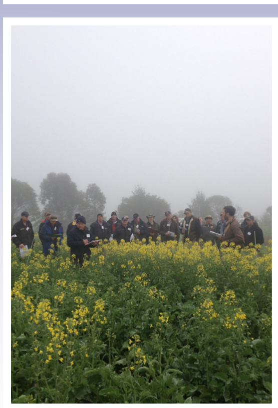
FarmLink

2014 Research Report

communication - coordination - collaboration




FarmLink Research

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FarmLink 2014 Research Report
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FarmLink gratefully acknowledges the contributions of all project collaborators to this report and for the time and effort they have invested in ensuring the success of FarmLink.

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A word from Chairman and CEO

Dear Members,

It is with pleasure that we present to you the 2014 FarmLink Annual Research Report. In many respects 2014 has been a pivotal year for FarmLink - over the twelve months we have restructured and reinvigorated the business. As a business we are now in much better shape than we were this time last year. This has taken a focused effort from the board and staff and given the progress we have made on the business front, it is pleasing to be also able to deliver to you a package of Research, Development & Extension (RD&E) outcomes for the FarmLink region.

Highlights for this year included our 10th anniversary annual dinner held in July at the Magpies Nest Restaurant in Wagga Wagga, attended by around 60 FarmLink members. The night celebrated FarmLink's long and impressive history and recognised the enormous contribution of our members and volunteers in the establishment of FarmLink and in its ongoing success.

In September we held our annual open day at Temora Agricultural Innovation Centre, which was our most successful open day so far, with 150 people participating in the day consisting of a mix of field walks, presentations and trade displays. The opportunity to catch up with other farmers and industry players over refreshments at the close of the day was wonderful.

In 2014 we have added a few new names to the group of wonderful organisations that sponsor FarmLink and we are very grateful for the moral and financial support that we enjoy from these organisations. We hope to continue to build mutually beneficial partnerships between these companies, FarmLink and our members.

Our 2014 RD&E program and activities have included partnerships with GRDC, DAFF, NSW DPI, Graham Centre, CSU, CSIRO, University of Adelaide, Cropfacts, AgroAgonomy, BCG, CWFS, SFS, Bayer, Landmark, BASF and SARDI. Through these partnerships we are able to deliver your RD&E outcomes in the following areas:

- Stubble management
- Strategic tillage
- Soil carbon
- Crop rotations and break crop incorporation
- Micronutrient deficiency
- Phosphorus rate variation
- Dual crop grazing
- Direct heading of canola
- Weed management
- Soil constraints
- Early sowing

We have also compiled research undertaken in other areas with outcomes of interest in our area -

- The effect of grazing intensity on crops
- Early Sowing of Barley and Early Sowing of Canola

We take this opportunity to thank you for your involvement in FarmLink and ask that if there are Research, Development or Extension needs on your farm, or in your business, that you contact us to talk about the issues so that we can look at ways to have the work undertaken.

Looking forward to 2015

Regards,

Bernard Hart
Chair

Cindy Cassidy
CEO

January
Meeting of Board

February
Meeting of Board
Members Consultation Meetings

March
Growers update – Wallendbeen
Sheep Handling Field Day
Soil Carbon Workshop
The Link Newsletter

April
Meeting of Board
Research Development and Extension Committee Meeting

May
Meeting of Board
Research, Development and Extension Meeting

June
Meeting of Board
Winter Bus Tour
The Link Newsletter

July
Meeting of Board
FarmLink Annual Dinner
Ariah Park and District Farmer Field Day

August
Meeting of Board
Sheep Dog Handling Course

September
Meeting of Board
Research, Development and Extension Committee meeting
Barellan Field Day
FarmLink Open Day
The Link Newsletter

October
Meeting of Board
Research, Development and Extension Committee meeting
Iandra field day

November
Meeting of Board

December
Meeting of Board
Research, Development and Extension Committee meeting
Stubble Demonstration
The Link Newsletter

Images

1 - Annual dinner - Kym Hampton, Executive Manager, Riverina, Commonwealth Bank addressed the FarmLink Annual Dinner.

2 - Annual dinner – FarmLink Chair Bernard Hart, CEO Cindy Cassidy and long time supporters John Pattison and Michael Sinclair cut the cake to celebrate 10 years of FarmLink Research.

3 - Uni crops comp – Some of the students participating in the annual University Crops Competition hosted by GrainGrowers.

4 - Grazing sheep – Sheep grazing trials at Temora Agricultural Innovation Centre.

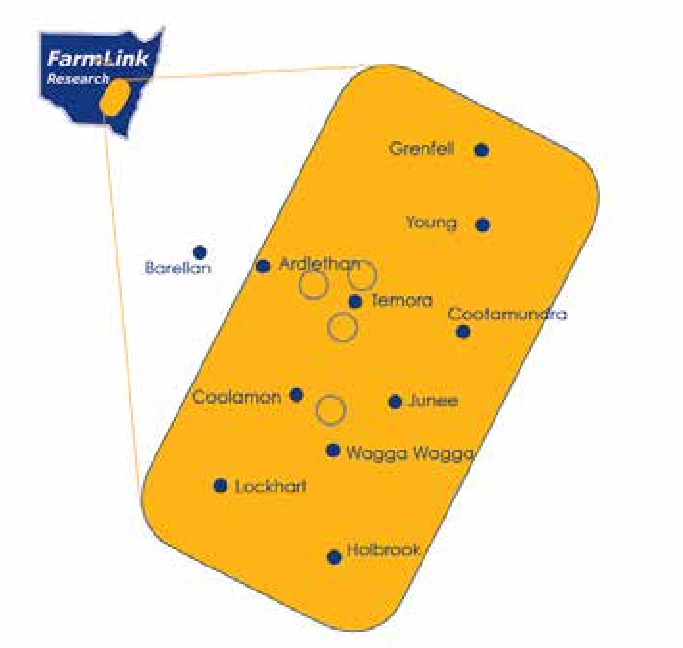
5 - Open day – Trial tours were conducted as part of the FarmLink Open Day during September.

6 - Open day – FarmLink CEO Cindy Cassidy welcomes everyone to the FarmLink Open Day.

FarmLink
Research Report 2014
01

Maintaining Profitable Farming Systems with Retained Stubble

2014 Trial Site



Project Partners

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Maintaining Profitable Farming Systems with Retained Stubble

The issues of Crop Sequences for Seeding Equipment; Rotary Harrows for Improved Herbicide Efficacy; Harvest and Post Harvest Stubble Management; and Stubble Management, Nutrition and Moisture Conservation in Mixed Farming Systems were all identified when developing the five year trial plan for the – Maintaining Profitable Farming Systems with Retained Stubble Project – funded by GRDC.

CSIRO, FarmLink Research, Farmers and Advisors have partnered to conduct the project across the FarmLink region aimed at investigating the potential of management systems to increase profitability when farming in full stubble retention systems.

The four key identified issues will be explored in-depth during the course of the project -

1) Crop Sequences for Seeding Equipment. Disc seeders have been widely adopted in our region to facilitate trouble free establishment of crops into large stubble loads. The disc seeder system has no registered pre-emergent herbicides available for weed control. Farmers and advisors are leading the development of systems that will successfully control a range of weeds. Crop sequences will be an additional tool to combat problem weeds in both the disc and tyne seeding equipment. This will be a small plot trial established into an existing population of annual ryegrass at the Temora Agricultural Innovation Centre.

2) Rotary harrows for improved herbicide efficacy. Local growers have been trialing the use of steel rotary harrows to increase herbicide efficacy, establishment percentages and reduce the impact of stubble born diseases. A farmer sown strip trial will be carried out to determine the differences between a range of treatments.

3) Harvest and post harvest stubble management. Some growers are harvesting at low heights to allow easy establishment of the following year's crop. This can reduce harvest efficiency and increase the time taken to complete harvest operations. A replicated farmer sown trial looking at the impact of short and high stubble height compared to post harvest treatments of burning and K-line trash cutting was established. Harvest delays increase potential for weather damage of grain crops which can decrease profitability.

4) Stubble management, nutrition and moisture conservation in mixed farming systems. This is an extension of the Water Use Efficiency Project and will be conducted at this trial site. Each plot will contain strips of knife point, spear point and disc openers to compare the impacts on each of grazing, stubble retention and burning.

The focus of the project for this 2014 Research Report falls on the third key issue - Harvest and Post Harvest Stubble Management - detailing results from the experiment located north of Wagga.

Harvest and post-harvest stubble management

James Hunt, Tony Swan, Brad Rheinheimer, Laura Goward (CSIRO Agriculture), Tony Pratt, Phil Moroney (FarmLink Research), Rohan Brill (NSW DPI)

Introduction

It is often stated that management of stubble begins at harvest, and many stubble retention practitioners advocate harvesting cereal crops low to the ground and spreading trash across the width of the header to allow direct seeding into residues the following year. However, harvesting low has several drawbacks, including decreased harvest efficiency and increased grain losses, wear and tear on machinery and chances of weather damage. This is particularly the case in the S NSW environment which tends to produce high biomass crops, and with equi-seasonal rainfall is prone to harvest rain.

The aim of this experiment was to evaluate different harvest and post-harvest stubble management techniques and measure their effect on harvest efficiency, grain losses and growth and yield of the subsequent crop.

Methods

The experiment was located on the property of Ben and Lou Beck at Downside, north of Wagga. The Beck's farm on a 9 m controlled traffic system, and their sowing/harvesting swathes were used as 'plots' (9 m x ~800 m). Four different stubble management treatments were applied in a randomized complete block design with 3 replicates. Treatments were;

1. Harvest tall ('tall')
2. Harvest tall & burn in autumn ('burn')
3. Harvest tall & chop in summer ('chop')
4. Harvest short & spread ('short')

These treatments were applied to frosted wheat cv. Suntop crop in 2013 that yielded ~2 t/ha of grain and had 7.6 t/ha of stubble. All treatments were harvested with a John Deere JD 9770 STS with PowerCast tailboard and speed was adjusted to give an acceptable level of losses according to the combine

Figure 1. Comparison of stubble length in 'tall' and 'short' harvest height treatments

Figure 2. Canola growth in different stubble treatments 30 May 2014

grain loss monitor. Grain yield, fuel consumption and harvest speed and efficiency were taken from the combine yield monitor. The 'tall' treatment was harvest at 60 cm above the ground (just below heads) and the 'short' treatment was harvested at 15 cm (Figure 1). The 'chop' treatment was applied using a K-line Traschcutter™ (bars lay stubble on the ground where it is cut with self-sharpening discs) in December 2013. The 'burn' treatment was applied on 19 March 2014. On 19 April 2014 the trial was inter-row sown to TT canola cv. Bonito using an Excel single-disk seeder. Crop emergence and NDVI were measured during the growing season, and soil and air temperature during winter. Hand harvest grain yield was measured by taking 15 x 1 m^2 hand harvests per plot across the elevation gradient in the field when 40% of seeds had changed color, and hand threshing once harvest-ripe. Machine harvest yield was measured by windrowing crop according to treatment readiness and then harvesting with JD 9770 STS and weighing yield from each plot in a chaser-bin fitted with load cells. Blackleg was scored after windrowing by digging up 50 stems

Figure 3. A comparison between 'tall' on left and 'burn' on right 13 August 2014

Figure 4. One of the 'burn' plots showing its more advanced stage of development relative to the stubble retain treatments (28 October 2014)

per plot, cutting at ground level with secateurs and scoring % stem canker infection. Frost damage was scored by counting the number of missing pods on 45 stems per plot and number of missing seeds in 225 pods per plot.

Results & discussion

Harvesting short reduced harvest efficiency by 3.8 Ha/h, yield by 0.14 t/ha and increased fuel consumption by 4.2 l/ha (Table 1). Based on combine running costs of $600/h and grain price of $250/t, harvesting short cost an additional $77/ha compared to harvesting tall.

Table 1. Harvest efficiency, fuel consumption and grain yield for wheat cv. Suntop in 2014 at different harvest heights. Values are means of three replicates taken from JD 9770 STS yield monitor and all differences are significant (P<0.05).

Harvest height	Efficiency (ha/h)	Speed (km/h)	Fuel (L/h)	Fuel (L/ha)	Efficiency (t/h)	Yield (t/ha)
Short (~15 cm)	5.7	6.2	54.3	9.6	14.0	2.05
Tall (~60 cm)	9.5	10.6	51.2	5.4	28.8	2.19
% decrease harvesting short	**41%**	**42%**	**-6%**	**-78%**	**51%**	**6%**

Soil and trash at seeding in 2014 were wet, and the Excel disc-seeder hair-pinned stubble and chaff lying on the ground in the 'short' and 'chop treatments. This was particularly bad in the 'short' treatment where chaff had been concentrated in bands due to inconsistent spreading by the combine across the swathe. In treatments with hair-pinning ('short' & 'chop'), canola establishment was reduced (Figure 2, Table 2). Establishment was better in the 'tall' and 'burn' treatments where there was no crop residue in the inter-row to interfere with the operation of the disc seeder. Early growth as measured by NDVI was slower in the three stubble retained treatments in comparison to the 'burn' treatment.

Table 2. Canola establishment and NDVI measured 30 May 2014

2013 stubble management	2014 canola establishment (plants/m²)	2014 crop NDVI 30 May 2014 (corrected for background stubble)
Tall	24	0.067
Burn	30	0.291
Chop	15	0.053
Short	16	0.027
P-value	**<0.001**	**<0.001**
LSD (P=0.05)	**3**	**0.052**

Development was also slower in the stubble retained treatments, and by 13 August the 'burn' treatment was in full flower whilst stubble retain treatments were just starting to flower (Figure 3). Minimum temperatures in August and September were extremely hostile (Table 3), and more frost damage was recorded in treatments which had higher plant densities ('tall' and 'burn' – Table 4, Figure 5). The exact reason for this is not clear, but we think the most likely explanation is that plants in the treatments with low density ('short' and 'chop') had more branches and soil water remaining, and could thus compensate better with more later flowering and growth. The more advanced development in the 'burn' treatment may have also contributed.

Table 3. Canopy temperature in the 'burn' and 'tall' treatments during August 2014

Time	Burn	Tall
8-Aug	-1.1	-1.0
9-Aug	-1.9	-1.8
10-Aug	1.3	1.3
11-Aug	-2.4	-2.0
12-Aug	-1.8	-2.0
13-Aug	-3.0	-2.8
14-Aug	-3.2	-3.8
15-Aug	-1.9	-2.0
16-Aug	-0.2	-0.3
17-Aug	7.7	7.7
18-Aug	5.9	5.7
19-Aug	2.0	2.1
20-Aug	-0.8	-0.8
21-Aug	0.4	-0.3
22-Aug	1.7	2.0

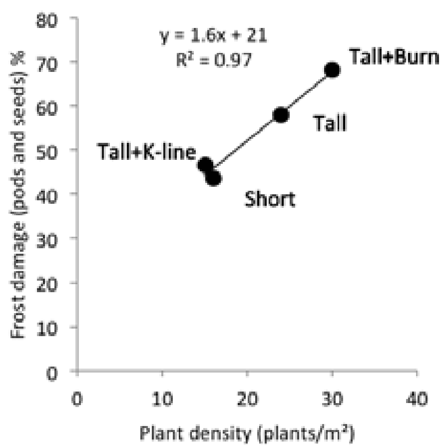


Figure 5. The relationship between plant density and frost damage in canola across different treatments in the experiment in 2014.

More frost damage in the treatments with high plant density meant that their higher dry matter could not be converted to yield, and there was no significant effect of treatment on either hand or machine harvest grain yield (Table 4). Even when yields were corrected for frost damage, there was no significant different between treatments. Blackleg infection was higher in the 'chop' treatment compared to the others, but there is no clear explanation as to why this may have been the case.

Table 4. Header and hand harvest grain yield, frost damage, frost adjusted grain yield and blackleg infection in the different stubble treatments in 2014.

2013 stubble management	Header grain yield (t/ha)	Hand grain yield (t/ha)	Frost damage (missing pods and seeds %)	Frost adjusted header grain yield (t/ha)	Blackleg (mean % stem infection)
Tall	1.3	1.4	58	2.0	19
Burn	1.2	1.4	68	2.0	25
Chop	1.3	1.6	43	1.8	36
Short	1.2	1.6	47	1.8	20
P-value	**0.486**	**0.508**	**<0.001**	**0.157**	**0.001**
LSD (P=0.05)	**NS**	**NS**	**8**	**NS**	**7**

Conclusions

Given that grain yields were equivalent in 2014, the relative advantages of the different 2013 stubble management techniques used here relate to their cost and ease of implementation. Using a combine harvester to manage stubble at harvest was expensive ($77/ha), increased wear and tear on the combine, and by slowing harvest exposed crops to greater risk of weather damage. Establishment was also poor in this treatment due to hair-pinning, but this may not have been the case if a tined seeder had been used to conduct the experiment. Harvesting tall and inter-row sowing was the cheapest form of stubble management and also gave good establishment. However, specialized equipment (disc seeder & 2 cm RTK) are required to achieve this in tall & heavy stubbles. Burning is cheap and effective at removing stubble, and allowed excellent establishment and greater early vigor for competition with weeds etc. However, because of its dependence on climatic conditions, it may be difficult to implement over large areas, particularly in hilly and timbered paddocks. Post-harvest stubble management of tall stubble with a K-line Trashcutter™ was much cheaper (~$12/ha) than cutting short with the combine, and gave a similar result in terms of establishment and plant yield.

Acknowledgements

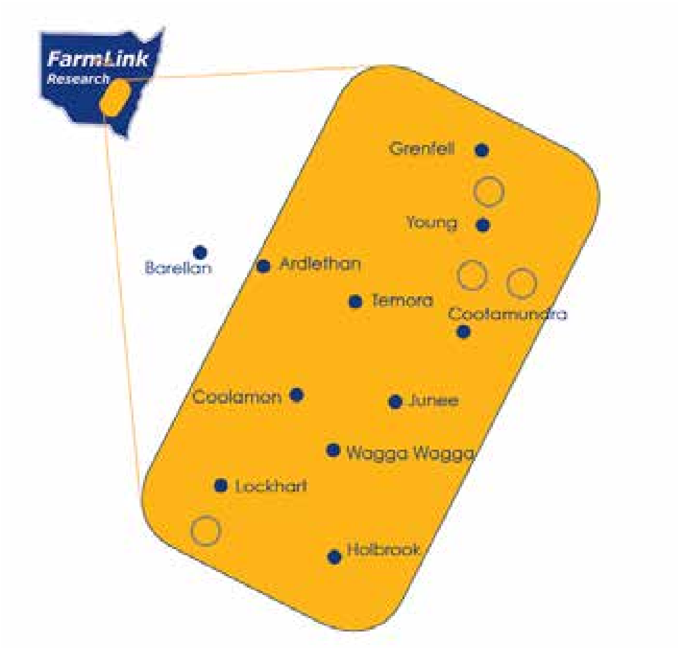
Huge thanks to Ben and Lou Beck for hosting and conducting operations on this experiment. This experiment was funded by GRDC project 'Maintaining profitable farming systems with retained stubble in NSW South West Slopes and Riverina', and designed in conjunction with the FarmLink Research project steering committee.

GRDC Project Code: CSP 00174

FarmLink
Research Report 2014
02

The strategic use of tillage within conservation farming

2014 Trial Site



Project Partners

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CSIRO

NSW Government Department of Primary Industries

Funding Partner

GRDC Grains Research & Development Corporation

The strategic use of tillage within conservation farming

Author - Mark Conyers on behalf of the team consisting of farmers Geoff and John Byrne, Chris Holland, Andrew Simpson, consultants Peter McInerney, Greg Hunt, Sandy Biddulph and Cindy Cassidy (FarmLink), John Kirkegaard, Clive Kirkby, Andrew Bissett and John Graham (CSIRO), Phil Eberbach (CSU), Vince van der Rijt, Albert Oates, Graeme Poile, Kurt Lindbeck (DPI NSW).

The project on the strategic use of tillage within no-till systems continued at the four sites in 2014. This year we report on the ongoing trends in aggregate stability (a soil physical property) at the Harden site. We also show a little of the soil P story that we are working on.

Soil Physical Properties

We have been collecting data on bulk density and water infiltration rates over the last two years. However the variable of most interest is the wet aggregate stability, a measure of how resistant the soil is to breaking down under raindrop impact or traffic. In 2013 we thought the story was over at the Harden site: the soil had recovered. However the wet autumn of 2014 resulted in a general loss of aggregate stability in all treatments (Figure 1). It also became apparent that the treatments where stubble was burnt never quite reached the same stability as where stubble was retained, or under pasture, although the difference at the site in Figure 1 is only ~5%. At the Thuddungra site, where we are also comparing stubble retention vs stubble burning, aggregate stability was less in the burnt system. So the caution is, although the soils in our trials appear to recover their aggregate stability from a single tillage within 1 to 2 years, recovery is slower where return of organic matter is minimal, and aggregate stability is subject to seasonal fluctuations.

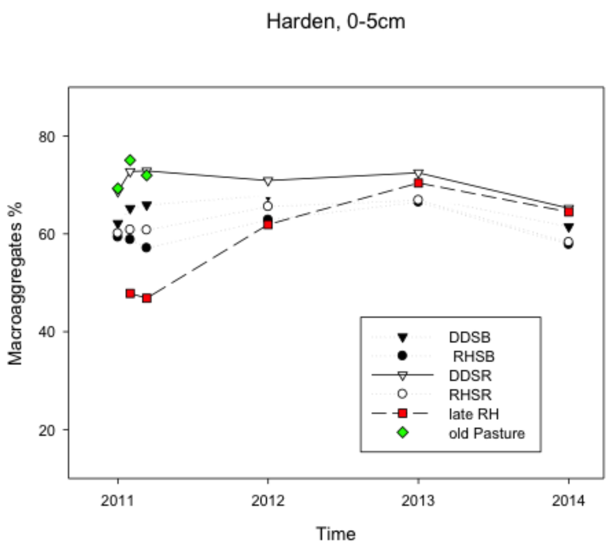

Figure 1. The wet aggregate stability in the surface 0-5 cm at the Harden trial site.

Soil Chemical Properties

Under minimum till or no till management there is a tendency for some nutrients to accumulate on the soil surface. An example from our Daysdale site is given in Figure 2. The soil sampler, when inserted to 10 cm depth, tells us that there is 103 ppm of Colwell P in the soil. As can be seen from the figure however there is a steep gradient of P from 130 to 5 ppm within the top 20 cm of soil. This might not be an issue when there is such an abundance of P in the soil, however in figure 3 we show a site from a P trial. The soil test P is 50 ppm at 0-10cm depth, which sounds more than adequate. However the placement of cereal seed ranged from 3 to 7 cm depth. The emerging seminal roots would experience far less P than indicated by the soil test. This might explain why, in no till systems, we frequently obtain responses to fertiliser P when we would not expect responses. This will be the subject of trial work in 2015.

Final findings and recommendations from this strategic tillage project will be available in 2017.

GRDC Project Code: DAN00152

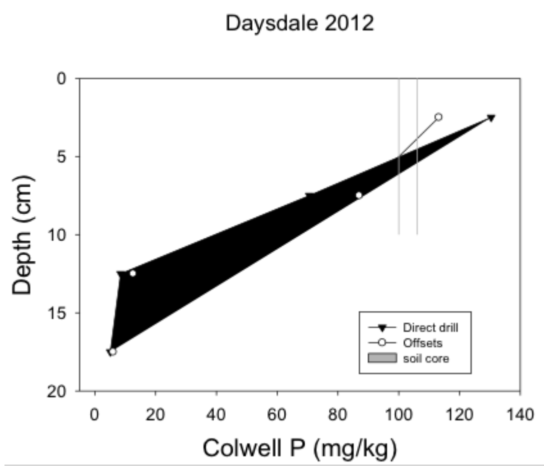

Figure 2. The effect of tillage on the distribution of soil P (Colwell P) with depth at the Daysdale site in 2012.

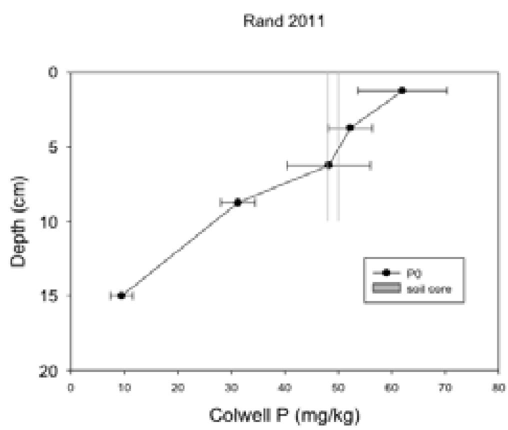

Figure 2. The effect of tillage on the distribution of soil P (Colwell P) with depth at the Daysdale site in 2012.

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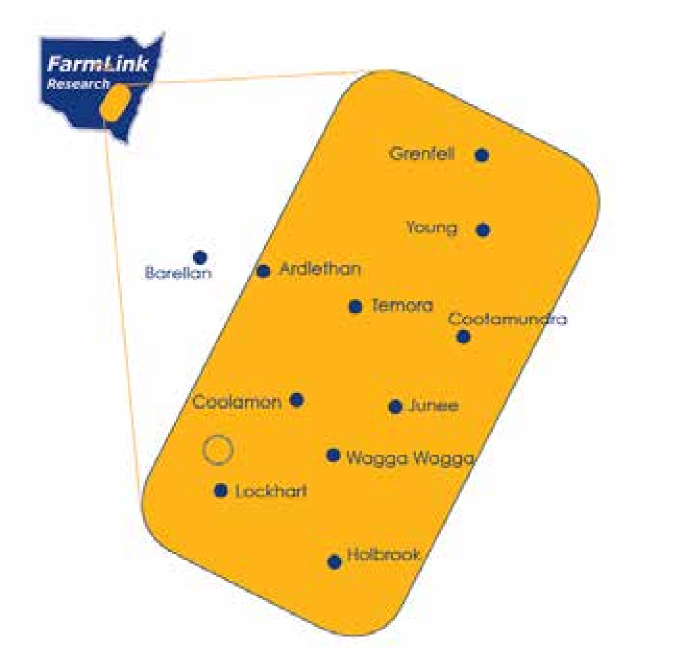
03

Crop Sequencing

2014 Trial Site



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Legume effects on soil N dynamics: Comparisons of crop response to legume and fertiliser N

Mark Peoples, Tony Swan, Laura Goward, James Hunt (CSIRO Agriculture Flagship), Guangdi Li (NSW DPI), Rob Harris (Vic DEPI), De-Anne Ferrier, Claire Browne, Simon Craig (Birchip Cropping Group), Harm van Rees (CropFacts), James Mwendwa (Central West Farming Systems), Tony Pratt (FarmLink), Felicity Turner MacKillop Farm Management Group), Trent Potter (Yeruga Crop Research), Allison Glover (Riverine Plains Inc), Jon Midwood (Southern Farming Systems)

Keywords: Pulses, canola, wheat, nitrogen, fertiliser

Take home messages

- The choice of legume species and management were found to influence the amount of nitrogen (N) fixed by both crop and pasture legumes by affecting either legume reliance upon N2 fixation for growth or changes in dry matter (DM) accumulation. On average 19 kg of N is fixed per tonne of shoot dry matter produced by pulse crops.
- The amount of N fixed by field peas tends to be lower than either lupin or faba bean.
- Medium to high soil mineral N concentrations at sowing (>50 kg mineral N/ha) appeared to suppress N2 fixation by field pea more than lupins or faba beans.
- Pulse legumes grown for grain generally result in lower net inputs of fixed N than either brown manured or forage legumes because large amounts of N are removed at grain harvest.
- Available soil N following either legume crops or pastures can represent an additional 40 to 90 kg N/ha in the 1st year and 20 to 35 kg N/ha for the 2nd year relative to continuous cereal sequences. This additional mineral N represented 7-11 kg N per tonne of pulse residue DM, or 15 kg N per tonne legume DM grown in a pasture.
- The increased N uptake by the 1st wheat crop grown after legumes was equivalent to 27-40% of N in the previous year's legume residues. In comparison, 47-59% of fertiliser N was recovered by wheat when it was applied at stem elongation just prior to a period of high crop demand for N.

Introduction

This paper reports results from previous research and some recent findings from a GRDC-funded project (CSP00146) where inputs of fixed N2 by different legumes have been routinely measured during experimentation and the nitrogen (N) dynamics of following wheat crops relying upon legume and/or fertiliser N have been assessed. The project examines the effect of legumes or canola break crops on subsequent cereal productivity in cereal-dominated cropping systems through participatory research, in partnership with leading grower groups and agribusiness consultants from NSW, Victoria and SA.

Legume inputs of fixed N

The amounts of N2 fixed by legumes are regulated by two factors: (i) the amount of legume N accumulated over the growing season (as determined by shoot dry matter (DM) production and %N content), and (ii) the proportion of the legume N derived from atmospheric N2 (often abbreviated as %Ndfa).

Amount of legume shoot N fixed = (legume shoot DM x %N/100) x (%Ndfa/100)

Comparisons of different legumes

Several project studies have demonstrated the impact of crop species and management on inputs of fixed N. This was exemplified recently by the SFS 'Pulse Challenge' competition where 21 farmer, agribusiness and researcher teams grew either field pea, lupin or faba bean at Lake Bolac or Inverleigh, Vic in 2011. When the three pulses were compared side-by-side, field pea fixed less N per tonne shoot dry matter (DM) production than either lupin or faba bean (Fig. 1a). Field pea's lower reliance upon N2 fixation for growth (%Ndfa) suggested that it was more sensitive to soil nitrate at sowing than the other crops (40 and 84 kg N/ha at Inverleigh and Lake Bolac at 0-100 cm, respectively; Fig. 1b). The N2 fixation data collated across all 21 crops indicated a strong relationship between the amounts of shoot N fixed (ranged from 1-163 kg N/ha) and shoot (0.04 t DM/ha where grass weeds were not controlled to 7.2 t DM/ha) and on average 19 kg shoot N was fixed per tonne shoot DM accumulated (Fig. 1c and d). Similar relationships were observed in trials undertaken in association with MFMG in SA and FarmLink in southern NSW, and have been reported previously across a range of environments and legume species (see also Peoples et al. 2009; Unkovich et al. 2010).

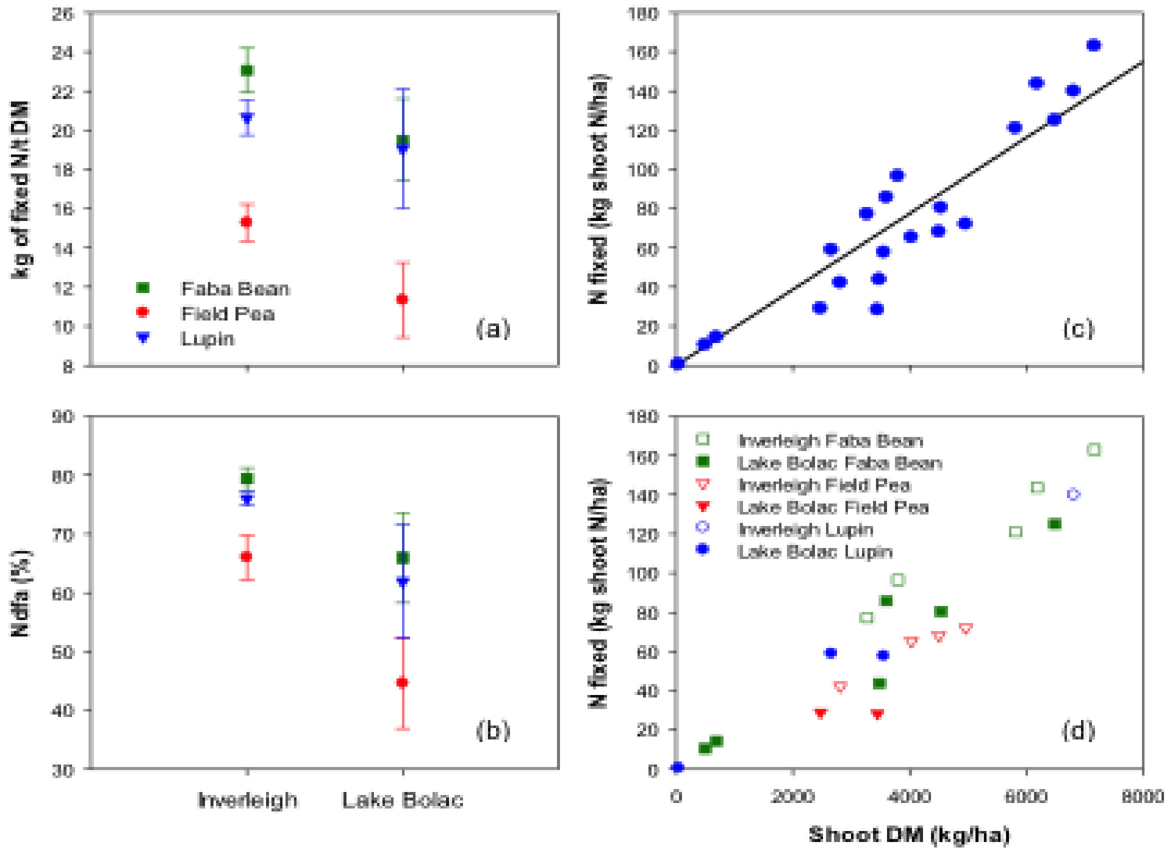

Figure 1. Estimates of (a) the amounts of shoot N fixed per tonne of above-ground dry matter (DM) by faba bean, lupin or field pea grown at Inverleigh and Lake Bolac, Vic in 2011, and (b) the percentage of legume N derived from the atmosphere (%Ndfa) for each pulse species and location. The relationship between the amount of shoot N fixed and pulse shoot DM depicted in (c) and (d) represented 19.4 kg N per tonne DM accumulated across all crops (R2 = 0.85). Bars indicate standard deviation.

N2 fixation by commercial pulse crops

A total of 35 commercial pulse crops have been sampled in famers' paddocks for determinations of N2 fixation in southern and central NSW, the Victorian Mallee and Wimmera, and the high-rainfall zone of south-eastern SA between 2001 and 2013. Amounts of shoot N fixed ranged from 12-180 kg N/ha (median 61 kg N/ha and 16 kg N/t DM) and %Ndfa from 8-87% (median 68%, Table 1). On-farm measures of %Ndfa were <50% N in 9 of 35 crops, with <10 kg shoot N being fixed per tonne of shoot DM in 7 of those crops. In some instances low inputs of fixed N could be related to direct effects of drought on growth, or high concentrations of soil nitrate where a period of drought was followed by a wet summer-autumn. In other situations this seemed to be related to routinely sowing legumes without inoculation, or the early termination of legume crops in mid-spring either by cutting for hay or sprayed with knock-down herbicides for weed control and to provide N benefits for subsequent crops (ie brown manuring).

Net inputs of fixed N2

The amounts of shoot N fixed by legumes are informative, but what is more important is how much

Legume	Number of crops	Shoot DM	Shoot N fixed		
		(t DM/ha)	(%Ndfa)	(kg N/ha)	(kg N/t DM)
Faba bean	5	7.2-8.4	68-89	117-152	16-18
		[7.6]	[74]	[135]	[17]
Lupin	11	0.9-10.2	20-82	20-150	9-21
		[5.5]	[59]	[74]	[15]
Vetch	3	4.2-6.3	54-84	53-135	13-22
		[5.1]	[69]	[89]	[17]
Lentil	3	2.0-5.3	17-82	20-104	4-20
		[4.0]	[50]	[51]	[13]
Field pea	7	2.3-5.9	8-85	12-87	2-20
		[3.9]	[53]	[45]	[14]
Chickpea	6	0.8-5.2	24-87	13-66	7-17
		[2.9]	[67]	[34]	[13]
Median all crops			**68**	**61**	**16**

Table 1. The range of measures of shoot dry matter (DM) production and estimates of N2 fixation for 35 commercial pulse crops sampled in farmers' fields between 2001 and 2013. Mean values for each parameter and crop species are shown in brackets.

fixed N might be contributed to the soil at the end of the growing season. Since the root systems of legumes can contain between 25% to 60% of the total plant N, this below-ground contribution of fixed N could be a substantial component of the potential carry-over N benefit for following crops and should not be ignored (Peoples et al. 2009). Since it is extremely difficult to fully recover root systems of legumes in the field, total N fixed is usually calculated by adjusting the shoot measures of N2 fixation to include an estimate of how much fixed N might also be associated with the nodulated roots using a 'root factor' (see Peoples et al. 2012; Unkovich et al. 2010). For many pulse legumes around one-third of the plant N may be below-ground in roots and nodules; in this case a 'root factor' of 1.5 would be used.

Location	Legume	Total amounts of N2 fixed[A] (kg N/ha)	N removed or lost (kg N/ha)	Net input of fixed N (kg N/ha)
Naracoorte, SA	Subclover pasture	102	8 in wool + 24 lost	+70
	Field pea for grain	125	128 in grain	-3
	Faba bean for grain	180	120 in grain	+60
Hopetoun, Vic	Vetch for BM	130	0	+130
	Vetch for hay	130	89 in hay	+41
	Field pea for grain	125	136 in grain	-11
Yarrawonga, Vic	Field pea for BM	86	0	+86
	Field pea for hay	86	65 in hay	+21
	Vetch for hay	141	82 in hay	+59
	Arrowleaf clover hay	138	70 in hay	+68
	Subclover for hay	118	68 in hay	+50
	Faba bean for grain	129	105 in grain	+24
	Chickpea for grain	50	60	-10
Wagga, NSW	Forage legume mix[B]	71	8 in wool + 17 lost	+63
	Vetch for forage	83	8 in wool + 23 lost	+52
	Field pea for grain	65	104 in grain	-39
	Lupin for grain	75	105 in grain	-28
Junee, NSW	Lupin for BM	246	0	+246
	Field pea for BM	114	0	+114
	Lupin for grain	310	214 in grain	+96
	Chickpea for grain	141	77 in grain	+65
	Lentil for grain	137	139 in grain	-2

Table 2. Examples of net contributions of fixed N where the total amounts of N2 fixed by different legumes grown for forage, brown manure (BM) or grain have been compared to estimates of the amounts of N removed in either hay, wool, or grain, or lost by volatilization from urine patches from grazed pastures (Peoples et al. 2012 and unpublished data)

[A] The amounts of shoot N fixed were adjusted to include an estimate of N contributed by the nodulated roots as described by Unkovich et al. (2010).
[B] Pasture mixture with a forage dry matter composition consisting of 41% balansa clover, 29% subclover, 17% berseem clover, and 13% arrowleaf clover.

Total N fixed = (shoot N fixed) x root factor

The net inputs of fixed N are derived by comparing the total amounts of N fixed to the amounts of N removed in harvested grain or animal products, or lost from the system via volatilisation of ammonia from urine patches where the legumes are grazed (Peoples et al. 2012).

Net input of fixed N = (total amount of N fixed) – (N removed + N lost)

Various studies undertaken in SA, Vic and southern NSW have compared inputs of fixed N by pulses grown for grain or brown manure (BM) and pure legume swards either cut for hay or used as grazed pasture. Data generated by experiments indicated that brown manured crops and forage legumes generally provided greater net returns of fixed N to soils than grain crops since large amounts of N were removed in the high-protein legume grain at harvest (Table 2). However, it is also clear from these data that different legume species have different potential for growth and N2 fixation regardless of their eventual end-use (Table 2).

Impact of legumes on available soil N

Crop legumes - Although legumes exert a significant effect on total soil N content through biological N2 fixation it is often difficult to quantify significant short-term changes because the inputs of fixed N are generally small relative to the large (and variable) background concentration of organic N in soil. By contrast measurements of elevated soil inorganic (mineral) N after legumes are very common across a wide range of different cropping systems. For example, a large data set of pre-season measures of soil mineral N collected from farmer paddocks in SA between 2002 and 2014 suggested that, on average, concentrations of soil mineral N after legumes can be expected to be 25-35 kg N/ha higher than following cereals (Table 3).

Paddock use in the previous year	Number of paddocks sampled	Soil mineral N	
		Measured range (kg N/ha)	Average (kg N/ha)
Wheat	847	8 - 200	67
Barley	267	9 - 203	56
Faba bean	99	36 - 187	97
Field pea	110	43 - 158	90
Lentil	248	26 - 245	87

Table 3. Examples of autumn measures of concentrations of available soil N (0-0.6m) following cereals or break crops from commercial cropping paddocks located on the Yorke Peninsula, the mid-north and upper north of South Australia between 2002-2014.[a]

[a] Client data courtesy of Allan Mayfield Consulting (Clare), Holmes Farm Consulting (Maitland) and McC Ag Consulting (Laura, SA).

Results from an experimental trial undertaken near Junee in southern NSW in 2011 (Table 4) indicated that soil mineral N measured just prior to sowing wheat in 2012 were 42 or 92 kg N/ha greater following lupin than after wheat or canola where lupin crops had been grown for either grain or brown manure (BM), respectively (Table 5). This represented the equivalent of 7-11 kg mineral N/ha per tonne of legume residue biomass. Concentrations of soil mineral N were still 18 or 34 kg N/ha higher under the lupin grain crop-wheat and lupin BM-wheat sequences, respectively than for wheat-wheat in 2013 when another wheat crop was grown (Table 5).

Table 4. Dry matter (DM) accumulation, grain yield and N remaining in crop residues where either lupin grown for grain or brown manure (BM), wheat, or canola were sown at Junee, NSW in 2011[a]

Crop grown in 2011	Peak biomass (t DM/ha)	Grain yield (t/ha)	Grain N harvested (kg N/ha)	N remaining in residues (kg N/ha)
Lupins BM	8.4	0	0	290
Lupins	9.9	3.5	210	188
Wheat +N[b]	11.1	4.8	87	64
Canola +N[b]	10.6	3.2	94	111
LSD (P<0.05)	**1.3**	**0.5**	**11**	**22**

[a] Growing season rainfall = 216 mm compared to long-term average of 311 mm.

[b] Urea fertiliser was applied to wheat @ 49 kg N/ha and canola @ 66 kg N/ha.

Table 5. Concentrations of soil mineral N (0-1.6m) measured in autumn 2012 and 2013 following either wheat, canola and lupin grown for grain or brown manure (BM) at Junee, NSW in 2011, and calculations of the apparent net mineralisation of N from lupin residues.

Crop grown in 2011	Soil mineral N autumn 2012 (kg N/ha)	Apparent mineralisation of legume N (% 2011 residue)	Soil mineral N autumn 2013 (kg N/ha)	Apparent net mineralisation of legume N (% 2011 residue)
Lupins BM	8.4	0	0	290
Lupins	9.9	3.5	210	188
Wheat +N[b]	11.1	4.8	87	64
Canola +N[b]	10.6	3.2	94	111
LSD (P<0.05)	**1.3**	**0.5**	**11**	**22**

It is possible to calculate the apparent net mineralisation of lupin N by dividing the differences in soil mineral N data following the 2011 lupin and wheat treatments (Table 5) by the amount of N present in the original lupin residues at the end of the 2011 growing season (Table 4) – note: this assumes a negligible net N release from the 2011 wheat stubble or roots and provides a conservative estimate of the apparent net mineralisation of the lupin N.

Apparent mineralisation = 100x [(mineral N after legume) – (mineral N after wheat)] /(legume residue N)

These calculations suggested that net mineralisation over the wet 2011/12 summer fallow (474 mm 25th Nov11 – March12) represented the equivalent of 22-32% of the 2011 lupin N, or 7-11 kg mineral N per tonne of residue DM. A further 10-12% of the residue N was subsequently released during the 2012/13 fallow period prior to sowing the 2013 wheat crop.

Pasture legumes – Information on the release of mineral N after legume-based pastures can be gleaned from data generated following 3 years of different pasture treatments imposed at two locations in NSW that differed in total average annual rainfall (550mm at Junee, and 430mm at Ardlethan). These data (Fig. 3) indicated that concentrations of soil mineral N measured in the autumn immediately after a pasture were related to the cumulative amount of legume shoot biomass grown during the pasture phase (Fig. 3). In this study, an additional 15 kg mineral N/ha (on average) was accumulated over and above background mineralisation of soil organic N for every additional tonne of legume foliage DM grown (Fig.3).

In systems where alternating phases of lucerne-based pasture and grain crops are used, the lucerne needs to be terminated with herbicide or tillage prior to sowing a crop. On-farm experimentation also undertaken near Junee indicated that both the concentrations of soil mineral N measured when sowing the first wheat crop after the lucerne pasture, and the subsequent impact on crop N uptake and grain yield, were closely related to the timing of the removal of the lucerne prior to cropping (Table 6). In this particular experiment soil mineral N was increased by around 0.75 kg N/ha for every additional day of fallowing, or by 0.5 kg N/ha per mm of rainfall over the fallow period (Angus et al. 2000).

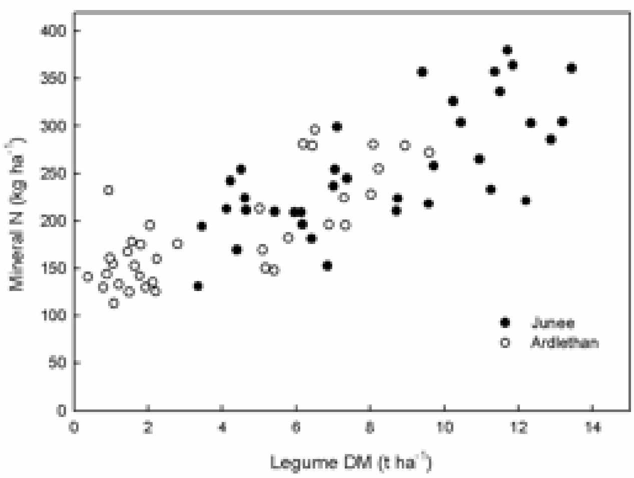

Figure 3 Relationship between concentrations of mineral N in the top 1m of soil just prior to cropping and the total shoot dry matter (DM) accumulated during the previous 3 years by pasture legumes. Regression equation: Mineral N = 14.8 x (legume DM) + 130 (R2 = 0.66).

Table 6. Example of the effect of timing of removal of lucerne prior to cropping on concentrations of soil mineral N (0-2m) at the time of sowing wheat, the subsequent crop uptake of N and grain yield.[a]

Time of lucerne removal	Sowing soil mineral N	Wheat shoot N at maturity	Wheat grain yield
(months prior to sowing)	(kg N/ha)	(kg N/ha)	(t/ha)
6	206	137	5.9
4	111	109	5.0
2	59	86	3.8

[a] Data represent the combined results of cultivation and herbicide removal treatments (Angus et al. 2000).

Comparisons of crop use of legume or fertiliser N

Not all of the N in legume residues will be available immediately to crops following either a pulse crop or a pasture phase. The decomposition and mineralisation of residue N into inorganic forms are microbial-mediated processes with the breakdown of organic compounds providing the soil microbes with a C source for respiration and growth. Much of the simple organic N released is rapidly assimilated (immobilised) by the soil microbial population (Peoples et al. 2009). Mineral N for uptake by plants becomes available only when the amounts of N released from the organic residues exceed the microbial growth requirements (i.e. when gross mineralisation of N exceeds microbial immobilisation). This is more likely to occur with legume material than with cereals residues since legume organic matter has a higher N content and lower C:N ratio. Since the conversion of organic N into inorganic N is mediated by soil microbes, only a portion of the N originally present in the nodulated roots and legume shoot residues will become available for plant uptake in the short-term.

The large differences in soil mineral N observed following lupin grown for grain or BM in 2011 compared to wheat or canola top-dressed with fertiliser N applied at stem elongation, in the experiment described above in Tables 4 and 5 resulted in major increases in wheat N uptake and grain protein in 2012 after both lupin crops (Table 7). Unfortunately the impact of the additional N supply via either of the lupin treatments or the top-dressed fertiliser N was not reflected in grain production as yields were just 0.4-0.6 t/ha greater than that achieved by wheat grown only with basal fertiliser N after wheat or canola (Table 7). Essentially the dry growing season in 2012 (168mm cf 300mm long-term average) restricted the full benefits of the additional N supplied to the wheat being translated into grain yield. However, the design of the experiment was such that it was possible to derive estimates of the apparent recoveries of lupin N and top-dressed fertiliser N by wheat using the following equations and the lupin residue N data from Table 4:

Apparent recovery legume N = 100x [(wheat N after legume) – (wheat N after wheat)] /(legume residue N)

Apparent recovery fertiliser N = 100x [(wheat N100N) – (wheat N49N)] /(51)

Table 7. Grain yield and crop N uptake by wheat in 2012 following either wheat, canola and lupin grown for grain or brown manure (BM) at Junee, NSW in 2011, and calculations of the apparent recoveries by wheat of either N from lupin residues, or top-dressed fertiliser N.

Crop grown in 2011	Sowing soil mineral N 2012 (kg N/ha)	N fertiliser applied 2012 (kg N/ha)	Grain yield (t/ha)	Grain protein (%)	Wheat N uptake (kg N/ha)	Apparent N recovery (%)
Lupins BM	169	49	4.0	13.6	184	27
Lupins	119	49	3.9	12.4	159	28
Wheat	77	49	3.4	9.9	106	-
Wheat	77	100	3.8	11.7	136	59
Canola	76	49	3.4	9.8	113	-
Canola	76	100	3.8	11.8	137	47
LSD (P<0.05)	**35**		**0.3**	**0.8**		

Note: All 2012 wheat plots received a total of either 49 or 100 kg N/ha comprising of either 2.5 and 46 kg N/ha, or 7.5 and 92 kg N/ha applied at sowing and stem elongation (GS31); respectively.

Subsequent calculations suggested that the 2012 wheat crop recovered the equivalent of 27-28% of the lupin residue N. This compared to apparent recoveries of 47-59% of the top-dressed fertiliser (Table 7). Data from an experiment undertaken at Breeza on the Liverpool Plains in northern NSW in the late 1990's also provided another opportunity to undertake similar calculations to determine the apparent uptake of legume residue N by wheat. In this case, the equivalent of 40% of faba bean N was recovered by the next crop (Table 8). Comparisons of treatments with or without above-ground residues imposed in the Breeza study suggested that ~70% of the faba bean N assimilated by wheat came from the nodulated roots.

Table 8. Wheat N uptake in 1998 following either faba bean or barley grown at Breeza, NSW in 1997, and calculations of the apparent recoveries by wheat of the N from faba bean residues.[a]

Crop grown in 1997	Residue N in 1997[b] (kg N/ha)	Wheat N uptake in 1998 (kg N/ha)	Apparent recovery legume N (%)
Faba bean	96	97	40
Barley	73	59	-

[a] Source: Peoples et al (2009). Note: no fertiliser N treatments were included in this study.
[b] Includes an estimate of the contribution of below-ground N reported by Khan et al. (2003)

The relatively high recovery (47-59%, Table 7) of the top-dressed fertiliser by the Junee wheat crop is not totally unexpected since the N was applied just prior to the period of peak crop demand for N, which is consistent with the most appropriate timing for N applications to achieve the highest efficiencies of N use and lowest risks of N losses (Crews and Peoples 2005). Unfortunately the experimental design prevented a similar estimate for the recovery of the basal fertiliser N applied at sowing. However, a number of studies have monitored the fate of fertiliser N supplied at sowing using isotopic tracers in the past in various rainfed cereal systems around the world, and some of these data are summarised in Table 9. While there is a range of results, it might be concluded that on average roughly one-third of the fertiliser N tends to be assimilated by the crop. This value is comparable to the estimates obtained for the effects of lupin and faba bean on crop N uptake reported in Tables 7 and 8.

LOCAL FOCUS:

Legume effects on available soil nitrogen and comparisons of the apparent recovery of legume or fertiliser N by wheat

Mark Peoples, Tony Swan, Laura Goward and James Hunt (CSIRO Agriculture Flagship), Robert Hart (Hart Bros Seeds), Bernard Hart (Hart Bros Seeds and FarmLink)

Elevated soil inorganic (mineral) N after legumes is common across many cropping systems. Results from an experiment undertaken near Junee in southern NSW indicated that soil mineral N measured just prior to sowing wheat in 2012 (0-1.6m) were 42 or 92 kg N/ha greater following lupin than after wheat or canola where lupin crops had been grown for either grain or brown manure (BM), respectively in 2011. The apparent net mineralisation over the wet 2011/12 summer fallow represented the equivalent of 0.1-0.2 kg N/ha per mm rainfall, 22-32% of the 2011 lupin N, and 7-11 kg mineral N per tonne of legume residue dry matter. Concentrations of soil mineral N were still 18 or 34 kg N/ha higher under the lupin grain crop-wheat and lupin BM-wheat sequences, respectively than for wheat-wheat in 2013 when another wheat crop was grown representing 10-12% of the 2011 legume residue N and 3-4 kg N per tonne of the residue biomass.

The differences in soil mineral N observed in 2012 following lupin compared to wheat or canola resulted in 55-80 kg N/ha more N taken up by wheat and much higher grain proteins (12.4-13.6% cf 9.8-9.9%). The additional N uptake was equivalent to 27-28% of the lupin residue N. This compared to an increase of 25-30 kg N/ha by wheat grown after either wheat or canola when top-dressed with an additional 50 kg N/ha which represented a 50-60% recovery of fertiliser N. These findings are compared to results from other similar experiment.

Table 9. Summary of the fate of fertiliser N applied at sowing collated from different rainfed cereal production systems.[a]

Measures	Crop uptake (% applied N)	Recovered in soil (% applied N)	Unrecovered [assumed lost] (% applied N)
Range	17-50	21-40	16-62
Mean	36	31	33

[a] Source: Crews and Peoples (2005)

Conclusions

Legume inputs of fixed N

The choice of legume species and management were found to influence inputs of fixed N by legumes by affecting either %Ndfa or DM accumulation. Around 19 kg of legume shoot N is commonly fixed per tonne of shoot DM produced by pulse crops. On-farm measures of N2 fixation suggest constraints to N2 fixation in 20-25% of commercial pulse crops. Median estimates of %Ndfa across 35 farmers' crops indicated that these crops were deriving ~70% of N requirements from atmospheric N2, and fixing ~16 kg shoot N/t DM produced. Residual fixed N from brown manured crops or pure pasture legume swards were generally greater than net inputs of fixed N remaining after pulses largely due to the export of large amounts of N in harvested grain.

Impact of legumes on available soil N

There is considerable evidence that the inclusion of legumes in cropping sequences results in higher available soil N for subsequent crops. Data collected from farmers' paddocks in SA suggest that this might represent on average 25-35 kg N/ha more mineral N than after wheat. Information collected elsewhere in south-eastern Australia indicate that in the case of a pulse grown for grain or BM concentrations of available soil N can be 42-92 kg N/ha greater than following wheat or canola in the 1st cropping season after the legume was grown representing apparent mineralisation of 20-30% of the N originally present in the legume residues, and 18-34 kg N/ha in the 2nd year, representing 10-12% of the residue legume N. The additional N mineralised prior to sowing the 1st subsequent crop can be equivalent to 7-11 kg N/ha per tonne of residue DM for pulses, and 15 kg N/ha per tonne of legume DM grown during a pasture phase.

Comparisons of legume and fertiliser N

As the release of inorganic forms of N from legume residues in soil is a microbial-mediated process not all the legume N returned to soil becomes available in the short-term. Consequently, the apparent recovery of legume N by a following cereal crop (27-40% across two different studies) tends to be lower than top-dressed fertiliser (47-59%), but may not be too dissimilar from fertiliser applied at sowing. However, losses of N from the system are usually lower from legume sources than from fertiliser (Crews and Peoples 2005), and a major contribution of legumes is the maintenance of the long-term organic fertility of the soil.

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References

Angus et al. (2000) Australian Journal of Agricultural Research 51, 877-890.

Crews and Peoples (2005) Nutrient Cycling in Agroecosystems 72, 101-120.

Khan et al (2003) Australian Journal of Agricultural Research 54, 333-340.

Peoples et al.(2009) Symbiosis 48, 1-17.

Peoples et al.(2012) Crop & Pasture Science 63, 759-786.

Unkovich et al. (2010) Plant and Soil 329, 75-89.

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Glossary of key terms used

- Mineral N – nitrate (NO3) and ammonium (NH4) sources of N. They are considered to be the most readily plant-available forms of N in the soil and are sometimes also referred to as inorganic N.

- Soil Organic N – organic forms of N in soil such as previous crop residues and humus that is not readily available for plant growth until it is converted into mineral N by soil microbes.

- Fixed N – the amount of atmospheric N2 biologically fixed by soil bacteria (rhizobia) via a symbiotic relationship with the legume in nodule structures on legume roots.

- Residual fixed N – the amount of fixed N calculated to remain in legume residues once N removed in agricultural produce (e.g. N exported in harvested grain, or N in animal products) is accounted for.

- Shoot N - amount of N in all above-ground plant biomass.

- Legume residue biomass - above-ground legume biomass that remains after grain harvest.

- Apparent net mineralisation of legume N - the total increase in soil mineral N equivalent to the differences in concentrations of plant-available soil N following a legume and after a non-legume compared to the amount N estimated to have been present in the legume residues.

- Apparent recovery of legume N - equivalent to the differences between wheat N uptake following a legume and wheat N after a non-legume compared to the amount N estimated to have been originally present in the legume residues the previous year.

- Apparent recovery fertiliser N - equivalent to the differences between wheat N uptake at two rates of fertiliser N compared to the difference in the amount of fertiliser N applied.

GRDC project code: CSP00146

The impact of canola on profit and herbicide resistant ryegrass in crop sequences in southern NSW

Tony Swan, Mark Peoples, James Hunt, John Kirkegaard and Laura Watson (CSIRO), Tony Pratt (FarmLink)

ABSTRACT

Research investigating the profitability of canola, pulse legume break crops and cereals in southern NSW between 2012 and 2014 has shown that canola was consistently the most profitable break crop and that any crop sequences involving canola in year one or two of the rotation were more profitable due to the high returns from grain yield. It was also demonstrated that cheaper, more effective ryegrass control could be achieved by many of the alternative break crops compared to the options available for best in-crop grass management within wheat where there is a high background of herbicide-tolerant ryegrass. It was apparent that there is a requirement for at least two break crop years to reduce seed bank numbers. A lupin crop grown for grain (spray topped at seed set to sterilize ryegrass seeds) followed by RoundupReady (RR) canola, or RR-canola followed by wheat (hay) may be most effective in terms of gross margins and reducing ryegrass numbers in the long run. One of the most profitable options to control herbicide resistant ryegrass was RR-canola followed by a wheat (high) treatment, but with approximately 20 ryegrass panicles setting seed per m2, this sequence may quickly become reinfested. Sequences that include growing pulses for brown manure are not as profitability but have benefits where annual ryegrass resistance and low soil N are problematic and by improving sustainability, reducing risk and improving timeliness of operations.

Key words: Canola, pulse legumes, crop sequences, herbicide resistant ryegrass, wheat, cereals.

INTRODUCTION

There is a wide-spread perception among farmers and their advisors that broadleaf break crops such as canola or legumes are higher risk and not as consistently profitable as cereals. The aim of GRDC project CSP00146 was to challenge this notion, and to examine the potential beneficial impacts of break crops on the longer-term financial performance of following wheat crops. This project recognises that profit and risk are key drivers of farmer decision making and endevours to investigate the overall profitability of the whole cropping sequence. Much of the project's experimental and communications program is based on the assumption that in the absence of high grain prices for canola or pulses, growers are most likely to want to sow broadleaf break crops to address specific agronomic problems when growing cereals. There is substantial evidence from surveys of farmers' paddocks across southern and western NSW, SA and Victoria that indicates there is wide-spread resistance or partial resistance of annual ryegrass to a wide range of herbicide groups (Broster et al 2011; Preston et al 2013). Consultation with grower group and agribusiness collaborators in project CSP000146 has identified difficulties in managing grass weeds as now one of the main constraints to wheat production across south-east Australia. This paper reports on the main outcomes to date from a series of phased experiments that have compared the impact of different inputs and herbicides applied to canola, pulse legumes, or wheat on the prevalence of herbicide resistant ryegrass and system profitability. The experiments address four key questions:

(1) Can a canola or legume break crop be as profitable as a cereal in its own right?

(2) Are there trade-offs between different break crop options and end-uses?

(3) Do the rotational benefits of break crops improve the profitability of subsequent cereal crops?

(4) Can resistant ryegrass be managed more cost-effectively under break crops than in cereals?

MATERIALS AND METHODS

Experiments were established in 2012 (Exp 1) and 2013 (Exp 2) in paddocks on two different farms at Eurongilly in south-eastern NSW where herbicide-resistant ryegrass was known to be present. The soils at both sites were red chromosols, (Isbell 1996). Growing season rainfall (GSR) in 2012 and 2013 and long term (GSR) at Eurongilly were 179 mm and 274 mm respectively, compared to 328 mm and average annual rainfall (AAR) of 556 mm.

Year 1 treatments imposed, input/risk categories and input costs are presented below:

1. Canola – low: cv's Crusher TT (Exp 1) and Stingray TT (Exp 2), target density of 40 plants/m2, seed dressed with Jockey Stayer and Gaucho, sown with MAP (25 kg/ha), then topdressed with ammonium sulphate (100 kg/ha) and urea (100 kg/ha Exp 1 and 160 kg/ha Exp 2). Total fertilizer elements as N:P:S (kg/ha) were 69.5, 5.5 and 4.4 (Exp 1) and 97.5, 5.5 and 24.4 (Exp 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent of 480 g/L trifluralin @ 2 L/ha; 900 g/kg atrazine @ 1.1 kg/ha; in-crop herbicide 250 g/kg butroxydim @ 80 g/ha + 900 g/kg atrazine @ 0.9 kg/ha. Total input costs for seed, fertilizer, herbicides and insecticides = $249/ha and $305/ha (Exp's 1 and 2).

2. Canola – high: cv Hyola 505 RR Hybrid (Exp's 1 and 2), target density of 40 plants/m2, seed dressed with Jockey Stayer and Gaucho, sown with MAP (75 kg/ha) and Impact Endure, then topdressed with ammonium sulphate (100 kg/ha) and urea (200 kg/ha Exp 1 and 360 kg/ha Exp 2). Total fertilizer elements as N:P:S (kg/ha) were 120.5, 16.4 and 25.1 (Exp 1) and 195.5, 16.4 and 25.1 (Exp 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent of 480 g/L trifluralin @ 2 L/ha; in-crop herbicide glyphosate (Round-Up Ready) @ 0.9 kg/ha at 2-3 leaf and 6 leaf stages. Total input costs for seed, fertilizer, herbicides and insecticides = $427/ha and $524/ha (Exp's 1 and 2).

3. Fallow - low: Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; fallow established in September 2012 with an application of 450 g/L glyphosate @ 2 L/ha + metsulfuron-methyl @ 5 g/ha, then follow-up with 250 g/L paraquat @ 2 L/ha. Total input costs for herbicides = $35/ha and $57/ha (Exp's 1 and 2).

4. Field peas BM - low: cv's Morgan (Exp 1) and Percy (Exp 2) for brown manure (BM), target density of 40 plants/m2, sown with MAP (25 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 2.5, 5.5 and 0.4 (Exp's 1 and 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent 480 g/L trifluralin @ 2 L/ha; 900 g/kg simazine @ 1.0 kg/ha; brown manure herbicide 450 g/L glyphosate @ 2 L/ha + 300 g/L clopyralid @ 150 ml/ha + 240 g/L carfentrazone-ethyl @ 25 ml/ha; fallow maintenance 450 g/L glyphosate @ 2.5 L/ha. Total input costs for seed, fertilizer and herbicides = $120/ha and $169/ha (Exp's 1 and 2).

5. Lupins - low: cv Mandelup for grain (Exp's 1 and 2) target density of 40 plants/m2, sown with sown with MAP (25 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 2.5, 5.5 and 0.4 (Exp's 1 and 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent 480 g/L trifluralin @ 2L/ha; 900 g/kg simazine @ 2.2 kg/ha; in-crop herbicide 250 g/kg butroxydim @ 180 g/ha; 250 g/L paraquat (Gramoxone) @ 400 ml/ha. Total input costs for seed, fertilizer & herbicides = $168/ha & $161/ha (Exp's 1 and 2).

6. Wheat - low: cv's Spitfire (Exp 1) and Gauntlet (Exp 2), target density 75 plants/m2, seed dressed with Raxil, sown with MAP (25 kg/ha) then topdressed with urea (100 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 48.5, 5.5, 0 (Exp's 1 and 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent 480 g/L trifluralin @ 2 L/ha + diuron 500 g/L @ 1 L/ha; in-crop herbicide 800 g/L prosulfocarb +120 g/L s-metalochlor (Boxer Gold) @ 1.5 L/ha at 2-3 leaf stage. Total input costs for seed, fertilizer and in-crop herbicides and foliar fungicide = $169/ha and $164/ha (Exp's 1 and 2).

7. Wheat - high: cv's Spitfire, (Exp 1) and Gaunlet (Exp 2), target density 150 plants/m2, seed dressed with Dividend, sown with MAP (75 kg/ha) and Impact Endure, then topdressed with urea (200 kg/ha Exp 1 and 360 kg/ha Exp 2). Total fertilizer elements as N:P:S (kg/ha) were 99.5, 16.4, 0 (Exp 1) and 173.1, 16.4, 0 (Exp 2). Herbicides for ryegrass control included initial knock-down with 450 g/L glyphosate @ 1.6 L/ha; pre-emergent 850 g/kg pyroxasulfone (Sakura 850WG) @ 118 g/ha + 500 g/L tri-allate (Avadex Xtra) @ 2 L/ha; in-crop herbicide 800 g/L prosulfocarb +120 g/L s-metalochlor (Boxer Gold) @ 2.5 L/ha + 100 g/L pinoxaden 25 g/L cloquintocet (Axial) @ 150 ml/ha at 2-3 leaf stage. Total input costs for seed, fertilizer, in-crop herbicides and foliar fungicide = $430/ha and $556/ha (Exp's 1 and 2).

There were two sowing times in 2012 (Exp 1): late April (canola and lupins) and mid May (field peas and wheat) and one sowing time in Exp 2 (2nd May 2013). The weed-free fallow commenced in early September and peaBM plots were sprayed in mid October (2012 and 2013) and re-sprayed within 14 days as a double knock. The lupin treatment was spray topped in mid November 2012 in Exp 1 only with Gramozone. Plots were 40m in length x 2m with each treatment replicated 4 times.

The sensitivity / resistance of the annual ryegrass populations at both the Eurongilly trial sites (Exp's 1 and 2) were tested by Plant Science Consulting SA in March 2012 and 2013, respectively. The result of the analysis indicated that the ryegrass was resistance to Group A herbicides Verdict (Haloxyfop-R), Select

(Clethodim) and Axial (Pinoxaden & Clinuintocet-methyl) and Group B herbicides, Hussar (Iodsulfuron-methyl-sodium) and Intervix (Imazamox + Imazapyr) to varying degrees (30% to 95%), but suggested that the ryegrass was still susceptible to Group M (Glyphosate) and one Group A herbicide, Factor (Butroxydim).

Experiment 1 - year 2 at Eurongilly (2013) only – Wheat or second break crop

Experimental details: Each of the replicated plots of all the break crop and cereal treatments from 2012 were split into three 13.3 m sub-plots, in a split plot design. Four treatments were sown in early May 2013, with treatments being canola, wheat (high or low input) and wheat (hay). Wheat (high and low input) were sown into all 2012 treatments and canola was sown into pulse, wheat or fallow 2012 treatments only. Wheat (hay) was sown into canola 2012 plots to act as a double break instead of sowing canola 2013 after canola 2012.

Year 2 - Experimental details and total input costs/ha are outlined as follows:

1. Canola (2013) following pulses (2012) - cv Hyola 575CL, target density of 40 plants/m2, seed dressed with Jockey Stayer and Gaucho, sown with MAP (75 kg/ha) and Impact Endure then topdressed with ammonium sulphate (100 kg/ha) and urea (100 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 74.5, 16.5, 25.1. Total input costs = $352/ha.

2. Canola (2013) following wheat (high or low Year) 2012 - cv Hyola 575CL target density of 40 plants/m2, seed dressed with Jockey Stayer and Gaucho, sown with MAP (75 kg/ha) and Impact Endure, then topdressed with ammonium sulphate (100 kg/ha) and urea (200 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 120.5, 16.5, 25.1. Total input costs = $417/ha.

3. Wheat (hay) 2013 following canola (high and low) 2012 - cv Gauntlet, target density 150 plants/ m2, seed dressed with Raxil, sown with MAP (25 kg/ha) and urea (40 kg/ha), then topdressed with ammonium sulphate (100 kg/ha). Total N:P:S (kg/ha) were 41.1, 5.5, 24.4. Total input costs = $157/ha.

4. Wheat (low) 2013 - cv Gauntlet, target density 75 plants/m2, sown with MAP (25 kg/ha) and Impact Endure and topdressed with ammonium sulphate (100 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 22.7, 5.5, 24.4. Total input costs = $133/ha.

5. Wheat (high) 2013 following pulses 2012 - cv Gauntlet, target density 150 plants/m2, sown with MAP (75 kg/ha) and Impact Endure and topdressed with ammonium sulphate (100 kg/ha and urea (100 kg/ha). Total fertilizer as N:P:S (kg/ha) were 73.7, 16.4, 25.1. Total input costs = $412/ha.

5. Wheat (high) 2013 following wheat (high and low) 2012 - cv Gauntlet, target density 150 plants/ m2, sown with MAP (75 kg/ha) and Impact Endure, then topdressed with ammonium sulphate (100 kg/ ha) and urea (200 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 119.7, 16.5, 25.1. Total input costs = $478/ha.

6. Wheat (high) 2013 following canola (high and low) 2012 - cv Gauntlet, target density 150 plants/ m2, sown with MAP (75 kg/ha) and Impact Endure then topdressed with ammonium sulphate (100 kg/ ha) and urea (260 kg/ha). Total fertilizer elements as N:P:S (kg/ha) were 147.3, 16.5, 25.1. Total input costs = $517/ha.

The herbicides used in all experiments in year 2 were similar to that used in year 1 for the repsective crop and input category. For more details, email author.

RESULTS AND DISCUSSION

Crop yields and gross margins

The cool end to the 2012 season and early November rain assisted the canola to yield similar to wheat in Exp 1 - year 1, with both the canola and lupin crops more profitable in year 1 than wheat. Similarly, the lupins in Exp 2 - year 1 (2013) were the most profitable, with canola having similar gross margins to wheat (H). The canola (Exp 2 - year 1) experienced moisture stress in October 2013.

In year 1 of both experiments, the brown manure crop or fallow treatments resulted in negative gross margins (Table 1). The average annual gross margin over the 2 years fell into four distinct categories (Table 1). The sequences with the highest average annual gross margins (>$600/ha) involved break crops in 2012 or canola in 2013, compared to the next cohort dominated by canola in 2013 (two with double breaks either peas or fallow). The third cohort involved fallow or combinations of wheat (H or L), with the final cohort either peasBM followed by wheat or wheat (L) (Table 1). The sequence with the lowest risk (highest profit/cost ratio) was canola (L) following wheat (L) with a profit of $2.30 for each $1 spent. However, this sequence has resulted in a significant increase in ryegrass DM and panicle number (Table 2).

Table 1. Comparisons of gross margins for 2012 and 2013, average annual gross margin ($/ha/yr) and average profit/cost ratio of canola or wheat grown with low or high input or for hay in Exp 1, years 1-2 (2012-2013) and Exp 2 year 1 at Eurongilly, NSW following cereals and various break crops in 2012. Crop 2012 pre-treatments are arranged in order of descending average annual gross margin.

Crop& input in 2012	Crop & input in 2013	Gross margin & Grain Yield* in 2012 ($/ha) & (t/ha)	Gross margin & Grain/Hay Yield* in 2013 ($/ha) & (T/ha)	Average Annual gross margin ($/ha/yr)	Average Profit/cost ratio (2 yrs)
Experiment 1					
				> $600/ha	
Canola (L)	Wheat (Hay)	$1,166 (3.0)	$644 (8.1DM)	$905	1.4
Canola (H)	Wheat (H)	$1,259 (3.5)	$533 (4.7)	$896	1.2
Canola (H)	Wheat (Hay)	$1,259 (3.5)	$533 (7.4DM)	$896	1.2
Canola (H)	Wheat (L)	$1,259 (3.5)	$489 (4.7)	$874	1.8
Canola (L)	Wheat (H)	$1,166 (3.0)	$537 (4.7)	$852	1.4
Lupins	Canola	$683 (3.1)	$967 (3.2)	$825	1.9
Canola (L)	Wheat (L)	$1,166 (3.0)	$480 (2.8)	$823	2.3
Lupins	Wheat (H)	$683 (3.1)	$726 (5.1)	$705	1.5
Lupins	Wheat (L)	$683 (3.1)	$651 (3.5)	$667	2.1
Wheat (H)	Canola	$257 (3.2)	$964 (3.3)	$611	1.0
				$400-600/ha	
Fallow	Canola	-$45 (nil)	$1,159 (3.6)	$557	1.8
Wheat (L)	Canola	$250 (2.0)	$820 (3.0)	$535	1.2
Wheat (H)	Wheat (H)	$257 (3.2)	$642 (5.0)	$450	0.7
Peas BM	Canola	-$160 (nil)	$1,019 (3.3)	$430	1.2
				$300-400/ha	
Wheat (L)	Wheat (H)	$250 (2.0)	$536 (4.6)	$393	0.8
Wheat (H)	Wheat (L)	$257 (3.2)	$510 (2.9)	$384	0.9
Fallow	Wheat (L)	-$45 (nil)	$799 (4.2)	$377	2.1
Fallow	Wheat (H)	-$45 (nil)	$761 (5.2)	$358	1.0
				<$300/ha	
Peas BM	Wheat (H)	-$160 (nil)	$707 (5.0)	$273	0.7
Wheat (L)	Wheat (L)	$250 (2.0)	$170	$210	0.8
Peas BM	Wheat (L)	-$160 (nil)	$525	$182	0.8
Experiment 2					
	Lupins		$741 (2.6)	$741	2.5
	Wheat (H)		$354 (4.0)	$354	0.5
	Canola (L)		$339 (1.6)	$339	0.8
	Wheat (L)		$300 (2.2)	$300	1.1
	Canola (H)		$161 (1.9)	$161	0.2
	Fallow		-$72 (nil)	-$72	-1.0
	Peas BM		-$204 (nil)	-$204	-1.0

*Brackets () indicates grain yield (t/ha grain) and Hay yield (t/ha plant dry matter)

Interaction between crop treatments and ryegrass plant populations.

The number of ryegrass panicles (m2) measured in spring year 1 in untreated areas were 1042 (Exp 1) or 1840 (Exp 2), reducing to between 30 to 534 under wheat (H & L) and to zero under canola (H), peasBM or fallow (Table 2). In year 1, the most effective ryegrass control was achieved from fallow, peasBM or canola (H) compared to wheat or canola (L) TT treatments (Table 2). In Exp 1 year 2, a second break crop of canola (H) resulted in the lowest number of panicles, and although the wheat (hay) treatment had between 577-791 panicles/m2 following canola (H or L), no seed was set (data not shown). The expensive herbicide costs ($142 & $154/ha) associated with consecutive wheat (H) treatments resulted in a significant reduction in ryegrass panicle numbers (42+ panicles/m2). However, if each panicle sets between 30-36 seeds/m2, re-infestation could quickly occur (Table 2, Exp 1).

Soil cores were removed from Exp 1 in March of 2012 (pre-experiment), 2013 and 2014 and from Exp 2 in 2013 (pre-experiment) and 2014 to measure changes in ryegrass seedbank numbers. Initial ryegrass populations were 450 and 2775 plants/m2 in Exp's 1 and 2. In Exp 1, by autumn 2013 there was a 12 fold increase in ryegrass seedbank populations (5492 m2) following low input wheat (2012) and a further 2.6 fold increase (14254 m2) where a second low wheat (2013) treatment. Comparitively, seedbank numbers reduced to 166 plant/m2 where canola (H) 2012 was followed by wheat hay (2013), and to 250 plants/m2 where wheat (H), lupins or peasBM were followed by canola in 2013 (data not shown). Similar, but higher plant numbers were found in Exp 2 following year 1 treatments.

Table 2. Measures of peak shoot dry matter (DM) accumulation crop treatments, and ryegrass DM and panicle numbers from Exp's 1 and 2, year 1 and Exp 1 year 2 at Eurongilly, NSW in 2012, Crops arranged in order of descending ryegrass panicle numbers (Exp 1 yr 1).

	Exp 1 (Year 1)	Exp 1 (Year 1)	Exp 1 (Year 2)	Exp 1 (Year 2)	Exp 2 (Year 1)	Exp 2 (Year 1)
Crop & input (Year 1)	Crop DM (t/ha)	Ryegrass DM & panicle # (t/ha) (no. m²)	Ryegrass DM & panicle # Wheat (H) (t/ha) (no. m²)	Ryegrass DM & panicle # Wheat (L) (t/ha) (no.m²)	Crop DM (t/ha)	Ryegrass DM & panicle # (t/ha) (no./ m²)
Untreated area	0	NA (1042)	NA	NA (1292)		NA (1804)
Wheat (L)	5.0	1.6 (504)	0.3 (71)	4.7 (880)	7.5	3.5 (534)
Wheat (H)	8.4	0.3 (78)	0.1 (42)	2.4 (313)	11.3	0.1 (30)
Lupins	6.5	0.1 (43)	0 (13)	1.4 (207)	5.6	1.5 (462)
Canola (L)	8.3	NA (32)	0.1 (22)	3.3 (406)	9.9	0.7 (193)
Canola (H)	12.0	0 (0)	0.1 (20)	2.9 (386)	12.4	0 (0)
Fallow	0	0 (0)	0 (2)	1.7 (60)	0	0 (0)
Peas BM	4.5	0.7 (0)	0 (8)	1.7 (274)	4.9	0.7 (0)

The effect of the high and low input treatments on ryegrass control and wheat grain yield can be seen in Figure 1. The high input treatment (open symbols) significantly reduced ryegrass DM and increased wheat grain yield. This compares to the increase in ryegrass DM under the low input treatments (closed symbols) resulting in a reduction in wheat grain yield of 450 kg/ha for every 1 t/ha of ryegrass DM (Figure 1).

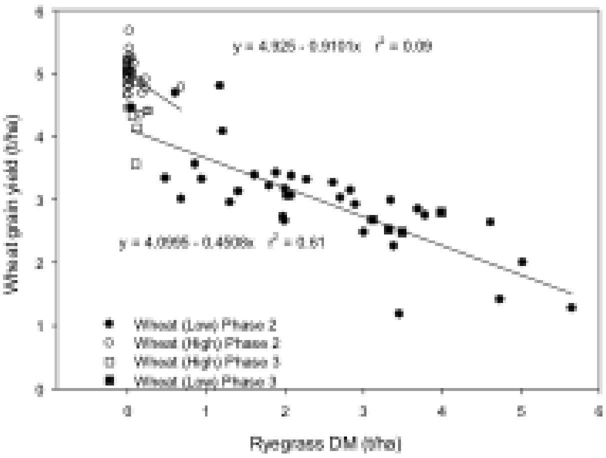

Figure 1: Wheat grain yield cf ryegrass DM from experiments 1 and 2, at Eurongilly.

CONCLUSION

Break crop choice and selection should be based on individual farm management and ability to manage the various break crop options. It is concluded that a crop sequence that includes a break crop is likely to be more sustainable in terms of N, reducing root diseases than continuous wheat and provide cheaper more effective ryegrass control where there is a high background of herbicide-tolerant ryegrass. It was apparent that there was a requirement for two break crop years to control ryegrass with one of the most profitable options being canola (H) followed by a wheat (hay) treatment or lupins followed by canola (H). Although canola (H) follwed by wheat (H) had a high gross margin, approximately 20 ryegrass panicles set seed per m2, indicating that this sequence may quickly become reinfested. Growing pulses for BM is beneficial where there is annual ryegrass resistance and low soil N. It also reduces risk and improves sustainability, but impacts negatively on profitability.

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REFERENCES

Broster, JC., Koetz, EA, and Wu, H, 2011: Herbicide resistance levels in annual ryegrass (Lolium rigidum Gaud.) in southern New South Wales. Plant Protection Quarterly 26, (1) 22-28.

Isbell, RF. 1996: 'The Australian soil classification.' (CSIRO Publishing: Melbourne)

Preston, C., Boutsalis, P., Malone, J., Abu-Yeboah, Patricia., Kleemann, S., Saini, RK, and G. Gurjeet, 2013: Maintaining the best options with herbicides. 2013 NSW GRDC Grains Research Update for Advisors, Temora.

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FarmLink
Research Report 2014

04

Increasing Soil Carbon

2014 Trial Site

Project Partners

FarmLink Research

GRAHAM CENTRE for Agricultural Innovation

NSW GOVERNMENT Department of Primary Industries

Funding Partner

clean energy future

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Enabling landholders to adopt profitable and sustainable carbon cropping practices

Iain Hume, Bev Orchard (GRAHAM Centre); Paul Bruest, Tony Pratt (FarmLink)

Project Description

This project is FarmLink's contribution to a large federally funded Department of Agriculture project lead by the CSU Graham Centre. Farm practices to increase the sequestration of carbon in soil through different stubble/nutrient practices (from burnt to fully incorporated with nutrients is being tested), on 14 properties across the dryland and irrigated broadacre cropping regions of southern and central NSW and Victoria. Change in soil carbon in two years is being measured as well as any yield effects.

Aim

To test the practicality of increasing soil humic carbon on farm.

Methods

Initial Design

Farmer hosted paddock scale demonstration trials

- 2 location sites
- GPS capabilities for sowing and harvest as well as mapping
- Conduct operations in relation to the trial
- Observe trial protocols and guidelines

3 core treatments:

1. Standing Stubble
2. Incorporated - Nutrients
3. Incorporated + Nutrients

Each treatment repeated twice in two blocks.

No of strips = 2 blocks x 3 treatments x 2 repeats = 12 strips

Soil sampling:

- 3 sampling locations per strip/block
- 2 depths 0-10cm and 10-30cm
- 78 soil samples before and 78 after experiment/demonstration.

Stubble Incorporation:

- Speedtiller supplied by local machinery company

Nutrient Spreading

- Ute mounted trial spreader

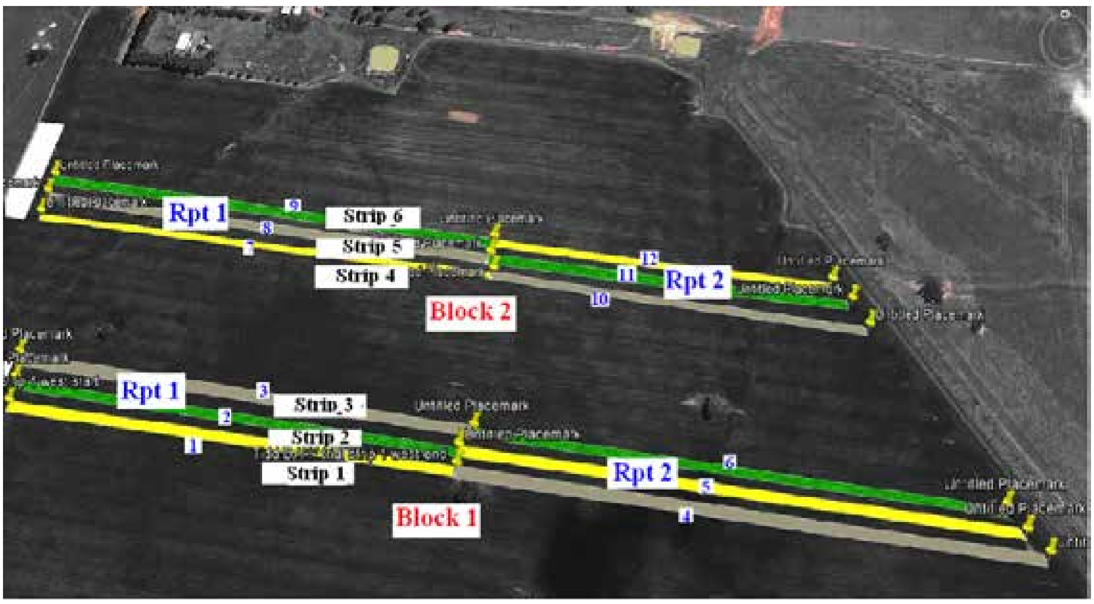
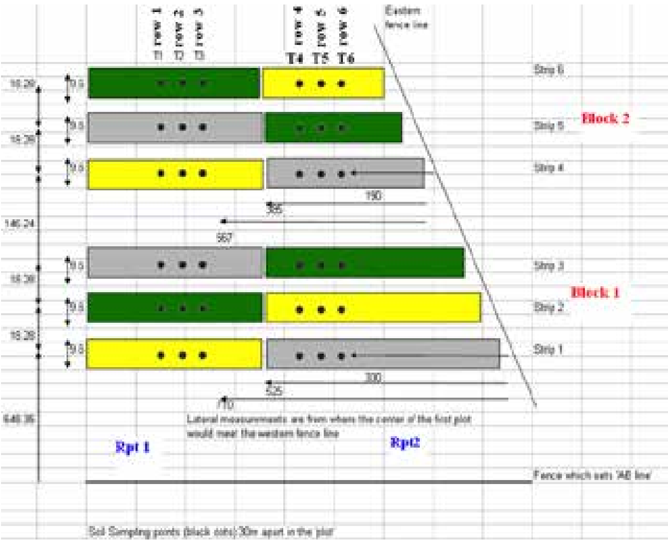


Figure 1: Trial Plan - Tidd



Control	
Incorporated	
Incorporated + Nutients	

Figure 1: Trial Plan - Tidd

Figure 2: Incorporation treatments for strip 1 & 2 at Tidds' looking from west to east. Standing stubble buffer in between.

Results and Discussion

Initial Soil Carbon

Soil was sampled before treatments were established. This was to establish a benchmark or starting point for the trials. These initial soil samples were analysed for C fractions. Each C fraction was in turn considered as the response variable and analysed according to the imposed experimental design. This analysis found no significant 'treatment effects', i.e. there were no significant (P=5%) treatment effects at either depth for any of Total, Particulate, Humic of Recalcitrant Organic Carbon. This confirms that the experiment has commenced with no bias towards any treatment at either depth. The mean paddock values of the four soil carbon fractions of the two field trial sites are similar (Table 1).

Table 1: The mean composition (%) and its standard error (in parenthesise) of the different soil organic carbon fractions at both field sites.

Location	C fraction	Depth 1 (0-10 cm)	Depth 2 (10-30cm)
Tidd	Total	1.251 (0.075)	0.529 (0.038)
	Particulate	0.101 (0.009)	0.022 (0.005)
	Humic	0.619 (0.031)	0.347 (0.017)
	Recalcitrant	0.296 (0.023)	0.125 (0.014)
Ingold	Total	1.363 (0.097)	0.455 (0.089)
	Particulate	0.115 (0.018)	0.029 (0.015)
	Humic	0.681 (0.045)	0.296 (0.058)
	Recalcitrant	0.318 (0.021)	0.089 (0.021)

- At both depths about half of the soil carbon is in the desirable humic fraction. Very little is as particulate soil carbon.
- The % soil carbon content of the top 10 cm of the soil is almost twice that of the 10-30 cm layer. This is true for all fractions.
- Our original large blocks at Tidds' did not account for much variation but they did at Ingolds'. We investigated this using a hypothetical design with long six long treatment strips, two replicates of each treatment each sampled six times.

The blocked design requires an F value of 5.14 for a significance treatment effect while the unblocked design requires a much higher F value of 19.00, thus treatment effects would be much harder to detect. The blocked design requires a difference of 0.335% in total organic carbon between treatments for significance at the 5% level, whereas the unblocked design requires a much higher value of 0.530%. This difference would have to be even larger if fewer samples were taken per treatment strip, i.e. the precision of the estimates would be much lower.

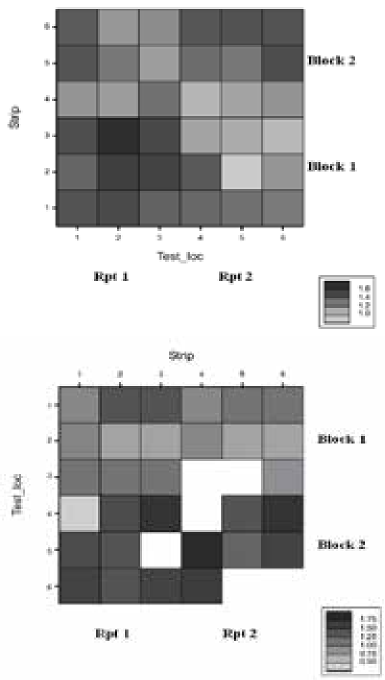


Figure 3: Initial total organic soil carbon content in the (0-10 cm increment)

TOP: Tidd

BOTTOM: Ingold

Figure 4: The photo above shows a Speedtiller just prior to incorporation of nutrient at Tidds', December 2014.

At Tidds' a single yield estimate was made for each treatment strip. At Ingolds' five estimates were made per strip from the header yield monitor. This restricted analysis of the Tidd data to ANOVA but allowed the use of REML to examine spatial patterns in the Ingold data.

Yield data for Tidds' is captured in Table 2 and for Ingolds' is captured in Table 3 for 2013 and 2014. Yield results at Tidds' in 2014 used a weigh-bin to record data for each treatment strip as they were harvested. At Ingolds', yield monitor data was made available post harvest for analysis

The stubble incorporation treatments did not affect canola yield at either location but yield was much higher at the Ingold site. At Tidds' in 2013 yield ranged from 0.94 to 0.99 t/ha with a mean of 0.97t/ha and showed no significant difference between the treatments. Similarly at Ingolds' 2013 yield ranged from 2.46-2.56 t/ha with a mean of 3.17 t/ha showing no significant difference between treatments.

Location	Stubble treatment			Mean of all treatments
	Retained	Incorporated	Incorporated + nutrients	
Tidd	0.943	0.962	0.992	0.966
Ingold	2.469	2.563	2.545	2.495

The Least Significant Difference between treatments is 0.277 t/ha at Tidds and 0.285 t/ha at Ingolds.

Location	Stubble treatment			Mean of all treatments
	Retained	Incorporated	Incorporated + nutrients	
Tidd	2.68	2.74	2.64	2.69
Ingold	3.62	2.98	2.92	3.17

Further analysis of yield data from 2014 is still in progress at time this report was compiled.

The stubble incorporation treatments had no significant effect on wheat yield at Tidds' again in 2014. However, at Ingolds' there is a significant difference between the retained stubble and the incorporated treatments at the 5% level of significance – although there is no difference between the nutrient treatments on the incorporated stubble.

Table 2: The yield (t/ha) of Canola under three stubble treatments at two locations.

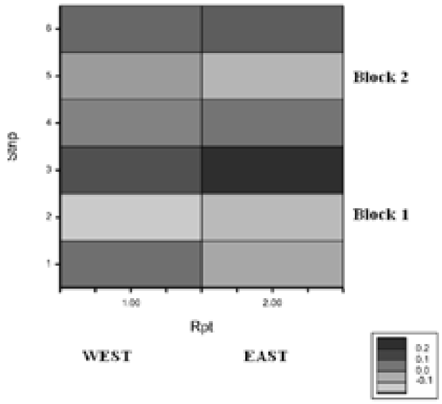


Figure 5: Variation (t/ha) from mean yield indifferent plots/strips at Tidds 2013

Further analysis of yield data from 2014 is still in progress at time this report was compiled.

Figure 6: Standing stubble on left v Incorporated at Ingolds' 2/9/14

Farming Soil Carbon – Possibility and Profitability

Compiled by: Iain Hume, NSW DPI, Wagga Wagga for FarmLink Winter bus tour

Carbon Input

The increase in humic soil carbon is calculated by assuming that 1 t of stubble contains 450 kg of C and 70% of C is lost in mineralization. So the maximum possible input of C is 137 kg per t of stubble.

The Carbon Farming Scheme valued Carbon at

$22.70/t, however the price of C sold to trading market was $3.10/t on June 2014.

The break even cost of field operations, calculated by subtracting the carbon value from the incorporation and fertiliser costs are significant (Tables 4 - 6).

Operation	10 t wheat stubble	6 t Canola Stubble
Incorporation [1]	$30.00	$30.00
Fertiliser	$62.82	$15.13
Spreading [3]	$2.00	$2.00
Total	$94.82	$47.13
Less C valued @ $22.7/t	-$31.00	-$18.60
Total Cost	**$66.92**	**$28.53**

Table 4: Cost benefit calculation

Product	Wheat			Canola		
	kg	$/kg	$/t stubble	Kg	$/kg	$/t stubble
DAP	9	0.72	6.44	3	0.72	2.13
Urea	1	0.54	0.54	1	0.54	0.39
Total	**10**		**6.98**	**4**		**2.52**

Table 5: Fertiliser needs per t of Stubble

	$/t	Freight	$/t landed
DAP	675	40	715
MAP	665	40	705
Super	283	40	323
Urea	502	40	542

Table 6: Fertiliser costs (1st June 2014)

Sources

1: Based on 6ha/hr and $40 fuel

3:http://www.depi.vic.gov.au/agriculture-and-food/dairy/pastures-management/fertilising-dairy-pastures/how-to-calculate-fertiliser-rates-and-costs

Profitability

The costs of fertiliser and incorporation could be covered by extra yield. The following figures show the increase in yield needed to break even for a range of grain prices and a value of between 0 and 20$/t for Carbon. These yield increases are large and have not been seen in our trials.

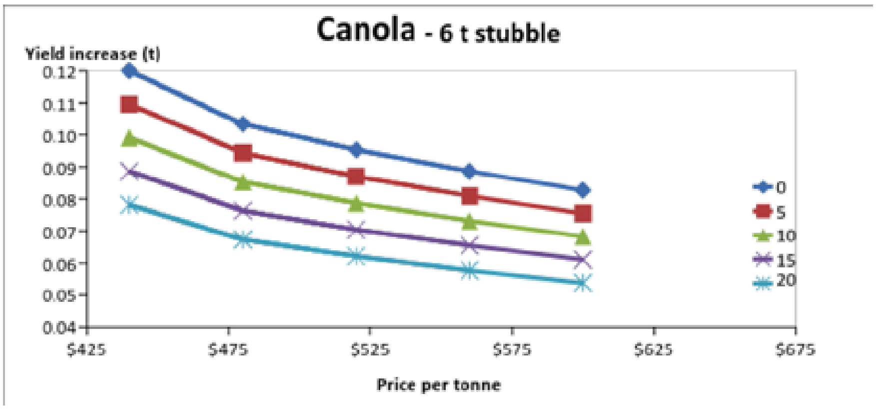


Figure 7: The breakeven yield increase of wheat under different price regimes.

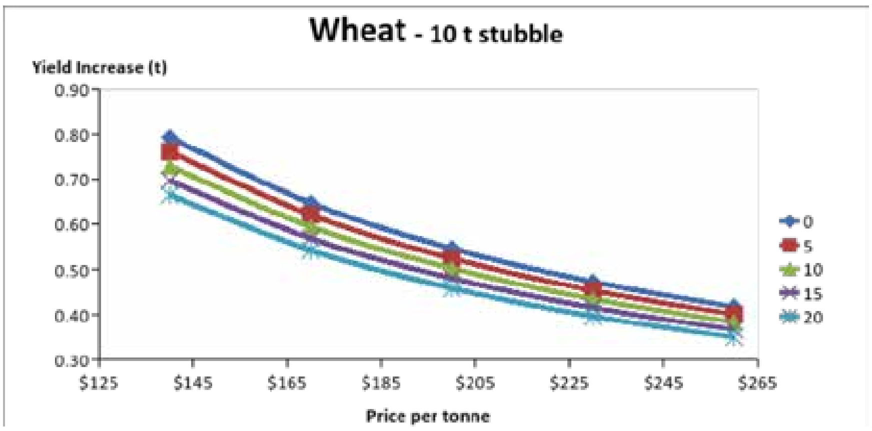


Figure 8: The breakeven yield increase of wheat under different price regimes.

Acknowledgements

Thank you to Iain Hume from EH Graham for his input at field days, analysis of data and assistance with this project.

Thank you to the Derek and Alexander Ingold and Geoff Tidd for hosting these trials and allowing us frequent access for data collection and for their efforts especially at harvest to accommodate our sampling and weighing. Thank you as well to Paul Bailes from Norwood Ag for the demonstration and use of the Speedtiller for our incorporation treatments. This project was funded by the Department of Agriculture 'Action on the Ground' .

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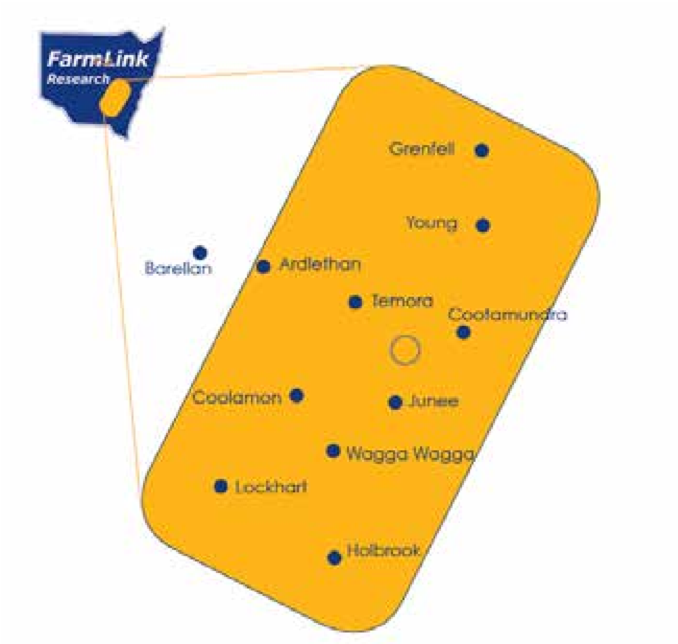
The Soil Carbon Frontier

2014 Trial Site



Project Partners

FarmLink Research

Crop Facts Pty Ltd

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clean energy future

Australian Government
Department of Agriculture

GRDC
Grains Research & Development Corporation

Farmers leading and learning about the soil carbon frontier

Tony Pratt, Erika McAllister, FarmLink Research. Harm Van Rees, Cropfacts

Background

Work conducted by Clive Kirkby, CSIRO has investigated the feasibility of increasing soil Carbon (C) levels with the use of balanced amounts of nutrients and incorporation of stubble. His work has established that the humus (stable) portion of soil carbon has relatively constant ratio of C, Nitrogen (N), Phosphorus (P) & Sulphur (S).

Humus	Carbon	Nitrogen	Phosphorus	Sulphur
	1t	83kg	20kg	14kg

Indicating humus is an accumulation of carbon as well as other nutrients and that the creation of humus requires more than simply available carbon.

Other work conducted by various researchers found that soil carbon levels in Australia are low and a range of factors contribute to the soils ability to capture and store C including the parent material of the soil, rainfall and land use. The Federal government has provided funding to research agencies to test the impacts on soil C of a range of agricultural practices.

Introduction

This Federal Department of Agriculture project examined existing, new and alternative strategies for farmers in the wheat/sheep zone to increase soil carbon. The project has developed a network of trial and demonstration sites which are coordinated by key farming systems groups, one of which is FarmLink. NOTE: Not all data has been collected and analysed and so this is a report of progress and outcomes to date for the project.

Aim

The overall aim of the project was to raise awareness of farmers about how they can reduce green house gas emissions, sequester soil carbon and make improvements in farm productivity. Trials were established within this project to determine if –

- additional nutrients are required to increase the level of carbon stored in the soil and if this is impacted by the timing of the nutrient application AND/OR treatment of stubble residue; AND
- land use impacts soil carbon levels over time

These trials formed the basis of communication and extension activities designed to deliver trial outcomes and raise farmer awareness of soil carbon issues.

Methods

The project had two components, a fully randomized small plot trial and farmer scale replicated paddock trial.

Treatments applied in both the small and large scale trials to increase soil carbon included a range of stubble management practices with the addition of nutrients depending on the level of stubble present. Stubble load sampling was conducted post harvest, before treatments were applied, to match the required level of nutrient to stubble (C) present.

a. Small Plot Trial

The small plot trial was located at the Temora Agricultural Innovation Centre and examined the impact of different stubble treatments, nutrient rates and nutrient timings on soil carbon sequestration

The trial was established with a fully randomized 4 replicate design using the following treatments -

- Stubble treatments
  - Intact – standing stubble following harvest of the previous crop
  - Incorporated – stubble incorporated using an offset disc post harvest
  - Removed – stubble removed via mowing and raking of plots
- Nutrient treatments
  - Base – normal practice N and P
  - Extra – normal practice N and P, plus extra N, P & S
- Timing of Nutrient treatments
  - Nutrients applied at sowing
  - Nutrients applied at harvest of previous crop

The treatments are summarized in Table 1 and the trial design set out in Table 2.

												Replicates
8	5	6	3	12	11	4	7	9	10	1	2	4
1	7	2	4	8	5	12	9	10	11	3	6	3
7	4	3	6	11	9	1	5	8	2	12	10	2
9	10	8	1	2	4	12	11	6	7	3	5	1
12	11	10	9	8	7	6	5	4	3	2	1	Plot number

Table 2: Trial plan for small plot Trial, TAIC

Treatment	Stubble	Nutrients	Timing
1	Intact	Base	Sowing
2	Intact	Base	Harvest
3	Intact	Extra	Sowing
4	Intact	Extra	Harvest
5	Incorporated	Base	Sowing
6	Incorporated	Base	Harvest
7	Incorporated	Extra	Sowing
8	Incorporated	Extra	Harvest
9	Removed	Base	Sowing
10	Removed	Base	Harvest
11	Removed	Extra	Sowing
12	Removed	Extra	Harvest

Table 1: Treatment list for small plot trial, TAIC

The trials were repeated over 3 years and sown to crop in a wheat (2012), wheat (2013), canola (2014) rotation.

Stubble management for the small plot trial involved the removal of stubble residue, incorporation of stubble and stubble left intact. Removal of stubble was achieved by mowing and raking from the plots and incorporation was achieved by offset disc or Speedtiller – an example of which can be seen in Picture 1. Nutrients were spread by hand to ensure accurate plot distribution.

Standard soil and soil bulk density sampling was conducted in year 1 of the project and will be repeated in March 2015 to capture starting and end soil carbon and other nutrient levels.

The trial was assessed for stubble cover, crop establishment and grain yield in 2012, 2013 and 2014.

Picture 1: Small plot trial TAIC, post harvest incorporation and nutrient application. Incorporated plot on left, intact on right and reps of trial in background.

b. Paddock Scale Farmer Trials

The paddock scale trials were located on co-operator farms at Dirnaseer, Coolamon and Ariah Park in 2013 and 2014. The three treatments and trial plan are below (Tables 3, 4, 5 & 6). Sites were selected where cropping and pasture paddocks were adjacent – creating 'paired' paddocks. Initial soil testing was conducted on the paired paddocks in 2012 and will be conducted at the completion of the trial (March 2015) to compare start and finish soil composition under different management practices (ie cropping and grazing). Results from this experiment will be reported when available.

In addition to the paired paddock comparison, paddock scale trials, consistent with the small scale trial at TAIC, were implemented. The trials at Dirnaseer and Ariah Park were established with a fully randomized 4 replicate design while the trial at Coolamon contained three demonstration strips and these strips were discontinued in 2014. Three treatments were applied at each site as described in Table 3.

- Stubble treatments
    - o Intact – standing stubble following harvest of the previous crop
    - o Incorporated – stubble incorporated using a speed tiller
- Nutrient treatments
    - o Base – normal practice N and P
    - o Extra – normal practice N and P, plus extra N, P & S added pre-sowing

Treatment	Stubble	Nutrients
1	Intact	Base
2	Incorporated	Base
3	Incorporated	Extra

Table 3: Ariah Park, Coolamon and Dirnaseer treatment table

2	3	1		3	2	1
3	1	2		1	3	2

Table 4: Trial plan Ariah Park

3	1
1	2
2	3
1	2
2	3
3	1

Table 5: Trial plan Dirnaseer

2
1
3

Table 6: Trial/demonstration plan Coolamon

Picture 2: Paddock scale trial at Dirnaseer, Strip 4 N showing post harvest incorporation and nutrient application. Incorporated strip foreground, intact buffer strips on right and left and reps of trial in background.

Results & Discussion

a. Small Plot Trial

Harvest yield results for the small plot trial at TAIC from 2012, 2013 and 2014 have been analysed and are summarised in Table 7.

Treatment	2012 – Wheat Yield (t/ha)			2013 – Wheat Yield* (t/ha)			2014 - Canola Yield ** (t/ha)		
Extra NPS timing	Harvest	Sowing		Harvest	Sowing		Harvest	Sowing	
	2.8	2.8		3.2	3.1				
Stubble	Incorp	Intact	Rem	Incorp	Intact	Rem	Incorp	Intact	Rem
	2.8	2.7	2.8	3.1	3.1	3.2	2.5	2.5	2.5
Nutrients	Base	Extra		Base	Extra		Base	Extra	
	3.0	2.7		3.1	3.2		2.4	2.6	
Grand mean	2.8			3.1			2.5		
Lsd	0.145			0.085			0.48		

Table 7: Small plot trial Yield Data 2012, 2013 & 2014 TAIC * CV for 2013 4.6 **CV for 2014 4.1

Timing of nutrient application and stubble management had no impact on yield in 2012, 2013 and 2014. Analysis showed that there was a small but significant negative effect on yield by adding extra nutrients in 2012, a small but significant positive effect on yield in 2013 and no effect in 2014. Although the result in 2014 may have been confounded by indeterminate variation in yield across the trial unrelated to treatment or trial protocol generating some outlying values.

Picture 3: Small plot trial TAIC, 2014 Canola crop Plot 5 Stubble removed, fertiliser treatment: extra nutrients post harvest.

b. Paddock Scale Trials

Harvest yield results for the paddock scale trials at Ariah Park and Dirnaseer in 2013 have been analysed and are summarised in Table 8.

In the paddock trials at both Ariah Park and Dirnaseer there was no significant difference in yield between the treatments. Both trial paddocks were canola in 2013 with yield at Ariah Park depressed due to frost damage and the dry finish to the season.

Plant establishment, NDVI scans and grain yield for the paddock scale trial at Dirnaseer in 2014 are summarized in Table 9. Plant counts in the incorporated treatments were lower than the intact (retained) stubble treatment due to the sub optimal operation of the disc seeder at sowing resulting in deeper seed placement than would normally occur. The impact of the disc seeder on plant emergence can be seen in Picture 4. NDVI scans in early September showed that the addition of nutrients may have had an influence on early vegetative growth despite the incorporated + nutrients having lower plant numbers – this did not translate into a significant difference in yield. The intact or retained stubble treatment had a significantly higher yield than the incorporated treatments. This may have been a result of moisture conserved due to not cultivating the soil with the Speedtiller.

Location	Crop	Stubble treatment yield (t/ha)			Mean of all treatments	L.s.d
		Retained	Incorp	Incorp + nutrients		
Ariah Park	Canola	0.9	1.0	1.0	0.97	0.28
Dirnaseer	Canola	2.5	2.6	2.6	2.5	0.29

Table 8: 2013 grain yield data for paddock scale trials at Ariah Park and Dirnaseer.

Stubble treatment	Dirnaseer Wheat 2014		
	Ave. plant counts/m2 (23/06/14)	NDVI (3/09/14)	Yield (t/ha)
Incorporated + nutrients	123.7	0.81	3.0
Incorporated - nutrients	123.1	0.77	2.9
Intact (retained)	132.7	0.75	3.6

Table 9: Plant establishment NDVI and grain yield 2014 paddock scale trial, Dirnaseer

Picture 4: Incorporated treatment at Dirnaseer paddock scale trial showing minor emergence issues due to pre cultivated treatments.

A dry short Spring across most of our region saw some treatment differences in mid October with the incorporated treatments showing signs of moisture stress. A Speedtiller was used for the incorporation process and resulted in top soil drying. This highlights how precious stored moisture can be when confronted with a dry finish to the season which can hasten senescence and crop maturity.

Picture 5: Dirnaseer paddock scale trial 15/10/14. Strip 2 (incorporated – nutrients), looking from N to S, you can see the crop is moisture stressed in comparison to the two intact stubble buffers either side.

Stubble treatment	Ariah Park	
	Canola Yield 2013	Wheat Yield 2014
Incorporated + nutrients	0.99 t/ha	2.64 t/ha
Incorporated - nutrients	0.96 t/ha	2.74 t/ha
Intact (retained)	0.94 t/ha	2.68 t/ha

Table 10: Yield Data 2013 & 2014. Paddock scale carbon trial, Ariah Park.

Yield data for the Ariah Park trial site in 2013 and 2014 is summarized in Table 10 and shows no significant impact of any treatment on yield.

Carbon Building Strategy Analysis

Possible costs associated with Carbon Sequestration program	Cost/ha
Nutrient purchase for 4t/ha wheat stubble	$55
Spreading nutrients	$12
Incorporation - speed tiller	$35
Total	$102

Table 11: Paul Breust FarmLink 2013

Table 11 provides a guide to the approximate costs associated with incorporation of extra nutrients on a commercial basis. A investment of approximately $100/ha would be required to increase soil C levels - this needs to be balanced against the benefits that higher soil carbon levels can have on productivity. These benefits arise from improvements in physical functions like water holding capacity, chemical functions and biological functions eg. Nitrogen mineralization.

Some yield mapping data and results for the paddock scale trials for Ariah Park and Dirnaseer are still being analysed and these data will be presented in future reports on this project.

Conclusions

Given that carbon sequestration is not an overnight process it is not surprising that there have been few significant results or trends to report on in either an intensive small plot or large paddock scale. It takes time for soil C to build up and measurable differences in yield from the soil C component may not be apparent initially.

Nutrient addition to balance the ratio of C:N:P:S has surprisingly had little impact on yield and this is possibly a desirable outcome as no difference between +/- nutrient treatments would indicate that the nutrients are available for stubble breakdown rather than going into the crop vegetative biomass.

In a paddock scale and across a whole farm there is a cost associated with the purchase, spreading and incorporation of nutrients which is over and above annual fertiliser crop allocations. This may prove a barrier to nutrient addition to stubbles to build soil C stocks. A research project funded by GRDC and Department of Agriculture (Federal) is determining the economic and environmental benefits of sequestering C on agricultural land in Australia.

Acknowledgements

Thank you to Harm Van Rees from Cropfacts for his assistance and advice with this project.

Thank you to Derek and Alexander Ingold and Geoff Tidd for hosting and conducting operations on these paddock scale trials. Thank you as well to Paul Bailes from Norwood Ag for the demonstration and use of the Speedtiller. This project was funded by Department of Agriculture 'Action on the Ground'.

Project Code: AOTGR1-955086-42

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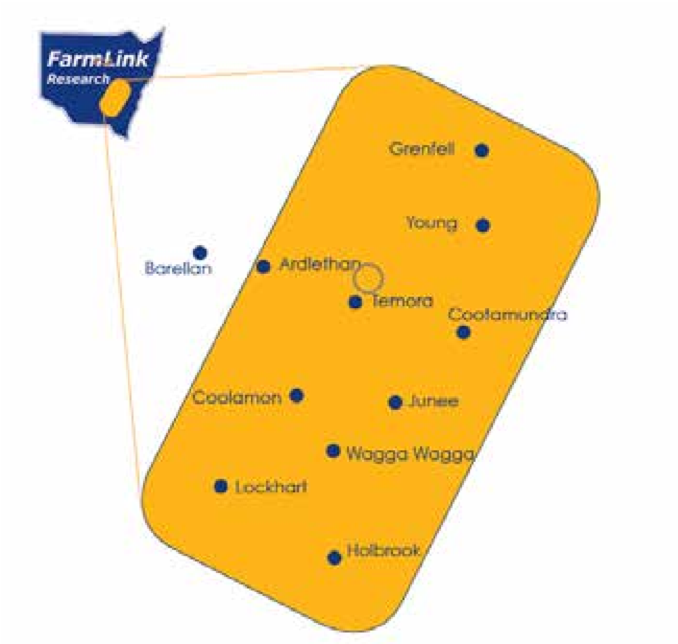
PodGuard Demonstration 2014

2014 Trial Site



Funded and Partnered by

Bayer CropScience

FarmLink Research

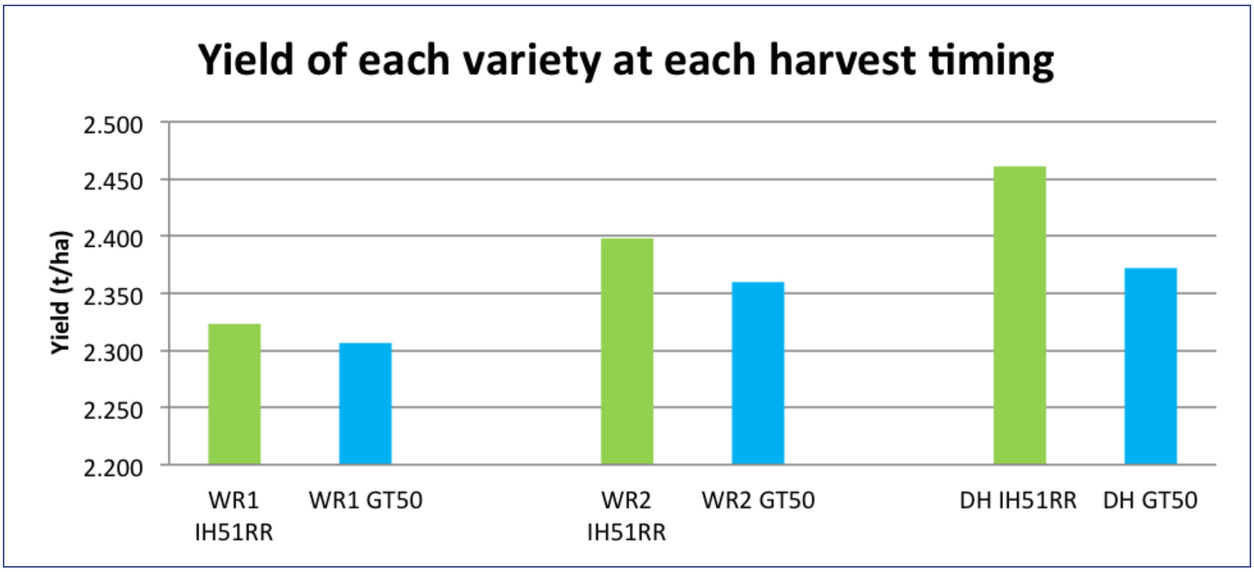
PodGuard Demonstration with FarmLink

Authors: Angus McClelland, Tony Pratt

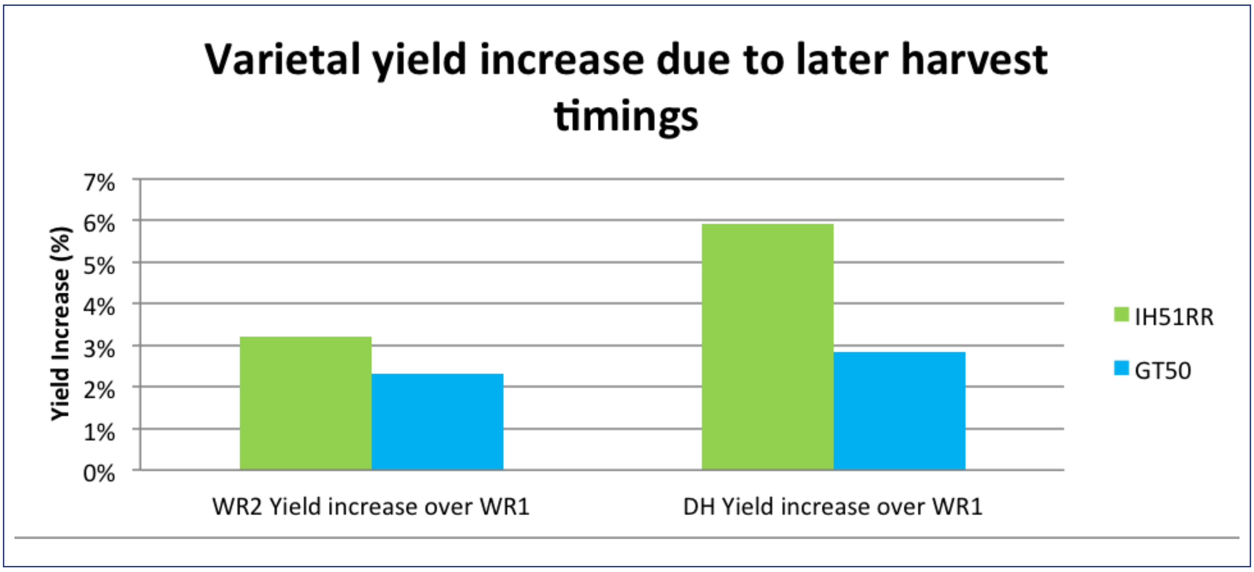
The 2014 cropping season saw FarmLink trial a new canola trait being trialled on farm by Bayer. Set up in a side by side comparison against the highly competitive hybrid variety GT50, IH51RR is Australia's first commercially available variety with Bayer's PodGuard trait. It has been well established that yield gains can be achieved by windrowing later or by direct heading canola, but this is often at the risk of canola pods prematurely opening due to high winds and temperatures before harvest, or during the harvest operation itself. The aim of this demonstration trial was to compare the ability of PodGuard to reduce the occurrence of these shattering events, allowing a variety with this trait, IH51RR to increase yields without losses due to shattering.

The two varieties were sown side by side at the Temora Agricultural Innovation Centre (TAIC) at the same time, with both establishing well. Rain throughout the early part of the season caused severe waterlogging across the demonstration site, greatly reducing the plant stand in parts. The dry finish to the season meant that good yields were achieved across the demonstration area, with the trial achieving the highest canola yields at the TAIC in 2014.

Three canola harvest treatments were used to test the PodGuard trait, with a normal windrow timing (WR1) at 40-60% colour change, later windrow timing at 70-90% colour change (WR2) and a direct head timing when both varieties had reached 8% grain moisture (DH). All canola cutting treatments were then harvested on the same day- that of the direct head timing (windrowing treatments with a pickup front). IH51RR reached maturity a number of days before GT50. To account for any paddock variability, four equal strips were used to calculate the yield of each treatment.



The chart above shows that both varieties increased in yield between the first windrow timing and the direct head timing. IH51RR increased in yield to a greater degree than GT50. Between windrow timing 1 and 2, IH51RR gains 75kg/ha yield, and GT50 57kg/ha. Between the second windrow and direct head timing however, GT50 has only gained around 12kg/ha, whilst IH51RR gained a further 63kg/ha. GT50 therefore gained 69kg/ha by direct harvest compared to windrow timing 1, compared to 138kg/ha for IH52RR.



The chart above comes from the same data set. It shows the percentage yield increase of both varieties when windrowing was delayed to 70-90% colour change, then the yield gained by waiting until a direct heading timing. Again, both varieties gained yield by waiting until a later than a normal windrow timing. GT50 gained around 2% yield by delaying windrowing until 70-90% colour change, but gained little more by direct heading. IH51RR however gained 3% by delayed windrowing and 6% when direct heading, when compared to the normal windrow timing. IH51RR therefore continued to gain yield the later the harvest timing went, whereas GT50 flat-lined, and gained little more yield.

PodGuard is a trait which strengthens what is known as the indehiscent zone of a canola pod, the area which naturally breaks open to allow shattering to occur. The trait has been shown across 10 years of trialling to greatly reduce the incidence, risk and severity of shattering in varieties bred to contain PodGuard. IH51RR is the first commercial variety with PodGuard, and grower-scale trialling in 2014 showed that the trait has a number of applications for growers. In this instance, PodGuard allowed IH51RR to continue to increase yield, by 6% over the normal windrowing timing at direct harvest. On top of this yield gain, eliminating windrowing from operations can save growers time and as $30-$40/ha. The benefit of direct heading IH51RR in this trial therefore was around $100/ha extra gross margin. As many have seen elsewhere there is a yield gain by direct heading a non-traited variety like GT50, but probable shattering losses before and/or during harvest operations have restrained these gains. In trials where a day of high temperatures and winds has occurred before the direct head timing, IH51RR with PodGuard has been shown to greatly reduce shattering losses over genetically similar non-traited Bayer lines and other competitors, with yield losses in non-traited lines more than double those of PodGuard.

In this trial at the Temora Agricultural Innovation Centre, IH51RR and GT50 yielded much the same at the normal 40-60% colour change timing. The PodGuard trait however has enabled IH51RR to continue to increase in yield right up to maturity, increasing its overall yield by 138kg/ha, whilst GT50 could only put on 69kg/ha. In the instance of IH51RR, these yield gains and windrow operation savings could be sought without increased risk of shattering. There were no severe shatter-causing weather events recorded during the harvest timings of this trial. In these instances, PodGuard has been shown to greatly reduce yield losses and give growers greater peace of mind at harvest.

Variety	WR1 IH51RR	WR2 IH51RR	DH IH51RR	WR1 GT50	WR2 GT50	DH GT50
Strip 1	2.251	2.468	2.529	2.308	2.119	2.264
Strip 2	2.356	2.376	2.568	2.303	2.422	2.401
Strip 3	2.317	2.39	2.522	2.331	2.381	2.456
Strip 4	2.369	2.358	2.565	2.284	2.517	2.434
Strip 5			2.121			2.305
Total	**9.293**	**9.592**	**12.305**	**9.226**	**9.439**	**11.86**
Av/ha	**2.323**	**2.398**	**2.461**	**2.307**	**2.360**	**2.372**

Variety	WR1 IH51RR	WR2 IH51RR	DH IH51RR	WR1 GT50	WR2 GT50	DH GT50
Av/ha	**2.323**	**2.398**	**2.461**	**2.307**	**2.360**	**2.372**

Variety	WR1 IH51RR	WR1 GT50		WR2 IH51RR	WR2 GT50		DH IH51RR	DH GT50
Av/ha	**2.323**	**2.307**		**2.398**	**2.360**		**2.461**	**2.372**

Variety	IH51RR	GT50
WR1	2.3233	2.3065
WR2	2.3980	2.3598
Yield increase over WR1	0.0748	0.0533
DH	2.4610	2.3720
DH Yield increase over WR1	0.1378	0.0655

Variety	IH51RR	GT50
WR1	2.3233	2.3065
WR2	2.3980	2.3598
WR2 Yield increase over WR1	3%	2%
DH	2.4610	2.3720
DH Yield increase over WR1	6%	3%

FarmLink/Bayer CropScience Pod Guard demonstration IH51RR canola, Temora Agricultural Innovation Centre (TAIC) 2014 (t/ha)

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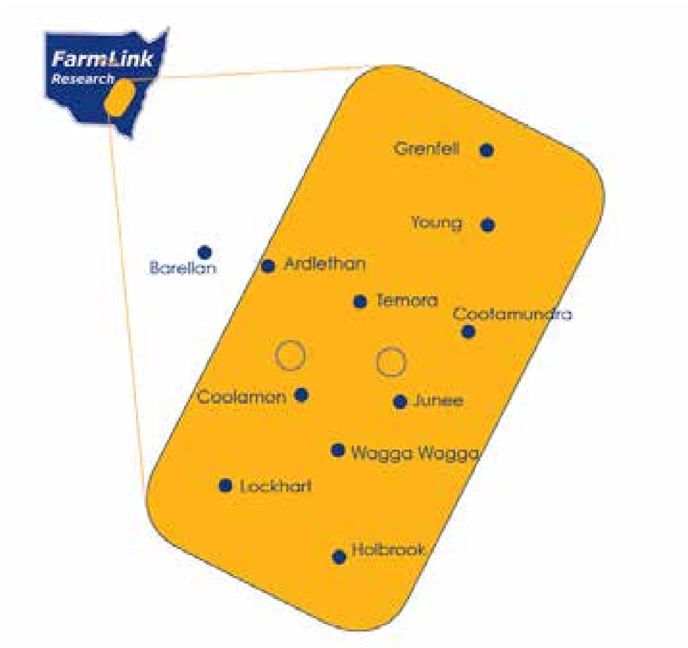
Early Sowing 2014

2014 Trial Site



Project Partners

FarmLink Research

CSIRO

Funding Partner

GRDC
Grains Research & Development Corporation

Early sowing in 2014 – how did it go?

James Hunt, Brad Rheinheimer, Tony Swan, and Laura Goward (CSIRO Agriculture); Neil Fettell (Central West Farming Systems); Barry Haskins, Rachael Whitworth and Mat Ryan (AgGrow Agronomy); Tony Pratt (FarmLink Research).

Keywords: stem frost, winter wheat, BYDV

Take home messages

- If sowing before 20 April, winter wheats (Wedgetail, Wylah, Whistler, Osprey) are at lower risk of stem frost damage than slow maturing spring wheats (e.g. Eaglehawk, Lancer, Bolac, Forrest).
- Keep spring wheats within 5-7 days of their optimal sowing date e.g. if Gregory's optimal sow date is 5 May, then don't sow it any earlier than 29 April.
- Be prepared to back-up imidacloprid treated seed with foliar insecticides if aphids are persisting in to autumn. Common wisdom in NZ is that imidacloprid activity ceases at the start of tillering.

Background

Southern NSW was one of the areas hardest hit by stem frost in July and August 2014, and this combined with heavy aphid infestations (due to above average temperatures in May) transmitting BYDV definitely took the shine off a lot of early sown crops. The early sowing trial sites at Junee Reefs and Rankins Spring were among the worst frost affected areas, and results from these trials highlighted some lessons for managing early sown crops into the future.

However, despite stem frost and BYDV, early sowing was certainly not the disaster many thought it would be. As a general rule, yields of early sown crops tended to be the same or slightly less than main season crops, with some notable commercial and trial exceptions, both positive and negative. To put 2014 in perspective, early sowing of slow maturing cultivars in southern NSW did not work as well as it has in previous years, but it wasn't terrible and this is the first year for a very long time where sowing early wasn't by far the most profitable thing to do.

Managing the risk of stem frost and BYDV in the future

Warm conditions in the first half of May made crops more vulnerable to stem frost. Above average temperatures put crops 11 days ahead of average by the time frosts hit in July. Crops that had moved from vegetative to reproductive phases (i.e. past Z30) were vulnerable.

Whilst the stem frost of 2014 was unprecedented in extent and severity, we can't ignore the potential for it to happen again. There are convincing links between the increasing occurrence and severity of frost events in SE NSW and anthropogenic climate change. Periods of above average temperatures during autumn are also likely to increase in frequency as the earth warms, which have the potential to accelerate the development of crops and make them more vulnerable to frost. It will also change the behaviour of insect vectors of viruses such as BYDV. We therefore have to learn what we can from 2014 in order manage these risks into the future. Big lessons from trials and grower experience in 2014 are;

1. If planting before 20 April, winter wheats (Wedgetail, Wylah, Whistler, Osprey) are at lower risk of stem frost damage than slow maturing spring wheats (e.g. Eaglehawk, Lancer, Bolac, Forrest). This is because winter wheats are slower to move from the vegetative to reproductive stage than slow maturing spring wheats, which are held back during stem elongation by photoperiod sensitivity. Winter wheats also have greater frost tolerance than spring wheats when both are in the vegetative stage. Provided they flower at the same time, yields of the best winter wheats are equivalent to yields of the best slow maturing spring wheats.
2. Keep spring wheats within 5-7 days of their optimal sowing date e.g. if Gregory's optimal sow date is 5 May, then don't sow it any earlier than 29 April. A lot the crops very badly affected by stem frost were sown much earlier than their optimal sowing date. Unless it is a very dry year, there is no real upside to sowing much earlier than a cultivar's optimal date.
3. In early sown crops be prepared to back-up imidacloprid treated seed with foliar insecticides if aphids are persisting later into autumn. Common wisdom in NZ is that imidacloprid activity ceases at the start of tillering.

2014 trial results

Rankins Springs

This site was deliberately situated on a long (18 month) fallow to see what role early sowing might play in making the most of stored soil water in long fallows. Highest yields at this site came from winter wheat cultivars Wedgetail and Osprey sown in mid-

April (Table 1). Wedgetail and Osprey out-yielded the best spring wheat (Gregory) sown in mid May by 0.8 t/ha despite being 12 and 32 years old respectively. This highlights the benefits of using slow maturing varieties and early sowing to take advantage of stored soil water in long fallows in the W NSW environment. It also highlights the lower exposure to stem frost of winter wheats. All spring wheats at the first time of sowing were affected by stem frost to a greater or lesser degree, whereas the winter wheats Osprey and Wedgetail almost entirely avoided it (Table 1). There was no stem frosting in the second time of sowing, however some of the faster maturing varieties may have been damaged by further frosts in mid-September. The high yields at this site were achieved by top-dressing 115 kg/ha N in July targeting 6 t/ha at 11% protein based on Yield Prophet forecasts suggesting high yields were likely given stored soil water from long fallow and the favourable start to the season. This high rate of N would also have affected the ability of stem-frosted treatments to re-tiller.

A density treatment at the mid-April sowing targeting 30, 60 and 90 plants/m² achieved densities of 23, 52 and 76 plants/m² averaged across cultivars. Establishment was patchy in the low density treatment, but despite this there was not a big effect of density on yield in most cultivars.

	Grain yield (t/ha)				Infertile tillers (tillers/m²)			
	Mid April			Mid May	Mid April			Mid May
Plant density (plants/m²)	23	52	76	70	23	52	76	70
Bolac	3.8	3.7	3.5	4.5	157	249	221	0
Dart	3.2	3.6	3.8	3.9	226	242	288	1
Eaglehawk	4.4	4.4	4.2	4.3	40	31	34	0
Gregory	4.1	4.0	4.0	4.9	203	180	243	0
Lancer	4.5	4.6	4.5	4.4	168	170	181	0
Osprey	5.3	5.7	5.1	4.7	2	19	23	0
Spitfire	3.7	3.4	3.1	4.1	227	225	323	0
Suntop	4.1	4.4	4.2	4.7	226	271	237	5
Sunvale	4.1	3.9	4.0	4.4	99	97	125	4
Wedgetail	5.7	5.7	5.7	4.6	0	1	12	1
P-value	**<0.001**				**<0.001**			
LSD (p=0.005)	**0.5**				**68**			

Table 1. Grain yield and infertile tillers (stem frost damage) from two times of sowing (including three different plant densities at the mid-April sowing) at Rankins Springs in 2014.

Junee (Hart Bros Seeds)

At Junee there were 18 individual stem frost events in 2014, 75 frosts (<2°C) in total including several in the period around anthesis in the first two weeks of October (Figure 1). There was also a string of hot days at anthesis. Wedgetail sown 7 April suffered 24-34 % stem frost damage and was not able to yield as well as Gregory and Suntop sown 21 May (Table 3). However, with the best agronomy treatment (100 plants/m² with all N fertiliser deferred until after Z30) it came close in spite of stem frost and severe BYDV infection. The results of the agronomy treatments highlight the importance of deferring top-dressing of N in early sown crops until after Z30.

Wedgetail sown 7 April did not appear to handle stem frost and BYDV as well as some other winter wheat cultivars. Both Osprey and Wylah out-yielded it at this sowing time (Table 4). The best performing material at this sowing date were experimental CSIRO winter crossbreds made by crossing elite spring wheats and selecting winter progeny (Table 4). These crossbreds are F3 and still segregating for many traits and have not been selected for yield. The highest yielding of these out-yielded Wedgetail by 1.8 t/ha, Suntop/Gregory sown 21 May by close to 1.0 t/ha and

Entry	Cross derived from	Habit	Yield (t/ha)
SDWW-0008-1-3	Espada/Gregory	Winter	4.0
SDWW-0009-3-3	Mace/Sunvale	Winter	3.4
SDWW-0012-3-3	Derrimut/Magenta	Winter	3.3
SDWW-0009-1-3	Mace/Sunvale	Winter	3.3
SDWW-0043-3-3	Forrest/Gregory	Winter	3.0
SDWW-0008-3-3	Espada/Gregory	Winter	3.0
SDWW-0043-2-3	Forrest/Gregory	Winter	3.0
SDWW-0043-4-3	Forrest/Gregory	Winter	2.8
SDWW-0008-2-3	Espada/Gregory	Winter	2.7
Wylah		Winter	2.7
SDWW-0005-6-3	Bolac/Spitfire	Winter	2.6
Osprey		Winter	2.6
Whistler		Winter	2.5
SDWW-0043-7-3	Forrest/Gregory	Winter	2.5
SDWW-0043-5-3	Forrest/Gregory	Winter	2.5
SDWW-0005-1-3	Bolac/Spitfire	Winter	2.3
Wedgetail		Winter	2.2
Trojan		Mid spring	2.1
SDWW-0007-2-3	Spitfire/Sunvale	Winter	2.1
Forrest		Very slow spring	1.9
Janz		Mid-fast spring	1.8
Lancer		Slow spring	1.8
Bolac		Slow spring	1.7
Eaglehawk		Very slow spring	1.7
Sunvale		Slow spring	1.5
Gregory		Mid spring	1.5
SDWW-0012-2-3	Derrimut/Magenta	Winter	1.4
Chara		Mid-slow spring	1.3
P-value			**<0.001**
LSD (P=0.05)			**0.5**

Table 4. Grain yields of winter and spring wheats sown 7 April at Junee. Entries shaded light gray are experimental winter wheats developed by CSIRO from crosses of elite spring wheats. Entries shaded dark gray are existing winter wheat cultivars. Entries with no shading are existing spring wheat cultivars.

matched the highest yielding treatments at the site (Mace and Corack sown 21 May yielded 4.1 t/ha in an adjacent trial). This material offers hope that in the future new winter cultivars will be developed that will have a significant yield advantage over the current ageing flock of winter cultivars and give growers some more competitive options for early sowing.

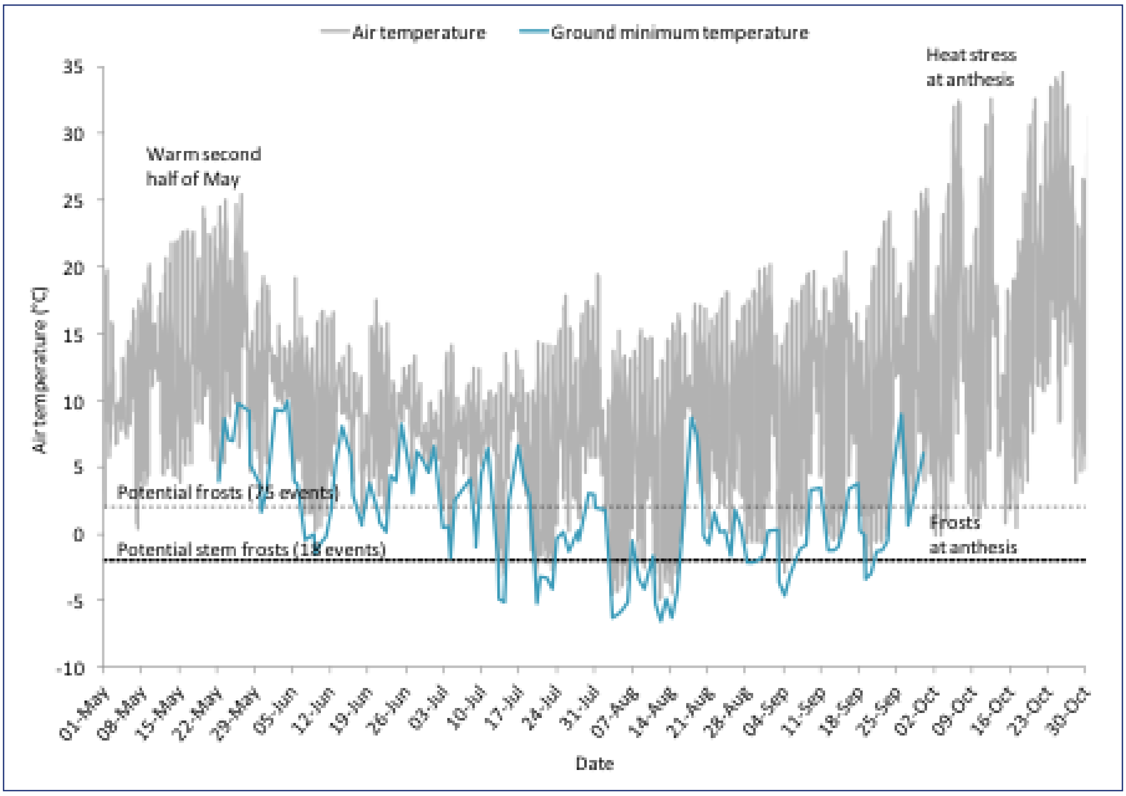


Figure 1. Air temperature at screen height and ground minimum temperatures for the 2014 growing season recorded at the Junee early sowing trial site at Hart Bros Seeds.

Grain yield (t/ha) and stem frost damage (% stems)		Wedgetail sown 7 April		Gregory sown 21 May		Suntop sown 21 May	
Plant density (plants/m²)	Defoliation @ Z30	100 kg/ha N broadcast at sowing	100 kg/ha N top-dressed Z30	100 kg/ha N broadcast at sowing	100 kg/ha N top-dressed Z30	100 kg/ha N broadcast at sowing	100 kg/ha N top-dressed Z30
50	Defoliated	2.0 (27%)	2.3 (24%)	-	-	-	-
50	Undefoliated	1.6 (29%)	2.3 (24%)	-	-	-	-
100	Defoliated	1.9 (34%)	2.6 (27%)	-	-	-	-
100	Undefoliated	1.7 (34%)	2.5 (29%)	3.0 (1%)	2.9 (0%)	2.9 (2%)	3.1 (6%)
P-value (yield)		**<0.001**					
LSD (yield)		**0.2**					
P-value (frost)		**<0.001**					
LSD (frost)		**9**					

Table 3. Grain yield and frost damage of Wedgetail sown 7 April with different agronomy treatments applied vs. Gregory and Suntop sown 21 May.

Existing winter cultivars dominated yields at the 24 April sow date (Table 5). Sown at this time they managed to avoid stem frost, but were still severely infected with BYDV despite imidacloprid seed dressing. The best winter and slow maturing spring wheats (Sunvale, Lancer) were able to equal or exceed the yield of Suntop and Gregory sown 21 May (~3 t/ha).

Entry	Habit	Yield (t/ha)
Wylah	Winter	3.7
Whistler	Winter	3.6
EGA Wedgetail	Winter	3.4
Sunvale	Slow spring	3.4
Rosella	Winter	3.2
Lancer	Slow spring	3.1
Kiora	Slow spring	2.8
Janz	Mid-fast spring	2.7
Bolac	Slow spring	2.5
EGA Eaglehawk	Very slow spring	2.3
EGA Gregory	Mid spring	2.1
Chara	Mid-slow spring	2.0
P-value		**<0.001**
LSD (P=0.05)		**0.2**

Conclusion

In 2014 despite an very unfavourable season with a warm May exacerbating multiple extreme stem frost events and favouring aphid activity and spread of BYDV, in many cases early sown wheat crops were able to equal main season crops. In the future, risk of stem frost damage can be minimised by using winter wheats if sowing prior to 20 April. Spring wheats should be kept within 5-7 days of their optimal sow date. Risk of BYDV should be managed by backing up imidacloprid seed dressing with foliar insecticides at the start of tillering if aphids are present. New winter wheat cultivars are in the pipeline and are likely to have significant yield advantages over current ageing material.

Acknowledgements

We would like to thank growers and advisors on FarmLink Research and CWFS Early Sowing Project steering committees for input into experimental focus and designs, Michael Pfitzner for hosting the Rankins Springs trial and Hart Bros Seeds for hosting the Junee trial.

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GRDC project code: CSP00178

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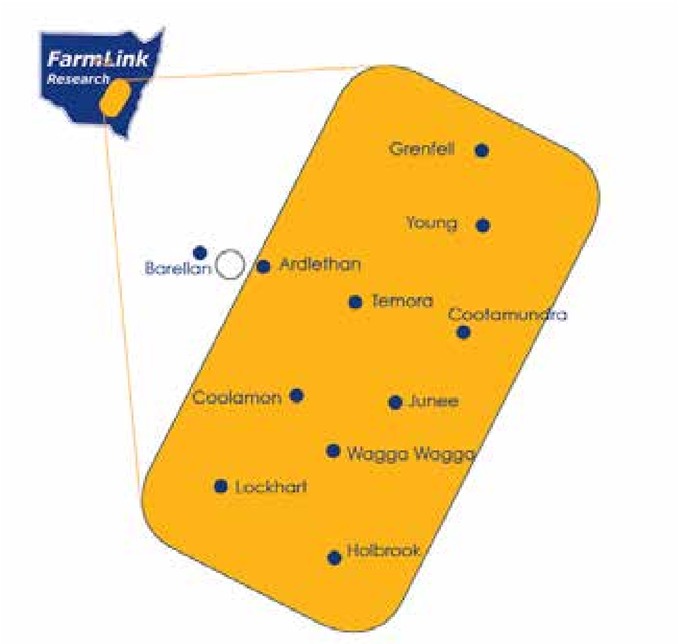
To Burn Or Not To Burn

2015 Trial Site



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CARING
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Barellan Farmers Tackling Stubble

Key points

• Burning, mulching or leaving the stubble standing had no impact on varietal performance in this trial, with no significant differences in plant establishment, grain yield or protein recorded.

• There was however significant differences in yield and grain protein between varieties, with EGA Gregory and Suntop top performing varieties.

• Burning or mulching stubble did lower ryegrass numbers in this trial.

• Stubble treatments had a large effect on how some pre-emergent herbicides performed in this trial. This result is expected and highlights the importance of understanding how individual herbicide properties vary when they are used in stubble situations.

Background

The farmers in the Barellan area of southern New South Wales are well aware of the benefits of conservation farming and stubble retention to their farming systems.

Farming systems that overcome some of the issues associated with stubble including herbicide management, variety choice and whether to burn, retain or cultivate stubble still raise questions in their cropping programs.

In the past the Barellan farmers have had little experience with locally managed trials, particularly in relation to stubble management. As a result a project was developed in conjunction with FarmLink. The aim of this project was to educate these farmers on how to plan their farming systems to overcome the issues associated with stubble.

Trial details

Two trials, a wheat variety x stubble management (sown 9th May) and a pre-emergent herbicide x stubble management (Gregory wheat sown 15th May) trial, were established in Barellan in May 2014, at Jeff Savage's 'Mayfield' property.

The trials were designed to measure and monitor the impact that various stubble management techniques have on;

1) Varietal performance

2) Pre-emergent herbicide efficacy

Trial 1: Impact of varietal choice and stubble management (stubble retention vs burnt stubble vs mulched) on grain yield and quality.

This trial consisted of 3 stubble treatments (stubble retained, stubble burnt and stubble mulched) by 12 varieties including Bolac, Crusader, Dart, Gregory, Lancer, Livingston, Merinda, Spitfire, Suntop, Sunvale, Ventura and Wedgetail. It was replicated 3 times and had plot sizes of 12m by 1.75m

Trial 2: Impact of pre-emergent herbicides on grain yield and quality.

This trial consisted of 3 stubble treatments (stubble retained, stubble burnt and stubble mulched) by 6 pre-emergent herbicide treatments including nil, 2L TriflurX?, 118g Sakura?, 2.5L Boxer Gold?, 2L TriflurX? + 2L Avadex? Xtra and 2.5L Boxer Gold? (applied at 2 leaf ryegrass). It was non replicated.

Figures 1 and 2 on the next page show the trial plans and treatments for these trials.

Results and discussion

Statistical analysis was carried out on the variety by stubble management trial for grain yield and protein. Varieties differed in yield and protein in this trial, however no significant interaction between varieties and stubble treatment was recorded.

No statistical analysis was carried out on the herbicide by stubble management as it was not replicated.

Variety x Stubble Management

Establishment scores, along with disease and weed scores, were taken on 5th June. Establishment was scored on a scale of 0 to 9, with 0 indicating very poor /uneven establishment and 9 very even establishment. The average establishment scores for each treatment is shown in figure 3, with scores ranging from 8 to 9. This trial mostly established well in all treatments.

No diseases were evident in the trial early post-emergence. The trial was sprayed for stripe rust on 9th September with Amistar Xtra? @ 750ml.

Weeds, mainly ryegrass, were sprayed on 22nd June with 300ml Axial? + 0.5% adigor + 1L Precept? 150. There was no recorded difference between weeds present and stubble treatment.

There was no impact of stubble treatment (standing, vs burnt vs mulched) on variety yield performance.

Row	Range 1	2	3	4	5	6
1	Wedgetail	Bolac	Spitfire	Gregory	Sunvale	Crusader
2	Spitfire	Ventura	Crusader	Sunvale	Ventura	Wedgetail
3	Livingston	Suntop	Livingston	Wedgetail	Spitfire	Suntop
4	Dart	Crusader	Suntop	Dart	Merinda	Dart
5	Sunvale	Lancer	Ventura	Lancer	Bolac	Gregory
6	Merinda	Gregory	Bolac	Merinda	Lancer	Livingston
7	Ventura	Dart	Livingston	Crusader	Sunvale	Livingston
8	Lancer	Spitfire	Lancer	Merinda	Suntop	Gregory
9	Merinda	Wedgetail	Spitfire	Sunvale	Spitfire	Dart
10	Gregory	Sunvale	Gregory	Bolac	Bolac	Ventura
11	Suntop	Livingston	Wedgetail	Suntop	Wedgetail	Merinda
12	Crusader	Bolac	Ventura	Dart	Lancer	Crusader
13	Dart	Crusader	Bolac	Spitfire	Spitfire	Merinda
14	Livingston	Wedgetail	Dart	Crusader	Bolac	Livingston
15	Merinda	Suntop	Lancer	Gregory	Crusader	Ventura
16	Spitfire	Lancer	Suntop	Ventura	Wedgetail	Sunvale
17	Sunvale	Bolac	Sunvale	Merinda	Dart	Gregory
18	Ventura	Gregory	Wedgetail	Livingston	Lancer	Suntop

retained	1	burnt	2	mulched	3

Figure 1: Trial plan for the variety x stubble management trial

Row	Range 1–2	Range 3–4	Range 5–6
1	Nil	Nil	Nil
2	2L TriflurX	2L TriflurX	2L TriflurX
3	118g Sakura 1	118g Sakura 2	118g Sakura
4	2.5L Boxer Gold	2.5L Boxer Gold	2.5L Boxer Gol 3
5	2L TriflurX + 2L Avadex Xtra	2L TriflurX + 2L Avadex Xtra	2L TriflurX + 2L Avadex Xtra
6	2.5L Boxer Gold @ 2Lf Rye	2.5L Boxer Gold @ 2Lf Rye	2.5L Boxer Gold @ 2Lf Rye

retained	1	burnt	2	mulched	3

Figure 2: Trial plan for the herbicide x stubble management trial

Figure 4 shows the differences in yield of all the varieties across all stubble treatments. There was a significant difference between varieties. Yields ranged from 2.61 t/ha for Sunvale and Wedgetail up to 3.22 t/ha for Gregory. The average yield for the trial was 2.82 t/ha.

Varietal performance may have been linked to acid soil tolerance, as this site had a pH of 4.3 CaCl2.

There were also no significant differences between the interaction of stubble treatment and variety for grain protein. There was a significant difference between varieties for grain protein.

Figure 5 shows the average grain protein of each variety across all stubble treatments. The average grain protein for the trial was 11.59%, ranging from 10.87% for Gregory up to 12.29% for Spitfire.

There was a significant difference in grain nitrogen yield between each of the varieties, figure 6. The average grain N yield was 324.65. Suntop had the highest grain N yield with 351.7 and Merinda had the lowest grain N yield with 299.8.

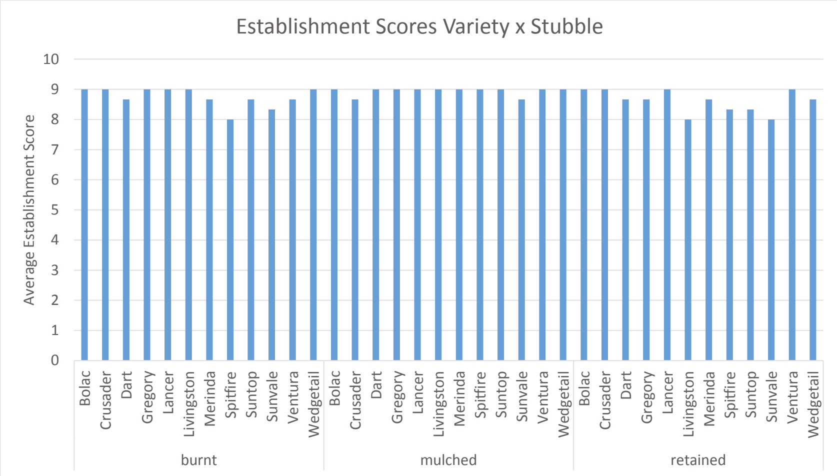

Figure 3: Variety by Stubble Management Establishment scores, taken 5.6.2014

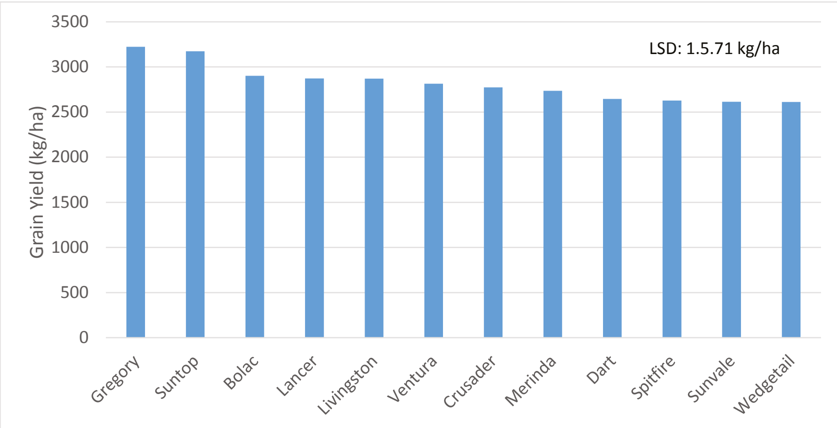

Figure 4: Average grain yield for each variety across all stubble treatments

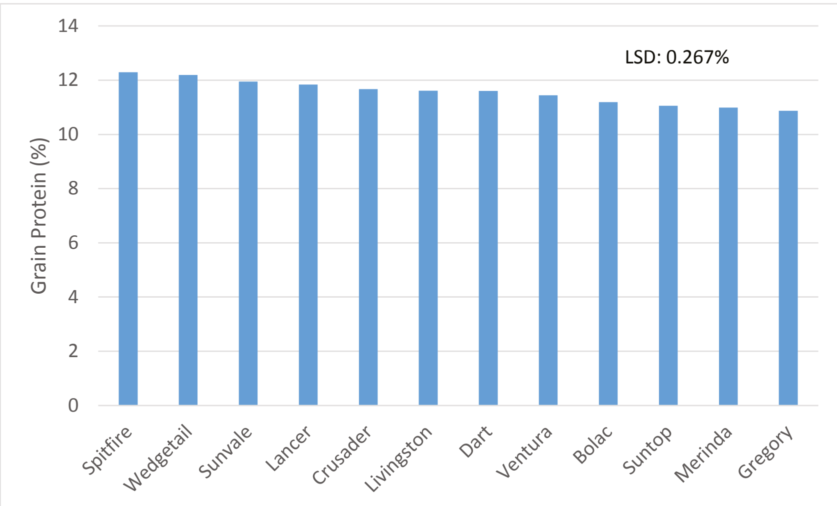

Figure 5: Average grain protein for each variety across all stubble treatments

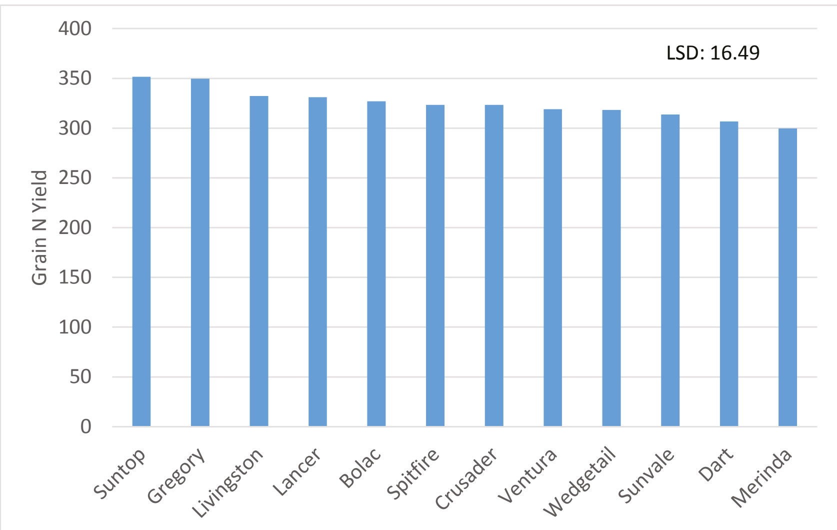

Figure 6: Average grain N yield for each variety across all stubble treatments

Herbicide x Stubble Management

Establishment, disease and weed scores, were taken on 5th June when the crop was at the two leaf stage.

Establishment was scored using the same scale as the variety x stubble management trial. There were no differences between any treatment, as all treatments established perfectly. There was also no diseases observed in this trial to report on.

The density of weeds was scored on a scale of 0 to 10, with the lower the score the less weeds. All treatments were scored in comparison to the nil retained stubble treatment, which had the highest density of weeds. Ryegrass was mostly at the 2 leaf stage when weeds were scored.

All herbicide treatments, with the exception of treatment 6 (2.5L Boxer Gold? - applied at 2 leaf ryegrass) were applied pre-emergence and incorporated by sowing (IBS). Treatment 6 was applied on 29th May when the crop and weeds were at the two leaf stage, known as early post emergent (EPE).

This demonstration trial did show the effect of either burning or mulching stubble on the following weed burden (figure 7).

This was demonstrated most noticeably in the nil herbicide treatment, where burning or mulching alone decreased weed presence by about 50%, probably as a result of seed destruction. The level of weeds remaining however was still unacceptable, and for commercially acceptable weed control a pre-emergent herbicide was warranted.

This demonstration also showed how some pre-emergent herbicides reacted to various stubble treatments.

Triflur X worked better when stubble was burnt, and better again when mulched. The opposite trend occurred with Boxer Gold when applied prior to sowing. Sakura seemed unaffected by the stubble treatment.

This highlights the way that stubble can react with various pre-emergent herbicides in turn affecting the outcome in weed control.

It would be unwise to draw any conclusions from just one trial, however this trial reinforces that Triflur X works better if there is less stubble that intercepts the herbicide from reaching the soil.

This is also the case (to a lesser extent) with Boxer Gold, however with this product we observed a reduction in efficacy compared to the burnt treatment when the stubble was mulched. This was most likely resulting from the layer of mulched soil limiting the herbicide and soil contact.

Sakura performed consistently across all stubble treatments in this trial.

Triflur X and Avadex Xtra gave the highest level of weed control along with Boxer Gold EPE. The issue with the Boxer Gold EPE was that it affected crop vigour quite noticeably, whereas no other herbicide had this effect on the crop.

In both cases weed control reduced when stubble was mulched.

Acknowledgements

This project CLG13-846 ‘To Burn or Not to Burn - Barellan Farmers Tackling Stubble’ is supported by FarmLink and Ag Grow Agronomy and Research, through funding from the Australian Government.

Ag Grow Agronomy and Research would like to thank trial cooperator Jeff Savage for hosting the trial, and also providing assistance with the management of the trial.

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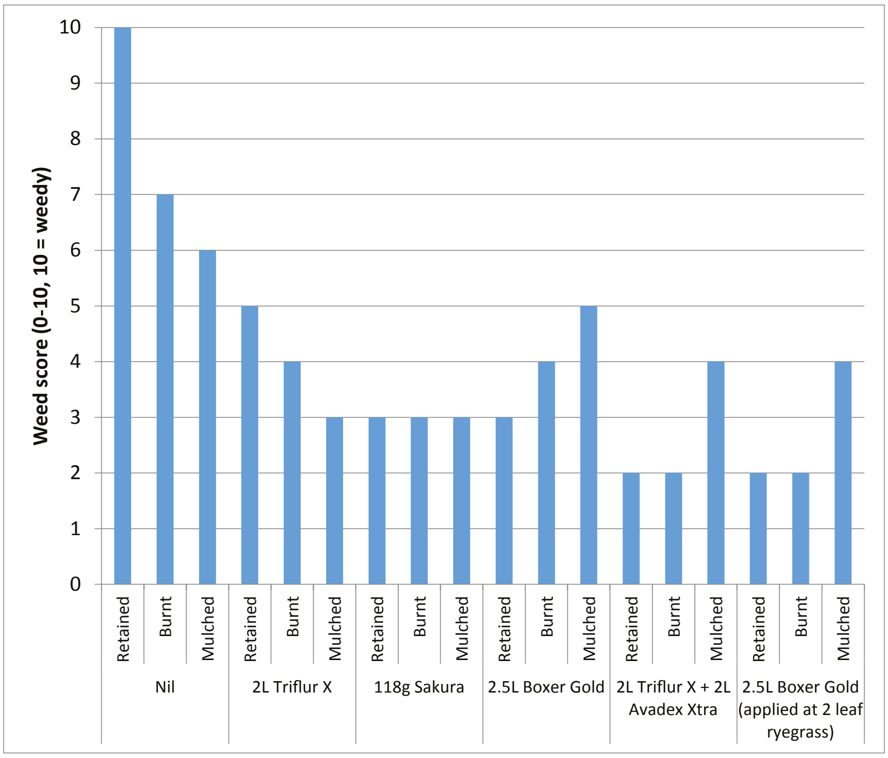

Figure 7: Weed scores of the herbicide by stubble treatment demonstration

Figure 8: Burning the stubble treatments in April

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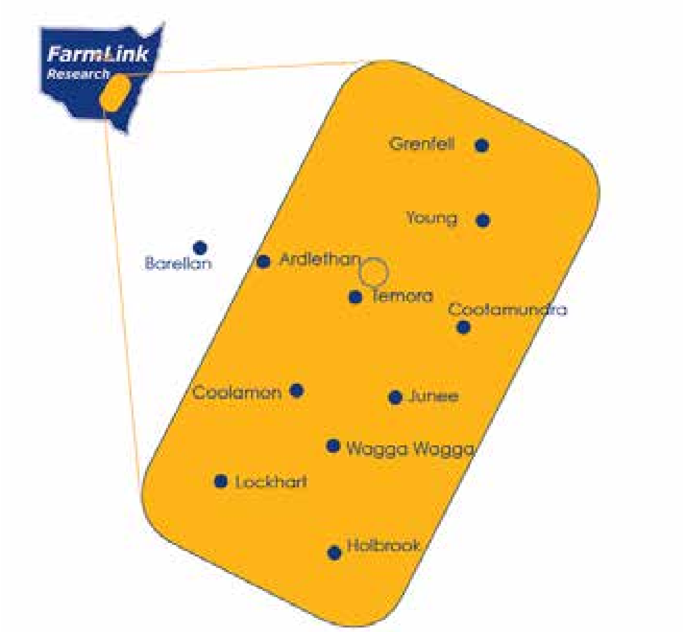
Grazing Canola Trial

2014 Trial Site



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Temora Agricultural Innovation Centre Grazing Canola Trial 2014

Tony Pratt - FarmLink Research Technical Officer and Temora Agricultural Innovation Centre (TAIC) Farm Manager

Key Messages

• Long season dual purpose winter type canola can persist in the medium rainfall zone at Temora and could provide a valuable feed gap resource and grain return at harvest, so long as it gets off to a good start.

• Adjustment may be needed to usual windrow and harvest schedules to accommodate for the extended time to maturity.

Background

Dual-purpose canola can be grazed by livestock during the vegetative stage and then grown on to produce grain thereby improving farm profitability and reducing the production risk of canola. Dual-purpose canola is typically grown across the high rainfall zone where the risk of a false break or short spring is less likely. Sowing crops 2-3 weeks earlier than for grain-only crops maximises biomass available for grazing, with up to 800 DSE grazing days/ha achieved from spring cultivars. In general, biomass production is greatest in hybrid cultivars and lowest in triazine tolerant cultivars. Grazing canola can increase the severity of blackleg, so a cultivar with good blackleg resistance should be selected if crops are to be grazed. Little or no yield penalty is associated with grazing crops prior to stem elongation, but grazing crops late or hard can significantly reduce yield as flowering is delayed and grain filling occurs in hot, dry weather. Dual-purpose canola provides a significant opportunity to increase profitability, but growers need to be prepared to sow early with the appropriate cultivar type when the opportunity arises.

There has been significant interest from district farmers in recent years;

1) who have a mixed farming enterprise and are looking for the first time at alternative (to cereal) dual purpose crops for the benefits associated with including more break crops in their rotation, and

2) Who are already grazing canola periodically and are looking at new varieties and fine tuning their management skills both in the cropping and grazing areas, especially for dual purpose canola.

Aims

To conduct a paddock scale demonstration grazing canola trial at TAIC using a true winter type variety usually recommended for the high rainfall zone. The purpose of the trial was to -

• Develop some knowledge and strategies for managing a winter type canola in a medium rainfall environment. How far west is too far west for a winter type canola?

• Generate some basic data that may act as a performance indicator for the variety to be sown.

• Observe the yield response of canola to two different grazing regimes.

Consultation with Karl Schilg from Pacific Seeds, who supplied seed for the trial, led to the choice of the variety Hyola 971CL. The growing attributes and performance of this variety are listed below.

Herbicide Tolerance	Growing Habit	Breeding	Performance
Clearfield	Winter	Hybrid	Good DM & Yield

What we did

The trial site at TAIC consisted of a 7ha paddock that was sown with wheat in 2013 and barley in 2012. The paddock was divided up to give three equal areas of 1.6ha (some area along a fence line with trees was excluded). Below is a summary of the paddock management.

Paddock #13

- Paddock history: 2013 – Elmore wheat
  2012 – White Stallion barley
- Crop Type: Canola
- Soil type: Red/brown-clay/loam
- Variety: Hyola 971CL
- Soil pH: CaCl – 5.2
- Sowing date: 17/4/2014
- Sowing rate: 2.5kg/ha
- Fertiliser rate: 70kg/ha Map + Impact
- Fertilisers applied: 14/4/2014 – 80kg/ha Gran Am,
  14/8/2014 – 80kg/ha Urea
- Herbicides applied: 17/4/2014 – Treflan 1.7 l/ha,
  Gramoxone 1.5 l/ha

Three grazing treatments were implemented at the site to look at dry matter production, dry matter removal and crop recovery. The three treatments were nil graze, light graze and heavy graze. The grazing strategy was a crash graze approach as we were interested in seeing how hard you could treat the crop and then observe its recovery. The livestock used for the crash grazing were 325 merino lambs. Concern was raised at the class of livestock used, but the lambs' appetite proved more than adequate for our demonstration trial purposes.

What we found

Dry matter cuts were taken immediately prior to grazing and again post grazing on July 9, 2014. See table below. Additional observations were taken periodically through to harvest.

Observations of the light graze treatment post grazing showed that the sheep had removed some green leaf

Treatment	DM pre grazing 27/6/14 (paddock sample)	DM post grazing (9/7/14)	DM removal	Grazing Interval
Block 1 - Nil graze	3.03 t/ha	-	-	-
Block 2 - Light graze	3.03 t/ha	2.79t/ha	0.24t/ha	4 days (27 June- 1 July)
Block 3 - Heavy graze	3.03 t/ha	2.04t/ha	0.99t/ha	8 days (27 June-5 July)

Figure 3: Heavy graze 9/7   DM cuts

area from out of the crop canopy leaving plant stalk and stem visible. There were still lower leaves on the plants untouched and crop trampling was minimal. The heavy grazing treatment post grazing however, exhibited severe green leaf defoliation and all that was left, besides some plant material that had been trampled, was plant stem.

Further observations one month after grazing showed a remarkable level of recovery in the heavy grazing treatment and a static state of recovery in the light

Figure 1: Nil graze 9/7   DM cuts

Figure 2: Light graze 9/7   DM cuts

Figure 4: Nil graze 13/8   1 mth recovery

Figure 5: Light graze 13/8 1 mth recovery

Figure 6: Heavy graze 13/8 1 mth recovery

graze treatment. During this recovery phase there was an extended period of frost events, and the rainfall for August was below the long term average. Some purpling of the nil graze and light graze treatments was evident, with the nil graze having the most purpling on its leaves. The heavy graze did not show any purpling. Anecdotally, Hyola 971 displays some purpling, but the frosts and lack of rainfall would have contributed to this as well. Below is a comparison between the light and heavy graze treatments.

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Rainfall (mm)	20.6	29.6	83.9	56.4	71.3	64.8	44.5	26.2	35.0	17.6	19.8	-

GSR = 315.8mm

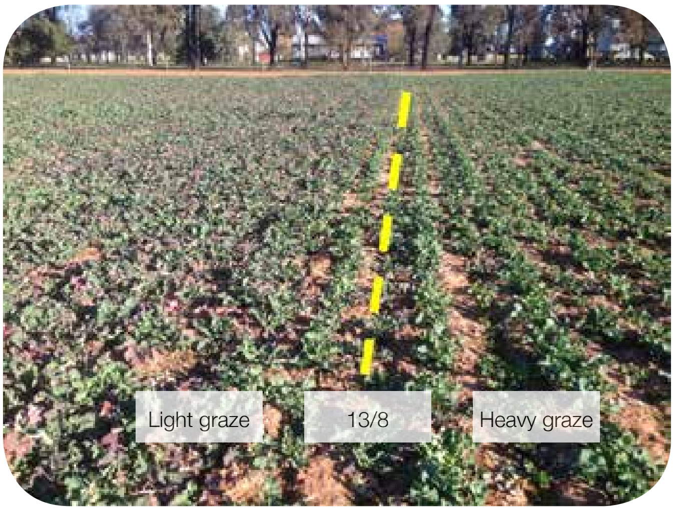


Figure 7

Urea was spread on the three treatments at a rate of 80kg/ha on the 14/8/14 and some small rain events through August and September may have been enough for the crop to use some of the applied N. However, the nil and light graze treatments still had some purpling up until stem elongation and early flowering.

Flowering was later and longer than other commercial paddocks of canola (Gem GT 50RR) and although all treatments had some plants flowering by early September the heavy graze block was visibly behind the other two treatments

Commercial paddocks of spring type canola at the TAIC were windrowed on the October 27, 2014 at 60-70% colour change. The three treatments in the trial were windrowed on the November 4, 2014 which was at 40% colour change for the nil graze treatment and 30% colour change for the heavy graze treatment. This was a little earlier than optimal, but access to a contract windrower and extended logistics with harvest at the TAIC meant windrowing was conducted early, with an anticipation that yield and oil was compromised.

The paddock was harvested on November 28, 2014. Data was recorded on the yield monitor of the CASE harvester from the several runs within each treatment and an average calculated. The results are tabled below. No statistical analysis has been done on these yield results.

Treatment	Yield monitor block average
Block 1 – Nil graze	0.813t/ha
Block 2 – Light graze	0.928t/ha
Block 3 – Heavy graze	0.793t/ha

From the results above it can be seen that the light graze was the highest yielding treatment. The 2014 season finished with a dry spring, some removal of plant biomass has potentially lowered the plant water usage and let this treatment fill grain. The nil graze had used too much soil moisture maintaining vegetative biomass, and the heavy graze yielded 0.793 and clearly too much biomass was removed for the plants to recover. In comparison spring type grain, only canola at TAIC had an average yield of 1.53 t/ha in what was considered a tight finish to the 2014 season.

This demonstration trial was included in FarmLink's Open Day field trial program where over 40 people attended a session that looked at the trial site and heard from guest speakers. Susie Sprague from CSIRO Plant Industries gave an update on dual-purpose cropping trial work she and project team leader John Kirkegaard and colleagues have been working on at Greenthorpe. Susie generated some information looking at best bet management for grazing canola, experimental results and the suitability of winter cultivars for Temora. This information is included as Appendix 1.

Conclusion

The demonstration trial that was conducted at the TAIC using a winter type dual purpose grazing canola has been successful in raising issues in relation to crop management and cultivar selection.

Changes which could be implemented to increase both the grazing and grain yield opportunity would include:

- Better paddock selection and preparation in terms of size, fertility and weed pressure.
- Sowing a variety like Hyola 971 earlier with the available moisture - it could have been sown in mid-March and available for grazing sooner and possibly for longer
- Being mindful of grazing intensity and biomass removal as yield can be reduced by high levels of defoliation
- More targeted and maybe split application of Nitrogen to initially get high biomass and canopy closure and later to aid in plant recovery.
- Allowing adequate post grazing recovery period for acceptable grain recovery
- Possible dessication of crop at maturity and direct head harvesting as alternative to windrowing as the extended time to maturity of a winter variety may be out of step with windrow contracting services.
- Being aware of the limitations and risks of growing a long season winter type cultivar in a medium rainfall environment.

Acknowledgements

This research demonstration trial was undertaken by FarmLink Research at the Temora Agricultural Research station (TAIC). We thank Karl Schilg from Pacific Seeds Susie Sprague and Colleagues from CSIRO and Craig Warren from Landmark for organizing windrowing of blocks.

Dual Purpose Canola

Refining variety and management recommendations to improve productivity and resource use efficiency of dual purpose crops in Australia

Author - Susie Sprague, CSIRO: susan.sprague@csiro.au, (02) 6246 5387

Best-Bet Management

- Paddocks should be well prepared to capitalise on early sowing opportunities and ideally have adequate stored water to ensure good even establishment and early biomass. Press wheels can improve establishment in dry conditions. Crops sown 2-3 weeks earlier than normal (early-mid April) can produce significant biomass (1.5-4 t/ha) in the mid-winter feed gap and allow the resting of pastures.
- Current spring varieties can be managed for dual-purpose use from early April sowings. Use the most vigorous varieties (e.g. hybrids) with good blackleg resistance (>R-MR) and the correct phenology for the site and season. Grazing reduces biomass and slows the development of these early-sown crops back into the normal window. Weed management is an important consideration in varietal choice given early sowing and the withholding periods for some chemicals.
- Strategies to increase early biomass for grazing include earlier sowing (not too early); varietal choice (hybrid>conventional>triazine tolerant); increased sowing density; adequate nitrogen.
- Grazing can commence as soon as plants are well anchored, although generally biomass levels or chemical withholding periods would preclude grazing until the 6-8 leaf stage which coincides with mid-June for early April sowings (>1.5 t/ha biomass).
- Canola is palatable to livestock, has high feed value, and has produced good liveweight gains (210-300 g/day). We have had no animal health issues, however, guidelines for grazing brassicas should be followed. Most growers have achieved 600-800 dse. grazing days/ha in the period mid-June – mid-August with various animal classes.
- Growers should ensure they have adequate livestock on hand to capitalise on this high value feed. The choice of enterprise and class of animal will determine the profitability of dual-purpose use (e.g. cross-bred fat lambs vs breeding merinos).
- Top-dressing with N after grazing should be considered to ensure the crop has adequate nutrition to maximise regrowth and yield.
- Grazing from 6-8 leaf stage and before buds start to elongate has little impact on flowering time (2-3

days delay), yield or oil. Grazing more advanced plants heavily or late delays flowering and can reduce grain and oil yield. Crops with good grazing management have little yield penalties depending on seasonal conditions for re-growth. In general, grazing into August has resulted in some yield penalties although the grazing value can offset moderate yield penalties.

- Growers should evaluate the direct economic benefits from grazing in relation to potential yield loss (which can be minimised with good management), and indirect benefits such as a reduction in crop height/bulk to facilitate harvesting, grass weed control, pasture spelling, disease break and management flexibility.

Experimental Results

Greenethorpe – CSIRO

Cultivar Hyola971CL (winter) sown 25 March and cultivar Hyola575CL (spring) sown 16 April were defoliated at various growth stages and severity leaving different amounts of residual biomass. Both undefoliated cultivars had the same grain yield (2.8 t/ha) in a dry finish but the winter provided 3.7 t DM/ha forage compared to 0.7 t DM/ha by the spring (Table 1). Yield was reduced by grazing after the start of stem elongation and also by grazing hard even in the safe window (prior to stem elongation) as crops flowered too late and did not recover sufficient biomass to maintain grain yield. In some situations, the yield penalty from late/hard grazing was offset by the value of forage but the spring cultivar was much more sensitive to late or hard grazing than the winter cultivar. Yield loss was generally avoided if >1.5 t DM/ha and >3.0 t DM/ha remained at the end of July for spring and winter cultivars, respectively.

Table 1. Effect of defoliation treatments on removed dry matter (DM), residual DM and grain yield recovery in Hyola971 winter canola and Hyola575 spring canola at Iandra, Greenethorpe, 2013. Optimal economic outcomes are highlighted in grey. GSR (A-O): 270mm; 359mm LTM.

Var.	Lock-up time	Cutting intensity treatment	Removed DM (t/ha)	Residual DM (t/ha)	Grain yield (t/ha)	Relative Yield (% of uncut)	Relative economics ($/ha)
Hyola 971CL sown 25 March	UNCUT				2.79		
	6-8 leaf (7 May)	Hard	0.9	0.4	2.90	1.04	+280
	BV (19 June)	Double (+6-8lf)	3.6	0.9	2.16	0.77	+585
	BV10 (24 Jul)	Double (+6-8lf)	2.4	2.6	2.59	0.93	+500
	BV20 (6 Aug)	Double (+6-8 leaf)	3.8	3.6	2.77	0.99	+940
		Triple (+6-8lf+BV)	4.4	1.6	2.37	0.85	+890
		Moderate	1.9	5.3	2.88	1.03	+520
	6 July	Grazed	5.6	0.4	2.04	0.73	+1025
Hyola 575CL sown 16 April	UNCUT				2.82		
	6-8 leaf (17 Jul)	Hard	0.7	0.2	2.55	0.91	+40
	BV (24 Jul)	Moderate	0.2	1.2	3.01	1.07	+145
		Hard	0.8	0.6	2.29	0.81	-65
	BV10 (30 Jul)	Moderate	1.1	1.0	2.78	0.99	+255
		Hard	1.4	0.7	1.99	0.71	-65
	BV20 (6 Aug)	Light	0.4	3.1	2.58	0.91	-20
	30 Jul	Grazed	0.9	0.2	2.13	0.76	-120

Residual biomass (t DM/ha)

0.2 t DM/ha

0.9 t DM/ha

3.6 t DM/ha

Temora – FarmLink and CSIRO

Spring canola grown at Temora provided 500-800 DSE grazing days/ha at Temora with little or no yield penalty (see Table 1).

Table 2: Grazing and grain yield achieved at FarmLink site at Coleman's, Temora in 2010 and 2011.

Are winter cultivars a suitable fit for Temora? Results from APSIM simulations

APSIM has been used to predict the grazing and grain potential of different canola maturity types at Temora using 50 years of weather data (Table 3). Sowing opportunities for winter canola are limited and crops are at greater risk of failure due to subsequent dry autumn conditions. Although grazing and grain yield of winter canola is high in some seasons, the variability in predicted grain yield is also high. The winter x spring canola has a similar predicted yield than spring types (but greater yield variability), however as they can be sown earlier they have much greater forage production. Sowing opportunities are more consistent for spring canola (with minimal chance of crop failure due to a false break) but the amount of grazing is lower. At present, no winter x spring cultivars are commercially available but they are in development.

Table 3: Summary of predicted (by APSIM) sowing opportunity, grazing and grain potential for winter, winter x spring and spring canola maturity types at Temora over 50 years. Results are based on 60 plants/m2 with 250kg N/ha at sowing and 100 kg N/ha applied post-grazing.

GRDC Project Code: CSP00160

Year	Sown	GSR (mm)	Grazing			Variety	Yield (t/ha)	
			Time	SR	DSE.d/ha		UG	Graze
2010	15 April	460	30/6-1/7	Crash	517	Tawriffic	4.1	4.0
2011	14 April	200	24-25/6	Crash	~800	45Y82	3.4	3.1

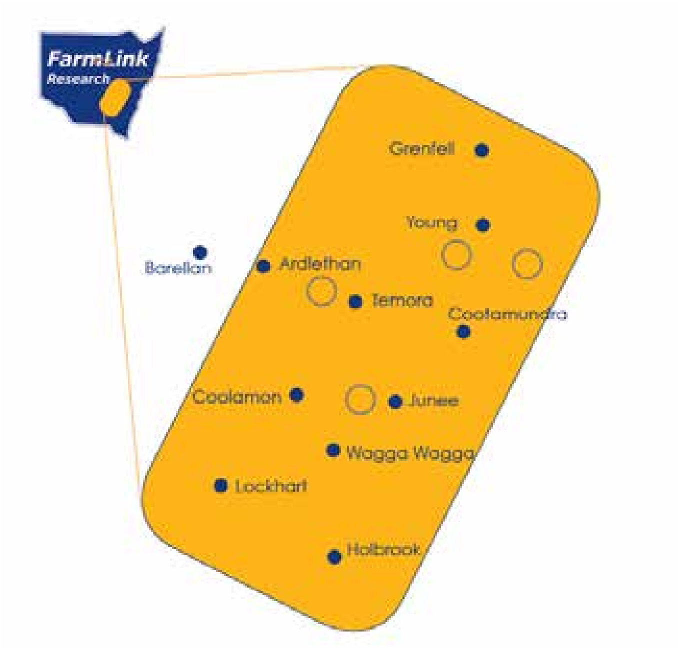
Table 2

Variety	Sowing	Sowing opportunity	Start graze	Start flower	Grazing (range) DSE.d/ha	Yield (range) t/ha
Winter	8 Mar	34%	28 Apr	4 Sept	2700 (2400-3200)	3.1 (1.0-4.8)
	22 Mar		15 May	11 Sept	2400 (2200-2800)	3.3 (1.0-5.2)
Wint x Spr	22 Mar	55%	8 May	27 Aug	2200 (2100-2500)	2.8 (0.8-4.8)
	26 Apr		24 Jun	11 Sept	1700 (2000-2500)	3.2 (1.0-4.8)
Spring	26 Apr	70%	18 Jul	30 Aug	800 (800-1100)	2.8 (1.2-4.1)
	17 May		7 Aug	10 Sept	600 (500-700)	3.0 (1.2-4.0)

Table 3

Phosphorus Rates: A FarmLink Member Project

2014 Trial Site



Project Partners

FarmLink Research

THE UNIVERSITY of ADELAIDE

NSW GOVERNMENT Department of Primary Industries

Funding Partner

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Can phosphorus rates be reduced?

Author – John Angus

Soils in the FarmLink area are naturally low in phosphorus (P), and fertiliser containing available P is normally applied to all crops. Research in the 1960s and 70s showed that the critical level of soil P needed for maximum crop yield was about 30-35 mg/kg using the Colwell test. Since that time, farmers have used two rules to maintain the soil P concentration.

- Rule 1 is to replace the P removed in grain by applying about 4 kg P for each tonne of target yield (or about 8 kg P per tonne of canola).
- Rule 2 is to apply a minimum of 10 kg/ha of P to balance the 'fixation' in soil.

Many optimistic growers applied 20 kg P/ha in the expectation of wheat yields of 5 t/ha or canola yields of 2.5 t/ha.

In recent years the critical level of soil P has been modified using the Phosphate Buffer Index (PBI), which means that soils with high buffering capacity require more P than the original recommendations. For the levels of PBI on red brown earth and red soils in the FarmLink region, the critical level of Colwell P is 20-30 mg/kg.

These rules need to be checked because of changes in the past decade. During the droughts since 2002 P removal was less than expected but many farmers optimistically continued to apply sufficient fertiliser for high target yields. Accordingly soil P increased on many paddocks to levels that had never been seen before. Another change is that a new test of soil P, called DGT (diffuse gel technology) has become available and has been more accurate than Colwell in predicting grain yield responses to P on alkaline soils in South Australia.

The aim of the project was to conduct a series of experiments to find out:

- Whether P application rates could be reduced without affecting yield and profit
- How rapidly the levels of soil P decreased with low rates of P fertiliser
- Whether the DGT test was preferable to the Colwell test for soils in the FarmLink region

To assess profit we need to compare grain revenue with nutrient costs. We assume that one tonne of MAP costs $800 and contains 100 kg of N and 220 kg of P. The alternative source of N is urea, in which the N costs $1.40/kg, so the value of N in one tonne of MAP is $140. Therefore the value of P in one tonne of MAP is $800 minus $140. Since one tonne of MAP contains 220kg of P, the cost of P is ($800-$140)/220= $3/kg. Later in this article we calculate the profit from any additional grain and assume that wheat the farm-gate price of wheat is $250/t, canola $450/t and barley $220/t. Note that this definition of profit uses the conservative assumption that profit means only that additional revenue covers additional costs. Most growers would want additional revenue to be at least double additional costs.

The FarmLink experiments

The experimental locations were at Wagga Wagga, Ariah Park, Harden and Grogan over the 5 years of the project. All were sown and harvested on commercial-scale plots by FarmLink members on their own farms with their own equipment. The sowing dates were generally in the first half of May and P fertiliser was banded with the seed. The experimental crops were managed by growers as part of the paddock and the crop species grown was the same as the paddock as a whole. The plot areas were located by GPS on airseeders and headers. The harvested grain from each plot was augered into a mobile bin and weighed with a load cell. Results were not available for all experiments but we ended up with yield results from 16 trials.

At each experiment, fertiliser P was applied as monoammonium phosphate (MAP) at rates of 5, 10 and 20 kg P/ha, with a zero P control. To allow for additional N applied with the MAP, we added urea to bring the level of N up to a constant level on each plot. There were three replicates at each experiment. Where possible the experiments were repeated on the same plots in successive years, for example the control plots were unfertilised in each year. The rotation was decided by the grower

Soil P levels were measured before sowing at all experiments. Samples of the top 10 cm of soil were collected and sent to the University of Adelaide for analysis by the Colwell and DGT methods.

Yield results

Yields are available for sixteen of the experiments and the results are shown in Table 1. Yield responses to P varied between sites. The variability between sites is not surprising and is consistent with the variability among multi-site tests of P fertiliser. These were conducted in the FarmLink Region in previous decades when the background level of soil P was much lower than now. The results in Table 1 show no strong pattern of responses related to season or site, although the smallest yield responses to P were in the low-yielding experiments. Two of the largest responses, at Grogan and Ariah Park in 2011 were at relatively high yield levels, but for the high-yielding 2012 wheat at Cunningar there was response to only the lowest rate of applied P.

The profitability of each additional P application is colour coded in Table 1, with blue indicating that the additional returns from grain exceeded the additional cost of P and red indicating returns less than costs. Like yield, the profitability varied between sites and years. The maximum rate of P fertiliser was profitable at only three of the 16 experiments.

Table 1. Yield (t/ha) in response to P fertiliser. The blue cells indicate profitable yield responses and the red cells indicate unprofitable responses.

Year	Location	Colwell P in	Crop	Phosphorus rate (kg/ha)			
				0	5	10	20
2009	Wagga Wagga	56	barley (frost)	0.77	0.67	0.65	0.62
2011	Wagga Wagga		Canola	1.43	1.37	1.56	1.49
2012	Wagga Wagga		Wheat	2.31	2.50	2.58	2.70
2009	AriahPark	58	Wheat	1.41	1.56	1.52	1.60
2010	Ariah Park		Wheat	3.27	3.28	3.28	3.16
2012	Ariah Park		Wheat	3.47	3.33	3.39	3.44
2009	Harden	40	Canola	1.12	1.24	1.07	1.23
2011	Cunningar		Canola	2.40	2.31	2.22	2.28
2012	Cunningar		Wheat	4.73	5.04	4.80	4.74
2009	Grogan	35	Wheat	1.97	2.14	2.04	2.05
2011	Grogan		Wheat	4.46	4.69	4.96	5.37
2012	Grogan		Wheat	4.58	4.53	4.33	4.58
2009	AriahPark	51	Wheat	1.67	1.74	1.76	1.80
2011	AriahPark		Wheat	3.85	4.27	4.59	4.74
2012	Ariah Park		Canola	1.13	1.37	1.44	1.44
2013	Ariah Park		Wheat	3.47	3.33	3.39	3.44

Averaged over all experiments, the most profitable rate of fertiliser P was 5 kg/ha, equivalent to 23 kg/ha of MAP. The optimum varied between experiments, as presented in Table 2, which shows that for seven of the 16 experiments no P fertiliser was economically justified.

Table 2. Summary of the optimum rate of fertiliser P in the experiments

Optimum P fertiliser application	Number of experiments
No P fertiliser	7
5 kg P/ha	5
10 kg P/ha	1
20 kg P/ha	3
Total	16

Grain protein was measured for some of the experiments and generally showed no response to P or a small increase. The results are not reported here.

Grain yield and soil tests

Colwell P tests have provided a guide to the use of P fertiliser application on soils that are low in available P. The data collected in this project provides an opportunity to assess the relationship of this test to yield at high levels of soil P and compare it with the DGT test Figure 1 shows data for Phosphorus Use Efficiency plotted against soil P levels measured by the two methods. PUE was calculated as the additional yield divided by the additional P fertiliser for each level of P in each experiment.

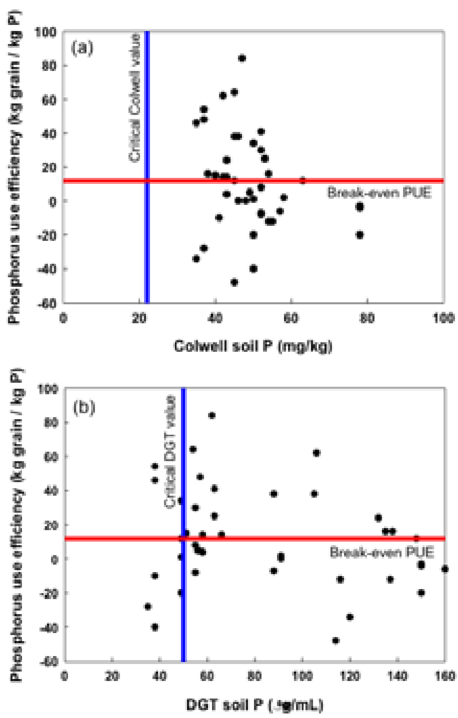

Figure 1. Relationships between soil tests and phosphorus use efficiency (PUE) for (a) the Colwell and (b) the DGT test. PUE means the kilograms of additional yield divided by the kilograms of applied P. The vertical lines show critical levels of soil P for both tests and the horizontal lines show the economic break-even values of PUE.

For all soils sampled, the Colwell P values were greater than the critical value, above which P fertiliser is not expected to increase yield. The data are scattered above and below the economic break-even suggesting that the test is not useful in predicting yield response to P fertiliser. For most of the soils the DGT-P values were greater than the critical value and this test was no more reliable than Colwell in predicting yield response.

The variability of the yield responses was greatest at soil-P values just above the critical levels and there were smaller or negative yield responses at very high soil-P values.

Changes in soil P

The soil P levels measured at the time of sowing over several years on the same plots give us an opportunity to measure the rate of change. At three of the experimental sites there was a continuous record over the 4 or 5 years. These results help to explain changes in soil P with continuous cropping.

At the start of the experiments in 2009, the average soil Colwell P was 57 mg/kg and with no added P this level decreased to 41 mg/kg by 2012, a rate of about 5 mg/kg per year (Figure 2). When P fertiliser was added the level decreased less rapidly and at the highest P rate actually increased. The level was almost stable with an annual application 10 kg P/ha. The decreases measured by the DGT method were similar, but showed similar rates of soil-P decline with applications of 10-20 kgP/ha.

The results in Figure 2 show variation between years for both the Colwell and DGT tests and apparently greater variability with the DGT test.

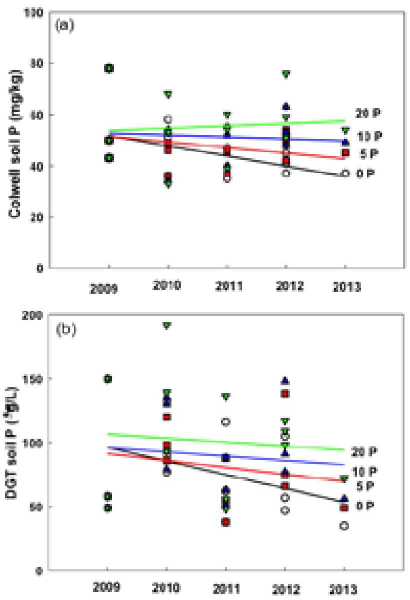

Figure 2. Changes in soil P measured by the Colwell test (a) or the DGT test (b), sampled before sowing on the same plots from 2009 to 2013 at three experiments (Ariah Park, Grogan and Wagga Wagga). The different symbols represent the rates (in kg P/ha) of fertiliser applied each year and the trend lines are fitted to the data. Symbol colours are the same as line colours

Comparing Colwell P and DGT tests

We compared soil P measured by the Colwell and DGT tests for all experiments and treatments where both were measured. Colwell and DGT tests have different units, but the numbers for DGT, as presented by the laboratory, are about twice the Colwell numbers for DGT greater than about 80 μg/mL were about twice the Colwell values, but below this level the two tests were similar. Comparisons of the tests have not shown such a close relationship on alkaline South Australian soils where the DGT tests were closely related to yield response to P and the Colwell tests were poorly related.

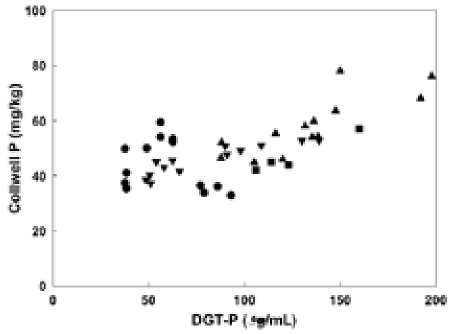

Figure 3. Comparison of the Colwell and DGT tests of soil P.

Phosphorus requirements with early sowing and N fertiliser applications

Two other topics are relevant to this discussion. Neither are part of this project but they have implications for how the results are interpreted.

Early sowing

Experiments conducted at Condobolin during the 1970s showed that early sown wheat crops required less fertiliser P to reach potential yield than crops sown at the normal time. This result has particular importance with the increasing areas of early-sown grazing crops. The implication is that rate of P fertiliser can be reduced for these crops.

What is not known is whether low rates of P can be applied to a series of early sown crops. Reduced P application to an early-sown crop, combined with increased P removal in the higher yields of these crops may lead to rapid decrease in soil P.

Phosphorus – nitrogen interaction

Experiments conducted by staff of Incitec-Pivot at Rand and other locations investigated the crop requirements for combinations of N and P fertilisers. The experiments consistently showed greater yield response to N fertiliser at high levels of P fertiliser than at normal application rates. The yield responses to P were also greater at higher levels of soil P than the critical value of 30-35 mg/kg Colwell for red soils in the region.

Conclusions

Soil levels of available P were about twice the critical level at the16 on-farm experiments because, like most of the cropping soils in the region, normal rates of P fertiliser had been applied and little P had been removed by low-yielding crops during the drought.

The requirement for P fertiliser for crops growing on these soils was less than previous recommendation. On average, the economically optimum rate of fertiliser P was 5 kg P/ha. The yield response to P fertiliser was variable and soil tests did not explain the variation, which was probably due to seasonal variation that is not well understood.

The DGT test was no more reliable than the Colwell test in explaining yield response to P fertiliser.

A rate of 10 kg P/ha was sufficient to maintain soil P at the elevated levels it had risen to. With no application of P fertiliser soil N decreased at about 5 mg/kg each year. The amount of P removed by crops during this experiment was below average because of low yields and it is likely that the rate of decrease would be greater with average crop yields. The annual decrease can be used to extrapolate to the time when soil P falls to the critical level.

Reduced rates of P fertiliser are justified for soils with P levels well above the critical level, particularly when crops are sown early. While this applies to average conditions, there will be yield foregone on some paddocks and in some seasons. If significant amounts of N fertiliser are to be applied, a maintenance rate of 10kg p/ha of P fertiliser is still recommended rather than applying none, regardless of the soil test.

Acknowledgements

FarmLink thanks members who hosted the trials: Matt and Sam Dart, Darryl and Peter Harper, Ben Beck, Craig Warren and Terry Brown. Paul Breust coordinated the trials using FarmLink core funding. Sean Mason from the University of Adelaide analysed soil phosphorus levels, Mark Conyers from NSW Department of Primary Industries helped design the experiments and interpret the results and John Angus from Stockinbingal wrote this report

FarmLink
Research Report 2014
11

Managing Micronutrient Deficiencies

2014 Trial Site

Project Partners

FarmLink Research

NSW Government – Department of Primary Industries

SARDI – South Australian Research and Development Institute

Funding Partner

GRDC Grains Research & Development Corporation

Impact of zinc and copper applications on wheat yields at Temora and Harden in 2014

Authors - Sjaan Davey and Nigel Wilhelm (South Australian Research & Development Institute, Adelaide)

Key Messages

• Industry guidelines for interpreting zinc and copper levels in soil and plant tests appear to be valid for current farming systems in local situations

• No increases in wheat performance with zinc or copper applications on sites with reports of deficiencies in previous years.

Background

Concern has been raised across the grains industry that:

1) strategies for managing trace element deficiencies are less well known than those for managing nitrogen and phosphorous deficiencies, and

2) trace element supplies in soils may not be adequate for current, more productive and more intensive cropping systems.

The reality is that trace element management packages for manganese, zinc and copper were developed 20 – 40 years ago in substantially different cropping systems and economic climates when fertilisers were relatively cheap. Speculation that these packages need to be reviewed and adapted to current farming systems, economic climate and the new cropping areas has driven this GRDC funded project.

Aims

To use trial sites deficient in zinc or copper for wheat to:

• evaluate the effectiveness of a range of application strategies and sources.

• determine minimum rates of zinc or copper to correct a deficiency.

What we did

Trial sites with a suggested history of either zinc or copper deficiencies were located near Harden and Temora, NSW. Both sites were sown with 60 kg/ha of Axe wheat, the zinc site on 3 July 2014 and the copper site on 2 July 2014. A range of zinc or copper application strategies and rates were applied as treatments during the course of the 2014 season. The zinc trial site was harvested on 9 December and had an approximate growing season rainfall of 151 mm. The copper trial site was harvested on 1 December and had an approximate growing season rainfall of 91 mm.

Before sowing each trial site was sampled for soil fertility to depth including extractions for zinc and copper. Plant growth mid season and tissue analyses of the youngest emerged blades from selected treatments were measured.

What we found

Soil tests from the zinc trial showed zinc concentrations ranging from 0.71 to 0.92 mg Zn/kg (DTPA) in the top 10 cm which are all greater than the 0.3 mg Zn/kg guideline for zinc deficiency in these soils. Plant tissue test results of 20 mg Zn/kg in the un-amended control were also not in the deficient range (less than 16 – 20 mg Zn/kg) according to existing industry standards. In combination, the soil and plant tissue tests indicate that the zinc site should not have been deficient in zinc for wheat, which was confirmed by the absence of a response to the zinc applications applied during the growing season. The average yield for this site was 3 t/ha.

Soil copper concentrations in the top 10 cm at the copper site pre- seeding ranged from 0.38 to 0.45 mg Cu/kg, all of which are above the current critical level guideline for deficiency of <0.2mg Cu/kg (DTPA). YEB analysis for the un-amended controls in this trial was about 3 mg Cu/kg which is greater than the critical range of 1.5 to 2 mg Cu/kg. In combination, the soil and plant tissue test values indicated that a yield response to copper at this site should not have occurred, and wheat performance was not improved by Cu applications at any stage in the season. The average yield for all treatments across this site was 1.8 t/ha.

Commercial practice

While soil tests for zinc or copper deficiency can be a guide, plant tissue tests are still the preferred method of diagnosing trace element deficiencies in broad acre crops. Results from these initial trials in our project suggest that there is no reason yet to doubt current zinc and copper guidelines for wheat in both soil and plant tissue tests.

This project will continue for the next two seasons to further investigate responses and relevance of trace element application strategies, rates and guidelines.

Acknowledgements

This research is funded by the GRDC (project DAS00146) and SARDI. We thank FarmLink Research, Sergio Moroni (NSW DPI) and Charles Sturt University for conducting the two trials on our behalf. We also thank Andrew King and Chris Hardwick for allowing these trials to be run on their properties.

GDC Project Code: DAS00146

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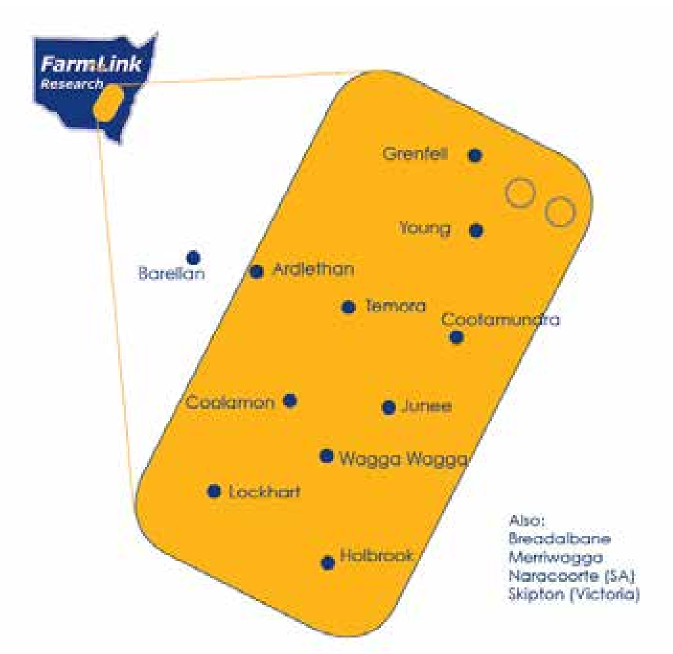
NPKS - Regional Soil Testing

2014 Trial Site



Project Partners

FarmLink Research

NSW Government Department of Primary Industries

Funding Partner

GRDC Grains Research & Development Corporation

NPKS fertiliser responses - field trial report

Mark Conyers and Jonathan Holland (NSW DPI), Karen Giddings and Cindy Cassidy, (FarmLink)

The purpose of these GRDC funded trials is to provide soil test calibrations with fertiliser responses for situations where the national database has minimal data. For example there are very few response curves for K and S, particularly for pulses. Three projects are running: one in each of the western, northern and southern GRDC regions. NSW DPI and FarmLink, together with Southern Farming Systems, the Mackillop Farm Management Group, and AgGrow Agronomy, are responsible for the southern GRDC region.

In 2014 we established seven trial sites, five of which were in NSW. Unfortunately one of the NSW trials was lost due to circumstances beyond our control, so only six trials are described here.

Cowra

We had two trials on the Cowra Research Station, managed by Col McMaster of NSW DPI:

The first was a comparison of P responses by faba beans, chick peas, field peas and canola compared with wheat. P rates were 0, 10, 20 and 30 kg P/ha as triple super. This will help us to assess the relative P requirements of crops for which we have little soil test calibration data.

In addition at this site, where we had rates of P applied to canola, we compared the P response at 3 sowing dates: 17 April, 7 May and 22 May 2014. Comparisons of how P response varies with sowing date have previously been made for wheat but not for canola to our knowledge.

The second trial site was a N response trial (0, 40, 80, 160 kg N/ha as urea) on wheat. At the middle rate (80 kg/ha) we compared split with upfront applications, and also urea vs polymix as the source of N. The latter provides a slow release form of N.

Wagga Wagga

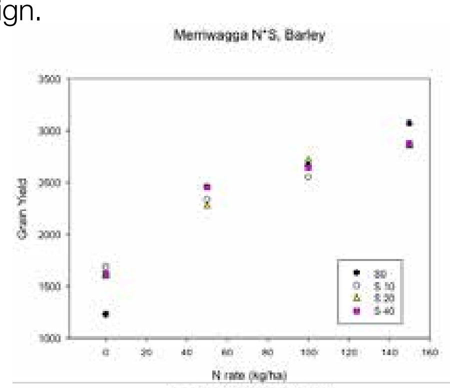
In general, grain yield responses to N (x axis) were small in 2014 due to the dry spring. Early dry matter responses to S (0, 10, 20, 40 kg S/ha) in both wheat and barley did not translate into grain yields.

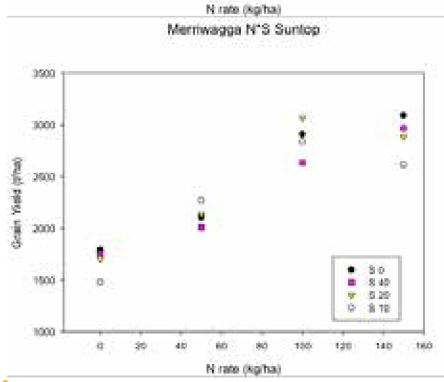
Breadalbane

This trial is about 25 km west of Goulburn, and operated in conjunction with Richard Hayes and Matt Newell of NSW DPI. Although originally intended to be a K trial, the soil acidity was such that the trial design had rates of K (0, 25, 50, 100 kg K/ha) with and without 2.5 tonne limestone/ha. The crops sown were wheat (Revenue) and triticale (Endeavour). These were sown in March and grazed during the season before harvesting for grain in December 2014.

Merriwagga

This site was run in conjunction with Barry Haskins and Rachael Whitworth of AgGrow Agronomy. The trial involved 4 rates of N (0, 50, 100, 150 kg/ha) as urea by 4 rates of S (0, 10, 20, 40 kg/ha) as gypsum. The crops were wheat (Suntop) and barley (Buloke). It is hard to find S deficient sites, and S deficiency is often associated with high rates of N, hence the N*S trial design.





Interstate

In addition we are attempting to obtain K response calibrations for grain crops in SA and Victoria. Briefly, we had a site near Naracoorte with SARDI and the Mackillop Farm Management Group in which rates of K (0, 25, 50, 100) were applied to wheat (Scout), barley (Granger), and lupins (Mandelup). In Victoria in conjunction with Southern Farming Systems, we had a site near Skipton where the rates of K (0, 25, 50 and 100 kg/ha) were applied to wheat, barley and field peas (Oura).

Grain and anthesis dry matter samples, and soil samples, are currently queued for processing. Results will become available over the next 12 months.

GRDC Project Code: DAN00168

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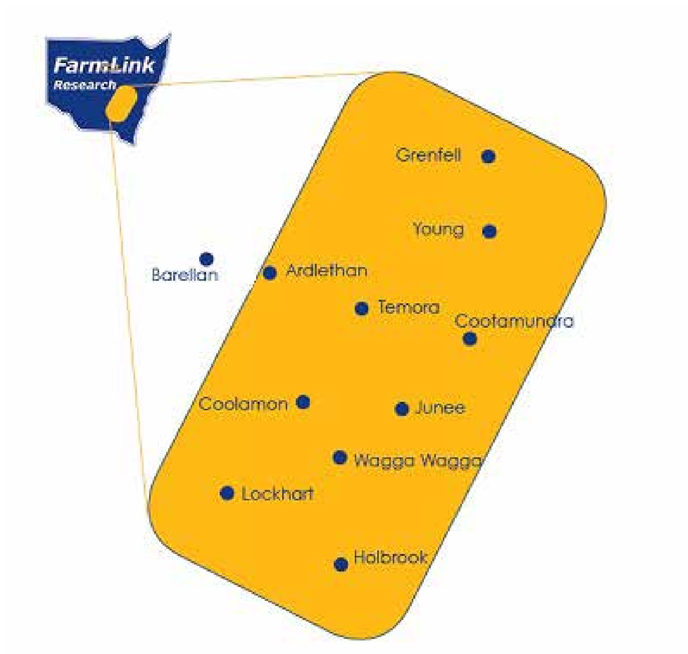
FarmLink Member Profiling Project

2014 Project Reach



Project Partners

FarmLink Research

FarmLink Farmer Member Profiling Project

Author – Erika McAllister (FarmLink)

Project Aim

The farmer member profiling project was created to help FarmLink better understand who its members were, what they were doing on farm, what changes they had made to their farming practices and why members valued FarmLink. Another aim of the project was to evaluate FarmLink's performance and members' perception of the organisation.

FarmLink plans to regularly update its member information so that it can measure change in farming practice through FarmLink's activities and also remain aware of members' changing research, development and extension needs.

The results of this project will help FarmLink to represent members' needs more effectively to funding bodies, develop relevant research priorities and provide a better service.

Project Background

At the beginning of 2014, FarmLink talked to its members about the need to better understand them and its plan to undertake a member profiling project to capture member information in a consistent manner. FarmLink will use consolidated data and analysis of information in communication with funding bodies, sponsors and other stakeholders but will only use individual's information for internal purposes. FarmLink will maintain the confidentiality of information disclosed in the survey.

The project was designed and implemented using the online surveying tool, Survey Monkey. In mid-June the survey was made available online and promoted via FarmLink's e-link. In early July hardcopy versions with reply paid envelopes were sent out to members who had not yet filled out their member profiles, along with the invitation to FarmLink's annual dinner.

Method of completion	Surveys completed
Online	54
Hardcopy	53
TOTAL	107

Figure 1: Responses

What we discovered

The survey provided FarmLink with a solid background to our members' farming operations and the way they benefit from the work of FarmLink. Moving forward, this gives FarmLink a base from which to plan future projects and to improve the areas of operation where applicable. An advisor component was also included in the survey, but results have not been included for the purpose of this report.

A small snapshot of the survey results revealed that of our 320 members, 93 per cent are farmers and seven per cent are advisors and industry partners.

Our members manage over 720,000 hectares out of 1.2 million hectares encompassed by the FarmLink region, with farms ranging from as small as 10 hectares up to 40,870.

Of the survey respondents, 63 per cent of them fell into the 40-60 year-old age bracket, with 77 per cent of respondents being mixed farmers 23 per cent straight croppers, and providing employment for approximately 825 people on-farm.

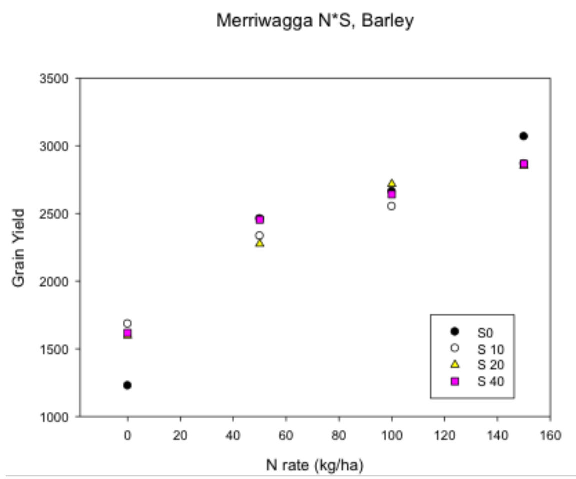
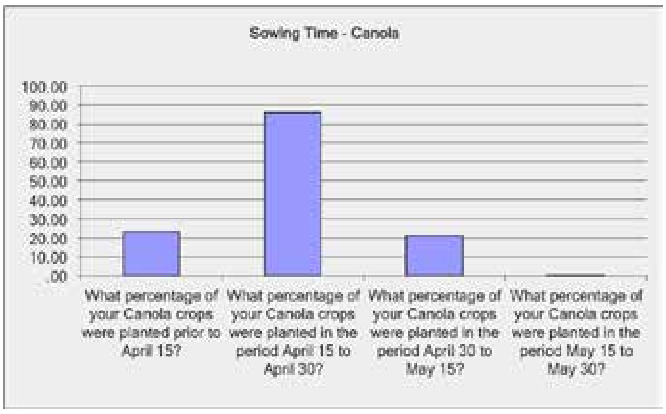


Figure 2: Average annual rainfall of FarmLink members

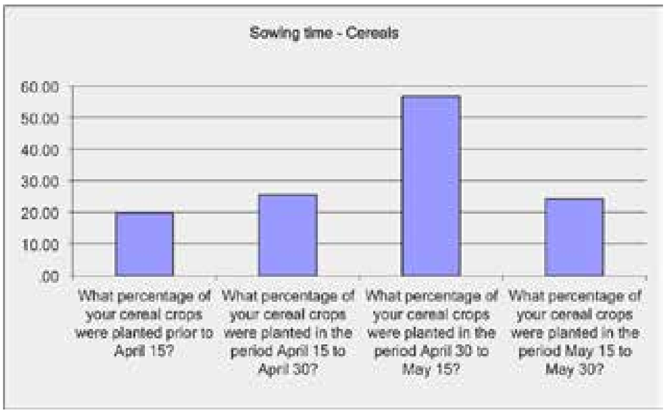
Of those survey respondents who had implemented any practice change as a direct result of information provided by FarmLink, the main areas of change were Cereal Grazing, Nitrogen management in crop using PAW, Magnesium and Calcium supplements for sheep, Early sowing of cereals and canola, Reduced tillage, Stubble retention, Summer weed control and WUE.

Does the new practice reduce risk?	59.2%
Is the new practice officially approved?	6.8%
Is the new practice achievable?	52.4%
Is the new practice recommended by someone you know?	22.3%
Is the new practice ethical?	15.5%
Is the new practice innovative?	27.2%
Does the new practice fit in with the bigger picture?	77.7%
Other (please specify)	20%

Figure 3: Drivers of Practice Change – what do you take into consideration when implementing change?



Data collected on sowing times showed that the majority of Canola crops were planted between April 15 and 30 (ABOVE) while the majority of Cereal crops were planted between April 30 and May 15 (BELOW)



When it comes to their involvement in FarmLink, respondents most valued –

1) the access to research results and technical information from FarmLink

2) access to local trials relevant to your farming practices; and

3) access to locally organised events

Conclusion

The project has been a very valuable in collecting data and information about FarmLink members. FarmLink has already been able to use the data to better tailor research proposals and other activities to FarmLink members' requirements.

The data shows that FarmLink members value the work FarmLink does, along with the sense of community that FarmLink provides. FarmLink has made significant contributions to improvements in local farming practices as demonstrated in the on-farm changes that have come about through the work of FarmLink.

For future profiling activities, we identified the opportunity to structure the questions differently to ensure more consistency in the way they are answered and the analysis able to be undertaken.

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Contributed Articles

The effect of grazing intensity on crops

Authors - Alison Frischke and Dannielle Ick (BCG)

Key Words

grazing crops, forage value, grazing intensity, grain & graze 3

Take home messages

- Grazing crops early and/or lightly will generally not affect grain yields.
- Plant recovery is supported by having more green material remaining after grazing; the more the merrier!
- Early sown winter wheat can produce more biomass earlier in the season than spring wheat varieties.

Background

In low rainfall areas, taking advantage of an early sowing opportunity by planting a cereal crop with good early vigour will provide green feed for livestock in early winter and give pastures time to bulk up before grazing. However, grazing a crop can be a risk to grain production when plants have limited growing season time and/or moisture to allow them to recover from grazing. They must be able to produce enough biomass for storage of carbohydrates in leaves, stems and roots to use for grain fill.

Often a yield loss will be accepted as a fair trade for the feed value to the livestock enterprise, but careful grazing management can minimise it. Grain & Graze 2 trials at Raywood in 2012 and Watchupga East 2013 (see BCG 2012 Livestock Research Results pp. 58-62 and BCG 2013 Season Research Results pp. 204-207) indicated that a crop can be safely grazed without yield penalty when a quantity of leafy material remains after grazing to aid crop recovery. This amount will vary with the crop stage of growth, and grazing duration and intensity.

BCG, through the Grain & Graze 3 initiative, conducted a trial in 2014 to further explore 'safe' grazing management practices.

Aim

To validate the effect of grazing intensity and growth stage on forage value and yield response of different wheat varieties, with sowing times suited to cultivar.

Trial details

Location:	Quambatook
Soil type:	Clay loam without sub-soil constraints
GSR (Apr-Oct):	168 mm
Crop types:	Rosella, Revenue, Scout and Mace wheat
Sowing dates:	1 April (TOS1) and 6 May (TOS2)
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Target plant density:	150 plants/m^2
Harvest dates:	14 November (TOS1) and 1 December (TOS2)

Trial inputs

Fertiliser: Granulock supreme Z @ 50kg/ha at sowing plus 180kg/ha of urea (83 kg N/ha) top-dressed in two separate applications

Pests, weeds and diseases were controlled to best practice commercial standards.

Method

A replicated field trial was sown using a split plot trial design with time of sowing as main plots and variety x grazing as sub-plots. Winter wheat varieties Rosella and Revenue were sown at time of sowing 1 (TOS1) in April. TOS1 occurred after receiving 50mmof rain during March, with 10mm falling just prior to sowing. Mid and short season varieties Scout and Mace were sown (TOS2) in early May. TOS2 occurred after 30mm of rain during April, with 13mm falling just prior to sowing. All plots established very evenly.

Assessments included crop biomass removed at each grazing time and height, nutrient value of that grazed biomass, total biomass at anthesis and grain yield and quality parameters.

Grazing was simulated using a line trimmer, cutting the crop to the treatment height.

Using DM and feed tests, dry sheep equivalent (DSE) grazing days were calculated as follows:

DSE grazing days = DM (kg/ha) x feed test metabolisable energy (ME) / 8 MJ, which assumes that each DSE requires 8 MJ ME/day

Treatments for each variety are presented in results Tables 2-4.

2014 trial results

The season began in March with welcome opening rains which continued steadily until the end of July. However, little rain fell during spring and crops were forced to rely on stored soil moisture to finish. 72 days were recorded with a minimum temperature below 2°C; many plants suffered from stem frost.

Grazing value

Early grazing of crops occurred at GS16 when plants were 25-35cm. Late grazing occurred when plants were at GS30-32 when crops were 40-45cm tall.

All light grazes were to 25cm, moderate to 15cm and heavy to 10cm.

Feed tests indicated that all crops had adequate protein, metabolisable energy (ME), and fibre (NDF) to support lactating ewes and growing lambs (16% protein, 11 MJ ME/kg and >30% NDF). As crops matured, or were more intensely grazed, nutrient value reflected the change in plant structure with age and proportion of leaf: stem (Table 1).

		Rosella			Scout		
Grazing timing	Grazing intensity	Crude Protein (% of DM)	Metabolisable Energy (MJ/kg DM)	Neutral Detergent Fibre (% of DM)	Crude Protein (% of DM)	Metabolisable Energy (MJ/kg DM)	Neutral Detergent Fibre (% of DM)
Early GS16	Mod	31.9	12.0	38.9	27.6	12.0	42.4
	Heavy	30.7	12.1	34.4	31.6	12.6	36.7
Late GS30	Light	25.1	11.4	44.4	30.3	12.4	35.6
	Mod	22.3	11.2	43.2	29.2	11.8	37.6
	Heavy	20.6	10.6	48.0	22.4	11.3	42.7

Table 1. Feed value of Rosella and Scout wheat grazed at different times and intensities, Quambatook 2014.

As expected, the feed (dry matter) and subsequent grazing days' value increased the more heavily the crop was grazed, and the later the crop was grazed for all varieties (Tables 2, 3 and 4). Dry matter recovery by anthesis also followed a similar trend, with a tendency to have lower dry matter when grazed more heavily and later.

Grain value

Rosella: Despite a reduction in anthesis dry matter for later grazed crops, grain yields were unaffected by grazing at any stage or intensity in 2014 (Table 2).

The early sowing in April gave Rosella sufficient time in the season to recover and maintain production. However, Rosella yields were poor compared with the neighbouring Early Wheat Trial (av. 1.7t/ha), for which the reason is unknown. Plants that have lower yield potential need fewer resources to be able to recover and maintain grain yield when grazed.

Grain protein was higher for ungrazed and early-light grazed crop compared with later grazed crop to 10 and 15cm tall, but all protein levels were high, exceeding 14%. Grazing Rosella at any stage did not affect screenings.

Grazing timing	Grazing intensity	Dry matter of feed available (t/ha)	Grazing days	Dry matter at anthesis (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Ungrazed	-	-	-	6.40a	0.70	15.5a	3.5
Early GS16	Mod	0.37c	550c	5.80ab	0.76	15.2a	3.6
	Heavy	0.73b	1098b	5.75ab	0.83	14.9ab	3.9
Late GS30	Light	0.38c	528c	5.21bc	0.83	14.9ab	3.8
	Mod	0.71b	1014b	5.18bc	0.86	14.5b	3.3
	Heavy	1.57a	2082a	4.23c	0.89	14.4b	3.6
Sig. diff. LSD (P=0.05) CV%		**P<0.001 0.19 16.5**	**P<0.001 263 16.2**	**P=0.017 1.12 13.7**	**NS**	**P=0.021 0.64 2.9**	**NS**

Table 2. Feed value, grain yield and quality of Rosella wheat grazed at different growth stages and intensity, Quambatook 2014

Revenue was sown with the same treatments as Mace (Table 4). This variety has a higher vernalisation requirement (cold temperatures needed to trigger vegetative to reproductive growth) than Rosella, and it remained vegetative well into the season. By 22 May, 0.27t/ha of DM had been produced and by 26 June 0.88t/ha of DM when grazed moderately. Subsequently, Revenue flowered very late and with the dry spring conditions, failed to set grain for harvesting.

Scout: An early-mid maturing variety sown later, and hence grazed later, had similar value responses to grazing treatments to Rosella, but didn't produce quite as much dry matter. Grain yields were maintained in early grazed plots, and the lightly grazed later timing. Yields of the later, more heavily grazed crops to 15 and 10cm were lower than ungrazed crop.

Grain protein of Scout was unaffected by grazing. Screenings, however, were above 5% for all treatments and suffered from the late, heavy graze.

Grazing timing	Plant height after grazing (cm)	Dry matter of feed available (t/ha)	Grazing days	Dry matter at anthesis (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Ungrazed	-	-	-	5.75a	1.58a	12.9	5.8cd
Early GS16	15 (Mod)	0.28c	440c	5.84a	1.50a	12.4	5.1d
	10 (Heavy)	0.63b	949b	4.53b	1.35ab	12.2	5.8cd
Late GS30	25 (Light)	0.24c	375c	5.72a	1.29abc	12.5	7.2bc
	15 (Mod)	0.55b	810b	4.56b	1.19bc	12.4	8.2b
	10 (Heavy)	1.14a	1603a	3.87b	1.05c	12.7	11.1a
Sig. diff. LSD (P=0.05) CV%		**P<0.001 0.15 16.7**	**P<0.001 210 16.3**	**P=0.004 1.04 13.6**	**P=0.014 0.29 14.6**	**NS**	**P<0.001 1.76 16.2**

Table 3. Feed value, grain yield and quality of Scout wheat grazed at different growth stages and intensity, Quambatook 2014

Mace: This fast maturing variety had excellent feed value at the early grazing time compared with other varieties. Due to its fast maturity, grain yield and quality was unaffected.

Grazing timing	Plant height after grazing (cm)	Dry matter of feed available (t/ha)	Grazing days	Dry matter at anthesis (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Ungrazed	-	-	-	6.30a	2.21	11.5	3.5
Early GS16	15 (Mod)	0.49	749	5.05b	2.07	11.0	3.6
Late GS30	15 (Mod)	0.42	620	5.48ab	2.02	11.7	4.9
Sig. diff. LSD (P=0.05) CV%		**NS**	**NS**	**P=0.04 0.90 9.3**	**NS**	**NS**	**NS**

Table 3. Feed value, grain yield and quality of Scout wheat grazed at different growth stages and intensity, Quambatook 2014

Commercial Practice

Early planting of wheat varieties when opportunities present, matching the month of sowing with growth type (i.e. winter wheat to late March-early April and spring wheat to late April-very early May) capitalises on early moisture, spreads the sowing window for the farm program, and presents a grazing opportunity for livestock.

Unfortunately, in this trial Rosella did not perform as well as expected, but in the neighbouring Early Wheat variety trial, both winter wheats (Rosella and Wedgetail) sown early yielded as well as May sown Scout. Winter wheats are capable of producing more biomass at an earlier date, creating greater forage value at a time of increased demand.

Trial results support previous work which showed that if the crop is sown at the appropriate time, and grazed early, or lightly, as it approaches GS30, then it should recover and maintain grain production. However, the ability of the crop to recover depends on the time of grazing in the year and plant maturity, stored and in-season rainfall, and the intensity of grazing.

On-Farm Profitability

Livestock production is a reliable source of income for mixed farming businesses across seasons. Growing green feed for ewes and lambs with high nutrient demands when other pasture growth is limited will improve survival of ewes and lambs, and lamb growth rates.

With careful grazing management, crops can be grazed early and lightly in most years without suffering yield penalty. This will be a trade-off in the amount of feed available for stock and potential grain yield penalties later. Heavier and later grazing, when there is more feed, may incur yield penalty risk. In 2014, it was more profitable to graze Rosella and Mace as they maintained yield in addition to their forage value. Grazing Scout was profitable early, but a decline in yield and subsequent income of later and more heavily grazed crop needed to be balanced with grazing value.

Making the decision when to graze will depend on the need for feed and importance of livestock and cropping to the business.

Acknowledgements

We would like to thank Gavin Mann of Quambatook for hosting the trial. This research was funded through GRDC's 'Grain & Graze 3' project (SFS00028).

Contact

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GRDC project code: SFS00028

Early sowing of barley in 2014 – how early was too early for current varieties?

Rohan Brill and Karl Moore – NSW DPI Wagga Wagga

Introduction

This trial was designed to assess the effect of early, mid and late sowing dates on the phenology and grain yield of several newer barley varieties in comparison with traditionally grown varieties in southern NSW.

Site details

Soil type: Red clay loam

Previous crop: Wheat (2013 and 2012), stubble burnt on 23 April

Rainfall: 240 mm April–October + 100 mm December–March

Fertiliser: 100 kg/ha MAP at sowing + 100 L/ha UAN 29 May

Results

The 23 April sowing of quick varieties such as Hindmarsh and La Trobe resulted in flowering occurring in late August (Table 1). These early flowering varieties had lower yield from the 23 April sowing compared to the 13 May sowing. Compass and Urambie achieved similar yield from the 23 April sowing as the 13 May sowing despite Compass flowering in early September when sown early. Urambie is considered a 'winter' variety; however it was generally faster to flower than Navigator and only slightly slower to flower than Gairdner.

	Grain yield (kg/ha)			Anthesis date		
Variety	23-Apr	13-May	11-Jun	23-Apr	13-May	11-Jun
Bass	2995	3708	1862	8-Sep	18-Sep	28-Sep
Buloke	3246	3504	2127	4-Sep	16-Sep	26-Sep
Commander	3582	4240	2510	9-Sep	18-Sep	28-Sep
Compass	4236	4215	2972	3-Sep	14-Sep	25-Sep
Fathom	3435	4272	1821	4-Sep	13-Sep	23-Sep
Flinders	3058	3811	1742	11-Sep	18-Sep	29-Sep
Gairdner	3083	3629	1690	11-Sep	19-Sep	30-Sep
Granger	3601	3604	1746	7-Sep	17-Sep	29-Sep
Hindmarsh	3585	4527	3016	27-Aug	10-Sep	22-Sep
La_Trobe	3922	4626	2901	28-Aug	10-Sep	22-Sep
Navigator	3225	3564	1658	15-Sep	21-Sep	2-Oct
Schooner	2769	3097	1928	6-Sep	17-Sep	26-Sep
Scope	3315	3491	2957	4-Sep	16-Sep	26-Sep
Skipper	3589	4255	2491	31-Aug	11-Sep	24-Sep
SYRattler	2840	3921	2249	10-Sep	16-Sep	29-Sep
Urambie	4079	4115	1665	13-Sep	19-Sep	30-Sep
Westminster	3426	3212	1769	11-Sep	18-Sep	29-Sep
Wimmera	3363	3863	1809	10-Sep	18-Sep	29-Sep
Mean of TOS	3408	3870	2162			
L.S.D. (p=0.05)		387 kg/ha				

Table 1. Grain yield and anthesis date of eighteen barley varieties sown at three dates at Matong in 2014.

La Trobe and Hindmarsh were the highest yielding varieties from the 13th May sowing date, with these treatments achieving the highest yields of all treatments in this trial.

There was a strong (R^2=0.68) relationship between anthesis date and grain yield (Figure 1). Highest yields were achieved where anthesis occurred around mid-September. Flowering too early reduced grain yield through frost damage or low grain numbers (further analysis to be conducted), while late flowering occurred in a period of moisture stress and rising temperature.

Temperature data for this site showed nine mornings with minimum temperature below 0ºC in August (coldest -3ºC on 3 August) and two mornings below 0ºC in September (coldest -1ºC on 4 September).

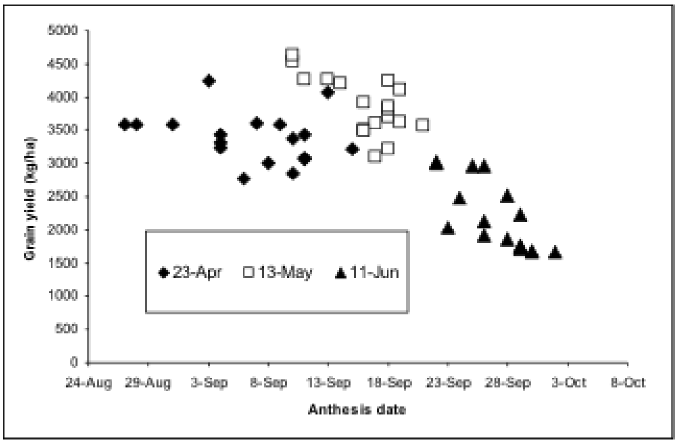

Figure 1. Effect of anthesis date on grain yield of eighteen barley varieties sown at three dates at Matong in 2014.

Summary

The trial highlighted the need to match sowing date to varietal development in order for anthesis to occur in its optimum window. 2014 will be remembered for the number of frosts received, however there were only relatively minor frost events in the window where most of the barley treatments reached anthesis. The frost events in early August may have caused some yield loss from early sowing of varieties such as Hindmarsh and La Trobe through stem damage; however stem frost damage was not strongly apparent in these plots.

Barley has traditionally been the crop that has been sown late in the sowing program; however this trial quantified the yield loss that occurs in barley as a result of late sowing.

Acknowledgements

Thanks to the Hatty family – Stephen, Michelle and Rodney at 'Yarrawong' Matong for their cooperation with this trial. Thanks also to Technical Assistants Warren Bartlett, Greg McMahon, Russell Pumpa and Sharni Hands.

Contact

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GRDC project code: DAN00173

Early sowing canola in 2014 – pushing the limits

John Kirkegaard (CSIRO Agriculture), Rohan Brill (NSWDPI Wagga), Julianne Lilley (CSIRO Agriculture), Nicole Whittaker (Kalyx Australia, Wagga Wagga), Rob Hart (Hart Bros Seeds, Old Junee)

Keywords: canola, sowing date, hybrids, flowering time, frost

Take home messages

- Early sowing of canola (mid-late April) is known to increase canola yield potential, but performance of new varieties from early April sowing is uncertain.
- In 2014, sowing in early April maximised yield of all varieties where frost and water-stress were absent.
- At sites where frost and water-stress were significant, variety choice was critical for success from early sowing – slower developing spring varieties had highest yield from early sowing, while faster-developing varieties developed pods in mid-winter which were exposed to August frost events resulting in reduced yield.
- Initial results suggest early April sowing may be feasible in low-medium rainfall regions with correct variety choice and tactical agronomy.

Background

Anzac Day (25 April) has been the traditional target date to commence canola planting in southern NSW and there is an abundance of research that shows this late April sowing window is higher yielding than later sowing. The research suggests that yield potential drops off by 5% per week from late April. Changing seasonal conditions and improved agronomy have created interest in the feasibility to move canola into an earlier April window. However, aside from recent experience in grazing experiments there is little commercial experience of canola sown in early April in the low-medium rainfall zones.

Managing the agronomy of early-sown crops successfully is likely to require careful variety selection to optimise flowering time, and canopy management by manipulating seeding density and nitrogen. Weeds, pests and diseases and successful establishment are also important issues. The new GRDC-funded “Optimised Canola Profitability” project commenced in 2014 as a collaboration between CSIRO and NSWDPI with interstate collaborators in QLD, Victoria and SA. There were several sites in the FarmLink area in 2014 and we provide a summary of the key 2014 outcomes.

Field experiments in the FarmLink area 2014

Field experiments were conducted at Greenethorpe, Junee, Ganmain and Condobolin in 2014 with a common set of 6 canola varieties sown on 4 dates; 1 April (not Junee), 15 April, 28 April and 13 May. The flowering response of the varieties was recorded along with data on temperature, frost incidence water use, biomass production and yield. A summary of the key outcomes is provided here.

Site conditions in 2014

The sites in 2014 can be characterised as follows.

Greenethorpe - The site was sown on long-fallow after lucerne, had high water and N availability and was on elevated ground with no frost and good disease control.

Ganmain and Junee - These sites were sown after crops of barley and peas respectively, had moderate soil water storage at sowing, experienced a warm autumn, cold and frosty August and a dry spring.

Condobolin – The site at Condobolin had significant early water stress during the warm May and then a frosty August and hot, dry spring.

Yield outcomes in 2014

At Greenethorpe in the absence of frost and with no water stress, there was very little interaction between sowing date and variety (Figure 1a). Under these circumstances the early sowing treatment (April 1) had the highest grain yield for all varieties and yield declined with later sowing. The high grain yields achieved from early sowing support the hypothesis that earlier sowing promotes high grain yield potential – and this was expressed under the conditions at Greenethorpe.

At Ganmain (Figure 1b), where frosts during the early podding stage were a major factor there was a significant interaction between sowing date and variety on crop yield. The fastest developing variety from the early sowings (Hyola575CL) suffered a yield penalty at

April 1 sowing, presumably as a result of frost damage on small pods which had begun developing in mid-winter. In contrast, 45Y88 CL which was slower to flower than Hyola575CL at the early sowing, achieved its highest yield from 1 April sowing with reduced yield at later sowing. The yields of the other varieties were similar at sowing dates between 1 and 28 April. The TT varieties were generally lower yielding than the spring-type Clearfield hybrids. The winter variety Hyola971CL was very late to flower, but still achieved grain yields from the first three sowing dates similar to TT varieties, presumably due to access to deeper soil water (data not shown).

At Condobolin (Figure 1c), although the yields were lower overall, there was a similar trend to Ganmain, where Hyola575CL had reduced grain yield from 1 April and 15 April sowings compared to the 28 April sowing, whereas the yield of 44Y87CL was not significantly different between those dates.

At Junee (Figure 1d), the earliest sowing date was 15 April, and only the earliest flowering variety Hyola575 CL showed a yield penalty with early sowing. The other varieties had reduced yield as sowing was delayed to late April and into May.

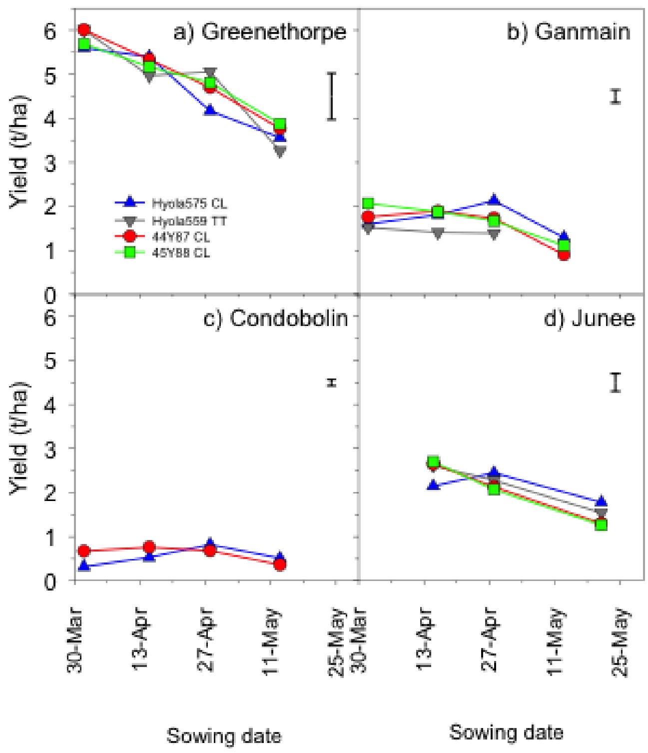

Figure 1. The effect of sowing date on the yield of a range of canola varieties at 4 sites in the FarmLink area during 2014. The Greenethorpe site had no frost, no disease and high water and N availability (on fallow), Junee and Ganmain had winter frosts while Condobolin had water stress and frost. Hyola575CL suffered yield penalties at the frosty sites as a result of its earlier flowering when sown early, which was not the case for later-flowering lines. (LSDs P=0.05 shown as vertical bars)

Pushing the WUE limits

Earlier sowing generally increases the WUE of canola for a number of reasons including;

(1) Rapid soil coverage reduces evaporative loss and more water is transpired by the plant

(2) The crop is transpiring under cooler conditions so the transpiration efficiency (conversion of water to biomass) is more efficient

(3) The crop avoids heat and water stress during reproductive stages in spring

(4) The longer vegetative stage allows roots to access deeper water

Figure 2 shows that the early-sown hybrids in 2014 achieved high water-use efficiency compared to the series of experimental crops grown between 1991 and 2003 (Robertson and Kirkegaard, 2005), suggesting that the early-sown hybrid systems are "pushing the boundary" for water-use efficiency.

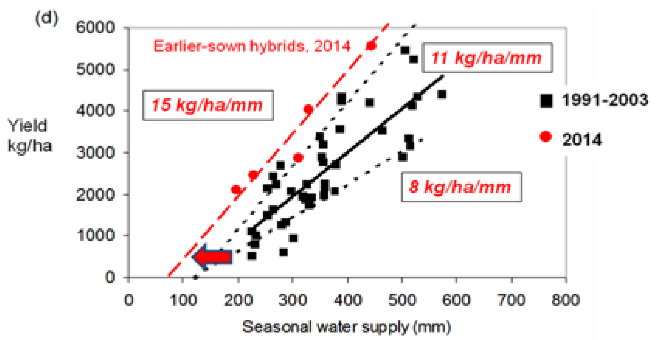

Figure 2. The relationship between yield and seasonal water supply (rainfall plus soil water use) for 42 well-grown experimental canola crops in southern NSW between 1991 and 2003 (shown as squares). The WUE averaged 11 kg/ha.mm (above a 120 mm evaporative loss – solid black), but ranged from 15 kg/ha down to 8 kg/ha (dashed black - Kirkegaard and Robertson 2005). The early-sown hybrids sown in 2014 (shown as red dots) have "pushed the boundary" presumably due to reduced evaporative loss and more water transpired by the plant (see red arrow and dashed line).

Our goal over the next 5 years in the Optimised Canola Profitability Initiative is to understand the drivers of higher yield, and the risks associated with those systems so we can devise profitable strategies to capitalise on these higher yield and WUE opportunities.

Conclusion

In 2014, despite an unfavourable season with a warm May (leading to rapid development) and significant late-winter frost events, early-sown canola crops were able to equal and in many cases better the yield of main season (25 April) crops. However understanding how specific varieties will respond to early sowing was critical, and more information is required to identify varieties suited to early April sowing. Tactical agronomy packages that manage the risks and costs in early sowing systems are the target of ongoing research, which is only just beginning in this new GRDC project.

Acknowledgements

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Hardseeded annual legumes – an on-demand break option with significant benefit to the mixed farming zone

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Keywords: biserrula, serradella, bladder clover, hardseeded, on-demand break option, summer sowing, weeds, liveweight gain

Take home messages

- Summer sowing of hardseeded annual pasture legumes using seed harvested on farm is proving to be a robust method of establishing pastures for use as 'on-demand' break options in crop-pasture rotation systems for the low and medium rainfall areas of NSW.
- On-farm results show hardseeded legumes are regenerating vigorously following a cropping phase without the need for resowing with significant benefit to the cropping enterprise.
- Summer sowing appears to have potential for suppression of both early and late germinating problem weeds in cropping systems and as such may assist in reducing the impact of increasing herbicide resistance.
- Both research experiments and on-farm monitoring shows annual legumes are capable of very high levels of livestock production with livestock offering additional weed control options

Background

A major objective of current studies at the Graham Centre is investigating strategies to improve profitability and sustainability of mixed farming systems. A key area within this objective is assessing the impact hardeeded annual pasture legumes can have on both crop and livestock performance. Hard seeded annual legumes such as biserrula (Biserrula pelecinus), bladder clover (Trifolium spumosum), gland clover (T. glanduliferum) and French serradella (Ornithopus sativus cvs. Margurita and Erica) have the capacity to be used as 'on demand' break options in cropping systems providing valuable nitrogen and disease breaks for the cropping system whilst also providing high quality fodder for grazing livestock.

Three key questions in developing strategies for widespread use of these legumes by the mixed farming industry are:

i. How can they be readily and reliably established?

ii. What is their impact on the cropping system?

iii. What is their impact on the livestock system?

These three questions will be addressed in the remainder of this paper using results of on-farm monitoring in southern NSW.

Methodology

Mike O'Hare at Beckom has been growing hardseeded annual legumes since 2009 and now has half his farm with a biserrula (cv. Casbah) seedbank and the other half, a mixed bladder clover (cv. Bartolo) and gland clover (cv. Prima) seedbank. There is also a small area of French serradella. Mike's rotation is to sow the annual legumes in late February-early March using seed harvested on farm. The biserrula seed is scarified to approximately 50% germination prior to sowing while the bladder and gland clover is sown unscarified. (Note: Our replicated experiments covering central and southern NSW have shown excellent establishment of unscarified biserrula in summer sowing situations, which differs significantly from the Western Australia experience). Inoculant used has been ALOSCA of the appropriate group. The legumes are allowed to grow and set seed in the first year with grazing pressure dependant on seasonal conditions. Legumes are then allowed to regenerate in the second year and sprayed out using a knockdown in September (i.e. no seed set in the second year). Paddocks are then sown to canola and in the following year, wheat. Following this, legumes are left to regenerate. Thus the legumes are only permitted to set seed every fourth year. Last year (2014) was the first opportunity to measure the effect of this type of rotation on legume regeneration following the cropping phase at a reasonable scale. Regular measurements were taken on regenerating biserrula, bladder clover and French serradella areas. Measurements taken included autumn, late winter and peak spring herbage availability. Differences in crop yield and cropping inputs for the cropping phase are discussed while the results of on-farm monitoring of lamb liveweight gain is also reported.

Results and discussion

Agronomy – on farm impacts of use of hardseeded legumes in cropping systems

The ability of legumes to regenerate as an 'on-demand' break in the cropping rotation was clearly demonstated on-farm at Beckom in 2014. All areas evaluated had been in legume pasture in 2010 and allowed to set seed with some grazing occurring. In 2011, legumes regenerated and were grazed from germination (in rotation) through to mid September when all herbage was sprayed out (prior to seed set). Canola was sown in 2012 and wheat in 2013. The farmer reported 0.5 t/ha increase in canola yield following the legumes compared to his conventional non-legume paddocks with only starter fertiliser used at sowing. The wheat yield was no different to conventional paddocks. These results support earlier studies (Hackney et al. 2012 a, b, c) which showed at least comparable performance of wheat after hardseeded legumes with no fertiliser addition compared to paddocks where legumes were not grown and all nitrogen was supplied via inorganic nitrogen sources.

In terms of regenerating legume productivity (Figure 1), bladder clover and French serradella were very similar at all measurement periods. Biserrula had 600-1000 kg DM/ha more feed on offer in late autumn compared to French serradella and bladder clover respectively. Again in late winter, biserrula produced an additional 1000 kg DM/ha compared to the other two species and compared at peak spring, the feed on offer on biserrula was on average 1600 kg DM/ha greater than the other two species. The high feed availability of all species, but particularly biserrula, in the autumn-winter period is of substantial value to livestock enterprises in the mixed farming zone and also has implications for increased N-fixation for following crops.

Biserrula has a higher hard seed content than both bladder clover and French serradella and therefore it is probable that there was greater seedbank available for germination following the cropping phase compared to the other two species. The results found here again differ somewhat from the WA experience. In WA, both bladder clover and French serradella

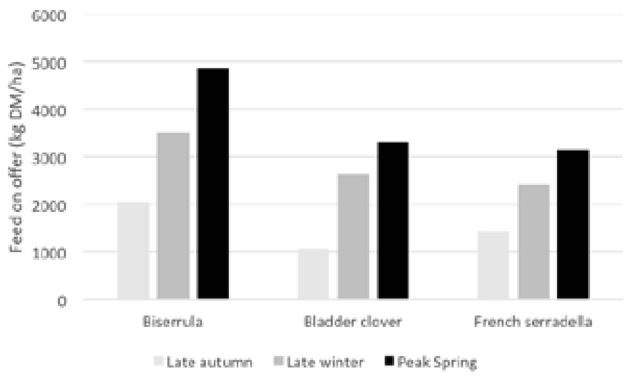

Figure 1. Herbage of offer (kg DM/ha) for biserrula (cv. Casbah), bladder clover (cv. Bartolo) and French serradella (cv. Margurita) at Beckom NSW in late autumn (19 May), late winter (20 August) and peak spring (20 September) regenerating in 2014 after a three year fallow/crop phase.

are used primarily in 1:1 rotations as their hard seed levels (~55% in WA conditions) tend not to give good regeneration results if the cropping phase is extended for longer. Biserrula, in WA situations may be used in cropping phases lasting from 2-5 years with capacity to still regenerate. The results from Beckom indicate bladder clover and French serradella are persisting well in the seed bank even with a one year in four seed set. There is considerable complexity in the hard seed breakdown/seed coat formation/total seed production area that needs to be well defined to understand at a regional level the optimal rotation strategy for these species. This is currently one focus of our research.

Livestock production

At Beckom, feed on offer at the end of winter in the regenerating biserrula paddock used was 4000 kg DM/ha with biserrula contributing >90% to total herbage availability . Seasonal conditions deteriorated considerably from late August onwards. Ewes and lambs were introduced to pasture on 3 September 2014 and feed availability at that time was 3880 kg DM/ha. At the conclusion of measurements and when lambs weaned, approximately 1700 kg DM/ha remained.

Liveweight gain differed between sexes and was averaged 350 g/head/day overall (Figure 2).

Biserrula can cause primary photosensitisation in sheep and this was observed in the lambs with 4% affected with mild photosensitisation. The farmer is aware of this risk and part of his strategy in managing this risk is having areas of non-biserrula pasture – that is, the bladder/gland clover mixed pasture. If animals begin to show early warning signs of photosensitisation which includes drooping ears and slight depression, sheep are moved into another paddock. In some instances this is another biserrula paddock that may contain some other species such as annual ryegrass.

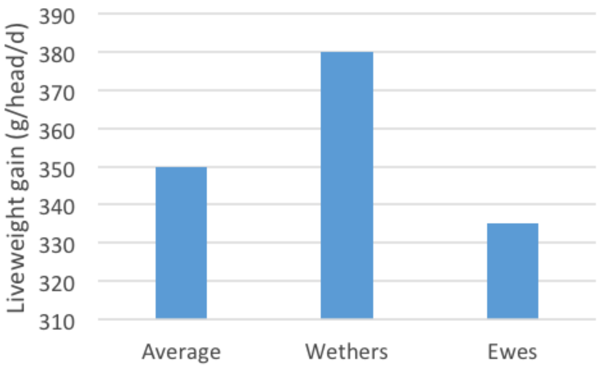

Figure 2. Daily weight gain of crossbred lambs shown as average, for wether lambs and for ewe lambs at Beckom NSW in spring 2014 over a 56 day period.

A feature of biserrula, and particularly of the variety Casbah, is its lower level of palatability compared to some other common pasture species. This difference in palatability can be used as a weed removal strategy with sheep eating plants such as annual ryegrass preferentially, thus reducing its impact on the following cropping system. Additional research we have undertaken in replicated experiments also shows biserrula and other hardseeded legumes when used in summer sowing situations has direct physical suppression on weeds including annual ryegrass compared to pastures sown in late autumn.

Conclusion

Programs of study underway at the Graham Centre are well on the way to offering to producers strategic methods of introducing hardseeded annual legumes into mixed farming systems to optimise crop, livestock and pasture production while exploring tactical use of these species to combat weeds which impact on crop performance. So far, results of these projects have shown significant potential of summer sowing compared to conventional sowing as a means of introducing these legumes into the farming system, while offering a tactical means to reduce weed incidence. Additionally, monitoring of producers large scale sowings have shown these species can considerably boost following crop productivity with reduced reliance on fertiliser nitrogen and operate very effectively as an on-demand break option in a cropping rotation. This is a major step forward from the traditional crop-pasture rotation system practised in south-eastern Australia where pastures have traditionally been resown following a cropping phase with often mixed results. In the break year, there is significant potential for these legumes to contribute to high levels of livestock production as evidenced by on-farm results. An additional bonus, particularly with biserrula, and specifically it seems, with Casbah biserrula, is the ability to use grazing to tactically remove problematic weeds in the pasture phase thus reducing their impact in following crops. More research is needed on a regional basis to identify the best options for specific crop rotation – soil-climatic-livestock associations, but what is evident is the tremendous capacity of these legumes to complement cropping systems in southern Australia.

References

Hackney, B., Rodham, C., Piltz, J. (2012a). Using biserrula to increase crop and livestock production. Meat and Livestock Australia.

Hackney, B., Rodham, C., Piltz, J. (2012b). Using bladder clover to increase crop and livestock production. Meat and Livestock Australia.

Hackney, B., Rodham, C., Piltz, J. (2012c). Using French serradella to increase crop and livestock production. Meat and Livestock Australia.

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FarmLink Research Limited - who we are and what we do

FarmLink Research Limited (FarmLink) is a not for profit agricultural research and extension organisation in southern NSW owned by growers and involving advisers and researchers.

FarmLink's main objective is to coordinate and communicate private, public and grower group funded research and development activities within in the region. FarmLink has been operating since 2003. Currently there are four full time staff working from the Temora office, based at Temora Agricultural Innovation Centre. The primary focuses for the business are research, communication and collaboration.

Research

FarmLink conducts rural and agricultural research and extension activities in southern NSW and results are distributed across Australia. In 2014, FarmLink undertook research projects ensuring the results are relevant for southern NSW. Projects relating to early sowing, micronutrient deficiency, direct heading of canola, strategic tillage and stubble management are just some of those being conducted.

Communication

Communicating quality and timely research to farmers is a key priority for FarmLink. At FarmLink we understand how the information, support and tools enables informed decision making and a rapid adoption of new technologies and farming practices in the FarmLink region. FarmLink members receive a range of publications including fortnightly e-links, quarterly newsletters, reports and updates. Communication is not just one way. FarmLink provides training, workshops, field days and crop walks to members throughout the year.

Collaboration

FarmLink is about - collaboration, we work closely with a number of organisations such as CSIRO, NSW Department of Primary Industries, Central West and Riverina Local Land Services, Graham Centre, agribusiness, Charles Sturt University and other farming system groups across Australia. FarmLink annually coordinates a regional tour for members where other agricultural industries are explored and showcased. FarmLink manages project funds from a range of providers including GRDC. Our links with the nation's leading research bodies guarantees value for local farmers.

Objectives

The objectives of FarmLink are:

(a) To improve the viability of farm businesses in southern NSW through research and development of systems that will further the environmental and economic sustainability of the region;

(b) To act as an independent regional grower and industry driven organisation that recognises and addresses the research and development needs of local communities in southern NSW;

(c) To develop, test and extend innovative science based management systems to improve profitability and protect the natural resource base of mixed farms in southern NSW; and

(d) Coordinate and communicate more widely and effectively the results of private, public and grower group funded research and development activities relevant to farming systems in southern NSW.

FarmLink 2014 Research Report

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