
| PBA Jurien | 45 | 45 | 41 | 44 |
| PBA Mandelup | 44 | 47 | 49 | 47 |
| Wonga | 55 | 53 | 44 | 50 |
| **Average/ TOS** | **45** | **44** | **42** | **44** |

Yields trended consistently according to time of sowing. TOS1 produced the highest yields, decreasing as time of sowing became later. This is especially apparent between TOS2 and TOS3. Jurien yielded the highest across all sowing dates, yielding 3.25t/ha in TOS 1, (0.25t/ha, or 8% higher than any other variety). Jindalee yielded the lowest in TOS1 (2.63t/ha), with only 4% difference between the remaining four varieties.

**Table 3: Grain yield (t/ha) per variety sown at three different times of sowing at Wanilla, Lower Eyre Peninsula, 2016.**

| Variety | Flowering | TOS 1 4-May | TOS 2 19-May | TOS 3 7-Jun |
|---|---|---|---|---|
| Jindalee | Late | 2.63 | 2.40 | 2.10 |
| PBA Barlock | Mid | 2.99 | 2.38 | 1.55 |
| PBA Gunyidi | Mid | 2.98 | 2.45 | 2.08 |
| PBA Jurien | Early | 3.25 | 3.08 | 2.22 |
| PBA Mandelup | Early | 2.87 | 2.53 | 2.09 |
| Wonga | Mid | 2.94 | 2.72 | 2.17 |
| LSD (P=0.05) | | | | 0.27 |
| CV | | | | 6.40 |

**Table 4: Date and number of days from sowing to 50% flowering of Lupins across six varieties and three sowing dates at Wanilla, 2016**

| Variety | Date of 50% flowering | | | Days from sowing till 50% flowering | | |
|---|---|---|---|---|---|---|
| | Time of sowing | | | Time of sowing | | |
| | 4-May | 19-May | 7-Jun | 4-May | 19-May | 7-Jun |
| Jindalee | 14-Aug | 28-Aug | 11-Sep | 102 | 102 | 96 |
| PBA Barlock | 11-Aug | 28-Aug | 9-Sep | 99 | 102 | 94 |
| PBA Gunyidi | 5-Aug | 23-Aug | 9-Sep | 93 | 97 | 94 |
| PBA Jurien | 3-Aug | 19-Aug | 6-Sep | 91 | 93 | 91 |
| PBA Mandelup | 5-Aug | 23-Aug | 6-Sep | 93 | 97 | 91 |
| Wonga | 10-Aug | 26-Aug | 9-Sep | 98 | 100 | 94 |

Table 4 displays flowering times in correlation to variety and time of sowing. Whilst no vast differences can be seen, small points of notice include Jurien and Jindalee as the first and last to flower. They are also the highest and lowest yielding varieties. The days between varieties becomes much lower in TOS3, similarly to yield differences in TOS3. The flowering window across all varieties is only 11 days at the most (TOS1). This **Time of sowing x plant density**

**Table 5: Yield (t/ha) as a result of differing sowing rates sown at 3 different times, at Wanilla, Lower Eyre Peninsula, 2016.**

| Plant density (pl/m²) | 4-May | 19-May | 7-Jun | Seed rate (kg/ha) |
|---|---|---|---|---|
| PBA Jurien 20 | 2.82 | 2.31 | 1.79 | 32 |
| PBA Jurien 35 | 3.19 | 3.01 | 2.13 | 57 |
| PBA Jurien 50 | 3.42 | 3.08 | 2.45 | 80 |
| PBA Jurien 65 | 3.59 | 3.28 | 2.64 | 104 |
| PBA Jurien 80 | 3.53 | 3.35 | 2.77 | 130 |
| | | | | |
| LSD (P = 0.05) | | | 0.27 | |
| CV | | | 6.4 | |

Table 4, and Figure 1 display a clear trend towards yield increase as a result of increased plant density and earlier time of sowing. Highest yields were achieved in TOS 1 at a plant density of 65 pl/m². However, when the sowing rate was dropped to 50pl/m², yield loss was insignificant. TOS 1 is the exception with yields showing a minor decrease as plant density reaches 80pl/m². This trend becomes less apparent as TOS becomes later (Figure 2). A significantly higher yield loss percentage is seen in the third time of sowing as plant density decreases, in comparison to TOS1 (Figure 2).

**Figure 1: Yield as per sowing density represented across three sowing dates (4th May, 19th May, 7th June)**

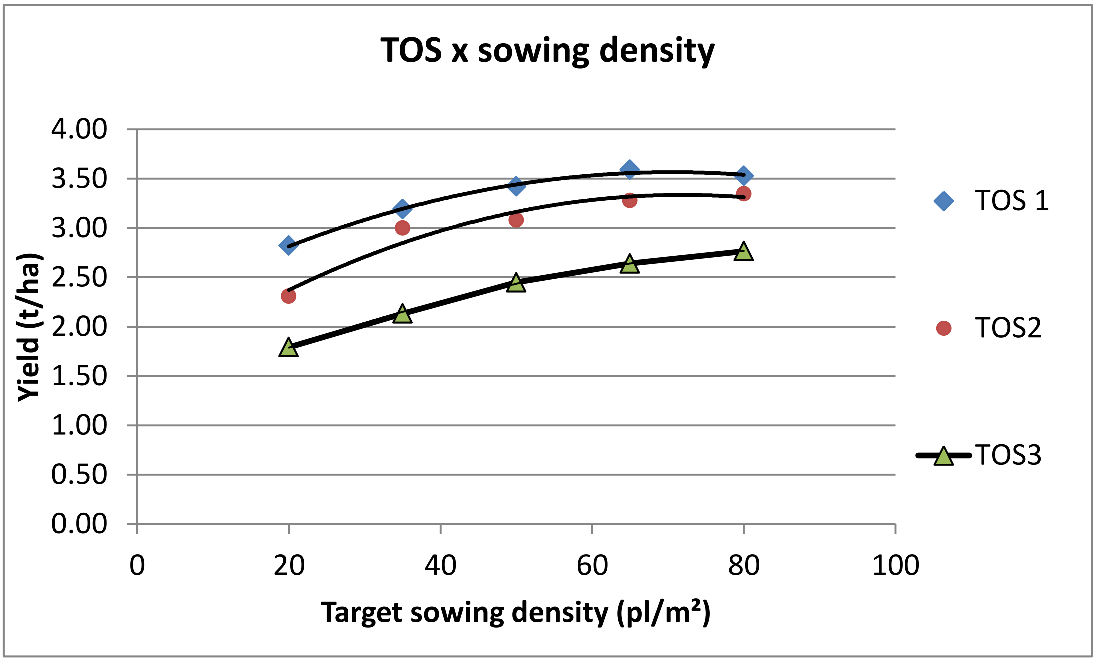
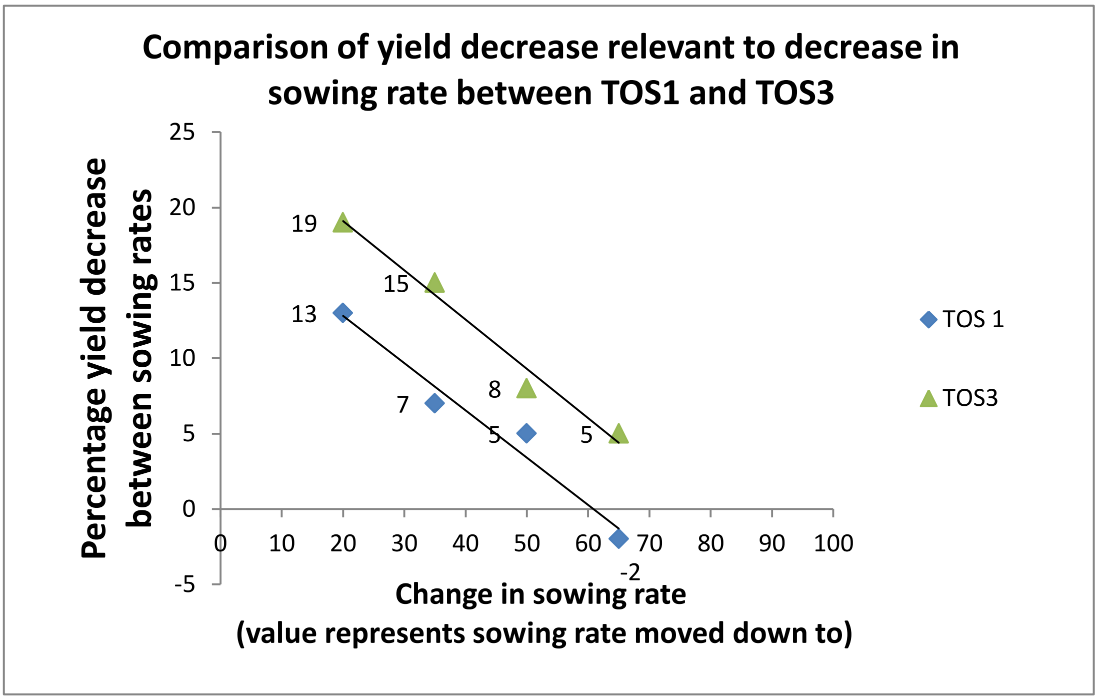



**Figure 2: Comparison of yield decrease relevant to decrease in sowing rate between TOS1 and TOS3, Wanilla, Lower Eyre Peninsula, 2016**




## Canopy Management

Plant physiology responses were seen in the trial, however no treatments saw a positive yield response.

**Figure 3: Architectural response to Lontrel treatment (right), in comparison to Nil treatment, (left).**


**Table 6: Yield, height and pod umber on the primary stem as a Result of varied canopy management strategies, Wanilla, Lower Eyre Peninsula, 2016.**

| Treatment | Yield (t/ha) | Height (cm) | Pods on 1° |
|---|---|---|---|
| Carbendazim + Tebuconazole | 3.13 | * | * |
| Cycocel - Early | 2.95 | 75 | 9 |
| Cycocel - Early & Late | 3.04 | 69 | 11 |
| Cycocel - Late | 2.90 | 78 | 10 |
| Eclipse/ Brodal | 3.20 | * | * |
| Ethral Early & Late | 2.24 | 47.2 | 7 |
| Ethral - Early | 2.86 | 56.8 | 8 |
| Ethral - Late | 2.52 | 72.6 | 5 |
| Glyphosate | 2.10 | 44 | 6 |
| Lontrel | 3.07 | 65.8 | 7 |
| Mechanical Pinching - Early | 2.75 | 68.75 | NA |
| Mechanical Pinching - Late | 2.62 | 82.5 | NA |
| Moddus Early | 2.96 | 66 | 8 |
| Moddus Late | 2.98 | 71.2 | 9 |
| Nil | 3.22 | 76 | 10 |
| Sprayseed Early | 2.85 | * | * |
| | | | |
| LSD (P = 0.05) | 0.35 | | |
| CV | 7.70 | | |

Many treatments had a significant impact on plant physiology. Flowering times were altered (generally delayed), plants became shorter and overall a decrease in yield was seen. Some interesting points to note was how a plant treated with Lontrel (@50ml/ha) looked not long after pod set (Figure 3) yet how the end yield was still very reasonable. Early Ethral treatment opened the canopy (Figure 4) leaving future potential. Many treatments were based upon lodging, of which there was none, despite weather conditions. The use of Eclipse had no effect on yield.

**Figure 4: Comparison of canopy cover and crop bulk, late flowering. Nil treatment (left), and early Ethral treatment. Wanilla, Lower Eyre Peninsula, 2016**

The site as a whole yielded considerably well. The warmer (than average) autumn, paired with a long cool spring favoured the indeterminate growth habits of lupins. For these reasons, any results above should be considered in context to the season of 2016 at Wanilla.

Despite the favourable finish, it should be noted that the earlier times of sowing still out yielded later times. It may be thought that in better years the later TOS will 'catch up' how ever this was not the case. PBA Jurien grew well, displaying good early vigour with a high end yield resulting. Jindalee did not yield as well as any other varieties

**Acknowledgement**

Funding – LEADA, SARDI

Andrew Green and family for hosting trials. The SARDI Port Lincoln New Variety Agronomy team for managing the trials.

# MANAGING RYEGRASS THROUGH CROP COMPETITION

**Blake Gontar,** SARDI Port Lincoln

As part of the Stubble Initiative (LEA00001) SARDI, on behalf of LEADA, established two field trials in 2014 to evaluate crop competition as a tool to reduce weeds, namely annual ryegrass (ARG). These two trials, at Yeelanna and Wanilla, have run continuously over three years, with some variation in crop sequence between the two sites. For each site and in each year, agronomic management options, including seeding rate, cultivar choice and time of sowing, have been tested.

In 2016, the Wanilla site was sown to canola, following two cereal rotations, while the Yeelanna site had a cereal rotation following lentils in 2015 and the same cereal rotation in 2014. The 2015 lentil trial was not evaluated as lentils are considered to be poor competitors and management options within this crop are likely to be limited.

While reference will be made to previous years, this paper will mainly focus on the 2016 growing season. Since plots were established in the same location consecutively, any differences in ryegrass density at emergence in 2016 can be viewed as a cumulative effect over the 3 years.

**Table 1. Cultivars, plant target rates and times of sowing (TOS) tested at Wanilla and Yeelanna in 2016:**

| | *Wanilla* | *Yeelanna* |
|---|---|---|
| Cultivars | Canola – Stingray TT, Hyola 559 TT, 45Y89 CL, Archer CL. | Fleet, Emu Rock, Wyalkatchem, Mace |
| Seeding Rates | 30 pl/m$^2$, 45 pl/m$^2$ | 150 pl/m$^2$, 250 pl/m$^2$ |
| Time of Seeding | 29$^{th}$ April, 18$^{th}$ May, 1$^{st}$ June | 29$^{th}$ April, 18$^{th}$ May, 30$^{th}$ May |

## Method

Soil at Yeelanna was a reddish clay loam while at Wanilla, the site comprised of duplex gravelly loamy sand over heavy clay. Both sites were affected by waterlogging in 2016, with the Wanilla site particularly affected. A number of plots at Wanilla have been omitted from analyses as they either did not emerge or were so heavily infested by weeds that they had to be prematurely sprayed out to contain them. Sites were sown on the above-mentioned dates using a knife-point press wheel 6-row plot seeder. Trials were treated with label rates of glyphosate and oxyfluorfen and either a Sakura/trifluralin mix for cereals or trifluralin/Avadex mix for canola, with Rustler applied PSPE. No in-crop herbicides were used. Fertilisers were applied at seeding and throughout the year to ensure yields were not limited by nutrient deficiency. It is likely though that the extended waterlogging, particularly at Wanilla, deprived plants of fertiliser, as well as oxygen. Plots that did not recover from this stress have been omitted, as mentioned above.

In each year, crop establishment, ryegrass emergence and crop yield were measured. Measurements have generally been staggered to account for the different times of sowing. In 2016, a final visual assessment was made of the 'weed infestation' of each plot at harvest.

**Results**

***Yeelanna***

There were no differences in ARG emergence between the 8 combinations of variety x sowing rate for any of the three times of sowing. Given this site only had treatments applied in 2014 and 2016 (2015 sown to 1 lentil cultivar at same rate/timing), ARG emergence, likely a measure of the seedbank resulting from previous treatments, suggests the single year of treatments (2014) have not had a significant impact. There was a lot of variation in replicates in the 2016 trial, which makes determining subtle differences difficult. However, it seems unlikely that the subtle differences in vigour or plant architecture of the four cereal cultivars is sufficient to effect ryegrass growth. Seeding density also did not have a significant effect on ryegrass emergence in 2016.

As was found in the cereal phase (same treatments) at Wanilla in 2015, time of sowing effected ryegrass emergence. The 3rd TOS had 60-65 % fewer weeds emerging (P = 0.0003). This is likely to be a function of pre-seeding control of part of the weed seed bank with a knockdown herbicide, and potentially greater control of late-germinating weeds with the pre-emergent herbicide applied at seeding. Pre-emergent herbicide applied at seeding in TOS 1 may have begun to fail when ARG emergence counts were conducted, with late-germinating ryegrass seeds continuing to emerge.

**Table 2. Annual ryegrass emergence (plants/m$^2$) at Yeelanna in 2016.**

| Variety | Target Rate | Seeding | TOS 1 | TOS 2 | TOS 3 |
|---|---|---|---|---|---|
| Emu Rock | Low | | 133 | 116 | 32 |
| | High | | 115 | 146 | 35 |
| Fleet | Low | | 115 | 70 | 81 |
| | High | | 167 | 49 | 28 |
| Mace | Low | | 180 | 103 | 40 |
| | High | | 76 | 100 | 38 |
| Wyalkatchem | Low | | 111 | 158 | 58 |
| | High | | 115 | 115 | 19 |
| AVE for TOS (all variety x sowing rate) | | | 127[a] | 107[a] | 41[b] |

There were no differences in visual score for 'weedy infestation' at harvest, however it must be noted that there was a large proportion of missing data points in this data set, particularly for TOS 1 & TOS 2, as the crop was so heavy and lodged that no visual weed score could be attained.

**Table 3. Annual ryegrass visual score (0-5) at harvest at Yeelanna in 2016**

| Variety | Target Seeding Rate | TOS 1 | TOS 2 | TOS 3 |
|---|---|---|---|---|
| Emu Rock | Low | 3 | 2.5 | 2.5 |
| | High | 2.5 | 1.75 | 2.5 |
| Fleet | Low | N/A | N/A | 2 |
| | High | N/A | N/A | 2 |
| Mace | Low | 1.5 | 1.75 | 1.75 |
| | High | 1.67 | 1.75 | 2 |
| Wyalkatchem | Low | 1.25 | 2.5 | 2.5 |
| | High | 1.25 | 2.25 | 1.5 |
| AVE for TOS (all variety x sowing rate) | | 1.8 | 2.1 | 2.1 |

Finally, there were no significant yield differences between the 8 cultivar x sowing rate combinations, or between the interaction of these combinations with the three TOS. However, TOS itself did have a significant effect (P = 0.0002), with yield improving with every delay of seeding, across all combinations of seeding rate and cultivar. This is possibly the result of reduced disease (particularly NFNB in Fleet), none of the cultivars being well suited to the long season (i.e. none were able to gain significant benefits out of being sown early), and probably the reduced weed burden in TOS 3 enhancing yields in this group.

**Table 4. Yield (t/ha) of all treatments at Yeelanna in 2016.**

| Variety | Target Sowing rate | TOS 1 | TOS 2 | TOS3 |
|---|---|---|---|---|
| Emu Rock | Low | 4.53 | 5.23 | 5.20 |
| | High | 4.39 | 4.85 | 5.58 |
| Fleet | Low | 4.90 | 5.06 | 5.56 |
| | High | 4.82 | 5.32 | 5.89 |
| Mace | Low | 4.82 | 4.98 | 5.05 |
| | High | 4.71 | 4.68 | 5.49 |
| Wyalkatchem | Low | 4.95 | 5.48 | 5.08 |
| | High | 5.23 | 5.07 | 5.45 |
| AVE for TOS (all variety x sowing rate) | | $4.79^a$ | $5.08^b$ | $5.41^c$ |

Although the seasons were quite different, yields in 2015 at Wanilla (same treatments) showed similarities i.e. that delaying seeding to get good weed control doesn't necessarily reduce yields, provided the cultivar being grown is relatively fast maturing and the growing season is sufficient. In 2015 however, the ideal delay was 2 weeks, rather than the 4 weeks in 2016, possibly due to the harsh finishing conditions in 2015. Whilst the 2016 season was exceptional for the season length, it reinforces the yield benefit in delayed seeding where the weed seed bank is large. Early sowing of competitive crops is unlikely to be as effective as delayed seeding with a good knockdown and fast maturing variety like Mace, Emu Rock or Cobra. Whilst the long season shouldn't be relied upon, delaying seeding for 10 days after the initial opening rain, where that rain occurs early (i.e. late April – very early May) has proven an effective strategy for managing weeds, as well as being profitable where a cereal is to be sown in to  a heavy weed burden.

***Wanilla***

There were no differences in ARG emergence between any cultivar x sowing rate combination. However this appears to be more a reflection of the limits of cultivar selection, since across all combinations of TOS and cultivar, there was a difference between sowing rates (P = 0.0353) (Table 4).

**Table 5. Sowing rate effect on annual ryegrass emergence across all cultivars at Wanilla in 2016.**

| Time of sowing | Low | High |
|---|---|---|
| TOS 1 | 64 | 48 |
| TOS 2 | 19 | 10 |
| TOS 3 | 16 | 17 |
| AVE for seed rate (all TOS) | 33[a] | 25[b] |

In 2015, sowing rate across all TOS/Cultivars was not significant (P = 0.09). This may imply that higher seeding densities may need to be maintained for greater than 2 rotations to start to see reductions in weed emergence in the following year. This is possibly due to the effect of the reserve of weed seeds in the soil persisting beyond 2 years (Peltzer & Matson, 2002).  It may also indicate that, unlike cereals, canola may have significantly influenced germination in 2016, perhaps due to quicker and more substantial shading of the inter-row than can be achieved in cereals. This result seems to imply long term weed reduction in the order of 10-20 % may be possible if a high-density seeding strategy is continued, possibly enhanced by the inclusion of canola sown at high density within this strategy.

Once again, time of sowing had a substantial impact (P < 0.0001). After three years of delayed seeding, the second and third TOS had significantly and substantially lower ryegrass emergence.

**Table 6. Annual ryegrass emergence (plants/m$^2$) at Wanilla in 2016.**

| Variety | Target Sowing Rate | TOS 1 | TOS 2 | TOS 3 |
|---|---|---|---|---|
| Pioneer 45Y88 CL | Low | 46 | 32 | 31 |
| | High | 38 | 12 | 4 |
| Archer CL | Low | 59 | 15 | 9 |
| | High | 44 | 18 | 18 |
| Hyola 559 TT | Low | 53 | 18 | 8 |
| | High | 21 | 4 | 17 |
| Stingray TT | Low | 99 | 11 | 16 |
| | High | 91 | 8 | 28 |
| AVE for TOS (all variety x sowing rate) | | 56[a] | 15[b] | 16[b] |

The visual weed infestation score conducted at harvest reinforced the emergence data, with TOS 1 proving to be significantly more weed infested at harvest ($P < 0.001$). Given this visual score is based on the number of plants as well as their size, the positive relationship between ARG emergence and visual score at harvest was expected. However, regression analysis showed that, while the relationship is significant ($P < 0.001$) emergence only somewhat explained the variation in harvest weed score ($R^2 = 0.36$). This suggests other factors influenced the final 'weedy-ness' of plots.

This difference may be partly attributable to variety. Whilst there were no differences in variety x seeding rate combinations in TOS 2 and 3, there were differences in TOS 1. Stingray at both the low and high seeding rates was significantly more weed infested than all other varieties ($P < 0.001$).

**Table 7. Annual ryegrass visual score (0-5) at harvest at Wanilla in 2016.**

| Row Labels | Target Sowing rate | TOS 1 | TOS 2 | TOS 3 |
|---|---|---|---|---|
| Pioneer 45Y88 CL | Low | 2.67[a] | 1.33 | 1 |
| | High | 1.33[a] | 1 | 2 |
| Archer CL | Low | 2.75[a] | 1.25 | 2 |
| | High | 1.67[a] | 1 | 1 |
| Hyola 559 TT | Low | 2.75[a] | 1.25 | 2 |
| | High | 2[a] | 1 | 1 |
| Stingray TT | Low | 4.75[b] | 2 | 1.5 |
| | High | 4.75[b] | 1.33 | 2 |
| Grand Total | | 2.96[1] | 1.29[2] | 1.56[2] |

Finally, there were very few significant yield differences between treatments for the trial. This is likely due to the loss of reps for most combinations (waterlogging) reducing statistical power, plus the variation introduced due to the wet season. Beyond that, the data certainly suggest sowing at higher densities increased yield, the cultivar Stingray sown early was relatively low-yielding, no doubt because the weed density in TOS 1 would have had an effect. Across all other factors, TOS 2 was the better yielder (P = 0.003), possibly due to increased weed control in TOS 2 but also due to the fact that all varieties would be better adapted to this sowing window, whereas Archer would be too late-maturing for TOS 3 and Stingray too early for TOS 1.

**Table 8. Yield (t/ha) of all treatments at Wanilla in 2016.**

| Variety | Target Sowing rate | TOS 1 | TOS 2 | TOS3 |
|---|---|---|---|---|
| Pioneer 45Y88 CL | Low | 2.05$^{abc}$ | 1.73$^{abc}$ | 1.53$^{abc}$ |
| | High | 2.49$^{a}$ | 2.53$^{a}$ | 2.29$^{ab}$ |
| Archer CL | Low | 1.67$^{abc}$ | 2.20$^{ab}$ | 1.36$^{abc}$ |
| | High | 2.46$^{a}$ | 2.88$^{a}$ | 2.00$^{abc}$ |
| Hyola 559 TT | Low | 1.66$^{abc}$ | 2.10$^{ab}$ | 1.55$^{abc}$ |
| | High | 1.77$^{abc}$ | 2.26$^{ab}$ | 1.74$^{abc}$ |
| Stingray TT | Low | 0.65$^{c}$ | 1.81$^{abc}$ | 1.30$^{abc}$ |
| | High | 0.86$^{bc}$ | 2.26$^{ab}$ | 1.25$^{abc}$ |
| AVE for TOS (all variety x sowing rate) | | 1.70$^{1}$ | 2.22$^{2}$ | 1.63$^{1}$ |

**Conclusion**

The three year experiment conducted at these two sites indicates that increased seeding density may have limited potential to further control weeds in LEP farming systems. Whilst sowing density has elsewhere proven to be effective at reducing weeds biomass (Lemerle *et al*. 2004), those experiments have generally found that the rate of gain declines as crop density increases to more robust rates – this implies that the potential for gain on LEP, where seeding rates are generally robust already, may be modest. This was the case in this trial where cereal densities were manipulated from 150 to 250 plants/m$^2$ in cereals and 30 to 60 plants/m$^2$ in canola, resulting in only a 21 % decrease in ARG emergence after three years. This reduction may also be partially attributable to the inclusion of canola in the final year.

There were no differences in ryegrass emergence attributable to any of the cereal cultivars. This is likely due to the limited differences in vigour and crop architecture of the four chosen cereal cultivars, and more broadly, the same limited differences in most cereal cultivars gown commercially on the LEP. All four cultivars in this trial were semi-dwarf in stature and early to mid-maturing and this combination does not appear to possess strong competitive potential. The canola phase at Wanilla demonstrated greater potential, though this effect was somewhat obscured by waterlogging. The only open-pollinated, early maturing canola variety, Stingray, known to have very low biomass, appeared to allow a greater ARG biomass to develop. All other varieties appeared similar.

Finally, across all years, delaying seeding beyond the break of season to allow a flush of ARG to emerge and be controlled by a knockdown herbicide was the most significant and effective strategy to reduce weed emergence. Where the weed burden is high, it appears that the penalty associated with delayed seeding is likely to be offset by the reduction in weed competition, as demonstrated in 2015 and 2016. Incorporating this management tactic opportunistically into a seeding program, particularly where an early break occurs, is likely to have substantial benefits overall.

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# SAVING THE SOIL 'SKIN', THRIVING WITH NO-TILL

**Rick Bieber,** No-Till Farmer, South Dakota, USA

***Article from No-Till Farmer – Conservation Tillage Guide – August 2014,***

***Written by Loretta Sorensen.***

What began as an economic decision has morphed into a successful and profitable livestock and cropping operation for longtime South Dakota no-tiller Rick Bieber.

When Rick Bieber adopted no-till during the 1980s, he knew little about how or why reduced tillage might benefit his soils. He was simply searching for ways to lower input and labor costs to make his farming operation a paying proposition.

"I didn't have the money to purchase all the iron it would take to do the tillage that was considered to be essential to a successful farming operation at that time," Bieber says. "I had to make do with the aging, small amount of equipment I could afford."

But times have changed for Bieber, who with his son, Ben, raises wheat, corn, soybeans, flax, peas, sunflowers and alfalfa on about 5,000 acres near Trail City, S.D. They also manage 5,000 acres of rangeland, running a 600-head cow-calf operation.

Bieber has become one of South Dakota's most passionate advocates for no-till practices, speaking at numerous conferences and field days about the importance of soil health, not just reducing expenses.

"I'm not so sure that I introduced no-till practices so much as I re-introduced them to our farm," he says. "Many of the things we're beginning to do now were used in farming before all our modern technology was developed.

"Over the years I've come to view the soil to be similar to the skin that covers our human bodies, and residue and cover crops are like clothes on the soil," he adds. "Soil needs to be protected just like the skin on our bodies. Just as we don't like to be poked, prodded, cut, burned or frozen in any fashion, the soil doesn't like that either."

**The Start Of Change**

Bieber grew up on his family's wheat farm, which was established when both his maternal and paternal grandparents came to the Dakotas from Ukraine and homesteaded next to each other near Trail City.

The light soils found there have been prone to erosion for decades.

"One of my grandfathers was very conservation minded," Bieber says. "The other approached farming with the attitude of 'Let's see how much we can get off the land.' During the 1930s and '40s, soil that was lacking conservation practices blew heavily. The effect of that is still evident in the respective productivity of our farm ground today."

Bieber easily recalls the wheat fallow that was part of the traditional wheat-farming process his family practiced.

"In the 1970s, we tilled the heck out of everything," Bieber says. "Our county's average spring wheat yield was 17 bushels per acre. Our proven yield was 21 bushels per acre, so we thought we were doing well."

In the 1980s, soaring interest rates and the financial stress rippling through the farming industry pushed many U.S. farmers to the sideline, taking a toll on the Bieber family, too.

"There were a number of years when my father's income figures fell into the red. That's when we started taking a completely different approach to farming," Bieber says. "For economic reasons, I started using less tillage and looked for ways to cut input costs as much as possible."

With lowered inputs, Bieber says he began realizing annual profits, even when farming soil in desperate need of improvement. He soon took over operation of the land on his father's farm.

"Using that same low input, low-labor-cost paradigm, our farm survived the 1980s and thrived into the '90s," Bieber says. "Then came the 2000s, when we saw some of the most extreme weather conditions we had ever experienced on the farm.

"In 2006 we had the lowest rainfall ever recorded in our region. In 2012 we had some of the highest temperatures ever recorded in several decades. Still, our soils continued to perform."

**Optimizing Moisture Use**

Average rainfall in Bieber's locale ranges less than 17 inches per year, in addition to some snowfall.

Over the past 27 years, Bieber has learned that the amount of rainfall received isn't nearly as important as how efficiently rainfall is captured and used.

"It's probably one of the biggest questions I hear," Bieber says. "Everyone wants to know how much rainfall we receive. But the more important question is how we manage that rainfall."

As he's refined his no-till system, Bieber has learned that leaving residue on the soil surface, keeping a growing root in the ground throughout the growing season and leaving soil undisturbed all contribute to effective moisture capture and utilization.

"Soil scientists are now verifying what we have suspected for a while — that soil needs carbon to feed the biological 'family' that lives beneath the soil surface," Bieber says. "Soil organic matter is a source of carbon, but it is also the sponge that holds moisture in the soil at the root zone where it's available to plants."

Exactly what seeding rate and cocktail mix Bieber uses for covers "depends on about a million different things," he says. "We use a uniform distribution of all the plants in the mix so that there's the same number of each type of plant per acre.

"If you have large seeds, like sunflower, that means you may have 10 pounds of sunflowers per acre and the amount of the remaining seeds are calculated accordingly."

Rather than seeking a specific turnip, radish or seed that might be in short supply, or may not provide the necessary soil benefit, Bieber advises farmers to build their cover-crop mix from four different plant family types: Warm-season grasses and warm-season broadleaves, cool-season grasses and cool-season broadleaves.

"That's the natural plan found in God's design of the Earth," Bieber says. "Each of those types of crops serves a purpose. The farmer has to decide what his soil needs and then select the type of cover-crop mix that will satisfy those needs."

**Interseeding Success**

When corn reaches the V-6 or V-7 stage, Bieber flies on a cover crop like cereal rye so the cover will sprout and grow following a rain.

"Once that corn crop matures or freezes the cover crop takes over, sequestering carbon to continue feeding the soil biota," Bieber says. "In our area, that biologic activity will generally continue through October, November and into December."

Behind wheat, Bieber uses a seeder to plant a cover-crop mix of warm-season broadleaf and grasses, and coolseason broadleaf and grasses, so soil biology is fed throughout the current growing season. Winter freeze terminates the crop.

Among the species in the Biebers' cover-crop mixes are purple-top turnips, daikon radishes, lentils, peas, proso millet, German millet, flax, buckwheat and volunteer spring wheat. They've also used crimson clover and winter wheat.

Bieber's farm began experimenting with covers in 1998. In 2006, South Dakota State University began establishing research plots on their farm, the driest year on record on the farm.

"That year we had limited success with the covers," Bieber says. "But we planted them again in 2007 and 2008 and they did well."

To maximize benefits from covers, the Biebers graze livestock on them once the ground freezes, or as long as there’s a vigorous root system to support livestock hoof action.

“In the past, it seemed that whenever livestock loitered on farmland, subsequent crop yields suffered,” Bieber says. “For us, we are at least maintaining if not increasing yield, yet still using our soils for meat production.”

Because the covers feed soil biology and soil organic matter remains intact, moisture holding capacity of the soil continues to build. “The porous characteristics of the soil also allows plant roots to ‘breathe,’ even if moisture saturates soil,” Bieber says.

“It’s not my individual ‘recipe’ that’s important to cover-crop use. It’s the principle of using the correct family of cover-crop types to fulfill the needs of a farmer’s soil.”

**Optimizing Moisture Use**

The Biebers evaluate their annual land-management success by evaluating the pounds of harvestable material per inch of rainwater they produce.

They believe those numbers reveal both the quality of their soils and the level of success they’ve achieved in providing soils and plants with the best possible nutrients and growing environment.

“Since 1987, our yields have tripled and the number of harvestable pounds of material we raise increases every year,” Bieber says. “Healthy soils take care of the crops.”

Organic matter levels in soils surrounding the Bieber’s farm average 2%, but on their own farmland the range is 4% and 5%.

“That’s why we see such incredible results with so little rain,” Bieber says. “Typically, soils with 2% soil organic matter hold 3 or 4 inches of water at the root zone. With 4% to 5% organic matter, my soils hold more than 6 inches of moisture.”

Fine root systems of covers also stimulate soil aggregation or the binding of soil particles together. Taproots featured on some covers push down into subsoil, stimulating water infiltration and subsoil aeration. The living plants also help hold leachable nutrients such as nitrogen to keep it from leaching into groundwater.

“Recent research suggests that plant-root systems contribute twice as much organic material to soil during the growing season as what is found in the root system at the end of the growing season,” Bieber says.

**Diverse Rotations Prosper**

The Biebers use a 5-year crop rotation that includes cool-season grasses (wheat and oats), then warm-season grasses (corn, millet and forages).

From there, Bieber goes to broadleafs (sunflower, flax, peas, alfalfa) and anything else he believes will improve soils and reduce inputs for the following wheat crops. Whenever he's been tempted to deviate from his standard crop rotation to "chase a market," Bieber has found that yields suffer.

"We may stack crops back to back once," Bieber says. "If we try that more than 1 year, our inputs skyrocket and yields plummet." The Biebers find wheat stubble helps protect soils so corn plants following wheat have what they need to withstand extreme growing conditions that can occur in their location.

"The corn root system develops during a cool point in the growing season so when the heat comes, corn plants have a fully developed root that can stand adverse conditions," Bieber says. "If our moisture is short, we switch from corn to a crop with lower water use, like millets."

Corn plants also aid wheat because they support soil biology.

"Warm-season grass like corn causes soil biota levels to rise," Bieber says. "Before you grow wheat, you need to include a disease-breaking, soil biota-friendly broadleaf. That aids the wheat seed in taking on moisture and sprouting in a friendly environment."

The Biebers started no-tilling sunflowers in 2002, feeling that a broadleaf was needed in their rotation.

"Many broadleaves don't thrive under high temperatures and low moisture, but sunflowers will," he notes.

Sunflower yields for the Biebers have ranged from 2,400 to 2,600 bushels per acre. In 2010, one field topped out at 3,500 bushels per acre. Sunflowers follow corn and are planted between standing corn stalks.

"We strive to leave all crop residue attached to the root," Bieber says. "If you have long, tall residue, it's easier to plant into.

"It's like combing your hair. If your hair's on your head, it's easy to comb. If you cut it off and it's lying on the floor, you can't comb it. It's typical in the no-till industry to use chopping rollers or fluted rollers to chew up crop residue. That may make the field look prettier, but there are less residue-handling issues with long, tall stalks."

**Getting More Yield**

While keeping input costs low is a high priority on the Bieber farm, the Biebers do strategize to maximize yield.

“We manage intensely for highquality, high-yield wheat,” Bieber says. “We fertilize with our drill and topdress. We’ll fertilize wheat a third time when we feel it’s necessary in order to achieve high-quality spring wheat.

“We also fertilize our sunflowers, since that’s the deepest-rooting crop in our rotation. We don’t want vegetative growth on the sunflowers, but we want to give them full advantage of nitrogen during seed fill. The tremendous oil that produces in the sunflowers nets tremendous weight at the elevator.”

Bieber says his fertilizing practices stem from past experiences 20 or 30 years ago when his father didn’t apply added nutrients and experienced significant yield loss as a result.

Because of his soil quality today, Bieber doesn’t believe the extra fertilizer is really necessary.

“Fertilizing is really something I need to wean myself from,” he says. “I’ve just struggled with making that change. When we fertilize we broadcast it. We know we don’t have a loss of the fertilizer from volatilization or leaching because active soil biology consumes nitrogen molecules and holds them.”

Bieber points out that current soil-testing practices won’t necessarily reveal the presence of nitrogen in his biologically active soil, because soil biology captures the nitrogen and holds it until the plants need it.

“Current testing identifies nitrogen that’s floating in the soil but won’t measure what soil biology has captured,” he says.

**The Right Machines**

When it comes to equipment, the Biebers look for features that fit the requirements of their no-till system.

“It won’t matter what color that equipment is,” Bieber says. “In a no-till system, you need a low-disturbance planter or drill, and a sprayer that covers your acres in a comfortable fashion that’s friendly to your soil.”

On their planter, the Biebers adjust down pressure in relation to the mellowness of longtime no-tilled soils in order to avoid sidewall compaction.

“For us, coulters are a function of tillage,” Bieber says. “They wiggle the ground and disturb the ‘houses’ of the soil biota, which reduces soil health. In healthy soil, the seed trench should almost close itself. If someone’s having trouble closing the trench, it’s usually a soil-health issue.”

Stripper headers are another key tool for the Bieber farm, as they strip wheat kernels out of heads while leaving straw standing upright.

This allows operators to run combines at higher speeds and in tougher conditions than when using straightcut headers that put all the straw through the combine. They also benefit from the standing crop residue.

“The stripper headers eliminate the issue of uniform residue distribution,” their no-till and cover-crop practices, they’ve cooperated with South Dakota State University researchers to validate soil quality and crop yields.

In 2011, after 21 years of continuous no-till on the Bieber farm, a study was started to measure the effect of cover crops with and without added nitrogen, phosphorus and potassium on corn yields. Data showed a combination of cover crops and macronutrients resulted in the greatest corn yields.

“We evaluated the yields in terms of how many bushels were raised per inch of water,” Bieber says. “In our field with no cover and no added nutrients, we harvested 89 bushels per acre, or 6.36 bushels per inch of rain. In our field with covers but no added nutrients, we harvested 7.29 bushels per inch of rain, a total of 102 bushels an acre.”

In the field where both covers and nutrients were used, researchers harvested 177 bushels per acre, totaling 12.64 bushels per inch of rain.

Because moisture loss is often a concern surrounding cover crop use, the Biebers cooperated in a South Dakota State University study measuring stored soil moisture loss in test plots where covers were planted.

“In the plot where covers were planted in fall 2010, stored soil moisture in spring 2011 was 2.53 inches,” Bieber says. “In the plot with no cover, stored moisture that same spring was 3 inches. For all the benefits the covers provide, their use of .47 inches of moisture seems a good tradeoff.”

Researchers who evaluated the cost per bushel of corn for the farm’s 2011 harvest found that an average of 122.5 bushels per acre of corn was raised in fields where cover crops were planted. That same year, in fields without cover crops, corn yields averaged 108 bushels per acre.

"That year, the total cost of raising the corn in fields with the covers (including land cost) was $2.39 per bushel," Bieber says. "The cost in the areas without covers was $2.71 per bushel."

**Fall Cover Crops Shine**

In a 3-year test plot study conducted on the Bieber's farm by South Dakota State University researcher Cheryl Reese, data was gathered between 2010 and 2012 to gauge the impact of cover crops on soil quality, corn yield and soil nitrogen.

In this study, done jointly with the USDA's Natural Resources Conservation Service, cover crops were planted into the plot's wheat stubble in August 2010. Control plots were established at the same time to contrast the effect of no cover crop being seeded.

In spring 2011, Bieber planted corn into the test-plot area. A third cover crop treatment was added in June of 2011 as a cover crop was drilled into growing corn.

In Spring 2012, Bieber planted sunflowers across Reese's cover-crop plots, and the following fall Reese sampled sunflowers from the plots seeded in August 2010, those seeded in June 2011 and those plots that didn't have cover crops.

In that single-year, single-site comparison, sunflower yield was shown to be greater in plots where cover crops were planted in August 2010 as compared to the other two plots.

"From that study, Reese concluded that the fall cover crop provided the most yield benefit," Bieber says.

While more study of the benefits of in-season and fall cover crops is required, Reese theorized that the living roots provided by fall-sown covers might be assisting in "maintaining a healthy population of soil biota."

# THE ECONOMICS OF CONTROLLED TRAFFIC AND PRECISION AGRICULTURE ON BRANSON FARMS AND USE OF DIGITAL TECHNOLOGIES ON FARM

**Mark Branson,** Owner manager – Branson Farms, Stockport

The 1200ha Branson farms are located between Stockport and Giles Corner in the lower north of South Australia. Annual rainfall in 475mm which predominantly falls in the winter months; growing season rainfall (GSR) is 350mm which falls from April to October. As such, the farm is in the high rainfall zone for cropping in South Australia.

The Branson's have been early adopters of new technology throughout the generations with the $6^{th}$ Generation just starting work on farm. The Branson farm has been an early adopter of superphosphate, the ley farming system, rotations including grain legumes, using nitrogen based fertilisers, No-Till, Precision Agriculture (PA) and Controlled Traffic (CT).

The journey into PA started in 1997 with the purchase of a yield monitor but PA was not widely adopted until 2006 after Mark completed a Nuffield Scholarship on PA and Conservation Agriculture. After the purchase of new sowing equipment in 2002 No-Till was widely adopted even though it was introduced on some crops 20 years earlier. With the purchase of a RTK (2cm) autosteer system in 2004 CT was introduced and mostly the same CT lines are used today.

The PA on the Branson Farms includes a full Variable Rate (VR) program for Phosphorus and Nitrogen fertilisers, Seeding Rate and some Chemical applications.

A recent purchase of a Phantom 4 Drone has enabled the Branson's to map weeds, look at crop health from above and is researching further its potential benefits.

The Branson Farm is now one of the leading farms in Australia in the adoption of new cropping technologies into the farming system. Mark suggests that the secret to using technology is it must be used to fix problems, not purchased because it is the latest gadget. There is a toolbox of PA technologies out there, if one of them will be used to fix a problem at a good profit, then it will be a good buy, if not, don't purchase and leave it in the toolbox.

After 12 years into CT and 10 years into full PA, the system has bedded in and economic patterns have emerged. This economic study includes looking into improvements in crop yields using increasing crop Water Use Efficiency (WUE), management, and input usage prior to 2004 where underlying patterns have been calculated This is compared to after 2004 where No-Till, CT, and PA have been widely adopted and gains in the economics of the farm have been calculated through the adoption of these new technologies in the farming system.

A summary of the economics:

| | | | |
|---|---|---|---|
| Savings/Year | Yield Gains/Ha | $7.87/Ha | |
| | Input Overlap Savings | $7.24/Ha | |
| | PA SavingsPhosphorus | $16/Ha | |
| | Nitrogen | $33.78/Ha | |
| | Gypsum/Lime | $4.36/Ha | |
| | | ***Total Savings*** | ***$69.25/Ha*** |
| Expenses/Year | Machinery Purchases | $11.11/Ha | |
| | RTK GPS Signal | $0.17/Ha | |
| | Data Management | $1/Ha | |
| | | ***Total Expenses*** | ***$12.28/Ha*** |
| **Estimated Annual Benefit from CT and PA** | | | **$56.97/Ha** |

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# POST-EMERGENT WEED CONTROL OPTIONS IN VETCH

**George Pedler,** George Pedler Ag and **Ed Hunt,** Ed Hunt Consulting

*Location: Ungarra – Terry Young's*

**Take home messages**

- **Broadleaf weeds compete very well with vetch and can cause significant yield loss**
- **2,4D-B stand alone <u>or</u> in a mix with Diflufenican gives effective broadleaf weed control**

**Why do the trial?**

Vetch has limited registered post-emergent broadleaf weed control options. There are some herbicides pending registration and we wanted to have a look at these and other possible options for weed control and its subsequent effect on crop yield.

**How was it done?**

A suitable Capello Vetch paddock was located by Terry Young at Ungarra and had a weed spectrum including capeweed, mustard, wild turnip, mallow and sow thistle.

The crop was sprayed on the 31st of July, with three replicates of each herbicide treatment.

*Table 1. Spray application details*

| | |
|---|---|
| Spray Equipment | Airmix 01 @ 2.5 Bar = 96L/ha |
| Temperature | 11-13$^0$ |
| Humidity | 82% |
| Wind | NNW 9-12km/hr |
| Cloud Cover | 10-20% |

**Results & Discussion**

Weed control scores were taken 25 days after application and again at 85daa.

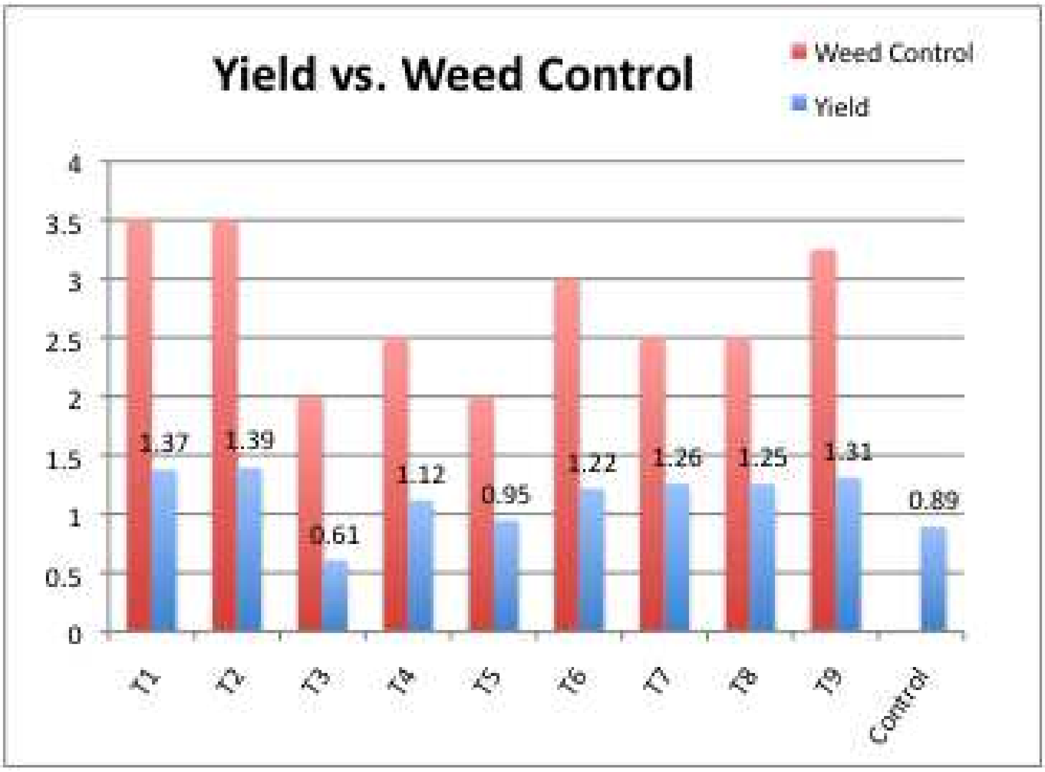
*Table 2: Herbicide Treatments and their two timing weed control scores from 0-5, where 5 is excellent control*

| | Product | Rate | Adjuvant | Rate | 25daa | 85daa | Comments |
|---|---|---|---|---|---|---|---|
| **T1** | 2,4D-B + | 500 | | | 2.5 | 3.5 | Reduced height/bulk. Poor on Milk Thistle |
| | Brodal | 50 | | | | | |
| **T2** | 2,4D-B | 1000 | | | 3 | 3.5 | **Best Control |
| **T3** | Broadstrike | 25 | BS1000 | 0.2% | 3.5 | 2 | Turnips & sow thistle got through |
| **T4** | Ecopar | 600 | BS1000 | 0.2% | 2.5 | 2.5 | Turnip & Mustard average control |
| **T5** | Ecopar + | 600 | BS1000 | 0.2% | 4 | 2 | Reduced height. Turnip better then T4 |
| | MCPA | 50 | | | | | |
| **T6** | LVE570 + | 25 | BS1000 | 0.1% | 3 | 3 | Turnip poor |
| | Brodal | 50 | | | | | |
| **T7** | ImazaMOX | 45 | BS1000 | 0.2% | 2.5 | 2.5 | Turnip & Mustard average control |
| **T8** | ImazaMOX | 60 | BS1000 | 0.2% | 3 | 2.5 | Turnip & Mustard average control |
| **T9** | 2,4D-B + | 500 | BS1000 | 0.2% | 3 | 3.25 | Mustard got through |
| | Brodal + | 50 | | | | | |
| | Bluespear (5:10:30) | 1000 | | | | | |

Scores at 25daa showed that Ecopar + MCPA (4) and Broadstrike (3.5) showed the greatest early signs of weed control. This was especially interesting as these two treatments turned out to be the weakest control when assessed again at 85daa. All other treatments showed good weed control at this early assessment timing other than T7:Imazamox and T4:Ecopar alone.

These scores show that Treatment 1 & 2 have the highest level of weed control, closely followed by T9, all of which contain 2,4D-B in the herbicide mix. Diflufenican was added as a mixing partner with the lower rate of 2,4D-B to see if a more economical option could give similar weed control results, which these results show it does.

*Figure 1: Yield (t/ha) vs Weed Control on a scale of 0-5 where 5=excellent weed control*




The relationship between weed control and yield is quite obvious looking at the trend in the above graph, with the control yield, where no weed control was applied, backing this trend up. The Broadstrike is the only treatment to have given a reduction in yield in comparison to the control, suggesting that crop safety may not be good enough for use on Capello vetch.

**Acknowledgements**

Terry Young for the location and for trial input and LEADA for their contribution to the project.

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ED HUNT CONSULTING

# EVALUATING PRE-HARVEST APPLICATION OF WEEDMASTER DST IN CANOLA ON THE LOWER EYRE PENINSULA

**George Pedler,** George Pedler Ag

**Take Home Messages:**

- **Timing and spraying conditions are critical in the level of ryegrass seed-set control achieved**
- **Compromising crop timing and focussing on ryegrass timing should be a priority where grass control is the main outcome target**

**Why do the trial?**

Annual ryegrass resistance to clethodim is rising at an alarming level and with this being the only group A herbicide that provides effective control of ryegrass, it was clear that investigation into alternative weed management strategies was necessary. With the new registration of Weedmaster DST for pre-harvest application in canola it was identified that there was not only a lack of local data on the Lower EP but also poor awareness of the rates and conditions required to gain adequate control of ryegrass seed set.

Following a strategic meeting of LEADA it was determined that a trial looking at different rates of Weedmaster DST, using farmer machinery in real paddock situations, would provide a useful set of local data. This would show local growers first-hand what timing and conditions were required at the same time as what the most cost effective option is for their business. This report looks at both spraying under the windrower as well as a crop topping application.

**How was it done?**

George Pedler Ag was contracted by GRDC and LEADA to conduct the canola harvest management demonstrations and final report. Two paddocks were identified for the demonstration, both of which had higher than average populations of ryegrass, a history of high Clethodim use and were employing the appropriate harvest management tool.

There was a range of treatments with differing rates of Weedmaster DST being the only variable in the trial. The addition of 0.25% LI700 was included with every treatment other than the control, whilst the same water rate, speed and height were maintained across each individual trial area.

**Paddock One**, situated 10km west of Cummins: Crop-topping took place as the ryegrass seed management tool with various rates of Weedmaster DST applied at 25% seed colour change on the $16^{th}$ October using a 30m Twin-Force Hardi Alpha boom. Each treatment had one replicate, consisting of a 30m boom width across the length of the paddock. Ryegrass seed samples were then collected in January, to be analysed for their seed viability. Management details are summarised in Tables 1 & 2 below;

**Table 1: Site history and management details for crop-topping trial in canola at Cummins, 2015.**

| | |
|---|---|
| **Location:** | 10km west of Cummins |
| **Plot Size:** | 925m x 30m Boom Width |
| **Replicates:** | 1 |
| **Soil Type:** | Loamy sand over clay |
| **Sowing Date:** | 27 April 2015 |
| **Harvest Date:** | 11 November |
| **Rotation:** | 2014 - Wheat |
| **Seeding Density:** | 3.5 kg/ha ATR Stingray Canola |
| **Fertiliser:** | Base of 70 N + 16 P/ha applied at sowing<br>70 kg /ha Urea post emergent (102.2 kg/ha of N applied in total) |
| **Pesticides:**<br>**April 27**<br><br>**April 28**<br><br>**June 1** | <br>**Knockdown:** 850g Terbyne Xtreme + 1L Triflur 480 + 600ml Glyphosate 540 + 18ml Nail240<br>**PSPE:** 1kg Simazine + 250ml Chlorpyrifos 500EC + 250ml Alpha Cypermethrin 100EC<br>**Grassfree:** 0.8% Ammonium Sulphate + 0.6kg Atrazine + 250ml Lontrel + 500ml Clethodim + 1% Kwicken + 3 L/ha Stoller Micromix |

**Table 2: Spray application details for the crop-topping trial in canola at Cummins, 2015.**

| **Spray Details** | | | |
|---|---|---|---|
| **Timing:** | 25% Seed colour change | | |
| **Spray Date:** | 16 October | | |
| **Spray Equipment:** | 03 AI nozzle, 100 L/Ha @ 6 Bar | | |
| **Weather conditions:** | | Start | Finish |
| | Time | 9:48am | 11:15am |
| | Temperature | 14.8°C | 16.5°C |
| | Humidity | 82% | 71% |
| | Wind | SSW 13km/hr | SSE 15km/hr |
| | Delta T | 2 | 4 |

**Paddock Two**, situated 10km south-east of Cummins: Herbicide application under the windrower took place as the ryegrass seed management tool. Various rates of Weedmaster DST were applied at 80% seed colour change on the 23rd October using an adapted 12m MacDon front powered by a Miller Nitro. Each treatment had three replicates consisting of a

12m windrower width across the length of the paddock. Ryegrass seed samples were then collected in January, to be analysed for their seed viability. Paddock Two management details are summarised in Tables 3 & 4 below:

**Table 3: Site history and management details for under the windrower topping trial in canola at Cummins, 2015.**

| | |
|---|---|
| **Location:** | 10km east of Cummins |
| **Plot Size:** | 1400m x 12m Windrower Width |
| **Replicates:** | 3 |
| **Soil Type:** | Loam over clay |
| **Sowing Date:** | 26 April 2015 |
| **Harvest Date:** | 14 November |
| **Rotation:** | 2014 - Wheat |
| **Seeding Density:** | 3.15 kg/ha Garnet Canola |
| **Fertiliser:** | 80 kg SOA spread pre-sowing<br>Base of 28 N + 13 P/ha applied at sowing<br>100 kg /ha Urea post emergent (95.6 kg/ha of N applied in total) |
| **Pesticides:** | |
| **April 26** | **Knockdown:** 2L Triallate + 1.5L Triflur 480 + 1.1L Glyphosate 517 + 80ml Oxyfluorfen 240 |
| **April 28** | **PSPE:** 250ml Dual Gold + 250ml Chlorpyrifos 500EC + 250ml Alpha Cypermethrin 100EC |
| **June 1** | **Grassfree:** 1% Ammonium Sulphate + 300ml Lontrel + 500ml Clethodim + 1% Kwicken |

**Table 4: Spray application details for under the windrower topping trial in canola at Cummins, 2015.**

| Spray Details | | | |
|---|---|---|---|
| **Timing:** | 80% Seed colour change | | |
| **Spray Date:** | 23rd October | | |
| **Spray Equipment:** | 01LD nozzle, 70 L/Ha @ 2 Bar | | |
| **Weather conditions:** | | Start | Finish |
| | Time | 12:54pm | 2:50pm |
| | Temperature | 23$^{o}$C | 25$^{o}$C |
| | Humidity | 31% | 26% |
| | Wind | ENE 11km/hr | NNE 7km/hr |
| | Delta T | 8.2 | 9 |

**What happened?**

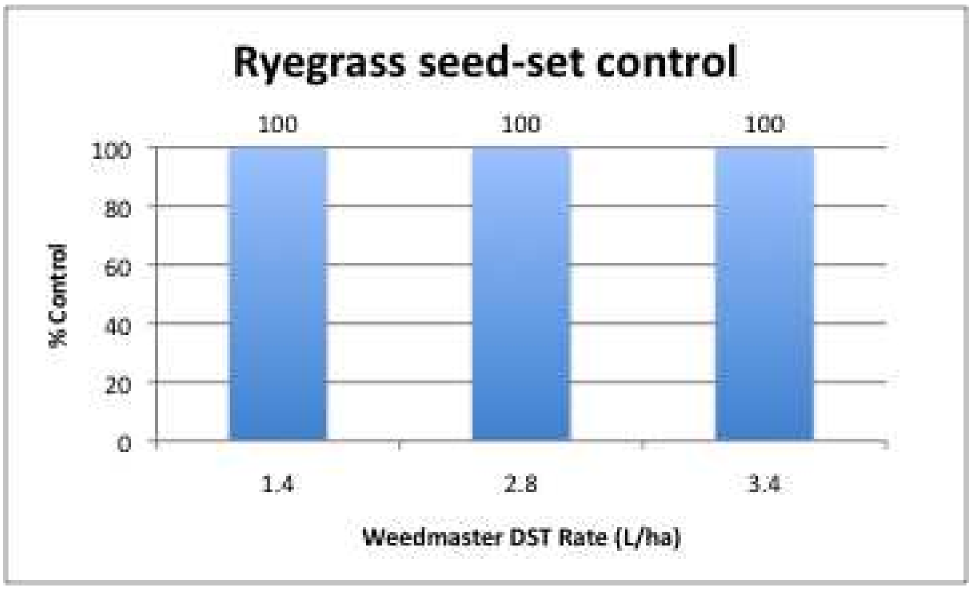
Growing conditions were good throughout the growing season in both paddocks with good yield potentials over 2t/ha, but with two very different crop densities. The Stingray in paddock one was full of pods and stood at only 1.4m tall, whilst the Garnet in paddock two had a large bulky canopy and stood around 1.8m when upright.

Paddock one & two both had very good control of ryegrass with the clethodim grassfree spray, with a further late germination being the main target population pre-harvest in both paddocks. The ryegrass in Paddock Two had a bigger population and the plants were more advanced plants than in Paddock One. The first week of October saw a very warm and windy weather event move through, which matured both of the crops and weeds faster than normal.

**Paddock One – Crop-Topped**

Spraying conditions for paddock one were ideal with a Delta T ranging from just below two at the start of the trial and finishing just under four, providing optimum conditions for plant uptake of the chemical. The weather following this spray application was also quite mild at 22°C the day following, creating good growing conditions for the plant, hence better chemical uptake. At harvest timing there was no noticed damage such as pod shattering or wheel track issues from this crop-topping application.

**Figure 1: Ryegrass seed-set control in Paddock One following the application of Weedmaster DST over the top of a standing Stingray Canola crop.**




**There was only one replicate for this trial, so no error bars or LSD have been recorded*

When seed was collected it was evident at how effective the pre-harvest herbicide application was in controlling the ryegrass with low plant numbers, and even lower seed levels. This effectiveness was confirmed with the ryegrass seed viability tests following the crop-topping application being exceptional, with 100% control across all three treatments where seed was collected.

This excellent result can be attributed to a number of things including the weather conditions at the time of application and the days either side of spraying; the timing of the ryegrass being one week earlier than would be normally applied under the windrower; and thirdly the cultivar being Stingray, which has a squat growth habit and a canopy that is easier to penetrate for crop-topping purposes over most canola varieties.

**Paddock Two – Sprayed under the windrower**
Spraying conditions for paddock two were not ideal with a Delta T ranging from just over eight at the start of the trial and finishing at nine, providing less than optimum conditions for plant uptake of the chemical. The weather following this application was also very warm, at 36$^{o}$C the day immediately after, creating far from ideal growing conditions for the plant.

**Figure 2: Ryegrass seed-set control in Paddock 2 following the application of Weedmaster DST underneath the cutter bar at windrowing of Garnett Canola**

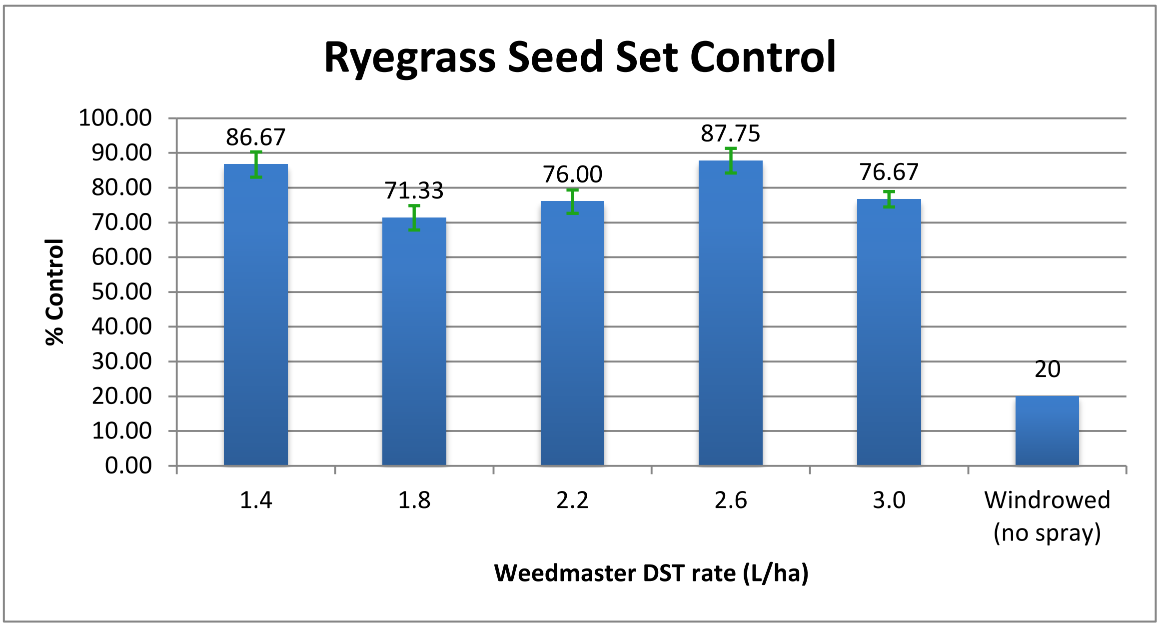



Figure 2 shows the excellent control of ryegrass seed-set with a mean reduction of 75% in seed viability across the range of treatments when applied underneath the windrower cutter bar. With the weather conditions experienced at the beginning of October, as well as the time of application and the day following, these results are very encouraging.

We would have expected some level of dose response with the treatments, with the data in Figure 2 showing the inconsistency to any dose response. With the lowest rate of 1.4L/ha giving us a seed viability reduction in excess of 86%, there is not much space to get this expected dose response.

**Messages from the trial.**

- Collaboratively this trial shows that the earlier timing window provided with an over the top crop-topping application offers additional flexibility for ryegrass control in canola.
- Providing growers have access to a self -propelled boom with sufficient clearance, crop-topping is an extremely effective weed management tool.
- In some situations crop-topping will make direct harvesting a more practical option, as was the case in this trial, where grain moisture was reduced by 0.5% in all treatments over the untreated plot, thus allowing earlier harvest timing.
- Ryegrass control can be significantly impacted when applications are made in adverse conditions. In this trial, the hot drying conditions of the early October weekend accelerated maturity, and when partnered with a poor Delta T at application, reduced control.
- Weather conditions should be considered in union with crop stage for pre-harvest timing.
- Even in adverse seasons and conditions, pre-harvest weed management in canola is still an extremely effective tool, giving highly effective results ranging in weed seed viability reductions from 71.3% up to 100%.

*George Pedler Ag conducted this trial in conjunction with Lower Eyre Agricultural Development Association (LEADA).*

*Many thanks to Scott, Mary-Anne and Ross Mickan; Wigline Spray Contracting; Simon, Brooke, Neil & Joyleen Pedler for their collaboration in conducting the trial; Peter Boutsalis, John Both & Chris Preston for their input with trial setup and analysis of results; And the Plant Science Consulting team for assisting with analysis of samples.*

GeorgePedlerAg INDEPENDENT CONSULTING SERVICES

GRDC Grains Research & Development Corporation

# IMPROVED SNAIL MANAGEMENT ON LOWER EYRE PENINSULA

**Blake Gontar and Michael Nash**, SARDI

## Introduction

Snails continue to be a major production constraint for many growers on the Lower Eyre Peninsula. This constraint has grown in parallel to the adoption of stubble retention, as stubble retention both provides a habitat for snails and also implies a reduction in tillage methods that might otherwise destroy snail populations. As part of the GRDC Stubble Initiative (LEA00002), SARDI, on behalf of LEADA, has undertaken field trials and monitoring to improve standard snail management practice on the LEP.

In 2016, SARDI undertook three trials as part of this program:

1. A replicated field trial evaluating existing cultural and chemical methods for controlling snails;
2. Monitoring snail behavior under changing summer weather conditions using a time-lapse camera and micro weather station;
3. Collection of snails for dissection to determine reproductive life stage.

This program focused on the late summer/early autumn period as we hypothesized that snails may be more active throughout summer on the LEP than previously thought and perhaps more than in non-coastal regions. Summer, late summer and early autumn snail activity (movement & feeding) on LEP may present a better opportunity to kill snails before any sensitive crop emergence. Furthermore, if early season activity also translates to earlier breeding/egg-laying, then management over summer may be critical to running down snail numbers long term, as this will only be achieved if egg-laying is limited.

## Methods

### 1. Field Trial

The field trial comprised replicated strips of (i) tilled stubble/soil, (ii) rolled stubble and (iii) untreated stubble, overlaid (perpendicular) with replicated strips of (a) 1.5 % metaldehyde snail bait (b) 3 % metaldehyde snail bait (c) untreated. Treatment strips were 75 m wide, such that the resulting plots were 75 m x 75 m, with 6 replicated plots for each treatment combination. Bait treatments were applied at different rates (kg/ha) to account for different bait size so that an equal number of baits would be distributed per unit area. This was done to ensure the same probability of interception by snails for each treatment. Bait size was determined prior to experiment and the 1.5 % product applied at 8 kg/ha and the 3 % product applied at 5 kg/ha. Both of these rates could be considered modest for the snail density.

Initial population density for each plot over the 30 ha trial was evaluated on the 17-18$^{th}$ February. For each plot, 10 random samples were counted within 3 m of the center of the plot. Sampling the center 3 x 3 m of each plot was done to ensure that snail mortality for that plot could be attributed to the treatment, with no or limited effect of neighbouring treatments.

Cultural treatments were applied on the 22nd February under optimal conditions with temperatures ranging between 30.5°C and 36.9°C throughout the day and RH remaining below 32%. Stubble rolling was conducted using a 3.4 m wide, 20 t steel ribbed roller towed at 12 km/h while tillage strips were applied with a K-line SpeedTiller (disc plow & cage roller) pulled at 8 km/h.

Bait treatments were applied on the 15th March ahead of a cool, moist weather period. Baits were applied through an air seeder (with tines raised) to ensure even distribution of baits across the trial site.

Post-treatment live/dead snail counts were conducted on the 31st March, having established that the majority of baits had been eaten or degraded. A further round of counts was conducted on the 6th June. Both counts involved taking ten random samples using 0.1 $m^2$ quadrat from the center of each field plot, with the 10 samples bulked and the total number of live/dead snails recorded as a single number.

**2. Snail Activity Monitoring**

A Brinno TLC100 time lapse camera was placed in the same field trial paddock, within one of the UTC replicates. The camera was located approximately 1 m from the ground pointing vertically down. The field of view achieved was approximately 0.5 x 0.5 m. The camera was set to take an image every 60 seconds. The camera was accompanied by an LED light bar connected to a 12 volt battery through a Kemo twilight switch, to allow the camera to take shots at night.

Immediately adjacent the camera, a Hobo micro weather station was also established to closely monitor weather conditions at ground level. The weather station provided data on soil moisture, leaf area wetness and two sets of temperature and relative humidity data – one at ground level and the other approximately 40 cm from the ground (i.e. at upper stubble height).
Analysis of the camera/weather data was undertaken by watching video and rating snail activity for every 15 minute period. A rating system of 0-3 was used were 0 was complete inactivity, 1 was slight movement or emergence from shell, 2 was at least one snail moving for a substantial portion of the period and 3 was multiple snails moving substantially. Activity was then analysed against the micro weather station data using backward and forward linear regression.

### 3. Reproduction Monitoring

Approximately 50 adult snails were collected from a transect along the western end of the field trial in rolled canola stubble each week from the 3rd March until the 12th May. Snails were preserved in an ethanol solution until dissection was possible. A subset of 25 snails were measured (shell diameter) then dissected, with the presence of food in their gut recorded, as well as the length of the albumen gland. The albumen gland of snails is known to enlarge relative to the size of the snail's shell as the snail moves into a reproductive phase (Baker, 2012).

In addition, snail reproductive behavior was monitored visually each week by traversing random transects over all stubble treatments. Behaviour such as movement, eating, mating and egg-laying was recorded.

**Results & Discussion**

**Field Trial**

Initial population density sampling showed considerable variations across the trial site, with a greater density of round snails, as well as conical snails (data not shown), in the north-eastern corner of the trial site.

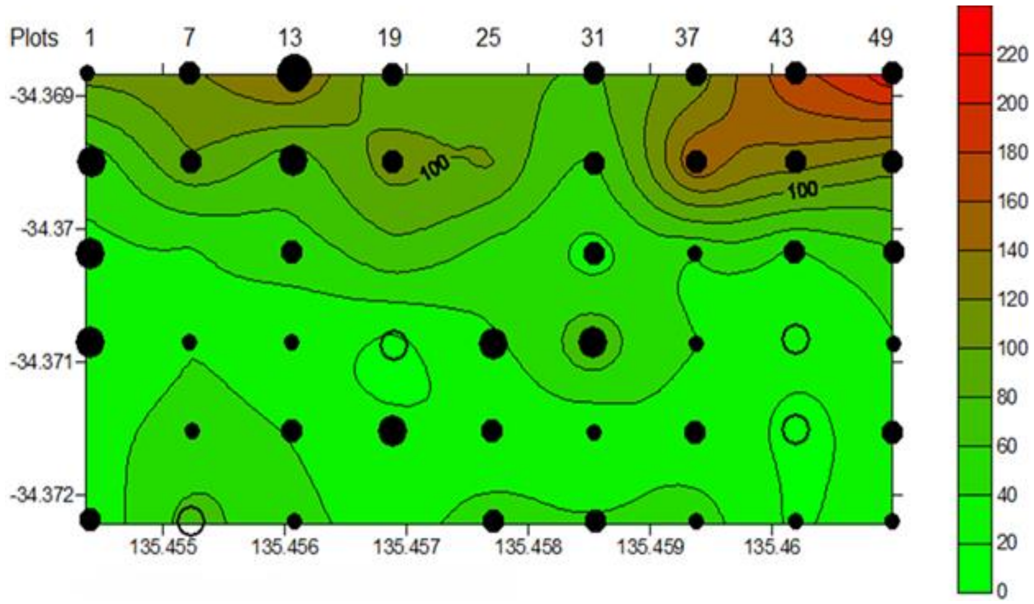



**Figure 1. Initial snail population density at Coulta in February 2016 (scale in no. of snails/m2).**

The effect of cultural controls was highly significant ($P < 0.001$). Population density data from March show that the two cultural control measures reduced the number of adult snails (corrected for initial and natural mortality) when sampled in late March. There was no difference between the two cultural controls.

Overall, bait did not significantly reduce snail numbers from the untreated control ($P = 0.347$). A number of explanations could be possible for this observation. The density of bait distributed was relatively low (5-8 kg/ha) – this was intended to ensure differences between baits would be detectable. However, given the initial density of snails and the overall lack of impact, it seems likely that a greater bait density might be required to detect differences between baited and un-baited treatments. Whilst weeds were generally well controlled during the time baits were present, there may have been an effect from alternative food sources (volunteer canola) within the paddock prior to baiting, with snails possibly having fed sufficiently before baits were applied. Finally, other research being conducted by SARDI suggests there may be a negative correlation between the annual escalation of the reproductive cycle of snails and their feeding i.e. snails may not be receptive to baits when they are in a breeding phase. Since snails at this site were shown to be escalating this cycle as early as late-February, it is possible that snails were more interested in mating during this period than food. This may prove to be a management issue that growers will need to be aware of and one that will be investigated further on the LEP in 2017.

Whilst the interaction of bait and cultural controls was not significant at the 0.05 significance level (P = 0.057), there seems to be some evidence to suggest that cultural controls may further improve baiting efficacy. Observations in the field at the time of post-treatment mortality sampling seemed to suggest a greater number of baits remained 'hidden' in tall standing stubble than where stubble had been tilled or rolled.

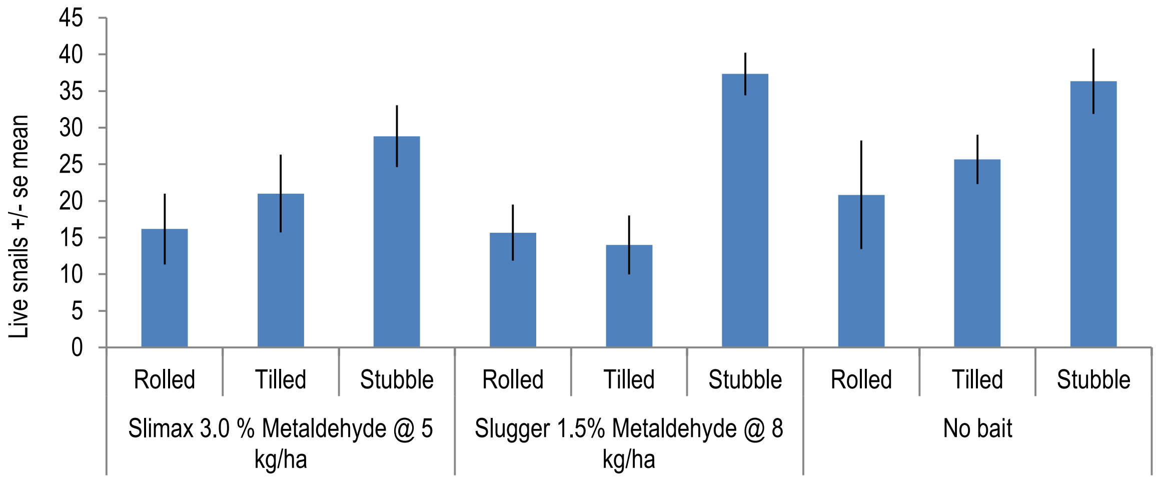



**Figure 2. Total live snails present at sampling following cultural and bait treatments (corrected for natural mortality and initial density) at Coulta in 2016.**

Finally, further population sampling in June demonstrated no treatment effects. This implies that the population dispersed and mixed quite thoroughly in less than 3 months. This accords well with local farmer's reports that snails are able to move and re-infest clean paddock quite rapidly where neighbouring (paddocks, native vegetation, pasture) populations are not controlled.

## Snail Video and Weather Monitoring

The snail video and weather station data gave a good visual insight into snail behaviour with a considerable amount of movement observed throughout late summer and early autumn. Of the environmental data collected, relative humidity (Rh) at upper stubble height (40 cm above ground) proved to be the single most powerful predictor of snail movement (AIC[#] = 860.71). However, the regression model was improved substantially by including all other environmental parameters, except leaf wetness (AIC = 735). Since leaf wetness was ranked as the third most powerful individual predictor (AIC = 1084.9), but dropped from the backward regression model, it is reasonable to assume that leaf wetness is well correlated with other terms in the model, i.e. Rh, temperature and possibly soil moisture. Soil moisture proved to be the least powerful individual predictor of snail movement (AIC = 1694.17). This may be due to the depth of the soil probe (10 cm) far exceeding the depth of influence on normal snail movement i.e. snails may need little more than surface moisture (< 1 cm) to begin moving.

Notably, the time lapse video captured what appeared to be mating on the 12th March, with two snails remaining joined for upwards of an hour. Field observations of mating were further recorded on the 31st March. The time lapse video also captured what appeared to be aborted egg-laying on the 6th April. During this period snails remained static on the ground after day-break for a period of 16 hours (not witnessed at any other time). The video also showed small burrows when the snails depart the next evening. This appears to indicate that snails were physiological ready to lay eggs, but possibly aborted due to insufficient sub-soil moisture. This activity followed a small rainfall event on the 5th April, sufficient to record a slight increase in the soil moisture data. However, this minor rainfall event followed a period of 12 days of no rainfall (0.4 mm on the 24th March) which is likely to mean sub-surface moisture was inadequate for egg-laying despite a recent fall triggering a response.

**Photo 1. Snails possibly observed mating (joined for > 1hr) on the 12th March; Photo 2. A large number of snail remaining on the ground after day-break for entire daylight period. Small burrows were visible when they departed the following evening.**

## Snail Sampling for Reproductive Potential

Snail dissections from the the first sampling time (3rd March) showed an already substantially enlarged albumen gland, suggesting snails had already entered their reproductive phase at this time. Dissections at this time also demonstrated that most snails' guts contained vegetative matter. Field observations of snails actively eating volunteer canola seedlings were made as early as the 17th February. This seems to suggest that snails had eaten, rehydrated from summer and were well into their reproductive phase in March. Continued dissections show albumen gland size reduced in response to a dry period in mid-March, and then slightly increased agin following the 0.4 mm rainfall event on the 23rd March. There was a significant increase in albumen gland size in early-mid February, which aligns with the small 5th April rainfall event, the aborted egg-laying on the 6th April, and the eventual en-masse egg-laying event observed on the 21st April.

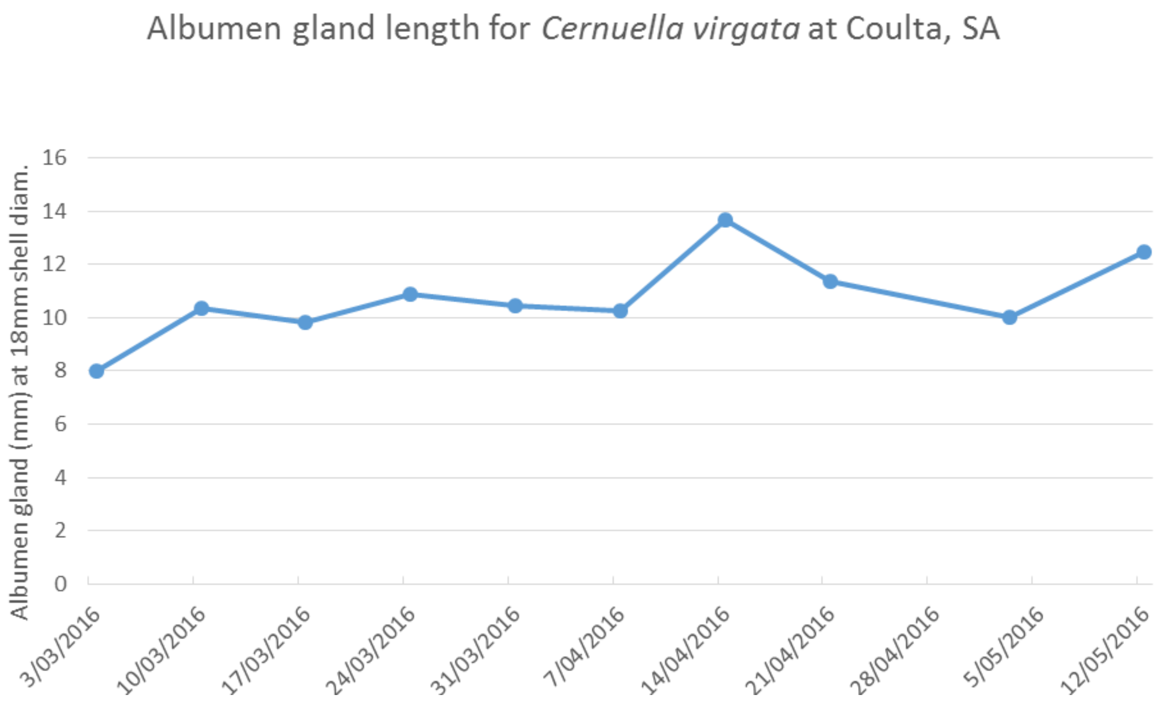



**Figure 3. Albumen gland size variation over time at Coulta in 2016.**

**Conclusions**

The monitoring and trial work undertaken demonstrates a number of important directions for snail management in farming systems on the LEP. Where conditions allow, snails are highly active over summer on the LEP. These conditions may include only high relative humidity (> 80%) overnight, especially where soil moisture is being periodically topped up with summer rains. Perhaps because these conditions allow them to remain mobile and hydrated, snails are feeding throughout summer. Furthermore, hydrated and fed, snails are capable of entering into a reproductive phase in March and may seek to lay eggs as early as 7th April. This date could possibly be earlier in even more favourable years.

Importantly, egg laying in 2016 took place on the 21st April – this date preceded the break of season for most growers, implying that baiting at seeding or after would not have been effective at driving down snail numbers long term. Whilst adult snails would have been reduced in this year, giving the impression of adequate management, the eggs would have hatched and a new cohort of young snails would have entered the crop.

Other (un-replicated, subjective) field observations during this program included the high proportion of adult conical snails to juvenile conical snails in tilled strips post-harvest – suggesting strategic tillage may have potential to influence conical recruitment – and the intermingling of Italian round snails and vineyard round snails in samples taken throughout the season. Observations from the Yorke Peninsula have generally found these two populations to remain separate. The findings from this research, together with the field observations, indicate the snail problem on Eyre Peninsula has some unique properties and may require specific management strategies for best effect.

In 2017, SARDI will undertake further monitoring and bait trial work, looking to detect opportunities to manage snails before egg-laying, with an emphasis on the January-March period. The effect of reproductive potential on bait acceptance will also be investigated.

**Acknowledgements**
Thank you to the Morgan family for providing a site for trial work, maintaining the site and undertaking treatment application operations this was an extraordinary contribution and was greatly appreciated. Thank you to Helen DeGraaf of SARDI Entomology for providing technical advice, conducting dissections and providing data. This work was conducted on behalf of LEADA under the GRDC-funded Stubble Initiative (LEA00002).

**Reference**
Baker, G.H. 2012 *The population dynamics of the Mediterranean snail,* Cernuella virgata *(Da Costa, 1778) (Hygromiidae), in continuous cropping rotations in South Australia*, Journal of Molluscan Studies, 78: 290-296

## ON-THE-GO SOIL PH MAPPING FOR MORE ACCURATE LIME APPLICATIONS

**Andrew Harding and Brett Masters,** PIRSA Rural Solutions SA

Soil acidity is an issue in many of the agricultural soils of the Lower Eyre Peninsula. Strongly acidic soils (pH <5.0 $CaCl_2$) can reduce crop and pasture productivity by reducing the availability of many important nutrients and increasing the availability of toxic elements such as aluminium.

Lime is the most economic and effective way of improving the soil pH. The amount of lime required for a paddock has usually been calculated from a single soil test, and then lime applied at a uniform rate across the paddock. In some cases soil samples have been taken in a grid pattern across the paddock to improve the effectiveness of lime application, however this method is time consuming and can be expensive.

Inherent variability within paddocks means that soil pH can vary significantly over a distance of as little as a few metres. Therefore applying lime as a uniform rate many areas can be un-limed or in some cases the soil may be over-limed.

Soil pH mapping uses new innovative technology to measure and map spatial variability of soil pH within paddocks. This enables pH zones to be identified and lime to be applied only in those areas that require it. This can improve the effectiveness and reduce the costs of lime applications to address low soil pH.

The Veris MSP-3 machine automatically samples the soil, taking a soil pH reading 'on-the-go', approximately every 25 metres along a sampling transect and georeferencing sampling locations, as it is driven across the paddock. At a distance of 36 metres between sampling transects the machine samples approximately 10 points per hectare. Approximately 150 to 200 hectares can be mapped per day. The soil pH data is then processed through *Farmworks* to generate a soil pH map and a lime prescription map.

The machine has been validated in a controlled environment and in the field and has been found to be highly correlated with laboratory data.

In 2016, a pH machine was used as part of the Natural Resources Eyre Peninsula (NREP) '*Farming acid soils champions for cost effective management of low soil pH on Lower Eyre Peninsula*' project supported by LEADA and the Cockaleechie Landcare Group, funded by the Department of Environment, Water and Natural Resources (DEWNR) and the Australian Government's National Landcare Program.

In total more than 1,080 hectares were mapped. Soil pH mapping revealed large variations in pH within paddocks on many Lower Eyre Peninsula paddocks. The mapping revealed that 64%

of the area mapped was below the target pH of 5.5 ($CaCl_2$) and with 33% below the pH 5.0 ($CaCl_2$).

The potential cost savings by only spreading lime where it is required and taking into account the mapping, lime freight and application the cost savings were $2,242 per paddock (41% of the cost of lime applications). The highest potential cost savings were on those paddocks with a high degree of variability, particularly those with a large proportion of neutral to alkaline soils.
The use of soil pH machines not only helps to identify pH zones within the paddock and enables more accurate targeting of lime applications but it can also help to save costs. More even soil pH conditions over the paddock results in an overall improvement in crop and pasture productivity.


A Veris MSP-3 soil pH and EC mapper, owned by Primary Industries and Regions SA (PIRSA) (Figure 1) will be used this year to map about 1,700 hectares under NREP and LEADA projects. This machine, with an experienced operator from PIRSA Rural Solutions SA, is available for hire to measure and map the spatial variation of pH and EC on your farm.

Three new Excel based tools designed to help landholders decide how to best tackle soil acidity on their properties were demonstrated during 'Farming Acid Soils Champions' workshops.

The tools, developed by PIRSA consultants, will provide farmers and consultants with ways to compare the cost of liming using different lime sources (Lime Cheque), calculate the rate of lime required to counteract acidification resulting from agricultural practices on a paddock (Lime Maintenance Rate Calculator), and estimate the cost of lost production in a paddock over time as a result of soil acidity (Acid$Cost). Funding to produce these tools was provided by DEWNR, the Australian Government and the Grains Research and Development Corporation (GRDC).

The Excel tools are available for download from the Ag Excellence Alliance website (http://agex.org.au/project/soil-acidity/). This page also hosts a range of resources regarding management of soil acidity in South Australia. For more information on the tools, or the pH mapper please contact Andrew Harding at the PIRSA Clare Office on 08 8842 6231, Mob: 0417 886 835 or e-mail andrew.harding@sa.gov.au.

# SUCCESSFUL FAMILY BUSINESS SUCCESSION STRATEGIES

**Rosemary Bartle,** Succession Planning Facilitator, Rabobank

Passing on the family farm to the next generation is a challenge. Often farmers do not address the issues of succession with enthusiasm or with thought to timeliness for some of the following reasons:

- There are equity and viability issues associated with handing management and assets to the next generation and maintaining the family business.
- There are difficulties associated with operating at the family/business interface. For example; agreement on roles, responsibilities, goal setting and decision making can be fertile ground for conflict.
- It can be difficult to realistically assess the risks associated with asset transfer, i.e. divorce and will contestation.
- There are often both financial and emotional aspects of retirement to consider.
- There are usually complexities associated with providing defined career paths, adequate remuneration and housing for the younger generation.
- There can be problems with the transfer of management and leadership, and "fear of losing control".
- There can be a range of tax implications involved with succession planning, with changes in legislation over time causing confusion.

The issues surrounding succession planning are complex. There is always emotional investment to consider as well as financial and associated business investment. It is important to realise that each family member's needs and therefore solutions to the above problems will be different.

**What are the implications of not addressing succession issues?**

- *Lack of direction and uncertainty for the younger generation* – this will have implications for the motivation and employment longevity of individuals involved in the business.
- *Lost opportunities* – missing the opportunity to harness the enthusiasm of youth, planning for off-farm investment to pay out/provide for off-farm siblings, building superannuation.
- *Relationship deterioration* – occurs as conflict builds due to lack of communication and planning.
- *Lack of planning* - will ultimately have an impact on farm productivity and therefore the ability of the business to continue into the next generation.

**What have families done to achieve a successful succession to the next generation?**

- *They are proactive* – they start communicating and planning early, aiming to be in control of their future, and involving all family members.
- *They make sure that all stakeholders hear the same conversation at the same time in the same place*, ensuring that the flow of information is equal. All family members are involved in formulating the succession plan.
- *They ensure the goals and aspirations of each individual are fully explored*, allowing for areas of misalignment to be investigated.
- *They make sure that all family members understand the financial reality of the business*.
- *They understand that reaching agreements on business goals, roles and responsibilities is important.*
- *They are not afraid of seeking outside help* – they acknowledge that they can't do it all themselves and realise the benefits of accessing outside expertise rather than focusing on the cost this may involve.
- *They understand that the process is both lengthy and complex*, which requires energy, commitment and perseverance.
- *They understand that succession planning involves change.* Everyone will feel comfortable with different rates of change, hence the process may stop and start over time and at varying times family members may feel frustrated or fearful.
- *They make plans that are driven by needs and goals,* rather than by tax minimisation or the fear of possible divorce.
- *They make plans that are flexible.*
- *They review plans frequently,* and are aware and accepting of the differing perspectives, and strengths and weaknesses of all family members.
- *They allow risk taking on an incremental basis.*
- *They allow the younger generation to spread their wings.* They encourage the younger generation to pursue education and experience outside the family business.
- *They are open* – they submit their business performance to outside scrutiny and are business focused. They compensate contributors to the business at market rates and understand the difference between business and emotional returns.

**What is possible if succession is addressed, and addressed early?**

- Realistic expectations and outcomes can be communicated between the generations to help in decision making.
- Off farm investment strategies and retirement planning can be implemented.
- All family members have helped build the plan so they are more likely to feel they own the plan and are less likely to contest it.
- Tax implications can be addressed and addressed early.
- Careers can be developed and compensation packages thoughtfully devised.
- Risks can be quantified, assessed and strategies put in place to mitigate them.

- Family relationships can be maintained and the business given every opportunity to prosper.
- The complexity of the process is addressed and more easily understood and dealt with over time.

*In conclusion, farmers who want to minimise the risk of underperforming businesses and who want to be in control of the future of the business, start the succession planning journey early. They understand it is difficult to do on their own and they realise the importance of harnessing the power of the whole family to ensure that continuity of the business is achieved.*

**Take home messages:**

- Start succession plan early and review the plan often.
- Formulating a plan is not easy and there are many layers of complexity.
- A number of professionals will need to be accessed for their expertise.
- Working in a multigenerational family business offers enormous opportunities but the family must realise that if the business is to continue, the participants must be objective and business focused.
- Decision making at the business and succession level must be formalised, employ processes that foster clear communication and involve all family members who are directly and indirectly affected by decision making.

Rabobank

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# NVT Variety Trial Results

**SA Barley variety yield performance -** 2016 and long term (2012-2016) expressed as t/ha and % of site average yield

| Variety | Mid and Lower Eyre Peninsula | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 (as % site average) | | | Long term yield brackets (12-16) | | | | | | | |
| | Wanilla | Wharminda | Cummins | No. Trials | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6.5 |
| Alestar | 103 | 97 | 103 | 11 | 94 | 95 | 96 | 98 | 101 | 103 | 104 |
| Bass | 100 | 107 | 100 | 13 | 98 | 100 | 106 | 99 | 97 | 93 | 103 |
| Buloke | - | - | 110 | 11 | 101 | 101 | 100 | 99 | 98 | 96 | 98 |
| Commander | 104 | 101 | 97 | 13 | 103 | 99 | 99 | 101 | 100 | 100 | 94 |
| Compass | 105 | 105 | 90 | 13 | 120 | 119 | 108 | 109 | 104 | 105 | 92 |
| Fathom | 108 | 108 | 102 | 13 | 113 | 114 | 115 | 109 | 103 | 100 | 101 |
| Fleet | 109 | 105 | 93 | 13 | 108 | 104 | 103 | 103 | 100 | 98 | 91 |
| Flinders | 104 | 97 | 96 | 13 | 95 | 96 | 96 | 95 | 96 | 95 | 99 |
| Gairdner | 80 | 83 | 85 | 13 | 92 | 89 | 84 | 89 | 92 | 92 | 88 |
| Granger | 94 | 88 | 103 | 13 | 96 | 97 | 98 | 99 | 100 | 100 | 102 |
| Hindmarsh | 98 | 108 | 100 | 13 | 114 | 117 | 111 | 106 | 102 | 99 | 100 |
| Keel | 94 | 100 | 94 | 13 | 111 | 111 | 109 | 103 | 98 | 94 | 95 |
| La Trobe | 96 | 112 | 102 | 13 | 113 | 116 | 112 | 107 | 103 | 101 | 102 |
| Maltstar | 106 | 109 | 109 | 11 | 92 | 92 | 99 | 100 | 102 | 103 | 107 |
| Maritime | - | - | - | 7 | 101 | 99 | 93 | 95 | 94 | 93 | 89 |
| Oxford | 106 | 102 | 104 | 13 | 86 | 87 | 98 | 97 | 100 | 100 | 109 |
| Rosalind | 109 | 102 | 111 | 9 | 117 | 121 | 116 | 114 | 111 | 113 | 109 |
| Scope CL | 91 | 88 | 91 | 13 | 101 | 100 | 97 | 98 | 97 | 96 | 95 |
| Spartacus CL | 101 | 120 | 103 | 9 | 115 | 119 | 115 | 108 | 103 | 100 | 103 |
| Westminster | 91 | 89 | 97 | 13 | 84 | 83 | 87 | 90 | 95 | 96 | 99 |
| **Site av. yield (t/ha)** | **4.41** | **3.95** | **6.50** | | **2.66** | **3.29** | **3.73** | **4.34** | **4.74** | **5.2** | **6.49** |
| ***LSD % (P=0.05)*** | *7* | *8* | *7* | *No. Trials* | **1** | **2** | **3** | **3** | **2** | **1** | **1** |
| **Sowing date** | 19-May-16 | 10-May-16 | 19-May-16 | | | | | | | | |
| **Soil type** | LS | LS | L | | | | | | | | |
| **J-M/A-O rain (mm)** | 108/480 | 93/338 | 83/404 | | | | | | | | |
| **pH (water)** | 5.4 | 6 | 8.6 | | | | | | | | |
| **Previous crop** | Lupin | gf Pasture | Canola | | | | | | | | |
| **Site stresses** | | | | | | | | | | | |

**Abbreviations**
Soil type: S=sand, L=loam
***Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2012-2016)***
***Data analysis by GRDC funded National Statistics Group***

**SA Wheat variety yield performance -** 2016 and long term (2012-2016) expressed as t/ha and % of site average yield

| Variety | Mid and Lower Eyre Peninsula | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 (as % site average) | | | Long term yield brackets (12-16) | | | | | | | | |
| | Cummins | Rudall | Wanilla | No Trials | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 |
| AGT Katana | 95 | 99 | 99 | 16 | 105 | 100 | 104 | 102 | 101 | 98 | 97 | 99 |
| Axe | 87 | 82 | 79 | 16 | 100 | 83 | 99 | 93 | 94 | 91 | 86 | 90 |
| Beckom | 108 | 113 | 117 | 13 | 109 | 116 | 108 | 112 | 108 | 105 | 108 | 108 |
| Chief CL Plus | 99 | 96 | 104 | 6 | 109 | 120 | 107 | 103 | 102 | 104 | 109 | 98 |
| Cobra | 111 | 107 | 114 | 16 | 102 | 112 | 106 | 107 | 107 | 107 | 111 | 108 |
| Corack | 104 | 94 | 113 | 16 | 113 | 113 | 116 | 104 | 109 | 103 | 106 | 102 |
| Cosmick | 102 | 96 | 115 | 13 | 106 | 111 | 106 | 108 | 107 | 104 | 106 | 107 |
| Cutlass | 102 | 107 | 97 | 7 | 96 | 102 | 97 | 99 | 101 | 104 | 103 | 105 |
| DS Darwin | 95 | 91 | 77 | 12 | 97 | 94 | 98 | 97 | 98 | 98 | 98 | 98 |
| DS Pascal | 99 | 88 | 87 | 3 | 83 | 82 | 85 | 94 | 93 | 98 | 96 | 101 |
| Emu Rock | 95 | 105 | 107 | 16 | 110 | 100 | 108 | 106 | 103 | 96 | 96 | 99 |
| Estoc | 90 | 107 | 93 | 16 | 97 | 99 | 97 | 98 | 99 | 101 | 100 | 100 |
| Gladius | 99 | 94 | 95 | 16 | 99 | 93 | 98 | 98 | 97 | 97 | 94 | 97 |
| Grenade CL Plus | 96 | 93 | 91 | 16 | 99 | 90 | 97 | 96 | 96 | 95 | 92 | 94 |
| Hatchet CL Plus | 95 | 102 | 100 | 16 | 101 | 86 | 100 | 96 | 96 | 92 | 89 | 93 |
| Kord CL Plus | 94 | 95 | 83 | 13 | 99 | 90 | 97 | 94 | 95 | 94 | 91 | 93 |
| LRPB Arrow | 108 | 111 | 115 | 7 | 111 | 122 | 111 | 110 | 109 | 107 | 112 | 106 |
| Mace | 104 | 101 | 105 | 16 | 112 | 113 | 113 | 105 | 107 | 102 | 105 | 102 |
| Scepter | 111 | 112 | 112 | 7 | 116 | 122 | 116 | 114 | 112 | 106 | 110 | 108 |
| Scout | 115 | 109 | 115 | 16 | 99 | 101 | 100 | 106 | 103 | 102 | 102 | 106 |
| Shield | 92 | 110 | 106 | 16 | 105 | 100 | 99 | 105 | 97 | 96 | 94 | 97 |
| Tenfour | - | - | - | 3 | 114 | 118 | 119 | 112 | 115 | 107 | 112 | 110 |
| Trojan | 114 | 106 | 87 | 16 | 100 | 113 | 105 | 105 | 110 | 110 | 113 | 112 |
| Wyalkatchem | 97 | 107 | 106 | 16 | 106 | 112 | 106 | 104 | 103 | 103 | 106 | 101 |
| Yitpi | 99 | 99 | 82 | 12 | 91 | 90 | 90 | 92 | 94 | 98 | 95 | 97 |
| **Site av. yield (t/ha)** | **5.85** | **3.96** | **3.97** | | **2.39** | **2.51** | **3.18** | **3.93** | **4.19** | **4.71** | **5.34** | **5.83** |
| ***LSD % (P=0.05)*** | *6* | *9* | *7* | *No Trials* | 2 | 1 | 3 | 3 | 4 | 1 | 1 | 1 |

| | | | |
|---|---|---|---|
| **Date sown** | 19-May-16 | 17-May-16 | 17-May-16 |
| **Soil type** | L | LSL | LS |
| **J-M/A-O rain (mm)** | 83/404 | 61/312 | 108/480 |
| **pH (water)** | 8.6 | 7.4 | 5.4 |
| **Previous crop** | Canola | gf Pasture | Lupin |
| **Site stresses** | | | |

**Abbreviations**
Soil type: S=sand, L=loam
***Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2012-2016)***
***Data analysis by GRDC funded National Statistics Group***

**Eyre Peninsula canola variety trial yield performance -** 2016 and predicted regional performance, expressed as % of site average yield

| Variety | LOWER EP | | | | | UPPER EP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 | Long term yield brackets (12-16) | | | | 2016 | | Long term yield brackets (12-16) | | | | |
| | Yeelanna | No Trials | 2.0 | 2.5 | 3.0 | Lock | Minnipa | No Trials | 1.0 | 1.5 | 2.0 | |
| AV Garnet | 96 | 9 | 99 | 105 | 109 | 94 | **No Trial** | 10 | 74 | 92 | 98 | Conventional |
| Nuseed Diamond | 101 | 8 | 117 | 104 | 119 | 110 | | 7 | 247 | 152 | 120 | |
| Victory V3002 | 77 | 7 | 102 | 105 | 96 | 85 | | 5 | 149 | 118 | 105 | |
| Site av yield (t/ha) | 2.83 | *No* | **1.71** | **2.10** | **2.64** | 1.54 | | *No* | **0.77** | **1.33** | **1.68** | |
| *LSD % (P=0.05)* | *12* | *Trials* | *5* | *3* | *1* | *6* | | *Trials* | 2 | 2 | 1 | |
| Banker CL | 117 | 3 | 112 | 118 | 134 | 105 | 112 | 4 | 100 | 115 | 118 | Clearfield Tolerant |
| Hyola 474CL | - | 6 | 100 | 100 | 107 | 93 | 92 | 8 | 103 | 107 | 108 | |
| Hyola 575CL | 81 | 7 | 99 | 99 | 103 | 90 | 89 | 6 | 101 | 105 | 106 | |
| Hyola 577CL | 92 | 5 | 100 | 107 | 120 | - | - | 0 | 91 | 104 | 104 | |
| Pioneer 44Y89 (CL) | 85 | 4 | 107 | 101 | 109 | 96 | 94 | 6 | 117 | 113 | 109 | |
| Pioneer 44Y90 (CL) | 111 | 3 | 117 | 121 | 134 | 101 | 101 | 4 | 127 | 124 | 116 | |
| Pioneer 45Y88 (CL) | 102 | 6 | 104 | 111 | 120 | - | - | 1 | 82 | 96 | 98 | |
| Pioneer 45Y91 (CL) | 105 | 1 | 110 | 118 | 122 | - | - | 0 | 102 | 102 | 101 | |
| Site av yield (t/ha) | 2.73 | *No* | **1.71** | **2.1** | **2.64** | 1.76 | 1.11 | *No* | **0.77** | **1.22** | **1.66** | |
| *LSD % (P=0.05)* | *12* | *Trials* | *5* | *3* | *1* | *5* | *9* | *Trials* | *2* | *3* | *3* | |
| ATR Bonito | 99 | 7 | 97 | 99 | 101 | 96 | Trial Abandoned - poor establishment | 8 | 92 | 94 | 99 | Triazine Tolerant |
| ATR Gem | 95 | 9 | 93 | 98 | 99 | - | | 2 | 87 | 91 | 96 | |
| ATR Mako | 76 | 5 | 98 | 98 | 96 | - | | 0 | 95 | 97 | 99 | |
| ATR Stingray | - | 6 | 95 | 89 | 112 | 103 | | 8 | 92 | 97 | 104 | |
| ATR Wahoo | 99 | 9 | 91 | 102 | 105 | - | | 0 | 77 | 85 | 92 | |
| DG 560TT | 102 | 1 | 103 | 100 | 100 | - | | 0 | 108 | 104 | 101 | |
| Hyola 450TT | - | 6 | 99 | 95 | 95 | 93 | | 7 | 102 | 104 | 99 | |
| Hyola 559TT | 106 | 7 | 105 | 103 | 105 | 102 | | 8 | 106 | 109 | 106 | |
| Hyola 650TT | 99 | 6 | 100 | 103 | 111 | - | | 0 | 97 | 102 | 100 | |
| InVigor T 4510 | - | 0 | 107 | 112 | 127 | 103 | | 2 | 113 | 112 | 109 | |
| Pioneer 44T02 TT | | 2 | 106 | 99 | 104 | | | 4 | 114 | 112 | 107 | |
| Pioneer 45T01 TT | - | 3 | 100 | 101 | 99 | 103 | | 2 | 103 | 101 | 96 | |
| Site av yield (t/ha) | 2.46 | *No* | **1.71** | **2.1** | **2.64** | 1.70 | | *No* | 0.77 | 1.22 | 1.66 | |
| *LSD % (P=0.05)* | *14* | *Trials* | *5* | *3* | *1* | *6* | | *Trials* | 2 | 3 | 3 | |
| Date sown | 04-May | | | | | 12-May | 10-May | | | | | |
| Soil type | CL | | | | | LSL | LSL | | | | | |
| pH (water) | 8.2 | | | | | 8.3 | 8.7 | | | | | |
| J-M/A-O rain (mm) | 71/449 | | | | | 42/288 | 63/260 | | | | | |
| Site stress factors | | | | | | | | | | | | |

**Soil type:** S=sand, C=clay, L=loam

***Data source: SARDI/GRDC, NVT and District Canola Trials. 2011-2016 MET data analysis by National Statistics Program.***

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# MEMBERSHIP SUBSCRIPTION

## 2017

## TAX INVOICE

*ABN 560 012 353 569*

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*Lower Eyre Agricultural Development Association Inc (LEADA)*
*PO Box 1197*
*Port Lincoln SA 5606*

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| *Business Name* | |
| *Mailing Address* | |
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| *Contact Person* | |
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