MacKillop Farm Management Group

"Maintaining profitable farming systems with retained stubble in the South-East and KI regions"

GRDC Project Code: MFM00006

Project Duration: 2013 - 2018

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Abstract

The GRDC funded project “Maintaining profitable farming systems with retained stubble in the South-East and KI regions” aimed to produce localised guidelines to allow those farmers who want to retain stubble to do so in a manner that is profitable.

Stubble retention across the South-East (SE) and Kangaroo Island (KI) regions of South Australia (SA) often presents challenges due to the high stubble loads that are often generated and the diversity of farm businesses.

Key challenges in retained stubble systems that were identified by growers were weeds, pests, disease and nutrition, along with the physical aspects of managing stubble at harvest, during the fallow period, at seeding and in-crop.

A combination of small plot trials, farmer scale trials and demonstrations, and extension activities were held over the five years to provide farmers with both the knowledge and practical skills to enable them to implement some of the strategies required to improve the level of management in retained stubble systems on their farms.

This work, combined with research collaboration and support has culminated in the production of ten guidelines each addressing different aspects of stubble management that were seen as challenges to retaining stubble systems in the SE and KI regions of SA.

Executive Summary

The project "Maintaining profitable farming systems with retained stubble in the SE and KI regions" was instigated to address key identified issues in retained stubble systems across the regions and to explore ways to try and resolve or minimise the impacts of these issues in a profitable manner.

Conservation farming has been widely adopted across the SA/Vic Bordertown Wimmera AEZ with the majority of crops across the regions being sown in one pass. Although conservation tillage equipment has been widely adopted in the MFMG and AgKI areas, it is not believed that these areas have the level of adoption of stubble retention reflected in the GRDC 2012 Farm Practices survey. The SE and KI regions are comprised of mixed farming systems and as a result the stubbles (often greater than six tonnes per hectare) are generally grazed by livestock. The management of such stubble loads then poses significant issues during seeding the following year with machinery unable to pass through and poor establishment issues often resulting.

Key local issues arising with stubble retention include crop establishment, nutrient management, weed control, disease control and pest management (snails being the major issue with slugs, millipedes and earwigs also being an issue in some areas). These issues can have a huge impact on production and farm profitability. When these issues arise, growers find that retaining stubble is often difficult to justify and is not the preferred option in local farming systems.

Trial and demonstration programs were developed to look at local topics and issues arising from challenges in stubble retention across the SE and KI regions. The work varied from small plot replicated trials to large farmer scale demonstration activities and locations varied depending on the issue being targeted. This program was developed in conjunction with growers, and protocol development was done in conjunction with SARDI and additional research support from CSIRO and University of Adelaide.

The trial and demonstration programs were supported with extension activities designed to assist growers with the skills and knowledge to implement some of the activities required to maintain profitability in retained stubble systems. Extension activities were often 'hands-on' with growers being shown not only why they should make changes, but showing how they to implement changes in their system for improved outcomes.

There was also the opportunity as part of the Stubble Initiative project to collaborate and add value to other research that was occurring in the region by providing additional monitoring and expanding these trials and demonstrations to allow for increased local outcomes where the topics aligned with the stubble management issues that were being explored as part of the project.

Locally specific guidelines were produced containing local research and development activities addressing individual issues and supporting findings from other research to allow growers to make more informed decisions when managing retained stubble systems.

The project has demonstrated that high levels of stubble can successfully be retained in the system, however there remains certain instances where removal may be required. The grower's ability to deal with issues will depend on both the issue being addressed and the individual farming system. Small changes may be able to be implemented immediately (e.g. improving spray deposition, rotating herbicides or improving bait distribution). Other changes may require new machinery or a large-scale change to the system which may require additional financial resources and may not be as readily achievable.

A key outcome has been the ability to validate farmer practice change; it provided support for the innovators to develop strategies around machinery use, and provided them with knowledge that allowed them to implement change immediately to fine tune their systems and maximise the benefit of the investment. This information was then extended to other growers, providing the early adopters with knowledge required to implement changes.

The benefits of crop rotations in sustainable systems has been demonstrated and the role of break crops in weed and disease management and crop nutrition explored. The need to implement an integrated weed management (IWM) approach, and the importance of soil testing, knowing your soil nitrogen (N) levels and understanding how that information can be used to improve nitrogen management in the system has been demonstrated.

The project has benefited industry by providing a level of environmental stewardship; encouraging and developing practices that will assist in reducing wind and water soil erosion, returning carbon to the soil improving the management of nitrogen in the system.

Throughout the life of the project, there has been a reduction in the total removal of stubble (through burning) with a decrease from 8.5% (2011) to 1.7% (2016). (Source: GRDC Farm Practices Survey Report 2016).

Contents

Background

The uptake of conservation tillage equipment has been high within the regions covered by this project, however traditionally stubbles were burnt due to issues faced by growers in retaining their stubble. It is estimated by the project team that within the project area, of those areas that were continuous/intensive cropping, a maximum of 10% had full stubble retention with no grazing (throughout the whole rotation). Cereal stubbles are generally grazed and then burnt, canola windrows are often burnt, and in some cases the bean stubble is slashed, raked and the whole lot burnt. Beans (faba's and broad) are generally grazed intensively and/or for extended periods due to the high nutritional value (largely attributable to the residual grain). Although growers understand that there are production and natural resource management benefits with retained stubble, the practicalities and constraints to profitability of doing so generally lead them to stubble reduction or removal. While growers appreciate the benefits of stubble retention, they are generally not confident to adopt the system due to a lack of locally validated information accounting for local issues. Such feelings are supported by common statements from growers such as "I know I shouldn't be burning, but I need you to show me how I can make money without lighting a match".

It is estimated that the total region cropped around the Lower South-East region is 77,000 hectares (producing 204,000 tonnes grain). Stubble retention in the Lower SE region is thought to be relatively low compared with the remainder of the SA/Vic Bordertown Wimmera AEZ. The MFMG membership base also extends into the Upper SE to north of Keith and Bordertown. In this region the rate of stubble retention is fairly high; particularly on sandy and loamier soils where the benefits of stubble retention from reduced wind and water erosion are received.

The area cropped on KI is estimated at 18,000 hectares, producing around 38,500 tonnes.

The project has utilised small plot trials and farmer scale demonstrations to provide local data contributing to eight outputs in the "Maintaining profitable farming systems with retained stubble" area as described in the 2012 GRDC Investment Plan. These are the areas that were seen as being barriers to retaining stubbles in a profitable manner by local growers.

With an increase in knowledge and skills, understanding the issues and how to address them in a profitable manner, overall soil health will improve resulting in longer term environmental benefits.

Project Objectives

The following outcomes were expected as a result of this project:

• Crop establishment in farm systems with retained stubble equivalent to systems where stubble is not retained.

• Profitable and sustainable farming system delivered by maximising capture and retention of soil moisture, reducing energy inputs (fuel usage) and minimising nutrient loss (stubble burning and soil erosion).

• Ability to manage weeds, pests and diseases in such a way that they do not unduly affect crop yield and input costs compared to crop systems where stubble is not retained.

• Timely seeding opportunities created by retained soil moisture and absence of significant sowing machinery issues (i.e. blockages, 'hair pinning', etc.).

• Ability to integrate stubble retention in mixed farming systems: ability to accommodate judicious grazing of stubble by livestock within the cropping cycle.

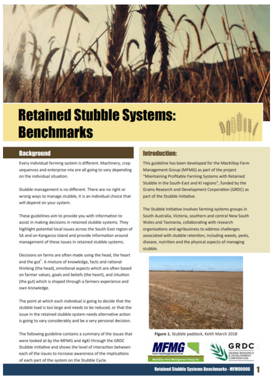
• Strategic use of stubble removal techniques (e.g. stubble baling, grazing, tillage and burning) where the impacts of stubble retention on crop profitability outweigh the long-term benefits of stubble retention in any one year.

Project Guidelines

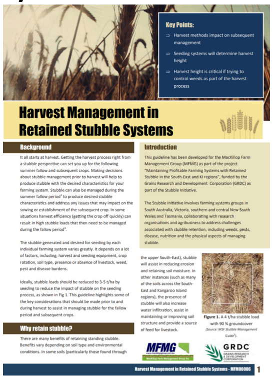
A key output of the GRDC Stubble Initiative was the development of guidelines around local issues that impacted on the retention of stubble. These issues were identified by the MFMG and AgKI management committees and the guidelines developed at the end of the project utilising local results and case studies. The Stubble Initiative book that contains all of the guidelines was also printed and delivered to growers as part of the project.

The guidelines for each topic are listed below. Click on the pictures below to link to the full documents.

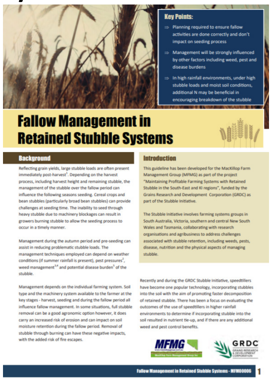
Retained Stubble Systems – Benchmarks



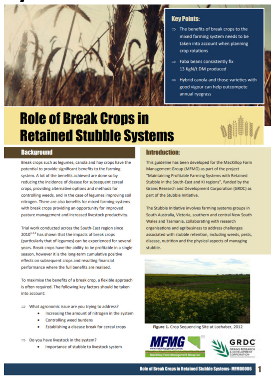
Harvest Management in Retained Stubble Systems



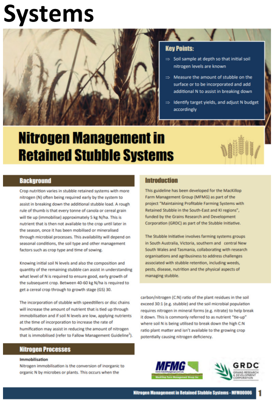
Fallow Management in Retained Stubble Systems



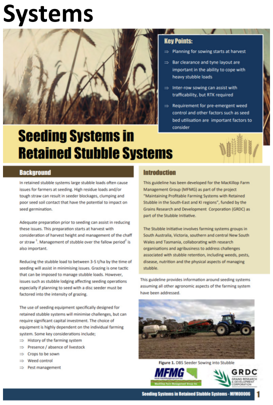
Role of Break Crops in Retained Stubble Systems



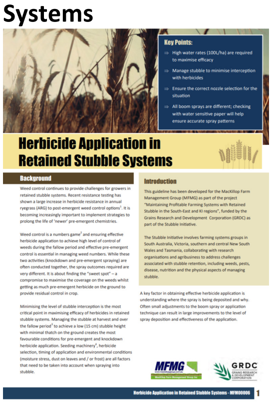
Nitrogen Management in Retained Stubble Systems



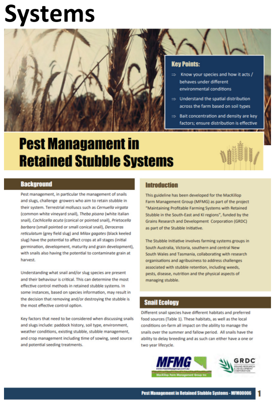
Seeding Systems in Retained Stubble Systems



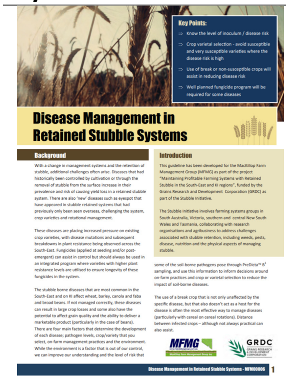
Herbicide Application in Retained Stubble Systems



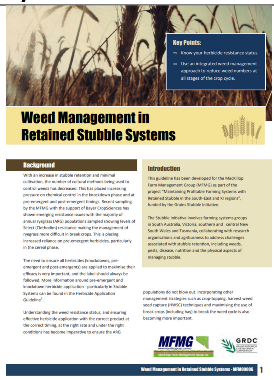
Pest Management in Retained Stubble Systems



Disease Management in Retained Stubble Systems



Weed Management in Retained Stubble Systems



The Stubble Project Guidelines Collation

Project Trials

Background

As part of the GRDC Stubble Initiative, a trial and demonstration program was developed to look at local topics and issues arising from challenges in stubble retention across the SE and KI regions. The issues being addressed were those that were selected by growers where they believed there were impediments to retaining stubbles and gaps in local knowledge around how to manage these issues.

Initially, key focus sites were identified at Frances and Conmurra in the SE where long-term impacts of varying stubble retention systems aimed to be explored. It quickly became apparent that a more targeted approach was required, with specific sites being sought to address specific issues. KI looked at a targeted approach from the outset.

Sites were located across the region from Sherwood in the North, to Millicent in the South (Table 1), and across KI (Table 2). Some sites looked at individual issues, others looked at a combination of issues depending on the outcomes required and opportunities at each site.

Table 1. Site location and topic (2013-2018), MFMG

Year	Location	Topic
2013-2016	Frances	Long Term Harvest and Fallow Management and the impacts on crop production
2013	Conmurra	Harvest and Fallow Management and the impacts on crop production
2013	Lochaber	Crop Sequencing Project – additional year of research
2014	Sherwood	Pre-emergent herbicide efficacy trial – Water rate
2015	Wolseley	Pre-emergent herbicide efficacy trial – Water rate and Ground Speed
2015	Keith	Speed tiller Demonstration
2015	Millicent	Speed tiller Demonstration
2016	Multiple sites	Impact of Grain Yield on Stubble Residue
2016	Furner	Impact of HWSC on soil nitrogen, soil moisture and pest control
2016	Multiple sites	Windrowed vs Standing stubble (Canola)
2017	Hatherleigh	Soil Humification Trial
2017	Bordertown	Canola establishment into different stubble conditions

Table 2. Site location and topic (2013-2017) AgKI

Year	*Location*	*Topic*
2014		Wheat Nitrogen Trial
2014		Canola Variety Trial
2015		Canola Blackleg Fungicide Trial
2016		Nitrogen management in soft wheat
2017		Influence of Stubble height on broad bean physiology

There was also the opportunity as part of the Stubble Initiative project to collaborate and add value to other research that was occurring in the region by providing additional monitoring and expanding these trials and demonstrations to allow for increased local outcomes where the topics aligned with the stubble management issues that were being explored as part of the project.

The projects where collaboration occurred are listed below in Table 2.

Table 2. Research collaboration contributing towards guidelines

Year	Project ID	Project Name
2013-2015	CSP00146	Facilitating increased on-farm adoption of broadleaf species in crop sequences to improve grain production and profitability
2013-2015	SFS00022 - MFMG	Pastures in crop sequencing for the high rainfall zone of Southern Australia – MFMG component
2013-2015	SFS00022 – AgKI	Pastures in crop sequencing for the high rainfall zone of Southern Australia – AgKI component
2013-2016	CSP00170	Measuring and Managing Soil Water in Australian Agriculture
2015-2018	DAS00134	Improved Management of Snails and Slugs
2015-Current	SFS00032	Harvest Weed Seed Control in the High Rainfall Zone
2017-2018	DAS00139	Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in South Australia
2016-Current	DAS00160	BA Biology and management of snails and slugs in grain crops

2013 Crop Sequencing Project

Regional specific examples from recent local research

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[1]CSIRO Canberra, [2]MacKillop Farm Management Group, [3]SARDI Struan

Funding Body: GRDC   Project Code: CSP00146   Project Duration 2010-2015

Key Outcomes:

- Break crops can be just as profitable as wheat crops
- Antas sub-clover (for hay production) as the break crop was the most profitable option
- Beans were the most effective at fixing nitrogen, averaging 13 kgN/tDM produced

Introduction

This report summarises the findings from a five year project conducted at Lochaber. The report is an extract from the full document which covers sites across the high and medium rainfall zone and has been compiled as part of the project. This document will be available on line shortly.

The project aimed to answer three key questions:

1. Can a break crop be as profitable as a cereal?
2. Are crop sequences including break crops more profitable than continuous wheat? and
3. What effects do break crops have on soil nitrogen availability?

The report is split into three sections below; each addressing these questions.

Figure 1. Photo of site with sequences set up in initial year of the phase.

Summary:

A three phased experiment was run in Naracoorte SA, with a series of break options and cereal treatments sown in Year 1 of each phase. The first phase (Experiment 1), established in 2011 and the second phase (Experiment 2), established in 2013 are shown here to illustrate the key learnings from the trials. Sowing a break crop into bean stubble (Experiment 3), established in 2012, (data not shown) reduced the impact of the experimental break crop as the benefit from the bean stubble was evident in subsequent rotations.

In Year 2 for each of the trials, break crop and cereal treatments were all sown to wheat. The first phase (Experiment 1) had two times of sowing and four different nitrogen rates and the second phase (Experiment 2) had one time of sowing and eight different nitrogen rates. In the third and final year of each of the phases barley was sown and managed the same across all plots.

The reason for the repeatability of the trial over three years was to capture variations in seasonal conditions. It must be noted that 2014 and 2015 seasons experienced below average rainfall from July to October. August and September 2014 and September 2015 were in the 10th percentile for rainfall and October 2015 was the driest on record.

Table 1. Monthly rainfall (mm), long-term rainfall (LTR) (mm) and growing season rainfall (GSR) March to October (mm), for 2011-15 at the Lochaber trial site.

(Naracoorte (View Bank) Station 26104 (36.85°S, 140.56°E, 42 m elevation) accessed online from Australia Bureau of Meteorology (http://www.bom.gov.au)).

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual	GSR March-October
2011	64.8	67.4	83.0	22.0	38.4	58.8	95.6	64.6	53.8	30.8	29.0	28.0	636.2	447.0
2012	4.2	1.6	27.4	18.2	36.8	94.2	66.0	80.8	33.6	26.0	11.8	17.4	418.0	383.0
2013	0.6	10.4	16.6	18.2	50.4	60.4	102.0	101.2	61.2	55.8	18.0	13.6	508.4	465.8
2014	26.2	0.8	14.0	38.4	38.0	84.0	68.8	21.0	16.4	11.0	20.0	10.8	349.4	291.6
2015	62.0	2.0	9.0	26.6	48.2	28.4	49.0	35.4	25.2	3.4	23.7	-	-	225.2
LTR	26.5	18.5	24.9	28.5	39.8	58.3	74.2	63.1	43.6	30.0	32.7	38.1	433.3	

Q1. Can a break crop be as profitable as a cereal?

[Naracoorte Experiment 1]

[Naracoorte Experiment 2]

This research project has shown that various break crops can be as profitable as wheat. In all three years of experiments sub clover (hay) returned a higher gross margin than wheat (grain) and in two of the three years this increase in financial return was significant (e.g. Table 2). Beans and winter sown peas also had significantly higher returns compared to wheat grain in two of the three years.

Safflower tended to have similar returns as the wheat grain treatment.

The canola treatment returns were variable over the three years. In Experiment 1, canola grain had a significantly higher return then wheat grain. In the other two years wheat grain had a higher (although not significant) return compared to canola grain. In Experiment 1, canola grain had a higher yield, 2.3 t/ha (Table 2), compared to Experiment 2, which was 1.7 t/ha (Table 3). A big difference between Experimental years was the commodity price for canola grain, ranging from $500/t (2011), $540/t (2012) and $490/t (2013). Therefore the variation in canola returns is driven by the volatility of the commodity price.

Break Crop Sown 2011	YEAR 1 2011	YEAR 1 2011	YEAR 1 2011
	Yield t/ha	biomass t/ha	Gross Margin ($/ha)
Sub clover (hay)	-	7.6	1051
Canola (grain and graze)	2.2	1.1	690
Canola (grain)	2.3	-	678
Peas (winter sown)	3.3	-	635
Beans	2.8	-	528
Canola (hay)	-	8.4	343
Wheat (grain)	3.8	-	336
Wheat (grain and graze)	3.7	0.5	336
Safflower (spring sown)	1.4	-	307
Wheat (0.3 m rows)	3.4	-	301
Barley (spring sown)	3.0	-	198
Peas (spring sown)	1.6	-	86
P value	<0.001	-	<0.001
l.s.d (P<0.05)	0.7	-	145

Over the life of the project the spring sown, barley and pea break crops were not as profitable as wheat.

Q.1 Naracoorte Experiment 1

The results from the first year (2011) of Experiment 1 (Table 2) show that there were many treatments that were more profitable than wheat in a single year. In fact, the only treatments that were less profitable than wheat were those that were spring sown instead of winter sown. Subclover was by far the most profitable treatment, with a gross margin three times that of the wheat treatments.

Table 2. YEAR 1 2011 break crop yield/dry matter (t/ha) and Gross Margin ($/ha). *Arranged in descending order of Gross Margin*

Q.1 Naracoorte Experiment 2

Table 3 highlights that in a different growing season (2013) (compared to 2011 in Experiment 1), there were again many treatments that were more profitable than wheat in a single year. In 2013, the trends in profitability were similar to that in 2011 (Table 2) except for the canola treatment. The canola treatment was less profitable than the wheat due to different seasonal conditions. The canola yields were lower and input costs were higher due to greater weed and insect pressure than in 2011. However, it remained more profitable than the spring sown options. These differences highlight the importance of multi-year comparisons to capture seasonal variability.

Table 3. YEAR 1 2013 break crop yield/dry matter (t/ha) and gross margin ($/ha)

Break Crop Sown 2013	YEAR 1 2013	YEAR 1 2013	YEAR 1 2013
	Yield t/ha	DM t/ha	Gross Margin ($/ha)
Sub clover	-	10.4	1097
Beans	3.8	-	934
Peas **(winter sown)**	4.5	-	922
Wheat **(grain)**	3.9	-	419
Canola **(grain)**	1.7	-	180
Peas **(spring sown)**	1.7	-	178
Barley **(spring sown)**	1.8	-	69
P value	<.001	-	<.001
l.s.d (P<0.05)	0.9	-	447

Q2. Are sequences including break crops more profitable than continuous wheat?

[Naracoorte Experiment 1](#)

[Naracoorte Experiment 2](#)

Across all seasons (over a three-year period) the most profitable rotations tended to be those where initially a break crop was utilised, compared to continuous cereals.

The sequences that included winter legume species as break crops were more profitable than continuous wheat across all years.

Based on 75 kg N/ha being applied on the year 2 wheat crop, sub clover (hay) was the most profitable break crop option over the life of the project, being the most profitable rotation across all Phases. Peas - winter sown and beans were the next most profitable, followed by canola grain, all more profitable than continuous cereal rotations. The spring sown break crops were not as profitable as continuous cereals.

The benefit of a break crop was emphasized when the following wheat crop was sown early (before wheat on wheat rotation) in the seeding program.

When evaluated the canola and wheat 'grain and graze' treatments suffered no yield penalty post grazing when grazed within the 'safe' period. Grazing of these crops should follow best management guidelines.

Overall disease levels were low during the trials, but the results highlight the potential for cereal on cereal rotations to have an increased risk of take all, root rot and crown rot.

Of the break crops safflower had the highest plant available water capacity, giving it a greater ability to extract soil water moisture from the profile. This capacity tended to have a negative effect on subsequent yields and quality. Water use efficiency of the wheat crop tended to be greater following a winter sown pea, bean and sub clover break crop. Post break crop harvest soil moisture levels tended not to vary between break crops.

Q.2 Naracoorte Experiment 1

Cumulative gross margins, for Experiment 1, are presented in Table 4 with a significant interaction between 2011 break crop and gross margin recorded. The highest gross margin on average was

$2278 with the break crop sub clover hay, which is significantly higher than all other gross margin averages. Peas - winter sown and canola - grain were the next best performing treatments on average. The wheat on wheat treatments performed between $1245/ha - $1127/ha, similar to the safflower and spring sown barley treatments.

Over the two year rotation, at the 75 kg N/ha treatment, the sub clover cut for hay returned the highest gross margin - $2264/ha; this was higher than all other treatments. Peas – winter sown, and canola – grain, had the second highest gross margins. Peas – winter sown had an increase of $549/ha in gross margin compared to spring sown peas. The lowest gross margins tended to be the cereal on cereal treatments.

Table 4. Cumulative gross margin ($/ha) – YEAR 1 2011 break crop + YEAR 2 2012 wheat TOS 1 (2012 N application rate x 2011 break crop).

Cumulative gross margin ($/ha) – YEAR 1 2011 break crop + YEAR 2 2012 wheat TOS 1					
Break Crop	YEAR 2 2012 wheat N application rate				
Sown 2011	25	50	75	100	
Sub clover (hay)	2248	2357	2264	2243	**2278**
Peas (winter sown)	1952	1871	1902	1736	**1865**
Canola (grain)	1827	1850	1881	1834	**1848**
Canola (grain and graze)	1758	1795	1739	1808	**1775**
Beans	1638	1593	1609	1614	**1614**
Canola (hay)	1484	1403	1384	1423	**1424**
Peas (spring sown)	1422	1258	1353	1293	**1332**
Wheat (0.3 m rows)	1159	1329	1362	1129	**1245**
Barley (spring sown)	1187	1236	1152	1220	**1199**
Wheat (grain and graze)	1178	1147	1202	1183	**1178**
Wheat (grain)	1156	1134	1087	1129	**1127**
Safflower (spring sown)	1201	1124	1082	1092	**1125**
Mean	**1518**	**1508**	**1501**	**1475**	
	P value	l.s.d (P<0.05)			
2012 N Treatment	0.189	NS			
2011 Break Crop	<0.001	96			
N Treatment X Break Crop	1.000	NS			

Over the three-year rotation, on average the TOS 1 gross margins were significantly greater than TOS 2, $2857/ha compared to $2720/ha. The 2011 break crop had a significant interaction with the cumulative gross margin, with the most profitable break crop on average being sub clover at $3608/ha over the three year rotation, and the least profitable was wheat - grain at $2354/ha. Nitrogen application rate did not significantly interact with the cumulative gross margin. The most profitable rotation was - sub clover X wheat + TOS 1 + 50 kg N/ha X barley, $3827/ha.

Q.2 Naracoorte Experiment 2

In the second year of Experiment 2 (2014) there was no significant interaction between wheat yield and N rate application; therefore applying additional N didn't increase yields. This was reflected in the gross margins, with the added input cost of N and no increase in yields significantly decreasing returns. After two years, the cumulative gross margins were significantly different between break crops, with sub clover hay ($1312/ha), peas winter sown ($1211/ha) and beans ($1187/ha) being the most profitable over the two years. Barley spring sown ($261/ha) was the least profitable.

Local farm practice considers 75 kg N/ha (i.e. Year 2 wheat treatment) as standard management and as such the three year cumulative gross margins for these treatments only are shown in Table 5.

Table 5. YEAR 3 2015 barley yield (t/ha), gross margin ($/ha) and cumulative gross margin (2013 + 2014 + 2015) – results from wheat plots with treatment 75 kg N/ha only.

Break Crop Sown 2013	YEAR 3 2015 Barley yield (t/ha)	YEAR 3 2015 Gross Margin ($/ha)	Cumulative Gross Margin ($/ha) 2013 + 2014 + 2015
Sub clover (hay)	1.7	-148	1109
Beans	1.8	-112	1084
Peas (Winter Sown)	1.8	-122	1025
Wheat	1.8	-117	586
Peas (Spring Sown)	2.1	-44	387
Canola	1.9	-97	353
Barley (Spring Sown)	1.6	-154	79
P value	0.542	0.542	0.036
l.s.d (P<0.05)	NS	NS	698

Q.4 What effects do break crops have on soil nitrogen availability?

Naracoorte Experiment 1

Naracoorte Experiment 2

On average across all break crop seasons beans had the highest level of N fixation, averaging 13 kgN/tDM produced.

Post-harvest, legume break crops had higher residual mineral N when compared to wheat and canola grain crops (Table x). This trend was observed after both the wheat and barley rotations (Table 3), suggesting the benefits of a legume break crop residual mineral N can last more than one season.

Under favourable seasonal conditions break crop treatments resulted in significantly higher subsequent wheat yields, regardless of the nitrogen treatment applied.

In dry spring conditions (Experiment 2, Year 2 (2014)) and subsequent lower wheat yield the impact of the legume break crop was not significant, although the rotations including beans and peas out-yielded the wheat on wheat rotation. Under these conditions there was no interaction between wheat yields and N treatment applied.

Across all seasons on average the wheat on wheat rotation had lower protein % and plump grain (>2.0 mm) %, compared to the legume break crop rotations.

In Year 3 of each of the experiments there was a significant interaction between barley yields X previous year wheat nitrogen application rate X initial break crop, again supporting the finding that the break crop influence can last more than one season.

Q.4 Naracoorte Experiment 1

Soil mineral N following all legume break crops grown in Year 1 of Experiment 1 (2011) were all significantly higher than the wheat (grain) treatment (Table 6).

Table 6. Experiment 1 Mineral N (kg N/ha) 0-60 cm pre-sowing YEAR 2 2012 wheat crop. ***Arranged in descending order of Mineral N.***

Break Crop Sown 2011	Mineral N 2012 (kg N/ha) 0-60cm
Peas (spring sown)	139
Sub clover (hay)	134
Beans	125
Peas (winter sown)	111
Wheat (grain and graze)	109
Canola (grain and graze)	106
Barley (spring sown)	103
Wheat (0.3 m rows)	98
Canola (grain)	93
Safflower (spring sown)	87
Wheat (grain)	81
Canola (hay)	55
P value	<0.001
l.s.d (P<0.05)	20

Q.4 Naracoorte Experiment 2

The Mineral N results from the three year period for selected treatments in Experiment 2 (Table 7) highlight that after two subsequent cereal crops the Beans treatment still had significantly higher soil mineral N than any of the other treatments.

Table 7. Mineral N post-harvest (kg N/ha) 0-60 cm, Year 1 all treatments, Year 2 and Year 3 from treatments with 75 kg N/ha applied in 2014. ***Arranged in descending order of 2015 Mineral N.***

Break Crop	Mineral N (kg N/ha) 0-60 cm		
Sown 2013	May-14	Dec-14	Dec-15
Beans	175	94	116
Peas (winter sown)	148	84	69
Canola	123	110	64
Sub clover (hay)	144	110	61
Peas (spring sown)	148	86	57
Barley (spring sown)	84	66	54
Wheat	105	50	45
P value	0.028	0.002	<0.001
l.s.d (P<0.05)	47	25	18

Appendix

For the full report go to:

http://www.mackillopgroup.com.au/media/111%20Flyers%20KM/Final%20Report%20Project%20CSP00146%20Feb16.pdf

Acknowledgements

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Sherwood Pre-Emergent Herbicide Efficacy

Duration: 2014
Contributing to: Weed Control and Herbicide Application in Retained Stubble Systems Outputs
Type: Replicated small plot trial
Site Location: Sherwood   Longitude 140.65372 Latitude -36.08297
Farmer Co-operators: Jaeschke Partners
Rainfall Data:

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	*Jan - Mar*	April-Oct
Keith	10.2	13.4	16.1	35.4	29.6	73.2	49.5	24.7	14.7	3.8	17.3	4.1	**292**	*40*	231

Background:
Information generated from Western Australia suggests that increasing the water rates and droplet size of pre-emergent herbicides can increase pre-emergent herbicide efficacy on Annual Ryegrass (ARG) control. With increasing pressure being placed on pre-emergent herbicides (particularly new chemistries), maximising the efficacy is becoming increasingly important to assist in minimizing the risk of herbicide resistance. This trial aims to see if similar results can be replicated in retained stubble systems in the medium rainfall zone of the South-East of South Australia.

Aim:
To demonstrate the effect of water rates and droplet size on the efficacy of pre-emergent herbicides in retained stubble systems in the medium rainfall zone of South-East of South Australia.

Methodology:
Four pre-emergent herbicides (Sakura @ 118 g/ha, Boxer Gold @ 2.5 L/ha, and a mix of Trifluralin @ 1 L/ha + Avadex Xtra @ 1.6 L/ha) were applied on 19 June 2014 into a standing wheat stubble in a three replicate randomized small plot design. There was also a nil treatment (no pre-emergent) treatment applied. Each product was applied at four different water rates, 50 L/ha, 75 L/ha, 100 L/ha and 150 L/ha. Mace wheat was then sown by the grower at 110 kg/ha on 20 June 2014.

The herbicides were all applied with flat fan, low drift nozzles (not air induction). The water rate was varied through a change in ground speed and nozzle selection (pink nozzles for 50 and 75 L/ha water rates, and orange for 100 and 150 L/ha water rates).

Wheat establishment (40 days post-seeding), grain yield and quality were measured.

Annual ryegrass monitoring transects were established and ARG plant numbers were counted approximately 60 and 80 days post-sowing.

Results and Discussion

Wheat Establishment and Grain Yield

Wheat establishment was measured on the 28 July 2014. There was an average plant establishment of 200 plants/m^2. There was no significant difference in wheat establishment and herbicide treatment (Table 1). The plots were harvested on 28 November 2014 after a very dry season with an average grain yield of 1.2 t/ha. There was no significant difference in grain yield between treatments.

Table 1. Treatments applied, Wheat Establishment, and Grain Yield and Grain Quality, Sherwood 2014

Herbicide	Water Rate L/ha	Wheat Establishment plants/m²	Grain Yield t/ha	Grain Quality Screenings (% < 2.0 mm)	Test Weight (kg/hl)	1000 seed weight (g)	Protein (%)	Moisture (%)
Boxer Gold	50	181	1.10	0.5	82.1	36.9	13.6	11.5
Boxer Gold	75	206	1.17	0.7	82.0	37.0	13.6	11.5
Boxer Gold	100	196	1.09	0.5	82.5	36.7	13.2	11.5
Boxer Gold	150	159	1.44	0.4	82.5	36.0	12.6	11.5
Sakura	50	166	1.40	0.6	82.7	36.2	13.1	11.6
Sakura	75	213	1.20	0.7	82.4	35.7	13.1	11.4
Sakura	100	220	1.16	0.3	82.2	38.6	13.3	11.6
Sakura	150	221	1.33	0.8	82.8	35.4	12.9	11.5
Trifuralin+Avadex	50	263	1.10	0.5	82.4	37.1	13.4	11.5
Trifuralin+Avadex	75	192	1.10	0.5	82.4	37.1	12.7	11.6
Trifuralin+Avadex	100	190	1.08	0.5	82.8	36.0	12.6	11.5
Trifuralin+Avadex	150	195	1281	0.7	82.4	35.2	13.0	11.5
Nil			1.11					
Mean		200	1.20					
P(0.05)		n.s.	n.s.					
l.s.d		68.1	390.8					
cv%		2.8	6.2					

Ryegrass Establishment

Ryegrass counts were taken on 18 August 2014 and again on 10 September 2014 from the same transect within the plots.

Results are shown in Table 2. Sakura at a water rate of 150L/ha had the lowest ryegrass population at assessments, 90 and 40 plants/m^2 respectively.

Boxer Gold treatments had moderate ryegrass populations, compared to the other two herbicide treatments. At the August assessment Boxer Gold 150 L/ha was comparable to the Sakura treatments. The Trifluralin + Avadex Xtra treatments had the greatest ryegrass counts at both sampling dates. In August the Nil and Trifluralin + Avadex Xtra treatments were significantly the same, but Sakura and Boxer Gold treatments had significantly fewer plants than the Nil. The Nil had a significantly higher number of ryegrass plants by 10 September 2014 than all other treatments.

There was a 28 % decrease in ryegrass numbers in the Nil between ARG assessments; this may be because of drought conditions. Therefore, it may be assumed there would be a natural decline in plant numbers between the two assessments, regardless of treatments. However, Sakura treatments had above 50 % decreases in ryegrass numbers between the two ARG assessments.

By 10 September all four Sakura water rate treatments had significantly fewer ryegrass plants than the Trifluralin + Avadex Xtra water rate treatments.

Table 2. Annual Ryegrass plants/m^2 60 and 80 days post-sowing, Sherwood 2014.

Herbicide	Water Rate L/ha	ARG 18 Aug 14 (plants/m^2)	ARG 10 Sept 14 (plants/m^2)	% difference Aug-Sept counts
BoxerGold	50	185	98	47
BoxerGold	75	177	112	37
BoxerGold	100	235	146	38
BoxerGold	150	129	83	36
Sakura	50	137	67	51
Sakura	75	142	65	54
Sakura	100	175	48	73
Sakura	150	90	40	56
Trifuralin+Avadex	50	354	231	35
Trifuralin+Avadex	75	387	269	30
Trifuralin+Avadex	100	425	187	56
Trifuralin+Avadex	150	352	198	44
Nil	-	535	387	28
Mean		256	148	
P(0.05)		0.001	<.001	
l.s.d		207.8	115.6	
cv%		15	16.2	

Note: cv% high because counted nil plots, high variation in scores

Ryegrass populations tended to be lower in the higher water rate treatments across the herbicide treatments. Figure 1 shows the percentage ARG control of Sakura at different water rates and how the level of control (relative to the Nil) increases with increasing water rates.

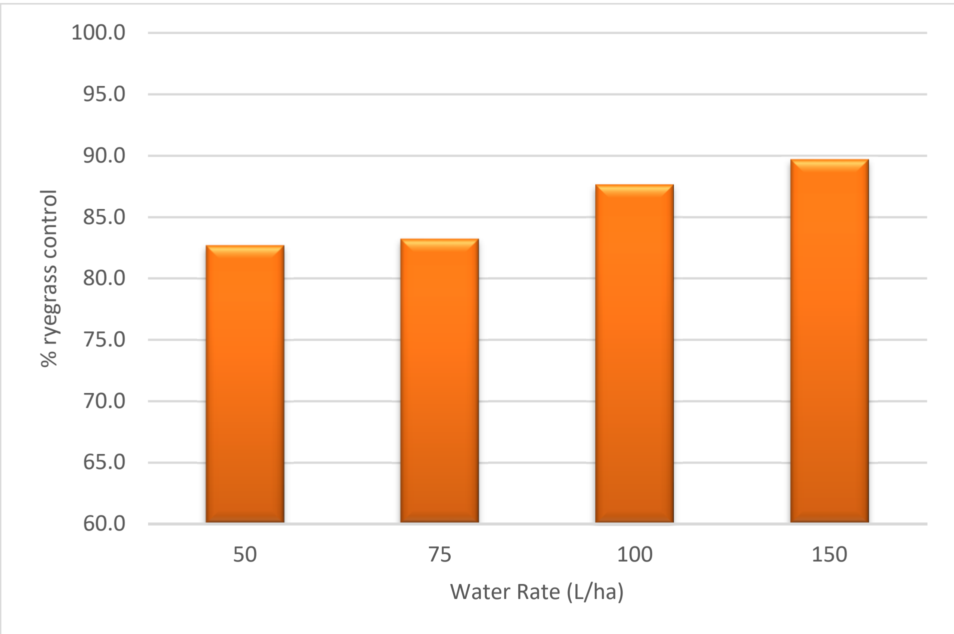

Figure 1. Percentage Annual Ryegrass control in Sakura water rate treatments with varying water rates.

Conclusion

Overall the efficacy of pre-emergent herbicide control of ARG increased with increasing water rates. This was particularly the case with Sakura, supporting the results from Western Australia. There was no significant difference between weed control treatments (both between and within herbicide treatments) on end grain yield. This trial experienced extremely dry conditions throughout the season, as such grain yield was limited.

The control of ARG requires the reduction in the number of seeds per square metre. The more effective each management action on weed control, the more sustainable the farming system will become.

There was no significant difference between weed control treatments (both between and within herbicide treatments) on end yield. This trial experienced extremely dry conditions throughout the season that are thought to have limited yield.

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Amanda Pearce, SARDI Struan

SARDI New Variety Agronomy Team, Struan

Jaeschke Partners, Sherwood (Farmer co-operators)

Wolseley Pre-Emergent Herbicide Efficacy

Duration: 2015
Contributing to: Weed Control and Herbicide Application in Retained Stubble Systems Outputs
Type: Replicated small plot trial
Site Location: Wolseley Longitude 140.92766 Latitude -36.34337
Farmer Co-operator: David Makin
Rainfall Data:

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	TOTAL	*April-Oct*
Wolseley	40.2	3.4	7.2	29.4	67.4	20.6	39.4	32.8	26.2	4.8	19.8	11	**302.2**	*220.6*

Background:
This trial work was instigated at the request of growers who wanted to expand the trial work conducted at Sherwood in 2014. The Sherwood trial evaluated water rate applications and the subsequent impact on Annual Ryegrass (ARG) control using different pre-emergent herbicides. The 2015 trial expanded on this work to include a water rate x ground speed trial, to determine if a reduction in ground speed improved the level of deposition and subsequent ARG control.

Aim:
To demonstrate the effect of water rates and droplet size on the efficacy of pre-emergent herbicides, and to assess the impact of increased ground speed on the efficacy of Sakura in retained stubble systems in the medium rainfall zone of South-East of South Australia.

Methodology:

1. <u>Pre-emergent herbicide efficacy</u>

Four pre-emergent herbicides (Sakura @ 118 g/ha, Boxer Gold @ 2.5 L/ha, and a mix of Trifluralin @ 1 L/ha + Avadex Xtra @ 1.6 L/ha) were applied on 2 June 2015 into a standing wheat stubble in a three replicate randomized small plot design. Each product was applied at four different water rates, 50 L/ha, 75 L/ha, 100 L/ha and 150 L/ha. Mace wheat was sown 2 June 2015 at 225 plants/m^2 and harvested on 20 November 2015.

The herbicides were all applied with flat fan, low drift nozzles (not air induction). The water rate was varied through a change in ground speed and nozzle selection (pink nozzles for 50 and 75 L/ha and orange for 100 and 150 L/ha).

2. <u>Impacts of changing ground-speed</u>

The pre-emergent herbicide (Sakura @ 118g/ha) was applied on 2 June 2015 into a standing wheat stubble at three different water rates (60, 90 and 120 L/ha water) and at two different ground speeds (12 and 24 km/hr), in a randomized small plot design. Mace wheat was sown 2 June 2015 at 225 plants/m^2 and harvested on 20 November 2015. Table 1 provides the nozzle selection and pressure used to achieve the desired spray pattern.

Table 1. Nozzle selection and pressure for each treatment.

Treatment	Nozzle Colour	Pressure psi	Speed Km/hr	Water Rate L/ha
Treatment 1	Green	3	12	60
Treatment 2	Yellow	4	12	90
Treatment 3	Purple	4	12	115
Treatment 4	Purple	4	24	60
Treatment 5	Red	4	24	90
Treatment 6	Brown	4	24	120

Wheat establishment counts were taken 28 days post-seeding and grain yield and quality data collected at harvest, 23 November 2015.Annual ryegrass monitoring transects were established and ARG plant numbers were counted approximately 60, 90 and 120 days post-sowing.

Results and Discussion

The 2015 season was extremely dry. This followed on from an extremely dry 2014 with no carry over stored soil moisture. It is thought that this may have had an impact on the efficacy of the herbicides in this season. Grain yields in 2014 and 2015 averaged 1.5 t/ha with the long-term average yields for this region 4.5 t/ha.

1. Pre-emergent herbicide efficacy

Wheat Establishment and Grain Yield

Wheat was sown at 225 seeds/m^2, targeting an establishment rate of 200 plants/m2. The establishment counts and grain yields and grain quality are presented in Table 2. Establishment tended to be significantly lower with the Trifluralin + AvadexXtra mix when compared to Boxer Gold and Sakura. This may have potentially been due to some herbicide toxicity with overthrow in the furrow occurring with the seeder was based on 6" (15 cm) row spacings. There was no significant difference in grain yield across the treatments with a site mean of 1.538kg/ha.

Table 2. Treatments applied, wheat establishment and grain yield and quality, Wolseley 2015.

Herbicide		**Establishment**	**Grain Yield**	**Grain Quality**				
	Water Rate L/ha	**plants/m²**	**t/ha**	Screenings (% < 2.0 mm)	Test Weight (kg/hl)	1000 seed weight (g)	Protein (%)	Moisture (%)
Boxer Gold	50	214	1.464	2.82	84.29	31.20	13.6	10.0
Boxer Gold	75	196	1.507	2.16	84.47	32.96	13.5	10.0
Boxer Gold	100	214	1.583	2.24	84.29	33.82	13.4	10.0
Boxer Gold	150	206	1.610	2.80	84.28	33.48	13.2	10.0
Sakura	50	203	1.650	2.53	84.24	32.68	13.2	9.9
Sakura	75	206	1.431	2.75	83.90	31.72	13.4	10.0
Sakura	100	211	1.566	3.31	83.86	32.44	13.3	10.0
Sakura	150	218	1.559	1.95	84.80	32.24	13.4	10.0
Trifuralin+Avadex	50	194	1.478	2.62	84.13	33.20	13.6	10.0
Trifuralin+Avadex	75	185	1.638	2.11	84.93	34.44	13.4	10.0
Trifuralin+Avadex	100	198	1.461	2.38	83.64	32.36	13.3	10.0
Trifuralin+Avadex	150	190	1.508	2.27	84.04	33.58	13.4	10.0
Mean		203	1.538					
l.s.d.		18.4	_					
P(0.05)		0.018	n.s					

Ryegrass Establishment

Initial ARG weed population at the site measured on 2 June 2015 (prior to knockdown) was 264 plants/m^2. The buffer plots (Nil Treatments) were used to monitor the effectiveness of the chemistries, with the October weed levels in the Nil being 529 plants/m^2. At this time established ryegrass plants were dying due to drought conditions and seedling ryegrass (that is thought to have germinated on September rains) were observed.

Table 3 shows the response between herbicides applied, water rate and weed populations.

In August there was a significant difference in ARG plants/m^2 between the different herbicides used, and also between the water rates, but there wasn't a significant difference between the chemistry and water rate interaction.

By September, there was still a significant difference between the herbicides used and ARG plants/m^2. Of interest are the ARG plant numbers in September, with Sakura herbicide at different water rates (Figure 1).

Even though the results in October were not significantly different, the more effective every single management action on ARG weed control is, the more sustainable the farming system will become.

Table 3. Interaction between herbicide application, water rates and Annual ryegrass numbers, Wolseley 2015.

Herbicide Applied and Rate	Water rate L/ha	AUG ryegrass plants/m²	SEPT ryegrass plants/m²	OCT ryegrass plants/m²
Boxer Gold	50	133	75	28
Boxer Gold	75	83	61	11
Boxer Gold	100	17	31	53
Boxer Gold	150	72	56	19
Sakura	50	92	50	28
Sakura	75	42	31	25
Sakura	100	14	14	39
Sakura	150	6	14	25
Trifluralin+Avadex	50	139	106	19
Trifluralin+Avadex	75	114	83	14
Trifluralin+Avadex	100	125	89	25
Trifluralin+Avadex	150	97	78	50
	Water rate P(<0.05)	0.04	n.s.	n.s.
	Water rate l.s.d	50.30	-	-
	Herbicide P(<0.05)	0.004	<.001	n.s.
	Herbicide l.s.d	43.50	22.70	-
	Water rate x Herbicide P (<0.05)	n.s.	n.s.	n.s.
	Water rate x Herbicide l.s.d	-	-	-

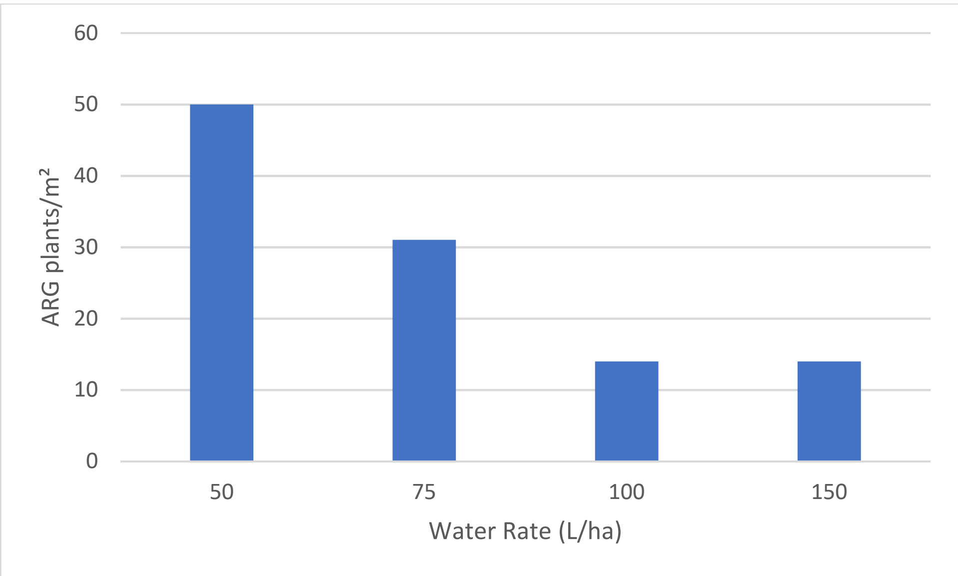


Figure 1. Annual ryegrass plants/m^2 in Sakura treatments with varying water rates, Wolseley, September 2015.

2. Impacts of changing ground-speed

The site was highly variable and data was analysed spatially. There was no significant difference in either wheat establishment or grain yield (Table 4) across the treatments.

Table 4. Treatments applied, wheat establishment, grain yield and grain quality, Wolseley 2015.

Treatment	Nozzle Colour	Pressure	Speed	Water Rate	Establishment plants/m² 30-Jun	Grain Yield t/ha 23-Nov	Moisture (%)	Grain Quality 2015 Protein (%)	Test weight (kg/hl)	Screenings (%< 2.0 mm)
Treatment 1	Green	3	12	60	181	1.83		12.9	84	2.8
Treatment 2	Yellow	4	12	90	194	1.70		13.4	84	3.3
Treatment 3	Purple	4	12	115	197	1.72		12.9	84	3.2
Treatment 4	Purple	4	24	60	205	1.77		12.7	84	3.1
Treatment 5	Red	4	24	90	206	1.86		13.1	84	3.2
Treatment 6	Brown	4	24	120	195	1.70		13.2	84	3.4
				Mean						
				P(<0.05)	n.s.	n.s.		n.s.	n.s.	n.s.
				l.s.d.	-	-		-	-	-

The results on ARG control were inconclusive with no consistent trends observed, and no significant effect in weed control resulting by the end of the season (October herbicide counts). Presented in Table 5 is the weed control data.

Table 5. Treatment applied and annual ryegrass control, Wolseley 2015.

Treatment	Nozzle Colour	Pressure	Speed	Water Rate	ARG plants/m² 30-Jun	5-Aug	7-Sep	8-Oct
Treatment 1	Green	3	12	60	60	51	22	18
Treatment 2	Yellow	4	12	90	40	42	33	25
Treatment 3	Purple	4	12	115	100	96	69	52
Treatment 4	Purple	4	24	60	104	125	82	20
Treatment 5	Red	4	24	90	48	47	29	27
Treatment 6	Brown	4	24	120	60	59	43	42
				P (< 0.05)	0.013	0.004	0.003	n.s.
				l.s.d.	41.3	34.33	26.82	-

Conclusion

The weather conditions in 2015 were extremely dry, and is thought that this may have impacted on the efficacy of the herbicides in this season.

The workshop series looking at herbicide efficacy in retained stubble systems (GRDC Stubble Initiative), re-enforced that it is the level of deposition on the stubble that is critical in determining the effectiveness of pre-emergent herbicides. If using the correct nozzle and water for the application, then the speed of application is not as critical. These trials support the importance of good levels of deposition (i.e. maximising the amount of pre-emergent herbicide that reaches the soil surface).

Acknowledgements:
David Makin, Wolseley   Amanda Pearce and SARDI New Variety Agronomy, Struan

Keith Speed tiller Demonstration

Duration: 2015
Contributing to: Fallow Management, Weed Control, Pest Management and Crop Nutrition in Retained Stubble Systems Outputs
Type: Farmer scale demonstration
Site Location: Keith   Longitude 140.34029   Latitude -36.12289
Farmer Co-operator: Chad Makin
Rainfall Data:

Site Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	TOTAL	*April-Oct*
Keith	59	3	10.8	40.3	35.5	19.2	43	26.3	20.6	3.2	59.6	8.6	**329.1**	*188.1*

Background:
This demonstration was established to validate the use of speed tillers in the medium rainfall zone mixed farming systems of the South-East of South Australia. It complements trial work at Millicent in the high rainfall zone of the South-East of South Australia, to see if similar results were being achieved across different soil and rainfall environments.

Aim:
To investigate the effect of various fallow management treatments on crop establishment and yield, weed and pest management and nitrogen management in retained stubble systems in a medium rainfall zone in the South-East of South Australia.

Methodology:

3. Barley

Three demonstration treatments (Speed tiller, Retained Standing Stubble (Nil) and Stubble Burn) were applied to a standing wheat stubble (harvested at 400 mm high with chaff spread in December 2014) during April 2015. The demonstration strips ran the length of the paddock (900 m) and were 10 m wide. Two replicates were established. The speed tiller incorporated the stubble to a depth of 175 mm and the burn treatment was applied as a cool burn in April.

The crop was sown to Compass barley at 80 kg/ha by the grower on 2 June and herbicide and fertiliser applications were applied as per regional farmer practice.

Initial crop establishment, crop vigour, weed counts and pest levels were monitored in crop. Initial soil nitrogen and moisture levels were measured, and in-crop nitrogen and moisture monitored. Grain Yield data was collected using the farmers harvester.

4. Beans

Two demonstration treatments (Speed tiller and Retained Standing Stubble (Nil)) were applied to a standing barley stubble (harvested at 400 mm high) during April 2015. The demonstration strips ran the length of the paddock (900 m) and were 10 m wide. Two replicates were established. The speed tiller incorporated the stubble to a depth of 175 mm.

The crop was sown by the grower on 28 May to Farah faba beans at 140 kg/ha and herbicide and fertiliser applications were applied as per regional farmer practice.

Initial crop establishment, weed counts and pest levels were monitored in crop, and soil moisture and nitrogen levels were monitored throughout the season. Grain Yield data was collected using the farmers harvester.

Results and Discussion

1. <u>Barley</u>

In a very dry season, the applied treatments did not improve barley establishment, nor did they reduce annual ryegrass (ARG) numbers or snail numbers. Grain yield was 0.07 t/ha and 0.08 t/ha greater with the Stubble Burnt treatment when compared to the Nil treatment and the Stubble Burnt treatment respectively. Due to a feed shortage, the crop was grazed lightly in July and then locked up for grain. The impact of this graze on final grain yield is unknown.

Annual ryegrass numbers did not vary significantly between the applied treatments. A high level of paddock variation was observed.

Table 1. Barley crop establishment, annual ryegrass (ARG) and snail counts, and grain yield, Keith 2015.

	Barley Crop Establishment	ARG plants/m²		Snails/m²		Grain Yield
Treatment	plants/m²	30 June 15	4 Aug 15	30 June 15	4 Aug 15	t/ha
Stubble Burn	221	29	119	0	0	2.28
Speed tiller	184	24	75	0	0	2.20
Retained Standing Stubble (Nil)	166	13	236	0	0	2.21
l.s.d	104.1	39.4	277.0			
P(<0.05)	0.3	0.4	0.2			

Soil nitrogen was measured throughout the season to see if there was any variation in nitrogen levels. The soil nitrogen levels were calculated using bulk densities from a nearby soil (APSOIL Keith No 1246), and the soil was sampled at two increments, 0-10 cm and 10-20 (rock) cm and sent for analysis. The soil nitrogen levels (Figure 1) varied with the initial levels being higher in the Retained Standing Stubble and Speed tiller treatments (80 kg N/ha) compared to the Stubble Burn treatment (55 kg N/ha). This difference decreased throughout the season and all three treatments had between 30-36 kg N/ha in August and between 1-8 kg N/ha in October.

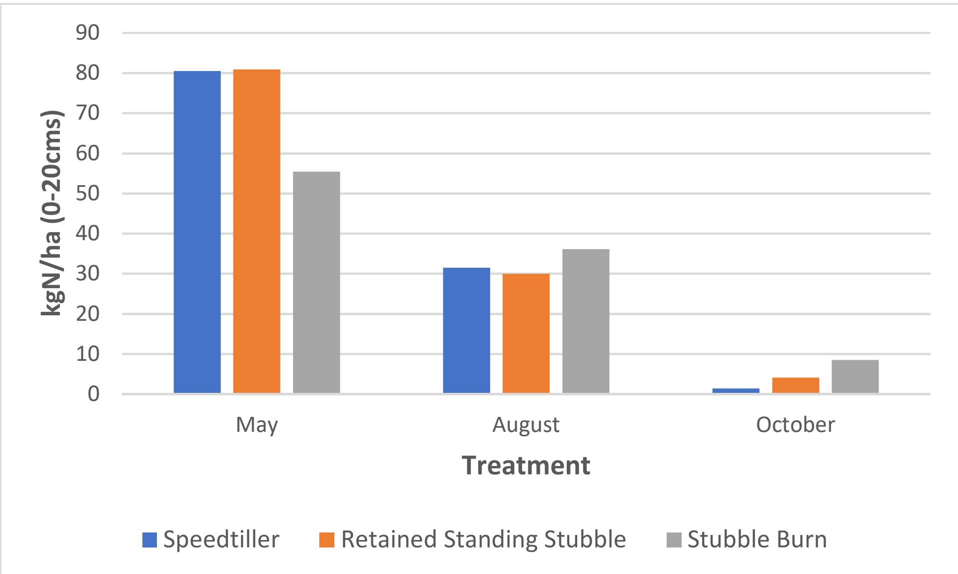


Figure 1. Soil nitrogen levels 0-20 cm throughout the growing season under different fallow management treatments.

No differences in soil moisture levels were observed between treatments at pre-seeding (26 May 2015), in-crop at growth stage 31 (4 August 2015) and at flowering (13 October 2015). The dry season would have had an impact on soil water moisture levels.

2. Beans

The bean site was monitored at approximately 60, 90 and 120 days post-sowing. No significant difference in crop establishment was measured between the treatments, Speed tiller 35 plants/m2 and Retained Standing Stubble 33 plants/m2. There were no visual differences in vigour between the treatments, and no snails or ARG plants observed. The extremely dry seasonal conditions resulted in very low grain yields with the faba bean yields not being detected by the farmer yield monitor.

A slight increase in soil moisture during flowering was observed in the Retained Standing Stubble treatment compared to the Speed tiller Treatment (Table 2).

Table 2. Gravimetric Soil Moisture (%), Keith 2015

	26 May 15		13 Oct 15	
	0-10cm	10-20cm	0-10cm	10-20cm
Speed tiller	23	24	7	11
Retained Standing Stubble	21	19	8	12

In contrast to the barley trial, initial soil nitrogen levels were higher in the Retained Standing Stubble treatment compared to the Speed tiller treatment. No differences were observed for the remainder of the growing season (Figure 2). As a legume crop it would have been expected that soil nitrogen levels would remain or increase over the season, but low soil nitrogen levels later in the season are probably reflective of the seasonal conditions and poor faba bean crop growth, as would have been expected.

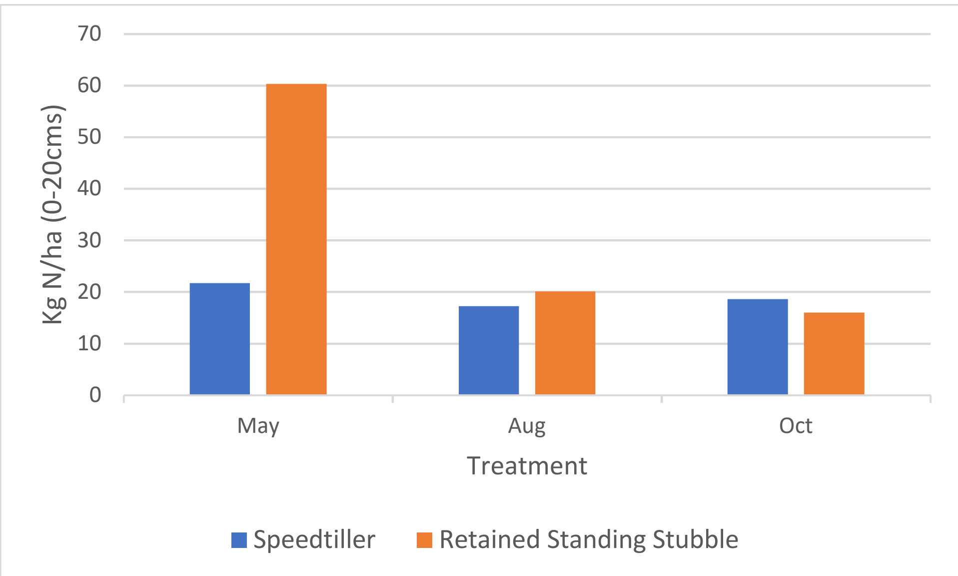


Figure 2. Soil nitrogen levels 0-20 cm throughout the growing season under different fallow management treatments.

Conclusion

The use of a Speed tiller to incorporate stubble did not appear to have any negative impacts in the mixed farming systems in the medium rainfall zone in the South-East of South Australia in a very dry season. There was high paddock variability, due to moisture stress, which would have impacted the results.

Compared to the cereal on cereal rotation, the cereal/pulse rotation appears to have retained slightly more moisture at flowering to allow the crop to finish. However these results are not conclusive as there was no grain harvest recorded for the bean crop where additional use of moisture may have been effective.

Acknowledgements

Leigh Muster, Wickam Flower Bordertown

Chad, Kylie and Kim Makin, Keith

SARDI New Variety Agronomy Team, Struan

Millicent Speed tiller Demonstration

Duration: 2015
Contributing to: Fallow Management, Weed Control, Pest Management and Crop Nutrition in Retained Stubble Systems Outputs
Type: Farmer scale demonstration
Site Location: Millicent Longitude 140.362396 Latitude – 37.587540
Farmer Co-operator: Greg and Tom Bell
Rainfall Data:

Site Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	TOTAL	*April-Oct*
Millicent	31.6	1.2	24.8	42.2	91.8	51.4	87.7	65	38.2	4.7	30.8	10.1	**479.5**	*381*

Background:
This demonstration was established to explore the use of speed tillers in mixed farming in the high rainfall zone. The trial work was established to complement the work being conducted at Keith, with the aim to see if similar results were being obtained across different soil types and rainfall environments. Speed tiller and nitrogen treatments were applied immediately post-harvest and again pre-seeding to try and identify the key timing of incorporation and if nitrogen treatments aided in breaking down the stubble.

Aim:
To investigate the effect of fallow management treatments on crop establishment and yield, weed and pest management and nitrogen management in retained stubble systems in the high rainfall zone in the South-East of South Australia.

Methodology:
The site was established in February 2015. Three replicates were established using farmer machinery. Five treatments were applied to a wheat stubble. The treatments were speed tiller incorporation immediately prior to harvest with or without the addition of nitrogen (N), pre-seeding speed tiller incorporation, with or without the addition of N, and stubble that was retained standing on the surface.

Canola was sown into the paddock on 10 May 2015. Canola establishment, annual ryegrass (ARG) establishment were determined and snails present under tile refuges were monitored throughout the season. In November 2015 canola plants were removed from treatments and the number of snails on them counted.

Initial and post-harvest soil moisture, initial soil N (2 weeks post-sowing) (0-100 cm) was measured. Topsoil N (0-20 cm) was monitored throughout the growing season. Grain yield was measured through the co-operating growers yield monitor.

Results and Discussion:

There were no significant differences between treatments in initial canola establishment, and there were no significant differences in ARG plant numbers six weeks post seeding (Table 1).

The snail populations were monitored and results sent through to Michael Nash, SARDI.

There was high snail population variability and the method of placing tiles across the paddock to provide a 'refuge' wasn't as successful as initially hoped. The control treatment (standing stubble) appeared to have slightly higher snail numbers on plants pulled, however in-field variability and the ability of snails to move between treatments resulted in inconclusive findings. The data from these measurements has not been published.

There were significant differences in the end grain yield as collected through the farmers yield monitor (Table 1). The control (sowing into standing stubble) and pre-seeding incorporation with no N treatments had significantly lower grain yields when compared to the incorporation of stubble immediately post-harvest, and incorporation pre-sowing with the addition of N.

Table 1. Canola crop establishment, ARG populations and grain yield.

Treatment		Canola Establishment plants/m2	ARG Establishment plants/m2	Grain Yield t/ha
Control (standing stubble)	minus N	56	60.4	2.12
Post harvest incorporation	minus N	44	8.4	2.23
Post harvest incorporation	plus N	48	18.0	2.25
Pre Seeding incorporation	minus N	52	13.9	2.15
Pre Seeding incorporation	plus N	52	27.8	2.24
	Mean	50	25.7	2.20
	l.s.d.	NS	NS	0.08
	P (<0.05)	0.773	0.448	0.033

NS = not significant

There were no significant differences in the soil moisture levels across the treatments at the initial (two weeks post-sowing) or post-harvest (Table 2) sampling times. There was a significant difference in the moisture levels at depth.

Table 2. Gravimetric soil moisture levels

Treatment		Pre Sowing gravimetric soil moisture % 0-10 cm	10-20 cm	20-60 cm	60-100 cm	Post Harvest gravimetric soil moisture % 0-10 cm	10-20 cm	20-60 cm	60-100 cm
Control	Minus N	30.9	27.3	19.8	15.3	15.4	19.2	16.6	15.4
Post Harvest	Minus N	30.9	27.4	19.7	15.6	16.8	18.6	16.4	15.2
Post harvest	Plus N	29.7	25.8	19.6	17.4	16.5	19.1	16.5	15.8
Pre Seeding	Minus N	31.0	26.7	18.6	16.5	15.8	18.5	17.2	15.7
Pre Seeding	Plus N	30.5	27.2	19.1	17.4	15.7	18.8	17.1	15.2
		Treatment - P value 0.718, NS				Treatment - P value 0.976, NS			
		Depth - P value <0.001; l.s.d 1.268				Depth - P value <0.001; l.s.d 1.421			
		Treatment X Depth - P Value 0.823, NS				Treatment X Depth - P Value 0.861, NS			

NS = not significant

Soil nitrogen levels were monitored to establish if there was any difference in nitrogen availability across the treatments – both initially prior to sowing (0-60 cm) and throughout the growing season

(0-20 cm). The samples were sent for analysis and the soil nitrogen levels were calculated using bulk densities for a nearby soil (APSOIL Millicent 1254). The initial soil nitrogen levels are shown in Figure 1. Initial levels are similar in the top 20 cm irrespective of whether stubble is incorporated or left standing on the surface.

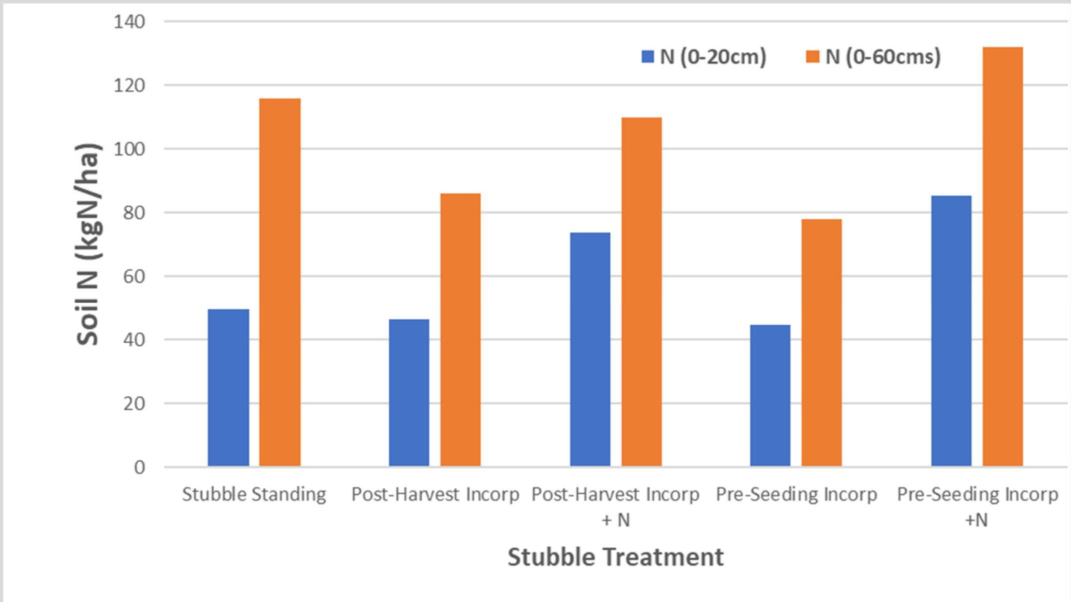


Figure 1. Soil N levels two weeks post-sowing at 0-20 cm and 0-60 cm under different stubble treatments, Millicent 2015.

Figure 2 shows the changes in soil N in the top 20 cm throughout the season. The initial soil levels are highest in those plots where nitrogen has been applied. By August, levels are similar with it being expected that the crop has utilised all of the nitrogen available in the topsoil for plant growth. In October, levels remain constant with the exception of the pre-seeding incorporated site where there is spike in N, potentially where biological activity is breaking down the stubble and providing mineral N to the crop. By the end of the season, November, the levels are slightly higher in the stubble standing strips, those treatments that had significantly lower yield when compared to treatments where nitrogen was applied as part of the incorporation, or where the stubble was incorporated early.

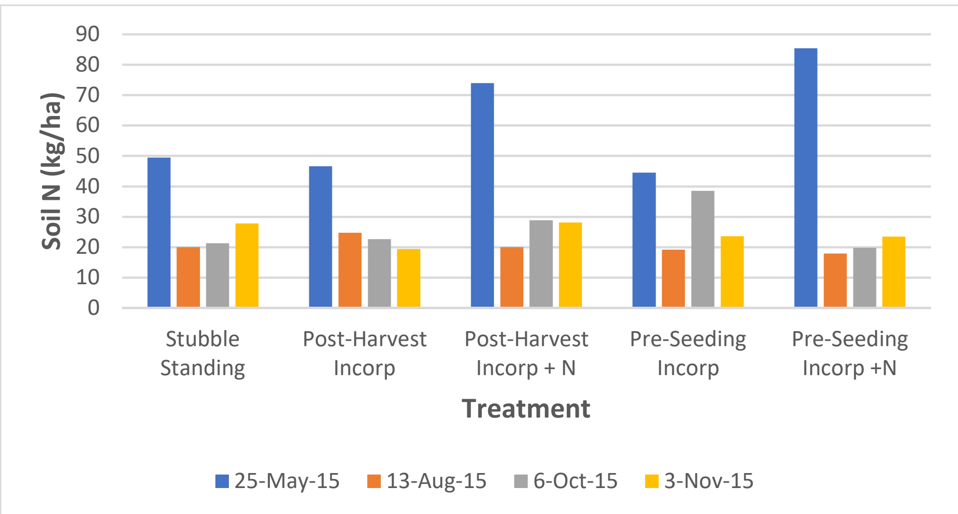


Figure 2. Soil N levels (0-20cms) throughout the growing season

Conclusion

On heavier soil types with higher levels of organic matter, using a speed tiller to incorporate a wheat stubble may assist in increasing canola yields. If incorporation occurs immediately post-harvest, then the addition of nitrogen may not be required if the soil nitrogen levels are adequate. If incorporation is delayed and occurs immediately prior to sowing, then the addition of nitrogen should be considered.

The initial soil nitrogen results collected two weeks post-sowing support the work conducted by CSIRO, where they have shown that nitrogen tie-up by cereal residue is not just a problem following incorporation, it also occurs in surface-retained and standing-stubble systems. The nitrogen tie-up is only a temporary constraint as the immobilised N will be released by microbial turnover later in the crop season (generally in spring). The general recommendation to manage tie-up is to supply more N (5 kg N for each t/ha of cereal residue) early in the crops life to avoid impacts of N tie-up on crop yield.

Acknowledgements:

Greg and Tom Bell, Millicent

SARDI New Variety Agronomy Team, Struan

Horsch Speed tiller, Millicent 2015

Incorporated stubble, Millicent 2015

Impact of Grain Yield on Stubble Residue

Duration: 2008-2016
Contributing to: Fallow Management, Harvest Management and Stubble Loads in Retained Stubble Systems Outputs
Type: Desktop Study
Site Location: South-East of South Australia (numerous locations)

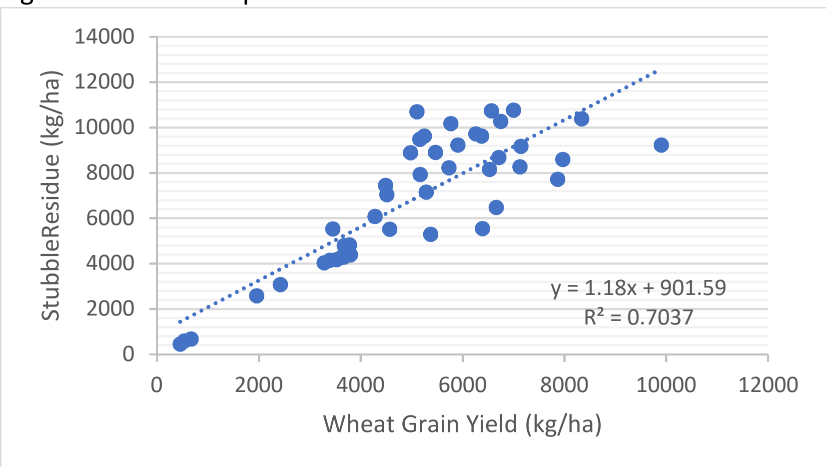
Background:
Harvest Index (HI) is often collected at replicated trial sites across the region to gain an understanding on the relationship between biomass production and grain yield. Knowing how much biomass is being produced can give us an indication of how much stubble residue may remain behind at harvest, and can assist us in making decisions both at harvest and during the fallow period to minimise issues at sowing time.

Aim:
To analyse the data collected over eight seasons and see if a correlation can be found in the South-East environment of South Australia between grain yield and harvest residue.

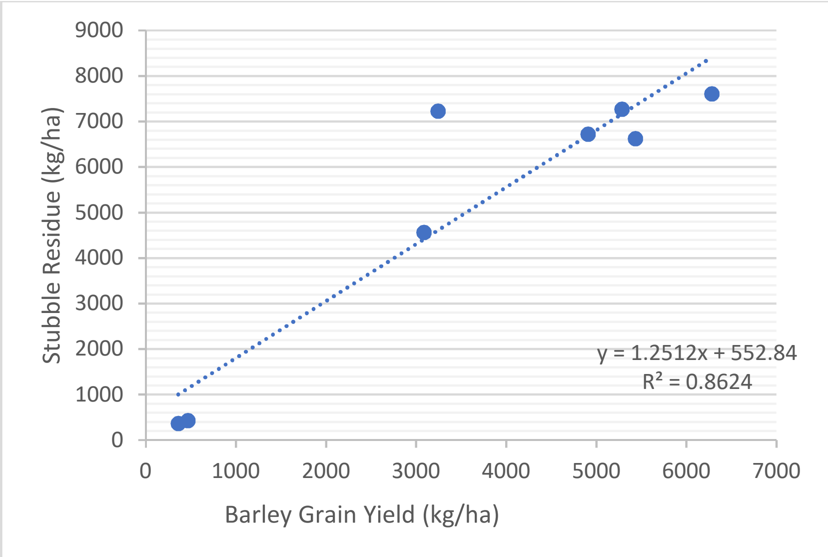
Methodology:
Historical data from various trials funded by the GRDC, SARDI and MFMG was collated and the harvest index and grain yield used to calculate the stubble residue. The data was then used to establish if there was a possible relationship between grain yield and stubble residue. This relationship was then used to estimate the residual stubble that could be expected at various grain yields. Data was utilised from cereal grain crops (wheat and barley), canola crops and bean crops.

Results and Discussion:
A good correlation was found between the grain yield and stubble residue for wheat, barley and canola (Figure 1 a-c). Providing an indication of potential stubble load to be present at harvest based on grain yield. This data has been sourced from small plot trials that have been managed under regional best practice agronomic practice in the absence of disease and weed burdens that can impact on grain yields.

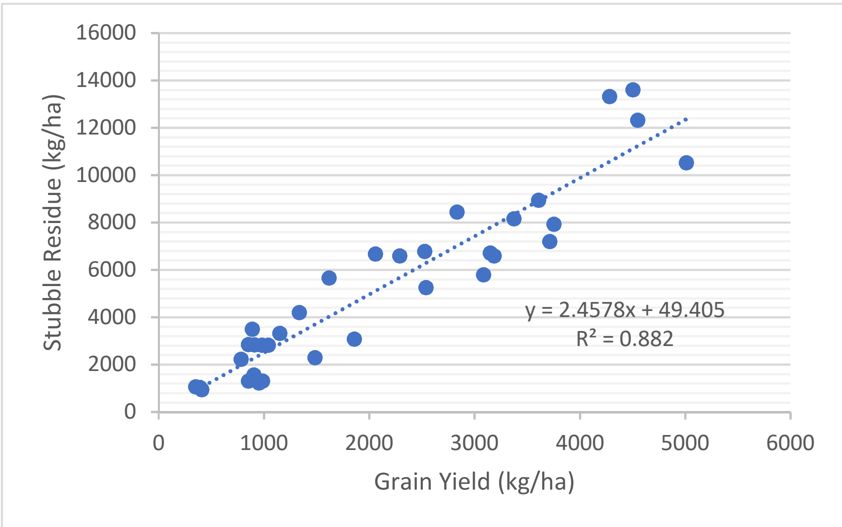
Figure 1. Relationship between Grain Yield and Stubble Residue



(a) Wheat Yield



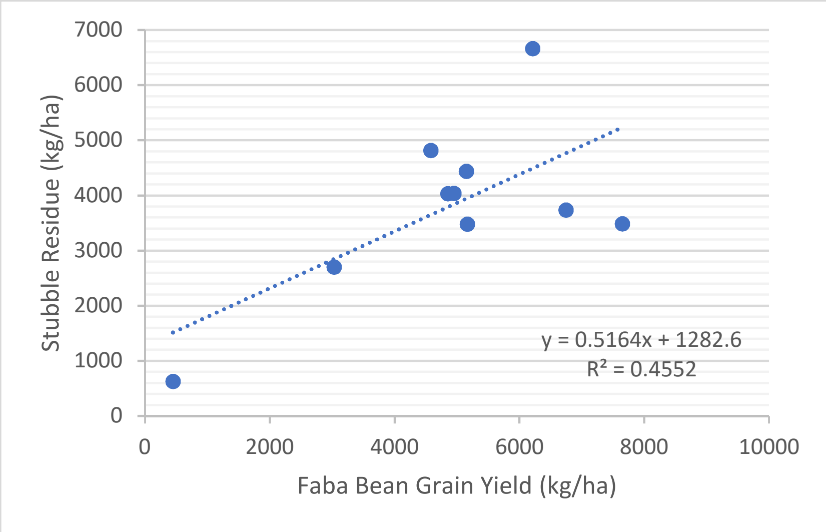
(b) Barley



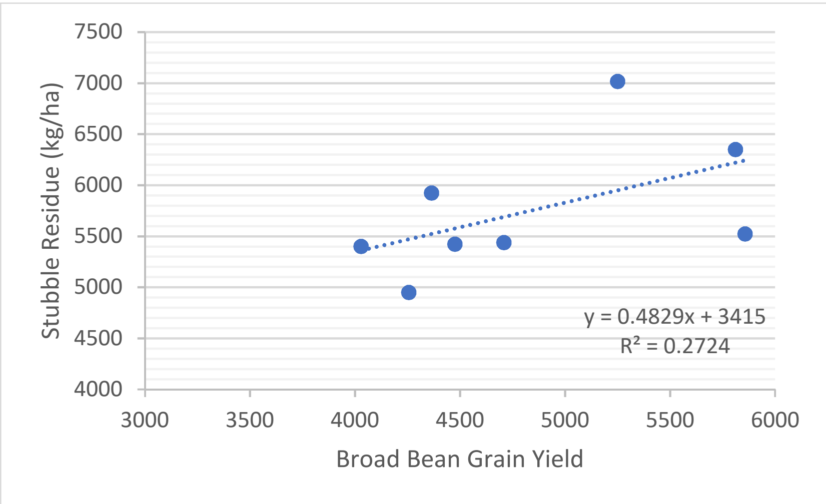
(c.) Canola

A similar relationship was not found with faba and broad beans, neither when they were assessed as beans together or when split into faba beans and broad beans (Figure 2 a-b). The data set to review was smaller when compared to the cereals and canola. The graphs demonstrate the variability between stubble load, grain yield.

Figure 2. Relationship between grain yield and stubble residue (beans)



(a) Faba Bean



(b) Broad Bean

Conclusion:

Having an indication of the stubble load present at harvest in cereals and canola (based on grain yield harvested) will help with future decisions around harvest management and management of stubble loads during the fallow period.

The data collated in this study does not allow this assumption for beans and so to accurately determine the stubble load, dry matter cuts may need to be taken.

The data presented should be used as a guide only, as all data sourced was collected in the absence of disease and weed burdens, and no frost or heat stress impacting on the grain yield. These factors can have a large impact on the grain yield and the subsequent relationship with stubble load.

Effect of canola harvesting methods on snails in the grain sample

Duration: 2015
Contributing to: Pest Management in Retained Stubble Systems Outputs
Type: Monitoring harvest plots
Site Location: South-East of South Australia (numerous locations)

Background:
Growers are concerned that windrowing canola may provide a refuge for snails prior to the harvest process commencing. Growers wanted to evaluate the impact of harvest technique on snails captured in the harvest sample.

Aim:
To evaluate if direct heading canola lowers the snail population captured in the harvester.

Methodology:
Buffer plots from ten canola variety trial sites (at four locations) were either windrowed at 40 % seed change colour, or left standing to be direct harvested (3 plots for each treatment at each site). These plots were then harvested with a small plot harvester and the number of snails present in 100 gm grain sample counted.

Results and Discussion:
No snails were counted in grain samples collected from Conmurra, Frances or Lameroo, in either harvest technique. Snails were counted in grain samples from Keith and the results are outlined below in Table 1.

Table 1. Average snails found per 100 gm grain sample.

	Harvest Technique	
Site	Windrowed	Direct head
Keith Triazine Tolerant	8	5
Keith Clearfield	2	3
Keith Conventional	2	4

Conclusion:

There were no snails found in grain samples at three of the four locations were samples were taken. As such, it is possible that spatial variability and snail density may have a greater impact on snails numbers in grain samples than harvesting method. Site variability is a key issue and more information around how sites can vary is demonstrated in the work by SARDI at Lake Hawdon in the GRDC Stubble Initiative pest management guideline.
http://www.mackillopgroup.com.au/media/GRDC%20Stubble%20Initiative/2018%20%20Stubble%20Management%20Book%20-Pest%20Management.pdf

Hatherleigh Soil Humification Trial

Duration: 2017
Contributing to: Fallow Management, Seeding Systems and Crop Nutrition in Retained Stubble Systems Outputs
Type: Replicated small plot trial
Site Location: Hatherleigh Longitude 140.246325 Latitude -37.499052

Farmer Co-operator: Chris and James Gilbertson
Rainfall Data:

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	*Jan - Mar*	April-Oct
Millicent	47.4	23	52.6	61.6	69.8	17.8	129.8	117.6	101	46.4	50.4	22.6	740	123	544

Background:
This replicated trial was established to further understand the impacts of returning large stubble loads to the system in the high rainfall zone of South Australia on subsequent crop (canola) establishment and to explore the concept of applying nutrients to increase the levels of soil humification based on the CSIRO calculator.

Aim:
To investigate the effect of fallow management treatments (stubble management and crop nutrition) on canola establishment, crop vigour grain yield in retained stubble systems in the high rainfall zone in the South-East of South Australia.

Methodology:
The site was established during harvest in January 2017, with wheat and barley plots being harvested at two different heights (approximately 40cms and 20cms) applied across both barley (6.5T/ha residue) and wheat stubble (9.5T/ha residue). The plots were either speed tilled or left as standing stubble in March 2017. Prior to incorporation, an additional treatment was applied, with a high and low harvest height treatment having the addition of nutrients at a 20% humification (as per CSIRO calculator). A 30% humification rate was also included in the treatment that was harvested high and incorporated. The treatments are shown in Table 1.
Initial stubble nutrient levels were measured to determine humification rates, and initial soil tests measuring soil nutrition and moisture were taken prior to treatments being applied (2 Feb 2017).
Archer CL Canola was sown on 12 May 2017 at 4.4 kg/ha and site was managed as per regional farmer practice.
Canola grain yield and quality was measured across all treatments on 14 Dec 2017.
Table 1. Treatments applied

	Stubble Height	Speed till	Nitrogen treatment
1	Low	No	No
2	High	Yes	No
3	High	Yes	20% humification
4	High	Yes	30% humification
5	High	No	No
6	Low	Yes	No
7	Low	Yes	20% humification

Results and Discussion:

Stubble humification rates were determined based on stubble residue loads and the results of a stubble nutrient analysis conducted by Feedtest (Australian Wool Testing Authority). These results were fed into the CSIRO stubble calculator and the humification levels determined (Fig 1 a-b).

Stubble Humification Calculator

		C	N	P	S
Stubble load (t/ha)	10				
Humification required (%)	20				
Stubble nutrient concentration (%)		45.0	0.700	0.077	0.089
Extra nutrients required (kg/ha)			7.0	1.5	2.8
Fertiliser type 1	Urea		46.0	0.0	0.0
	Single super			8.8	11.0
Quantity of fertiliser to supply exact nutrients (kg/ha)			15	17	25
Fertiliser cost ($/ha)			$16.6		
Fertiliser and spreading cost ($/ha)			$25.1		

Stubble Humification Calculator

		C	N	P	S
Stubble load (t/ha)	10				
Humification required (%)	30				
Stubble nutrient concentration (%)		45.0	0.700	0.077	0.089
Extra nutrients required (kg/ha)			45.4	6.1	8.7
Fertiliser type 1	Urea		46.0	0.0	0.0
	Single super			8.8	11.0
Quantity of fertiliser to supply exact nutrients (kg/ha)			99	69	79
Fertiliser cost ($/ha)			$77.9		
Fertiliser and spreading cost ($/ha)			$86.4		

Figure 1

(a) 20% humification rate (b) 30% humification rate

Initial soil nitrogen (N) levels were sampled immediately post-harvest in January 2017 and were converted to kg N/ha based on APSOIL 1254 which is located immediately adjacent to the site. There was 18 kg N/ha in the wheat stubble topsoil (0-10cms) and 21 kg N/ha in the barley stubble topsoil (0-10cms). There was a total of between 95 kg N/ha (wheat stubble) and 107 kg N/ha (barley stubble) in the total 0-70cm soil profile, which is seen as an adequate level to get the crop through to GS30-31.

There was no significant difference observed in canola establishment or in-crop vigour measured by a Greenseeker to assess variations in normalised difference vegetative index (NDVI). This result was as expected based on the adequate soil N levels sampled.

Canola establishment and subsequent grain yield and quality were measured across both the barley (Table 2) and wheat (Table 3) stubble treatments. There was no significant difference seen in canola establishment at this site across either of the stubble types and treatments. There was a significant difference between the canola yield in a retained wheat stubble harvested high and incorporated with the addition of nutrients targeting 30% humification (treatment 4) when compared to a standing stubble that wasn't incorporated (treatment 5).

Table 1. Canola crop establishment, grain yield and quality on barley stubble treatments

	Crop Establishment	**Grain Yield and Quality**			
Treatment	**plants/m2**	**t/ha**	**Protein**	**Oil**	**Moisture**
1	69	3.38	21.80	43.38	7.30
2	60	3.96	21.48	43.44	7.45
3	58	3.32	21.63	43.35	7.46
4	60	3.67	21.58	43.44	7.45
5	70	3.04	21.53	43.58	7.35
6	56	3.55	21.53	43.35	7.50
7	51	3.14	21.27	43.65	7.56
Site mean	61	3.44	21.55	43.46	7.44
P Value	0.547	0.033	0.622	0.387	0.693
l.s.d	NS	NS*	NS*	NS*	NS*
CV (%)		10.72	2.09	0.95	2.69

Table 2. Canola establishment, grain yield and quality on wheat stubble treatments

	Plant Establishment	**Grain yield and quality**			
Treatment	**plants/m2**	**t/ha**	**Moisture**	**Oil**	**Protein**
1	62	3.75	7.88	42.95	21.40
2	56	3.76	7.78	43.36	21.10
3	59	3.82	7.81	43.63	20.81
4	49	4.10	7.80	43.17	21.35
5	62	3.71	7.78	43.28	20.97
6	55	3.59	7.73	43.17	21.64
7	62	3.58	7.64	43.47	21.26
Site mean	58	3.76	7.77	43.29	21.22
P Value	0.761	0.05	0.553	0.15	0.007
l.s.d	NS	0.375	NS*	NS*	0.505
CV (%)		7.65	2.04	0.82	1.78

Conclusion

Knowing your initial soil nitrogen levels will assist in determining if there is likely to be a benefit of including nitrogen and other nutrients for humification when incorporating stubble. If initial soil nitrogen levels (0-60cms) are adequate i.e. above 70kg N/ha in the high rainfall zone, and above 50 kg N/ha in the medium rainfall zone, then the addition of nitrogen may not provide immediate responses – depending on the stubble nutrient levels.

Acknowledgements

Chris and James Gilbertson, Hatherleigh
Tony Swan, CSIRO
SARDI New Variety Agronomy Team, Struan

2014 Wheat Nitrogen Trial
As part of the KI GRDC funded stubble management project, more trial work was conducted in 2014 looking at nitrogen and sulphur management in wheat. The 8 treatments in the trial are defined in Table 1 below. Treatments are based on 150kg/ha of Urea (70kg/ha of Nitrogen).
The Trial was sown into a retained canola stubble, with the focus on managing Nitrogen and Sulphur nutrition with retained stubble.

Table 1- Nitrogen treatments defined. Treatments are based on district practice of 70kg/ha of N or 150kg/ha Urea.

Treatment/N rate	Treatment explained
Control (0kg/ha N)	No in-crop N fertiliser
Biopolymer Urea (70kg/ha N)	150kg/ha Urea coated with biopolymer powder. All broadcast at start stem elongation 15th Aug.
eNtrench™ (70kg/ha N)	150kg/ha Urea plus Dow eNtrench N stabiliser applied with a flat fan nozzle at 2.5L/ha at mid tillering on 30th July
EN-tec™ (70kg/ha N)	150kg/ha Incitec Pivot En-tec N stabiliser coated Urea applied at mid tillering 30th July
Urea 150 Mid tillering (70kg/ha N)	150kg/ha Urea applied at mid tillering on 30th July
Urea 150 Split (70kg/ha N)	150kg/ha Urea only, split application. First half at start of stem elongation 1st Aug, second half at flag leaf emergence 6th Sep
Urea 400 (140kg/ha N)	300kg/ha Urea split in 3 x 100kg/ha applications: start tillering 14th July, Start stem elongation 15th Aug, & Flag emergence 8th Sep. *Note final 100kg/ha application at flowering was abandoned due to lack of moisture, absence of forecast rainfall, hence only 300kg/ha of the intended 400 was applied.*
Urea AMS blend (70kg/ha N) (10kg/ha S)	135kg/ha Urea blended with 40kg/ha ammonium sulphate applied at start of stem elongation 15th Aug

The trial was a completely randomised block design with 4 replicates. This means that each nitrogen treatment appeared 4 times in the trial, once in each of the four blocks. Each plot was 8m long by 3m wide.

Agronomy and site conditions
The selected site at "Jenkins" block run by S & W Veitch on Margries Road was a well drained duplex soil. The soil was a fertile sandy loam with Colwell Phosphorous of 104mg/kg, Sulphur of 16mg/kg, and Potassium of 234mg/kg, making Phosphorus and Potassium levels high and sulphur marginal. Soil pH ($CaCl_2$) was 4.3 which is acidic.

Agronomy was typical of Kangaroo Island continually cropped paddocks and was the same for all treatments with the exception of in-crop nitrogen. The trial was sown to 100kg/ha of Scout bread wheat with 90kg/ha DAP on the 5th June. The paddock had previously grown canola in 2013, and broad beans in 2012. Trace elements were applied as foliar spray on 22nd of July and included 400ml/ha Zinc Oxide, 500ml/ha Manganese Oxide, 250ml/ha Copper Oxide and 10g/ha Molybdenum.

The trial received 405mm of an average of 600mm for the year. The site is well drained and the trial was not waterlogged.

Summary of new products

The following are the trial manager's interpretations of the manufacturer's information provided about the new products.

Biopolymer Urea
This product claims to contain negatively charged silica particles which bind to the Urea. This is supposed to stabilise the Urea enabling slow release into the soil and also reduce evaporation (volatilisation).

eNtrench™
This product is a nitrification inhibitor designed to be sprayed on soil at time of urea application. It reduces the bacterial conversion of ammonium N to nitrate N. Ammonium N is a more stable form of N. This results in less N loss from soil and potentially an increase in urea efficiency.

EN-tec™
Nitrification inhibitor that is purchased pre-coated onto N fertiliser. It reduces the conversion ammonium N to nitrate N by inhibiting the bacteria responsible. This results in less N loss from leaching and denitrification.

Both eNtrench and EN-tec inhibit the same process but contain different active ingredients.

Results

Table 2- Effect of N treatment on grain quality and classification

Treatment	Average yield t/ha	Test weight g/hL	Screening %	Protein %	Classification
Biopolymer	4.08	81.4	2.89	11.8	H2
Control	4.01	83	1.49	10.1	APW2
En-tec™	4.24	80.4	2.56	11.9	H2
eNtrench™	4.18	80	2.3	11.8	H2
Urea 150 GS31	4.28	81	2.13	11.7	H2
Urea 150 Mid Til	4.22	80.8	2.8	11.9	H2
Urea 400	4.02	77.6	3.96	12.3	H2
Urea/SOA GS31	4.24	81	2.35	11.9	H2

Grain quality

Grain quality results are not replicated and hence we have no statistics to support them. From previous N trial work and replicated quality data (2012) caution should be taken when comparing differences in protein of less than 1%. For example, protein differences between all the treatments resulting in protein of around 12% would not be statistically significantly different from one another. However, the control, at just over 10% protein is likely to be statistically significantly lower. Screening portions that differ by more than 1% are also likely to be statistically significant. The control plot had lower screenings, possibly indicating less crop canopy at grain fill and less moisture stress under very dry conditions.

Previous work with replicated test weight data indicates more variation than screenings and protein. Hence we can only suggest that control treatment produced the highest test weight, Urea 400 treatment the lowest and the remaining 70kg/ha N treatments somewhere in between. This is what we would anticipate from the interaction of moisture stress at grain fill with different canopy sizes from varied N nutrition. On the graph, you have spelt En-tech differently to the rest of document (En-tec).

Grain Yield

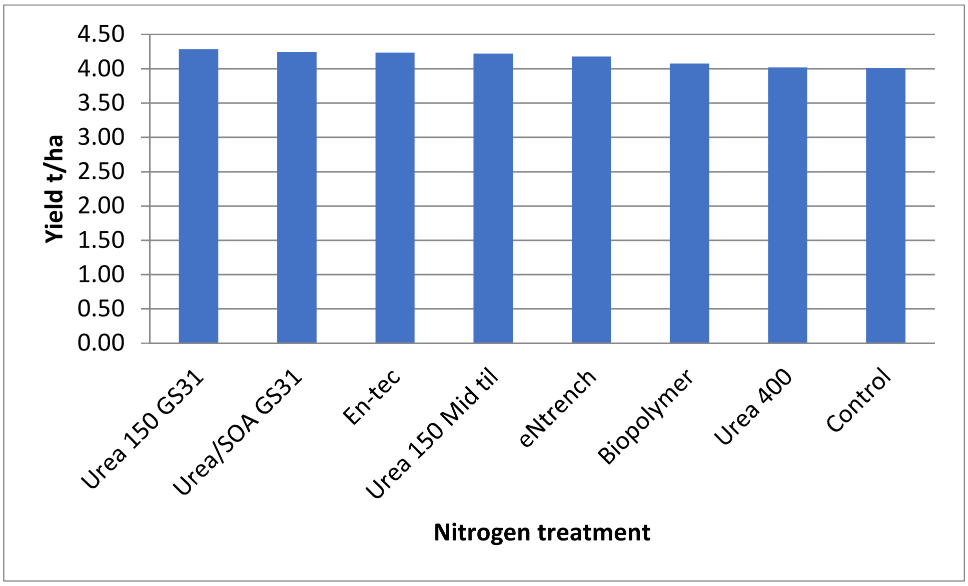


Figure 1- graphical comparison of the effect of Nitrogen treatment on grain yield.

From Figure 1 it can be seen that there are very small differences in yield. The 5% L.S.D. is 0.41 tonne/ha. This means that for the treatments that have yields that differ by more than 0.41 tonne we are 95% confident that the true yields would differ again if the treatments were applied at the same site under the same seasonal conditions. No yields differ by this amount and hence there are no statistically significant differences in yield at the 95% confidence level. This makes it difficult to evaluate En-tec™, eNtrench™ and Biopolymer urea coat products.

The Coefficient of Variation for the trial is 6.7%. This indicates that the results are reliable.

We could draw the conclusion that this site in the 2014 growing season was not very responsive to N treatment. The most likely explanation could be moisture stress at grain fill due to poor spring rains (29mm for Sep, 2mm for Oct and 0mm for Nov). Extra growth from N fertiliser would increase the crop water requirement, increasing stress and reducing yield potential. It could also be possible that soil N was not limiting at this site. This is less likely as there were visual biomass responses to N. Unfortunately we have no costly deep N data to further investigate this. For the mentioned reasons it would be unreasonable to expect the same N response (or lack thereof) in a different paddock and different season. For example, 2013 trial work on the Island indicated up to 1t/ha yield above the control for some N treatments.

Table 3- the effect of N treatment on yield as percentage of control over two different seasons

Treatment	**2014**	**2013**
Control	100	100
Urea 150kg/ha#	107	112
Urea 400 kg/ha*	100	109

150kg/ha Urea treatment all applied at GS 31 in 2014 but split mid tillering and GS 31 in 2013.
*Urea 400kg/ha was applied in 2013 but on 300kg/ha in 2014 due to dry conditions at flowering.

The N trial has now been held on the same property (different paddocks) for two years. It is interesting when we compare the yield results over the two years. 2013 was one of the wettest springs on record and 2014 one of the driest. In both years the 150kg/ha N treatment yielded better than the Urea 400 treatment (but this was not statistically significant in either year). This suggests that there is something other than N limiting yield for the Urea 150 treatment. The Urea 400 treatment cost extra and produced less yield in both seasons.

Gross Margin

Table 4- The effect of N treatment on gross margin

Treatment	**Gross grain income $/ha***	**N fert cost $ per ha**	**Gross margin $/ha^**
Biopolymer	$958	$90	$468
Control	$943	$0	$543
En-tec	$995	$101	$495
eNtrench	$982	$100	$482
Urea 150 GS31	$1,007	$75	$532
Urea 150 Mid til	$992	$75	$517
Urea 400	$944	$150	$394
Urea/SOA GS31	$997	$84	$514

^Assumes cost of growing wheat crop is $400/ha excluding any in-crop N.
*Gross income based on $235/t for all grades of wheat on farm. Calculated using KIPG estimated pool return per tonne for all grades of $260 less $15 storage and handling less $10 freight to silo.

Due to the large feed grain requirement on the Island for 2013, KIPG estimated pool returns are a flat rate over all classifications for wheat. This had limited impact on gross margin as all N treatments were classified as H2 except the control (see Table 2 for more details).

Interestingly, the highest gross margin was for the control as this treatment produced only a marginally lower yield but had no N fertiliser cost. The Urea 400 treatment produced the lowest gross margin. The EN-tec™, eNtrench™ and Biopolymer treatments had lower gross margins than the Urea 150 treatments applied at the same time due to their higher cost and similar yield. Because there are only small differences in grain yield, gross margin was negatively correlated with N fertiliser cost per ha (more dollars spent on fertiliser results in a lower gross margin).

This gross margin data refers to this site and the 2014 season and we must consider the conditions as discussed in the yield and grain quality results. For these reasons it would be inappropriate to conclude that applying no in-crop N would maximise gross margin in 19 out of 20 years, but reasonable to conclude this for 1 out of 20 years (2014).

Tiller density

Table 5- the effect of N treatment on tiller density as a percentage of the control for 2014 N trial.

Treatment	**Tiller density % of control**
Control	100
Urea 400	112
Urea 150 GS 31	112

Urea 150 Mid till	102

If we compare the Urea 150kg/ha treatment applied mid tillering to the control (no in-crop N) we get a 2% increase in tiller density. This is not likely to be statistically significant due to the large variation in the primary data. If we compare Urea 150kg/ha GS 31 (all in-crop N at start stem elongation) to the Urea 400 treatment (100kg/ha Urea applied at start of tillering) we see no difference in tiller density. This suggests that early applications of N did not influence tillering at this site in the 2014 season. Similar results have been observed in the 2013 N trial with high N rates during tillering not increasing tiller density.

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Take home messages

- Small differences in yield with extra N under conditions at this site
- Very dry spring needs to be taken into consideration when interpreting results
- High rates of N early did not have significant impact on number of tillers
- Grain quality higher for all N treatments.
- Further work required with En-tec™, eNtrench™ and Biopolymer urea coated product

Sponsors and contributors

- GRDC funding administered by AgKI
- S & W Veitch for providing trial site, spraying and seeding
- KIPG for performing grain quality tests
- Companies that provided product inc Dow and IPL
- Andrew Ware (SARDI) for statistical analysis

2014 Canola variety trial

Over the past four years the wheat variety trial has provided a valuable benchmark for varietal performance on Kangaroo Island. In 2014 a canola variety trial was run on the Island for the first time. The trial included 8 TT varieties of hybrid and open pollinated canola.

The variety Crusher was included twice (with and without stubble). This enabled us to look at the effect of stubble on crop emergence, blackleg infection and yield. The remainder of the trial was sown into burnt plots. Note that the whole trial site was burnt, and then reserved stubble added back to the "Crusher plus stubble" plots after sowing.

The trial was located on a well drained site at S & W Veitch's lease property on Margries Rd. The soil was a sandy loam with good fertility. It had Colwell P of 90mg/kg, Colwell K of 170mg/kg and Sulphur of 13.2mg/kg, all adequate. The soil was acidic with pH ($CaCl_2$) of 4.2.

The trial received 405mm of rain for 2014 compared to the average for the area of 600mm. The trial did not get waterlogged but suffered moisture stress at flowering/grain fill, with September-November rainfall totalling 31mm.

Trial management

The trial was sown on the 21st of May. All varieties were sown at 4kg/ha with 90kg/ha Mapstar™, providing 12 units N, 16 units P and 11 units of S per ha. At emergence the trial was treated with 1l/ha Lorsban, 40ml/ha Talstar and 20kg/ha snail bait to eliminate the impact of pests on small plots. In addition to N at sowing, 110kg/ha SOA was applied on 13th July and 100kg/ha Urea on 12th Aug.

The trial was a completely randomised block design with 4 replicates. This means that each variety appeared 4 times in the trial, once in each of the four blocks. Each plot was 8.5m long by 1.1m wide.

Grain yield

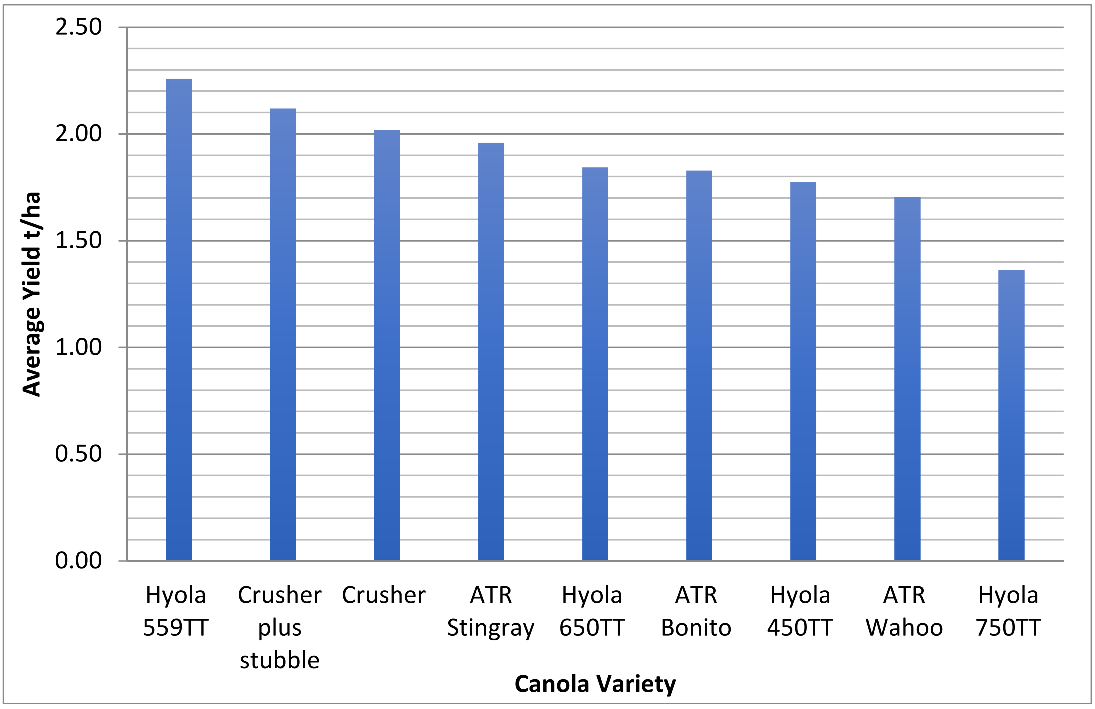

Figure 1 - graphic comparison of average yield over four replicates.

Statistically significant differences at the 95% confidence level can be summarised in Table 1. Varieties are all listed across the top in bold. The bold variety across the top yielded significantly higher than the varieties listed in itallics below, if any.

Table 1. Summary statistically significant differences at 95% confidence level.

559TT	**Crusher**	**Stingray**	**650TT**	**Bonito**	**450TT**	**Wahoo**	**750TT**
Crusher	*650TT*	*450TT*	*750TT*	*750TT*	*750TT*	*750TT*	
Stingray	*Bonito*	*Wahoo*					
650TT	*450TT*	*750TT*					
Bonito	*Wahoo*						
450TT	*750TT*						
Wahoo							
750TT							

Hyola 750TT was the lowest yielding variety. Hyola 750TT is a late season muturity while Hyola 559TT is a midseason. The below average rainfall and dry spring would not have favoured Hyola 750TT. Given an average season the relative performance of Hyola 750TT may have been better. Hyola 559TT was the best yielding variety, with yield statisitically higher than all other varieties in the trial. Crusher TT and ART Stingray performed well also and being open pollinated have the benefit of lower seed cost.

Grain quality

Table 2 shows oil content of the different varieties. All oils are good but there is a reasonable range from Hyola 450TT at 44.2% to Hyola 559TT at 47%. This accounts for $23 difference in price per tonne. Hyola 559TT was also the higher yielding variety and had the highest oil content, putting it in a good positon for gross margin analysis.

Table 2- Grain oil content

Variety	**Oil content %**
ATR Bonito	46.8
ATR Stingray	46.6
ATR Wahoo	46.4
Crusher TT	44.6
Crusher TT plus stubble	44.4
Hyola 450TT	44.2
Hyola 559TT	47
Hyola 650TT	45.3
Hyola 750TT	45.4

Gross margin

There are differences in the cost of growing the varieties due to variation in seed cost and end point royalties. Income per tonne also varies depending on oil content. For these reasons gross margin provides a better comparison of varietal performance than yield alone.

Table 3-seed cost, end point royalties, gross income and gross margin per ha.

Variety	Seed Cost/ha#	End Point Royalty Cost/ha	Average yield (t/ha)	On-farm value/t inc. oil bonus	Gross income/ha*	Gross margin/ha^
ATR Bonito	$4	$9	1.83	$476	$870	$357
ATR Stingray	$4	$0	1.96	$476	$933	$429
ATR Wahoo	$4	$9	1.70	$476	$811	$299
Crusher TT	$4	$0	2.02	$461	$930	$426
Crusher TT plus stubble	$4	$0	2.12	$461	$976	$472
Hyola 450TT	$57	$0	1.78	$461	$818	$261
Hyola 559TT	$57	$0	2.26	$484	$1,093	$536
Hyola 650TT	$57	$0	1.84	$468	$863	$306
Hyola 750TT	$57	$0	1.36	$468	$638	$81

*Based on KIPG estimated pool returns on-farm Feb 2015 less storage and haldling, less freight to mailand, less freight to KIPG silo ($445/t). Oil bonus is included where appropriate.
^Gross margin based on cost of $500 per ha to grow crop excluding seed and end point royalty.
#seed costs assumes retained seed at $1000/t and hybrid seed purchased at $28.50/kg.

Table 3 shows that as a general rule varieties that yielded higher produced higher gross margin. An exception to this is Hyola 650TT which slightly out-yielded ATR Bonito but had a gross margin of $50/ha less. This was due to higher seed cost and lower oil content of Hyola 650TT. Hyola 559TT had the highest gross margin and Hyola 750TT the lowest. The difference between Hyola 559TT and Crusher TT is notable with $110 extra gross margin even when taking the extra seed costs of 559TT into consideration.

Blackleg

Blackleg scores were taken at the ideal time for windrowing on 5th of November with the assistance of Andrew Etherton. The scores were done blind (without knowing the varieties) to rule out the possiblilty of bias. We would like to thank Andrew for his assistance with this. Scores were taken from 10 stems from each plot, a total of 40 stems scored per variety. Figure 2 below shows average blackleg score for each variety out of 5 with 0 indicating no infection and 5 being completely dead.

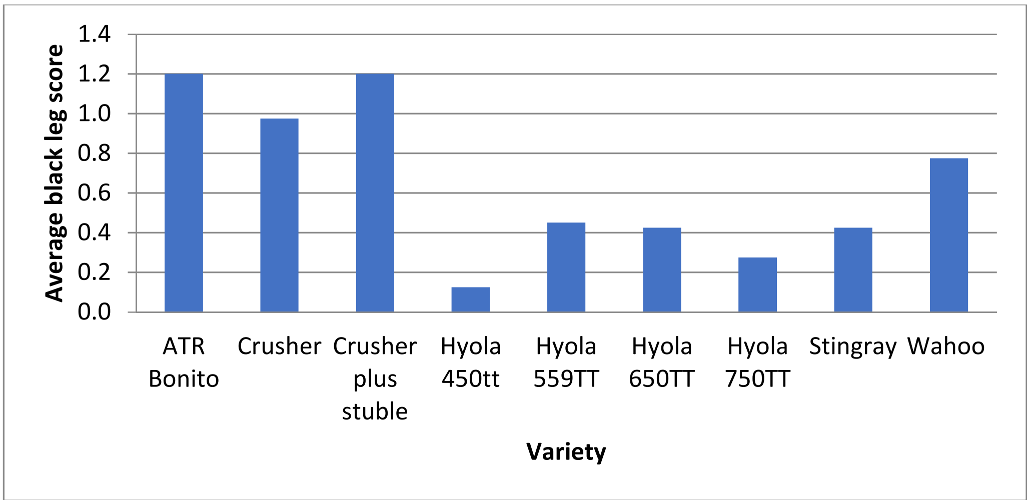

Figure 2- the comparison of black leg infection

There is a lot of variation in blackleg infection between varieties. It is interesing to note that there is no strong relationship between blackleg infection and variety yield, meaning that blackleg infection was not a good predictor of yield for the varieties in this trial (relationship not published in this report). This might indicate that blackleg infection levels were too low to have a significant impact on yield. The long term effect of increased blackleg infection also needs to be considered. The variation in blackleg infection indicates that variety selection can be a valuable tool for blackleg management on the Island.

For more detail on blackleg infection, strains on the Island and implications, please see blackleg report written by Andrew Etherton of Pacific seed (2014 AgKI Trial Results book). Note that both seed companies have been provided with the opportunity to interpret the results.

Seed treatment

All seed was treated with either Jockey™ (Fluquinconazole) or Maxim™ (Fludioxonil + metalaxyl) with the only exception being Hyola 750TT which had no treatment. This was not ideal but was due to availability of seed. Hyola 750TT had no fungicide at sowing and was the lowest yielding. But if we look at the blackleg scores we notice that Hyola 750TT had the second lowest blackleg score indicating Blackleg infection was not likely the cause of its lower yield. Hyola 750TT is a long season variety, henc e the poor spring rains would be a better explanation for its low relative yield.

Effect of retained stubble

The current Island standard of Crusher TT canola was included in the trial with and without stubble. Other than the addition of stubble post-sowing on day of sowing, the Crusher plus stubble treatment was treated the same as the Crusher treatment (note both plots were burnt prior to sowing). The Crusher plus stubble treatment had a higher average yield than the Crusher treatment but the difference of 100kg/ha is not statistically significant.

The impact of stubble on plant emergence was also not statistically significant. Plant densities (plants per m^2) measured on 22nd July were 83 for Crusher plus stubble and 96 for Crusher.

When we compare blackleg scores from Figure 2, the Crusher plus stubble treatment had more blackleg infection than the Crusher. This is intuitive given that the retained subble contained some canola stubble from the crop two years prior to the trial. Again it is unlikely that this small difference it statistically significant.

The stubble treatment is a positive result, producing no statistically significant difference in yield, emergence or blackleg infection. It is important to remember that the whole trial site was burnt and received high rates of snail/slug bait, both not common practice in a broadacre no-till system.

Take Home messages

- Longer season varieties had lowest yields in dry season
- Hyola 559 TT had highest yield, oil content and gross margin
- Need to consider gross margin over yield as seed and EPR costs differ
- Range of varietal resistance to blackleg at this site
- Addition of stubble had no impact on performance of Crusher TT

Sponsors and contributors

- Special thanks to Andrew Etherton of Pacific seeds for his assistance with blackleg scoring
- Phil Lintern of Agspec (Pod-ceal^{TM})
- GRDC funding administered by AgKI
- S & W Veitch for providing trial site
- Pacific seeds and Nuseed for providing seed
- Andrew Ware (SARDI) for statistical analysis
- More infromation available on varieties in the SARDI Canola Variety Sowing Guide 2015

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2015 Canola blackleg fungicide trial

Canola generally performs well compared to other crops on Kangaroo Island and as a result it has appeared relatively frequently in the Kangaroo Island crop rotation. Growing canola more frequently in a rotation increases the risk of the fungal disease blackleg. The 2015 canola fungicide trial funded through the GRDC Stubble Initiative project is designed to assess the efficacy of foliar, on-seed and on-fertiliser commercially available fungicides on blackleg control in retained stubble systems. Blackleg infection, yield and grain quality were measured.

Table 1 summarises the 8 treatments in the trial. All fungicide treatments are based around the district standard use of Jockey seed treatment. The exception being the control (no fungicide at all) and the Intake Hiload Gold treatments that did not receive any seed treatment.

Table 1 -fungicide treatments, application timing, rate and active chemical

Fungicide treatment	Treatment details	Active chemicals
Control	No fungicide	-
Jockey Stayer	Seed treated with 20 L/tonne of Jockey Stayer. This treatment appeared twice in the trial.	Fluquinconazole
Jockey plus Amistar Xtra	Seed treated with 20 L/tonne of Jockey Stayer, 1L/ha Amistar Xtra applied on 9th July (4-5 leaf stage)	Fluquinconazole and Azoxystrobin
Jockey plus Prosaro	Seed treated with 20 L/tonne of Jockey Stayer, Prosaro 450 ml/ha applied twice, once on 9th July (4-5 leaf stage) and once on 15th Aug (bud formation with some flowering started)	Fluquinconazole and Prothioconazole + Tebuconazole
Intake Hiload Gold 400	400 ml/ha Intake Hiload Gold applied on fert in furrow at seeding	Flutriafol
Intake Hiload Gold 200	200 ml/ha Intake Hiload Gold applied on fert in furrow at seeding	Flutriafol
Jockey plus Tebuconazole	Seed treated with 20 L/tonne of Jockey Stayer, Tebuconazole 290 ml/ha applied twice. Once on 9th July (4-5 leaf stage) and once on 15th Aug (bud formation with some flowering started)	Fluquinconazole and Tebuconazole

The trial was located on a well drained site on Matt Lovering's property on Three Chain road in Haines. The soil was sand over clay with moderate fertility. It had Colwell P of 19mg/kg, Colwell K of 108mg/kg and Sulphur of 12.9mg/kg. The soil was acidic with a pH ($CaCl_2$) of 4.6.

The trial received 394mm of rain for 2015 compared to the average for the area of 475mm. The trial did not get waterlogged but suffered moisture stress at flowering/grain fill receiving 28mm for September and 5mm for October. Soil moisture was poor early and as a result sowing occurred on the 26th of May which was later than most of the Island's cropping districts in the 2015 season.

Trial management

The trial site was sown to canola in 2013 and wheat in 2014, providing a one year break between canola crops. The trial was sown into a raked subble as some stubble needed to be removed to allow passage of the trial seeder. This could have potentially reduced blackleg inoculum levels. The small size of the trial site (20m wide) which was surrounded by retained stubble and the mobility of blackleg spores would have ensured the conditions were indicative of a true retained stubble system.

All treatments were sown with Crusher TT canola at 4kg/ha with 90kg/ha of starter fertiliser containing 15.5 units of N, 15.5 units of P and 9.5 units of S per 100kg. In-crop fertiliser was limited to 130kg/ha of Urea AMS blend (33 units N and 12 units S per 100kg) on the 28th of July. Grass and broadleaf weed control was excellent with no weed competition.

The trial was a completely randomised block design with 4 replicates. This means that each fungicide treatment appeared 4 times in the trial, once in each of the four blocks. Each plot was 8.5m long by 2.2m wide.

All plots were treated the same with the exception of fungicides. Blackleg infection was scored on the 7th November with 10 stems scored from each plot providing 40 scores for each treatment. Plots were harvested to provide yield data on the 30th of November. Seed loss from shattering was negligible.

Grain yield

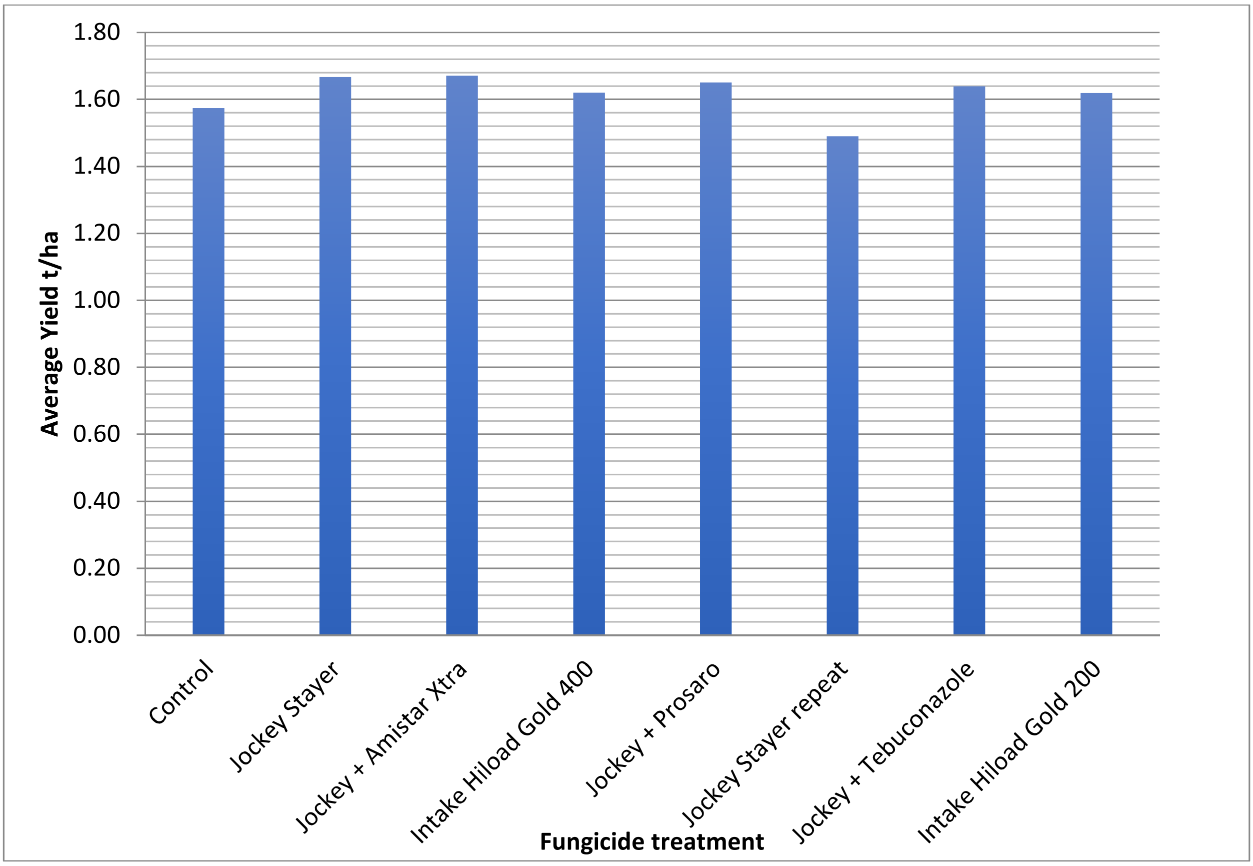

Figure 1- the effect of fungicide on yield

L.S.D 0.05 equals 0.21t/ha. Therefore we can be 95% confident that average treatment yields differing by more than 0.21t are statistically significantly different. There are no yields that differ by more than 0.21t/ha and hence we conclude that the fungicides treatments did not have an effect on yield at this location in the 2015 growing season. This does not mean that these fungicides cannot produce a yield benefit when used at a different site or in a different season. The coefficient of variation for the trial was 8.9% which suggests the results are reliable.

Grain quality

Table 2 shows oil content of the different fungicide treatments. There is a range of 2.7% between the lowest and highest oil concentrations (43.3% for the Jockey + Prosaro treatment and 46% for the control). Although we have no statistics on oil content (the data is not replicated) it is unlikely that this difference is statistically significant. Oil content had no impact on the gross margin calculations as KIPG offered no premiums or discounts for oil in 2015.

Table 2- Grain oil content

Treatment	Oil content (%)
Control	46
Jockey Stayer	45.4
Jockey + Amistar Xtra	44.8
Intake Hiload Gold 400	43.8
Jockey + Prosaro	43.3
Jockey Stayer repeat	44.9
Jockey + Tebuconazole	44.9
Intake Hiload Gold 200	44.4

Blackleg

Figure 2 shows average blackleg scores for each fungicide treatment out of 5, with 0 indicating no infection and 5 completely infected/dead.

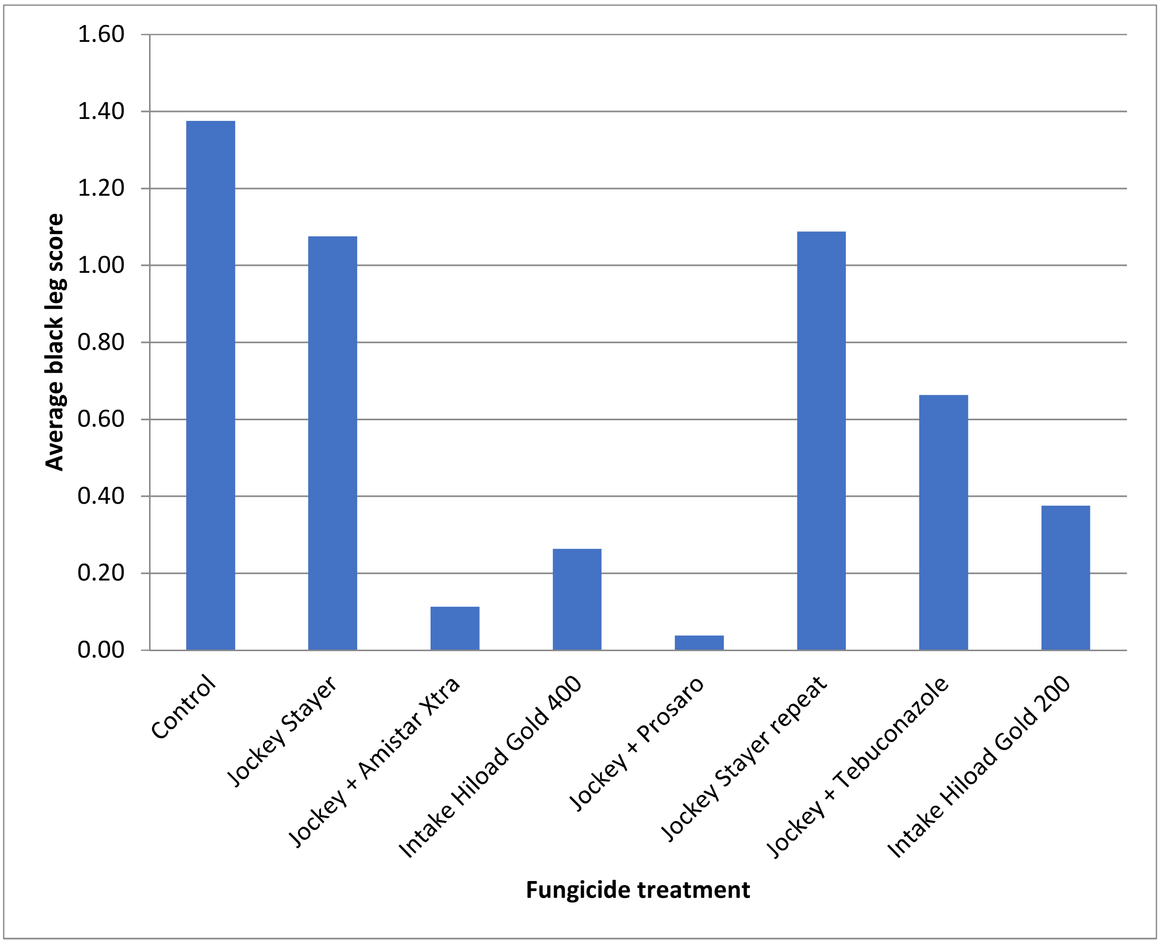

Figure 2- the effect of fungicide on blackleg infection

The LSD 0.05 for average blackleg score is 0.53 (half a score). This means that for average blackleg scores that differ by more than 0.53 of a score we can be 95% confident that the fungicide is more effective at controlling blackleg at this trial site in the 2015 season. Essentially all fungicide treatments provided statistically significantly better blackleg control than the control treatment (no fungicide) and Jockey only treatment. Intake Hiload gold, Prosaro and Amistar Xtra were the most effective at controlling blackleg.

Yield loss from blackleg infection occurs when more that half the stem is black or discoloured (GRDC Australian blackleg management guide 2012). This equates to a blackleg score of 2.5 out of 5. The results show that even the highest blackleg score- the control treatment with a score of almost 1.4 is well below the 2.5 benchmark. This supports the data which suggests that while we achieved good blackleg control with some of the fungicides, none of the fungicides produced a statistically significant yield benefit. The yield results may have been different if the trial was repeated under higher blackleg pressure.

This is possibly oversimplifying the assessment of severity of blackleg pressure at the trial site. If we take, say, the control treatment average score of 1.4, there were some stems that were scored higher and some lower (1.4 is the average score not maximum). The raw data shows some stems in some of the less effective treatments had blackleg scores of 4 and 5. But this equates to a small percentage of plants and hence is unlikely to have a large impact on yield.

The cost of the fungicide treatments (including application for foliar sprays) can be seen in Table 3. The Amistar Xtra and Prosaro treatments were the most expensive but also provided the most effective blackleg control. Prosaro is registered for sclerotinia control possibly providing some additional value if sclerotinia is a problem. There was no sclerotinia observed in the trial. Intake Hiload Gold was slightly less effective than Prosaro and Amistar Xtra on Blackleg but much cheaper, requiring a smaller yield increase to cover the cost of the chemical. Intake Hiload Gold at 400ml per ha was more effective than 200ml/ha (note these differences are not statisitically significant).

Gross margin

From Table 3 it can be seen that there are only relatively small differences in gross margins. When interpreting the gross margins it is important to remember that the yield differences were not statistically significant and hence it is likely that the gross margin differences attributed to yield are not either. The Jockey + Porsaro treatment had the poorest gross margin even though its yield was relatively high. This is due to the high costs of the fungicide treatment. It is likely that these fungicide treatments used under higher blackleg pressure would produce different gross margins. The fungicides that were good on blackleg control (see figure 2) are the more expensive treatments. These more expensive treatments require a large yield benefit to justify the economics of their use.

Table 3- Yield, fungicide cost and gross margin for the diffent fungicide treatments

Fungicide treatment	Average Yield (t/ha)	Fungicide cost $/ha	Gross income/ha*	Gross margin/ha^
Control	1.57	$-	$779	$329
Jockey Stayer	1.67	$2.6	$825	$373
Jockey + Amistar Xtra	1.67	$37.5	$827	$340
Intake Hiload Gold 400	1.62	$9.6	$802	$342
Jockey + Prosaro	1.65	$76.0	$817	$291
Jockey Stayer repeat	1.49	$2.6	$737	$285
Jockey + Tebuconazole	1.64	$20.0	$811	$341
Intake Hiload Gold 200	1.62	$4.8	$801	$346

*Based on KIPG estimated pool returns on farm Feb 2015 less storage and handling, less freight to mailand, less freight to KIPG silo ($495/t).
^Gross margin based on cost of $450 per ha to grow crop excluding fungicide
Note application cost of $5/ha included for foliar fungicides

Take Home messages

- Amistar Xtra, Intake Hiload Gold and Prosaro provided effective blackleg control.
- No significant yield increase from these fungicides
- Need to consider economics- high cost fungicides arent justified if blackleg risk is low
- Last year's work indicates variety selection also a good tool for blackleg control
- Blackleg is a problem in retained stubbles, fungicides and variety choice are 2 of many tools for blackleg control
- More info on blackleg www.grdc.com.au/uploads/documents/GRDC-FS-BlacklegManagementGuide-Revised.pdf

Sponsors and contributors

- Matthew Lovering for providing and spraying the trial site
- GRDC funding administered by AgKI
- Phil Lintern of Agspec (Pod-ceal™)
- Crop Care, Bayer and Syngenta for donating all fungicides used in trial
- Andrew Ware (SARDI) for statistical analysis
- L & C Berry for providing seed for the trial
- KIPG for testing grain

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2016 Nitrogen x Sulphur Management Trial in Soft Wheat

Background

Local wheat growers have expressed concern regarding the commonly grown soft wheat variety – Impala's poor tillering ability. This variety is also known to have 0.5% higher protein than other soft wheats making the nitrogen application strategy more critical.

Until recent years, little attention was paid to sulphur fertilisation with the main focus being nitrogen. With funding courtesy of the GRDC Stubble Initiative, a trial was designed to assess the effect of sulphur on tiller numbers, grain yield and quality when combined with in-crop nitrogen.

What was done

A replicated trial was set up in an Impala wheat crop on Ben and Sarah Pontifexs property on Elsegood Road, Macgillivray. The wheat was sown by the landholder on the 1st June at 100kg/ha with 100kg/ha MAP (10:22:0:1.5) having received a glyphosate knockdown plus Sakura pre-emergent prior to sowing. The wheat was sown into canola stubble.

The soil was sandy loam. Soil test readings from 0-20cm depth revealed a low background level of sulphur (4.3mg/kg) and nitrogen (5mg/kg nitrate and 6mg/kg ammonium) with pH_{CaCl2} 4.7.

The site received 789mm of rain for 2016, with 600mm falling in the growing season (April to October). The site did not get waterlogged despite experiencing a wet spring with 185mm of rain falling in September and 34mm in October.

The trial was a completely randomised block design with 4 replicates. Each plot was 10m x 2.2m wide.

The treatments chosen were based on variations of district practice supplying 100kg urea and 50kg sulphate of ammonia. Two treatments received and additional 50kg urea, totalling 150kg urea and +/- 50kg sulphate of ammonia.

The site was pegged and the first of the treatments applied on the 15th July when the wheat was at growth stage 13/14. On the following day, 30L UAN (12.5kg N) and 300g Rapisol (3:2:1) was applied by aerial application. The second round of treatments were applied on the 2nd August at growth stage 31/32. On the 6th August the site received an aerial application of 1L Agritone570 + 500g Rapisol 3:2:1. Harvest occurred on the 5th January 2017.

TABLE 1: **Nitrogen and Sulphur Treatments**

Trt No.	Treatment	Total N & S Supplied #
1	Control	23N, 1.5S
2	**GS14**: 50kg urea **GS30:** 50kg urea + 50kg SOA	79N, 13.5S
3	**GS14**: 100kg urea + 50kg SOA	79N, 13.5S
4	**GS30:** 100kg urea + 50kg SOA	79N, 13.5S
5	**GS14**: 50kg urea **GS30:** 70kg urea	78N, 1.5S
6	**GS14**: 120kg urea	78N, 1.5S
7	**GS30:** 120kg urea	78N, 1.5S
8	**GS14**: 50kg urea **GS30:** 100kg urea + 50kg SOA	102N, 13.5S
9	**GS14**: 50kg urea **GS30:** 122kg urea	102N, 1.5S

 # Total N and S supplied includes starter fertiliser and Easy N.

Results

For ease of explanation, the treatments will be referred herein by number.

TABLE 2: **Effect of N +/- S treatment on tiller numbers per plant**

Trt No.	Fert applied at GS14	Fert applied at GS30	Avg tiller no. per plant
1	0	0	1.5c
2	50U	50U + 50SOA	2.2bc
3	100U + 50SOA	0	3.2a
4	0	100U + 50SOA	2.8ab
5	50U	70U	2.6ab
6	120U	0	2.3b
7	0	120U	2.5ab
8	50U	100U + 50SOA	2.7ab
9	50U	120U	2.5b

From TABLE 2 it can be seen that applying all the urea and sulphur upfront (Trt 3 - GS14: 100kg urea + 50kg SOA) led to the highest tiller number with 3.2 tillers per plant, although this number was not statistically different from 4 other treatments. However the tiller numbers of this treatment 3 did differ significantly to those of treatment 6 - GS14: 120kg urea which received the same amount of nitrogen but no sulphur at the same timing. From this it could be inferred that supplying sulphur early supports tiller production. This makes sense as nitrogen and sulphur work synergistically inside plants and too little of one can affect the performance of the other. However these higher tiller numbers did not confer a yield advantage (TABLE 3) when comparing the 2 treatments (Trt 3 = 4.96t/ha vs Trt 6 = 5.03t/ha).

TABLE 3: **Effect of N +/- S treatment on yield, grain quality classification and gross margin.**

Trt No.	Fert applied at GS14	Fert applied at GS30	^Avg Yield t/ha	Test wt g/hl	Protein %	Classification	Urea & SoA Cost/ha	*Gross Margin $/ha
1	0	0	3.68 b	75.2	8.4	SFE 2	$0	$425
2	50U	50U + 50SOA	4.93 a	75.6	8.3	SFE 2	$67	$578
3	100U + 50SoA	0	4.96 a	75.8	8.7	SFE 2	$67	$592
4	0	100U + 50SOA	5.06 a	76	8.7	SFE 1	$67	$662
5	50U	70U	5.48 a	75.8	8.7	SFE 2	$54	$696
6	120U	0	5.03 a	76.6	8.7	SFE 1	$54	$670
7	0	120U	5.13 a	76	8.6	SFE 1	$54	$690
8	50U	100U + 50SOA	5.11 a	75.6	9.2	SFE 2	$90	$590
9	50U	120U	5.29 a	75.8	9.1	SFE 2	$76	$638

^LSD 5% of yield = 0.63. CV = 7.10

* Gross margin based on cost of $275/ha to grow excluding urea, SoA and spreading costs. Note spreading cost of $8.50/ha per pass. Price per tonne received based on KIPG estimated pool returns on farm Feb 2017 less storage and handling, less freight to mainland, less freight to KIPG silo ($200/t SFE1 (Test Wt >76), $190/t SFE2 (Test wt >68)

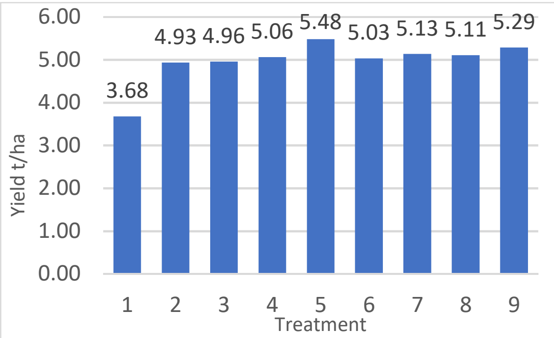
Yield

All treatments 2-9 differed statistically from the control (Trt 1) (TABLE 3). Since each of these treatments had either 79 or 102kg N applied in-crop it can concluded that this site in the 2016 season was very responsive to nitrogen.

However the 5% LSD of 0.63t/ha means that the yields between treatments 2-9 were not statistically different. As there were no statistical significant differences between the treatments it can also be deduced that this site was not responsive to sulphur. This was highly surprising given the low background level of S being equivalent to 11.2kg/ha and the distinct colour differences across the plots during the growing season with the S enriched plots exhibiting a healthy dark green colour. I am at a loss as to why a yield response was not found.

The yield of 3.68t/ha and subsequent gross margin of the Control (Trt 1) was quite respectable given that only 23kg of N was applied for the growing season. The background soil test taken to 20cm gave a reading equivalent to 28.6kg N.

FIGURE 1: **Comparison of the effects of N +/-S on grain yield**



The timing of whole or split applications of identical N & S amounts made no difference to yield. For example Treatments 2, 3 and 4 each supplied a total of 100kg urea and 50kg SoA at different timings yet the yields were similar (Trt 2 = 4.93t/ha, Trt 3 = 4.96t vs Trt 4 = 5.06t). This suggests that there was high utilisation of all fertiliser applied especially the early GS14 applied fertiliser with minimal leaching occurring. It also indicates that only 1 pass with the spreader was required.

Adding an extra 50kg of urea to treatments 8 and 9 over the standard practice did not bestow a yield advantage, indicating that maximum yield was realised with 79kg of N.

It is interesting to note that the highest and second highest yielding treatments (although not statistically significant) were treatments that contained no sulphur i.e. Trt 5 and Trt 9. This reiterates that the site was not responsive to sulphur in 2016.

Grain Quality

All treatments fell below the maximum protein threshold of 9.5% qualifying classification as SFE 1 (TABLE 3) a reflection of the cool wet spring. This included treatments 8 & 9 that received an additional 23kg of nitrogen (50kg urea). Interestingly these samples had a pronounced increase in protein content relative to the other treatments, indicating that the extra N applied went into protein as opposed to yield.

Despite satisfying the protein threshold for SFE 1, the test weights were borderline between SFE 1 and 2, likely attributable to the 50mm of rain received between maturity and harvest. It could be anticipated that harvesting before the 50mm rain event would have ensured SFE 1 grading.

Gross Margin

With reference to Table 3, it can be seen that there is quite a range between the lowest grossing treatment - the control of $424/ha versus the Trt 5 (50kg urea GS14 + 70kg urea GS30) of $696/ha. When interpreting the gross margins it is important to remember that all treatments yielded statistically more than the control but there were no statistically significant yield differences between treatments.

Take Home Messages

- Early sulphur application supported higher tiller numbers although this did not translate into yield
- Site was very responsive to at least 79kg nitrogen application.
- An additional 50kg urea (23kg N), resulted in slightly higher protein readings.
- Site was unresponsive to sulphur application.
- Timing and splitting of in-crop fertilisation conferred no yield advantage
- Good utilisation of applied N and S in spite of high rainfall year.

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- GRDC funding administered by AgKI
- B & S Pontifex for providing trial site, seeding and spraying
- KIPG for performing grain quality tests
- Andrew Ware (SARDI) for statistical analysis

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2017 Influence of Stubble Height on Broad Bean Physiology and Disease

Background

In recent years, the standard cropping rotation on Kangaroo Island has resonated around wheat - broad beans - canola. This sequence confers the nitrogen hungry crop - canola to take full advantage of any residual nitrogen left over by the beans and it ensures that the soft/biscuit wheat is grown in soil with low nitrogen reserves. Furthermore, this succession of crops, reduces the likelihood of emergence problems that may arise from sowing small seeded canola into heavy wheat stubble loads. Rather farmers opt to sow bigger robust broad beans into this nitrogen depleted and high stubble environment.

Research on the mainland has shown that sowing lentils in the inter-row in wheat stubble encourages the plant to grow taller in pursuit of sunlight, enabling easier harvest for what is normally a short crop. Although broad beans can be a tall crop, the bottom pods contain the largest beans as these set the earliest and thus have the longest time to fill. However, in many cases these large seeded pods are too close to the ground for the harvester to pick up and yet it's these big beans that are worth the most.

Like the lentil story above, local farmers are curious as to whether the height of the previous year's wheat stubble may influence the distance from the ground of the first pod. There was also contemplation as to whether the stubble height had an effect on disease incidence in the bean crop.

What was done

The trial was set up at the time of harvesting the 2016/17 Impala wheat on Ben and Sarah Pontifexs property on Elsegood Road, Macgillivray. The wheat was harvested at three different heights – one as close to the ground as possible, one at standard height, which is approximately a foot (30cm) off the ground and the other just below head height much like a stripper front would leave behind.

The site was sown to broad beans on the 27th May with a Tobin disc seeder at 175kg/ha with 40L of liquid fertiliser - Pulseaider and the appropriate rate of Strain F EasyRhiz freeze dried inoculant. Prior to sowing, the site received 2L Glyphosate + 20ml Nail. The post sowing, pre-emergent application consisted of 1kg Terbyne Xtreme + 100ml Spinnaker + 1L Gramoxone.

The soil was classified as a sandy clay loam. Soil test readings revealed a pH_{CaCl2} 4.4, phosphorous reading of 51ppm, PBI of 62, potassium 149ppm and 10ppm of sulphur.

The site received 391mm of rain for 2017, with 271mm falling in the growing season (April to October). June was an extremely dry month with only 11.8mm being recorded with the highest daily reading being 3.8mm on the 25th.

The measurements taken prior to sowing included 1) height of standing wheat stubble and 2) stubble load.

There were intentions to measure 3) disease score, 4) height of first pod from the ground and 5) grain yield but as discussed below the trial was not pursued post emergence.

Results

TABLE 1: **Measurements**

Intended Stubble Height	Stubble Height (cm)	Stubble Load (t/ha)
Low – ground level	8	3.54
Standard	25	"
Tall - heads only	50	"

Unfortunately due to a variety of factors, there was inconsistent establishment of broad beans across the three stubble heights and resultantly the measurements pertaining to disease incidence, height of first pod to the ground and grain yield were abandoned. One could say, the trial instead provided a learning opportunity on stubble handling and disc seeder set up.

Hair pinning and consequently poor placement of bean seed was the culmination of various factors that led to the poor establishment. These factors included heavy stubble laying on the soil surface, moist stubble at sowing, blunt disc blades, all topped off with decile 1 rain falling in June post sowing.

For seeds to imbibe they need to be surrounded in 100% humidity, meaning burial and seed soil contact is critical. Large seeds need to be placed deeper since they have a higher moisture requirement to imbibe and germinate. The deeper they are placed, the lower the likelihood of the soil drying out. Placing the seed in high humidity/moist conditions is also important for the survival of the rhizobia bacteria that subsequently infect the root hairs to form nodules and fix atmospheric nitrogen.

If large seeded beans are only partially sown/covered in soil, they require follow up rain or constant moist conditions to imbibe and germinate. Given that the June rainfall was a decile 1 meant that the topsoil had a drying trend and hence beans that may have otherwise persisted and survived in 'normal' KI June rainfall perished.

Although one would expect the 'tall' stubble height treatment to have been more immune to hair pinning, due to the wet summer the wheat was not harvested until March and resultantly the crop had begun to fall over by this stage.

As a general rule of thumb, if sowing with a disc seeder, the aim is to leave as much stubble standing as possible at the previous harvest. For this reason, stripper fronts which just take the grain heads off and leave the stubble standing, coordinate well with disc seeders.

In a similar vein, if livestock are to graze the stubble, they should be limited in the length of time they are allowed to trample the stubble, if at all. Standing stubble facilitates better penetration and hence efficacy of the knockdown and pre-emergent sprays.

Lodged or fallen stubble can be cut by discs provided they are sharp and the residue is dry. Much like a blunt knife, when discs become blunt due to wear they no longer slice stubble with ease and instead push the stubble into the slot. This is made worse when the straw is moist causing it to be tougher.

Another consideration that would assist in cutting through lodged straw when using a disc seeder is having sufficient down force on the bar to assist in forcing the disc into the ground. This is especially the case when sowing large seeds that need to be placed at their optimum seeding depth.

Take Home Messages

Whilst the trial didn't go according to plan there were still some key messages that arose:

- Maximising seed-soil contact is the aim at sowing especially for the larger seeds that require more moisture to imbibe and germinate compared to small seeds.
- Unseasonably low June rainfall hindered establishment of partially sown beans due to a drying topsoil. These may have been OK under normal June rainfall conditions.
- Hair pinning can be a serious issue when using a disc seeder especially when sowing into wet/moist lodged stubble.
- Solutions to avoid hair pinning – sow when stubble is dry (good in theory), keep stubble standing, use sharp discs and ensure bar has sufficient down force to cut through tough stubble.

Funding/Sponsors/Acknowledgments

- GRDC funding under the Stubble Initiative administered by Ag KI
- B & S Pontifex for providing and setting up the trial site, seeding and spraying

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FIGURE 1: Inconsistent establishment of beans across the trial site coinciding with heavy residue.

FIGURE 2: 'Tall' stubble height that had lodged and resultant poor establishment

FIGURE 3. Where there was little stubble, establishment was adequate.

Extension activities

Date	Location	Type of Activity / Output	Relevant Speakers / Topic
August 2014	Keith	Workshop & Site visit	Andrew Storrie, Peter Boutsalis
August 2014	Frances	Workshop & Site visit	Andrew Storrie, Peter Boutsalis, Sam Kleeman
August 2014	Naracoorte	Presentation	Jon Midwood (SFS)
August 2014	Furner	Workshop / Practical session	Russel Nicholl (AFSA), Helen DeGraaf (SARDI)
Oct 2014	Frances	Annual Field Day / site visit	
Oct 2014	Conmurra	Annual Field Day	
Spring 2014	KI	Annual Field Day	Michael Nash (SARDI)
Nov 2014	Millicent	Field Day	Speed tiller Demonstration
March 2015	Keith	Field Day	Speed tiller Demonstration
May 2015	KI	Workshop	Jack Desboilles
August 2015	Conmurra	Field Day	Root Boot machine demo
October 2015	Wolseley	Annual Field Day (Ag Bureau)	Chaff Cart
October 2015	Frances	Annual Field Day / site visit	Marg Evans, Hugh Wallwork, SARDI
October 2015	Conmurra	Annual Field Day / site visit	Marg Evans, Hugh Wallwork, SARDI
Feb 2016	Kingscote	Workshop	Bill Campbell (Farmano)
Feb 2016	Keith	Workshop	Bill Campbell (Farmanco)
March 2016	Furner	Workshop	Bill Campbell (Farmanco)
August 2016	Bordertown	Workshop / Practical session	Russel Nicholl (AFSA)
October 2016	Frances	Field Day	Machinery setup for harvest
October 2016	Conmurra	Field Day	Machinery setup for harvest
October 2016	KI	Field Day	Wayne Smith, Liz Farqhuarson (SARDI), Michael Eyres (Injeckta Systems) and Maarten Ryder (Adelaide Uni)
July 2017	Keith	Workshop / Practical session	Russel Nicholl (AFSA)
July 2017	Furner	Workshop / Practical session	Russel Nicholl (AFSA)
July 2017	KI	Workshop / Practical session	Russel Nicholl (AFSA)
Sept 2017	Keith	Field Day	iHSD weed seed mill, HWSC techniques
October 2017	Conmurra	Field Day	iHSD weed seed mill, HWSC techniques
October 2017	KI	Annual Field Day	Ted Langley, Grower, Pine Hill, SA
March 2018	Wirrega	Workshop / Agronomy 101	Nick Poole
March 2018	Millicent	Workshop / Agronomy 101	Nick Poole

Impacts

Key issues have been able to be investigated under local South East and KI conditions to improve outcomes for growers.

The project has provided capacity to validate farmer practice change; supporting innovators to develop strategies around machinery use and transfer and share that information to the early adopters.

It has provided growers with the tools they needed to allow them to implement change immediately to fine tune their systems

Growers have increased knowledge and skills around correct boom spray setup for maximum herbicide efficacy; nozzle selections, water rate usage, adjuvant use and the importance of correct deposition.

Has provided growers with information around integrated weed management (IWM) strategies looking at both mechanical and chemical options to control weeds in the system

Growers now understand the importance of adjusting spreaders for the correct situation; what the capacity of their spreaders are with regards to bait spreading vs fertiliser spreading and how to adjust machines to ensure and even spread pattern to maximise effectiveness of either the bait or fertiliser application. They also understand the importance of timing of bait applications to try and maximise kill on snails and slugs.

There has been an increase in understanding of the impacts of returning stubble to the system on soil N levels – an issue that was preventing people from returning stubble to the system previously.

The project has contributed to ensuring disease ratings of long season wheat varieties (particularly with eyespot) are identified for improved disease management.

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