Eyre Peninsula Farming Systems

2005 SUMMARY

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ABB Grain Ltd Foreword

Dear Grower,

I am delighted to have been asked to contribute the foreword to the Eyre Peninsula Farming Systems 2005 Summary.

ABB is proud to be involved in the production of this publication which is a valuable source of essential information for graingrowers containing research results for the year in review.

Throughout this book you will read of the results of much hard work and considerable ingenuity. Information that can be shared with other growers to educate, intrigue and motivate.

The supporting organisation behind this publication – the Eyre Peninsula Agricultural Research Foundation – is a worthwhile body that promotes the needs of growers and highlights the benefits of local research, especially for growers on the peninsula.

ABB recognises that research and development is a crucial part in sustaining our industry. That's why in 2005 alone, ABB provided funding of over $750,000 to R&D projects. This support ranged from sponsorship of grower improvement groups, (such as Eyre Peninsula Agricultural Research Foundation) through to investments in developing new barley varieties and better servicing grower and customer needs throughout the supply chain.

You as growers are an integral part of the R&D process – you are the essential first link in a supply chain that leads from the farm through to international grain markets. It is you who is responsible for creating the product that is taken by the markets, and the better that product is, the greater potential for a higher return.

In closing, I want to congratulate everyone who has been involved in the research that is contained in the following pages – for their positive contribution to our industry and their exceptional work.

Michael Iwaniw
Managing Director
ABB Grain Ltd

ABB

Eyre Peninsula Farming Systems 2005 Summary

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Front Cover:

From left to right: ARAB Conference visitors at MAC Canola Trials, 2005; Roger Laube (ABB Grain Ltd) addressing farmers at EPARF Breeding Better Varieties Field Day, 2005; ARAB Conference visitors being addressed by Amanda Cook at Streaky Bay Disease Trials, 2005; Dr Bob Holloway on the “royal management throne” at MAC Field Day, 2005.

Back Cover:

From top to bottom: EPARF Breeding Better Varieties Field Day with farmer groups at the canola trial site; EPARF Breeding Better Varieties Field Day farmer members; MAC researchers, EPARF Board member and GRDC southern panel members visit MAC 2004; ARAB conference tour visitors at Yarwonduttu rock, MAC 2005.

Inside Back Cover:

Photos from various Eyre Peninsula agricultural events in 2005.

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Geraldine Fuss, WOOF Design and Print.

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IMPORTANT NOTICE

About this manual

Hello all,

Well it's time for the annual publication of the 2005 research results from upper EP. We have ABB and GRDC to thank for sponsoring the publication of the 2005 edition. Remember to thank our sponsors if you have the opportunity, as feed back from the farming community shows the money invested into our book and project was appreciated and well spent.

Agricultural research continues to move along at the Minnipa Ag. Centre with the funding of a second EPFS project, for three years, and the ongoing EP Grain & Graze Project.

The Farming Systems project is concentrating on two large research issues, the use of soil moisture in low rainfall environments and disease issues. The disease research has been funded by SAGIT, and includes the role of brassicas in lowering disease levels the farming system and disease suppression in EP soils.

You may notice in the cereal and breakcrops sections are a little bit lighter than normal, this is due to reasons outside our control, as some trial results were not available at the time of publication.

The EP Farming System and Grain & Graze projects are working together to identify the most profitable enterprise mixes to use with farmer groups as the basis of discussions this season.

The EP Grain & Graze project has been involved in many activities this season including some very successful feed-lotting field days. This year the annual 2006 EPARF Field Day will focus on mixed livestock and cropping systems, and will be held on the 30th August, so jot this date into your diary.

EP Grain & Graze is also working with the EPNRM group on a large on-farm biodiversity study over the next three years – this will be all new information which hasn't been collected before.

As you can see there is lot's happening at MAC, and we will continue to research issues important to the groups so have your ideas ready for the group meetings next month. Let's hope there is lots of rain and we have a fantastic season in 2006.

Amanda Cook
Eyre Peninsula Farming System Project Co-ordinator.
SARDI, Minnipa Agricultural Centre.

Contents

Eyre Peninsula Agricultural Research Foundation (EPARF)

Geoff Thomas, Board Member

EPARF, which has united the functions of the Minnipa Agricultural Centre Advisory Committee and the Minnipa Research Foundation, formally commenced operation on 1 January 2005.

The main purpose of EPARF is to represent the interests of Eyre Peninsula by ensuring that the views of farmers and the broader agricultural community are used to determine what research and extension is done. It not only helps to set the directions, but also provides detailed inputs into the various activities and strongly supports the bids for funding.

EPARF has formed an alliance with SARDI and the University of Adelaide which provides greater security in the future, ensures that there is scientific rigor in all that we do, and diversifies our funding opportunities.

As a member of the Low Rainfall Collaboration Group, the Foundation will contribute to national low rainfall farm systems research and extension, and in return have access to the work of other groups and bring the results to EP farmers.

Achievements and Highlights in 2005

2005 FOUNDATION DAY

The Annual Foundation Field Day in August focused on plant breeding and was well attended by farmers, proving once again that farmers want to see events with a specialist focus. We were able to attract a number of new sponsors as well as those who have supported us before.

GRDC Farm Systems Project

EPARF supported the Minnipa Ag Centre in its successful bid to GRDC for a further three year funding for the EP Farming Systems Project, and in the implementation of the Grain and Graze Project.

OUR SPONSORS

A major highlight has been the support that we have received form a wide range of sponsors either for the Foundation Day or for our work in general. In all, our sponsors have contributed $95,000 in cash or in kind.

We acknowledge and thank the following:

- Agline for the supply of a new generation Beeline Controlled Traffic Unit.
- ABB Grain to support 50% of the publication of this book.
- AWB Limited to support the Farming Systems Competition.
- Modern Engineering and Construction for silo aeration equipment.

And for the Foundation Day

- Aust Centre for Plant Functional Genomics
- Aust Grain Technologies Pty Ltd
- Rabobank
- Bank SA
- Graintrust
- Dovuro
- Nufarm for research materials

We also thank Letcher & Moroney for their continued support and accounting services.

MEMBERSHIP

Membership of the Foundation is by annual subscription of $100 for the first person and $50 for each extra person within that farm business. At 31 December 2005, the Foundation membership had grown to 330, including an increased number of agribusinesses.

Members enjoy a package of benefits and have the satisfaction of knowing that they are supporting an organization established specifically to look after the interests of Eyre Peninsula.

THE EPARF BOARD

The Foundation Board Members are:

- Rowan Ramsey (Chair)
  Farmer, Buckleboo
- Peter Kuhlmann (Deputy Chair)
  Farmer, Mudamuckla
- Paul Kaden
  Farmer, Cowell
- Bruce Heddle
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- Dean Wilmott
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- Ed Hunt (resigned November 2005)
  Farmer and Consultant, Port Neill
- Geoff Thomas
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- Dr Mike Keller
  University of Adelaide
- Dr Peter Gibson
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- Sam Doudle
  Manager, MAC
- Lisa Bennie
  Executive Support, MAC
- Matt Dunn (new member)
  Farmer, Rudall
- Tim Richardson (new member)
  Agribusiness, Cummins

Board members and Minnipa staff comprise Committees for Farming Systems, Grain and Graze and the management of the Minnipa farm itself. Along with the Reference Groups in the various areas, these are the key bodies in driving the research and extension effort.

THE YEAR AHEAD

2006 will be a year of consolidation as we build further on our current projects and plan new areas of activity.

The Foundation Day will be held in August and focus on cropping/livestock interactions.

We will continue to actively seek new members and develop closer partnerships with agribusiness in the region.

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CHARTERED ACCOUNTANTS

2005 Eyre Peninsula Seasonal Summary

Greg Secomb[1], Kieran Wauchope[1] and Neil Cordon[2].

Rural Solutions SA, Port Lincoln and Cleve[1], Minnipa Agricultural Centre[2].

Western Eyre Peninsula.

2005 was one of those seasons we will remember for a long time with the basic philosophy of "gee, we got out of jail that year" and "we are thankful for the yields we actually got".

- The third week in June saw the opening rains across most of the district, ranging from 48 mm at Kyancutta to 135 mm at Elliston.
- Some farmers dry sowed small areas and by the end of June were at the 3-leaf stage and looking good. Although one month later than optimum sowing date, tractors were flat out trying to finish seeding by the end of June. Farmers in the Far West reduced their crop area by up to 50% and come harvest time with the yields and prices, felt comfortable with their decision.
- Most districts received average to above average growing season rainfall. This coupled with cool weather during grain filling provided good conditions for crop growth and grain production. Rainfall at selected centres was, (growing season rainfall in brackets) Streaky Bay 392 (341), Penong 258 (206), Nundroo 310 (278), Minnipa 334 (280), Mt Cooper 422 (368), and Elliston 434 (332).
- Insects were an issue during 2005 with Polyphrades, or native weevil, creating havoc on emerging crops and lesser budworm coming through later in the season. Large areas were sprayed to control these pests with lower than recommended rates working well. Lesser bud worm devastated medic pastures and appeared to feed on the medic flowers thus wiping out seed set.
- Mice became a problem in the Nundroo area with baiting required.
- Once again cereal root diseases reared their ugly heads with Rhizoctonia widespread early and Haydie and Crown Rot appearing later. Farmers have commented that their annual yield loss to root diseases can be up to 40%.
- Small areas of stripe and stem rust were reported, however very little spraying occurred, which indicates that there was little green cereal bridge from the previous year when stripe rust was widespread.
- Pasture growth was good which provided an ideal medic seed set and enabled many districts to cut hay. Stock was in excellent condition, with the bulk of feed limiting hand feeding.
- Overall the yields in the Western Eyre Peninsula ranged from below average to well above average. The more favourable areas were Streaky Bay, Mount Cooper, Elliston, Wudinna, Kyancutta and Warramboo. Those districts, which struggled to achieve average yields, include Wirrulla, through to Bookabie. With low grain prices these areas had below average incomes to a worse case scenario of just covering variable costs.
- The season suited later maturing cereal varieties and break crops with the stand out cultivars including Yitpi, Frame, Trident, Wyalkatchem wheat, Maritime and Sloop SA barley. Harvest quality was overall good with occasional deliveries of light test weights, black tipping and high screenings.
- Snails in harvest samples were a problem in the Streaky Bay and Elliston areas.

Lower Eyre Peninsula

Season 2005 will be rated as a solid year for LEP producers with good yields recorded across all crop types. Despite a much later than ideal start, regular rainfall during spring assured a kind finish to the season. The true break to the season came in the third week of June.

- Due to the late start more and more farmers planted their crops dry where conditions and paddocks were suitable. Pulse crops, some cereals and pasture paddocks were the main crops sown dry.
- Once it did rain, it got very wet during July in the higher rainfall districts (eg Wanilla), resulting in even further delays getting the crop in.
- By the end of August many areas were tracking at a decile 3-4. However by the end of the season, GSR deciles were up in the 6-7 mark for the Cummins district. Tumby Bay finished the growing season right on Decile 5.
- An exceptional spring was experienced with regular and consistent rainfall through late September, October and into November.
- Hay making attempts were affected by the wet spring.
- Stripe Rust was a continual threat with the moist spring conditions. Most wheat crops in the region were sprayed with fungicide, many received a second application. Harvest results tend to indicate that the Very Susceptible varieties experienced yield penalties, even where fungicide had been used.
- Pulse crops performed extremely well. Most yields were above average with some growers achieving record pulse yields. Heliothis pressure was again high as were foliar diseases with such favourable conditions.
- Observations from the fire-affected region indicated that the fire did not have a significant impact on crop and pasture performance. There had been an increase in broadleaf weed populations, particularly wild radish. However crops yielded on par with the rest of the district. Post fire monitoring has indicated that nutrient losses have not been significant. In areas of severe erosion there has been some loss, but typical results show no major difference.
- Lupin crops appeared to suffer the most in fire zone, as the absence of stubble allowed increased rain splash causing higher than normal infections of Brown Leaf Spot.

Eastern Eyre Peninsula

A late break in the season had farmers concerned coming off a poor feed and crop year in 2004 and a lack of sub soil moisture. The first significant rainfall came in June, which got the tractors moving.

- More farmers tried dry sowing crops this year due to the late break, some just to get cover and feed on bare ground, others to increase the chance of average yields.
- Dry sown crops were at 3-4 leaf stage while most cropping areas were still being sown. Some paddocks were not ready for dry sowing due to high numbers of weed seeds, hence a heavy reliance on in crop herbicide control.
- Most areas received average to above average rainfall by the end of 2005. Yearly rainfall recordings (growing season rainfall in brackets) were: Arno Bay 308 (233), Cleve 338 (267), Cowell 280 (192), Kimba 310 (260) and Lock 380 (333).
- Good establishment of medics and clover, which after the slow growth in the cold winter created useful amounts of feed in late spring, reducing the need for hand feeding.
- Rhizoctonia again caused problems, especially crops on infertile sands that had to establish in cold conditions.
- Crown Rot was also reported, notably around the Cowell/Micheville area.
- Late winter rainfall in August boosted yield potentials as Cleve received a pivotal rain event of 13 mm and a total of 40 mm for the month (Kimba 39 mm, Lock 44 mm), there were also some reports of frost in low-lying areas.
- Common and Lesser budworm created problems with large infestations noted in pastures and pulses, as well as surrounding cereal crops. Many implemented border sprays as a minimum around their cereals.
- Stripe rust again created much discussion and reduced the gross margins on susceptible wheat varieties. Spraying occurred on most MS-S varieties, with some having to employ multiple sprays due to the cool, moist conditions. Head infection was prevalent provoking uncertainty regarding its impact at the late growth stage. Growing resistant varieties seems the best option to avoid rust problems, as many questions regarding fungicide application produced many different options and rates.
- Pea area sown was slightly reduced but the crop was exceptional with yields of 1.5-2 t/ha reported near Cleve and Kimba.
- There was a huge reduction in area sown to canola due to the late break, however yields came close to average at harvest time (one farmer reported reaping around 700kg/ha).
- Late frosts caused significant damage around Lock, Murdinga and Tooligie. Some crops had losses between 50-90%, but higher areas lost around 10%.
- Large areas of cereal hay was cut due to the frosts and for weed control, however the wet spring conditions reduced the quality of the hay.

The season ended well with yields at and above average for most crops, with grain quality generally good. Lock/Tooligie area recorded 2 to 3.5 t/ha for wheat and around 2.5 t/ha for barley. Cleve and surrounding areas reported yields between 1.6 to 2.5 t/ha for wheat and barley, where Arno Bay harvested 1.6 to 2 t/ha of wheat and barley. Kimba averaged around 2 t/ha for wheat and 2 t/ha for barley, while Cowell and surrounding areas reported a range of 1.2 to 2 t/ha for wheat and 1.4 to 2 t/ha for barley.

Understanding Trial Results and Statistics

Jim Egan
SARDI, Port Lincoln

Interpreting and understanding replicated trial results is not always easy. We have tried to report trial results in this book in a standard format, to make interpretation easier. Trials are generally replicated (treatments repeated two or more times) so there can be confidence that the results are from the treatments applied, rather than due to some other cause such as underlying soil variation or simply chance.

The average (or mean)

The results of replicated trials are often presented as the average (or mean) for each of the replicated treatments. Using statistics, the differences between means are compared to see whether they are larger than is likely to be caused by natural variability across the trial area (such as changing soil type).

The LSD test

To judge whether two or more treatments are different or not, a statistical test called the Least Significant Difference (LSD) test is used. If there is no appreciable difference found between treatments then the result shows "NS" (not significant). If the statistical test finds a significant difference, it is written as "$P \leq 0.05$". This means there is a 5 % probability or less that the observed difference between treatment means occurred by chance, or we are at least 95 % certain that the different results are due to the treatment effects.

The size of the LSD can then be used to compare the means. For example, in a trial with four treatments, only one treatment may be significantly different from the other three – the size of the LSD is used to see which treatments are different.

Results from a replicated trial

An example of a replicated trial of three fertiliser treatments and a control (no fertiliser), with a statistical interpretation, is shown in *Table 1*.

TREATMENT	GRAIN YIELD (t/ha)
Control	1.32 a
Fertiliser 1	1.51 a,b
Fertiliser 2	1.47 a,b
Fertiliser 3	1.70 b
Significant treatment difference	$P \leq 0.05$
LSD (P=0.05)	0.33

Table 1: Mean grain yields of fertiliser treatments (4 replicates per treatment)

Statistical analysis indicates that there is a fertiliser treatment effect on yields. $P \leq 0.05$ indicates that the probability of such differences in grain yield occurring by chance is 5 % (1 in 20) or less. In other words, it is highly likely (more than 95 % probability) that the observed differences are due to the fertiliser treatments imposed.

The LSD shows that mean grain yields for individual treatments must differ by 0.33 t/ha or more, for us to accept that the treatments do have a real effect on yields. These pairwise treatment comparisons are often shown using the letter as in the last column of *Table 1*. Treatment means with the same letter are not significantly different from each other. The treatments that do differ significantly are those followed by different letters.

In our example, the control and fertiliser treatments 1 and 2 are the same (all followed by "a"). Despite fertilisers 1 and 2 giving apparently higher yields than control, we can't dismiss the possibility that these small differences are just due to chance variation between plots. And the three fertiliser treatments have to be accepted as giving the same yields (all followed by "b"). But fertiliser treatment 3 can be accepted as producing a yield response over the control, indicated in the table by the means not sharing the same letter.

On-farm testing – Prove it on your place!

Doing an on-farm trial is more than just planting a test strip in the back paddock, or picking a few treatments and sowing some plots. Problems such as paddock variability, seasonal variability and changes across a district all serve to confound interpretation of anything but a well-designed trial.

Scientists generally prefer replicated small plots for conclusive results. But for farmers such trials can be time-consuming and unsuited to use with farm machinery. Small errors in planning can give results that are difficult to interpret. Research work in the 1930's showed that errors due to soil variability increased as plots got larger, but at the same time, sampling errors increased with smaller plots.

The carefully planned and laid out farmer unreplicated trial or demonstration does have a role in agriculture as it enables a farmer to verify research findings on his particular soil type, rainfall and farming system, and we all know that "if I see it on my place, then I'm more likely to adopt it". On-farm trials and demonstrations often serve as a catalyst for new ideas, which then lead to replicated trial programs to validate.

The bottom line with unreplicated trial work is to have confidence that any differences (positive or negative) are real and repeatable, and due to the treatment rather than some other factor.

To get the best out of your on-farm trials, keep the following points in mind:

- Choose your test site carefully so it is as uniform as possible and representative - yield maps will help, if available.
- Plan and identify what sort of treatments you wish to investigate and their possible effects. Don't go overboard with too many treatments.
- Make treatment areas to be compared as large as possible, at least wider than your header.
- Treat and manage these areas similarly in all respects, except for the treatments being compared.
- If possible, place a control strip on both sides and in the middle of your treatment strips, so that if there is a

change in conditions you are likely to spot it by comparing the performance of control strips.

- If you can't find an area which is completely even for everything, then run your strips in a direction so that all treatments are equally exposed to the changes. For example, if there is a slope, run the strips up the slope. This means that all strips will have part of their length on the flat, part on the mid slope and part at the top of the rise. This is much better than running the strips across the slope, which may mean that your control ends up on the sandy soil at the top of the rise and your treatment on the heavy flat. This would make a direct comparison very tricky.
- Record treatment details and monitor the test strips, otherwise the whole exercise will be a waste of time.
- If possible, organise a weigh trailer come harvest time, as header yield monitors have their limitations.
- Don't forget to evaluate the economics of treatments when interpretting the results.

More comprehensive guidelines for setting up on-farm trials are provided in the publication "A manual for broad scale on-farm testing", available from MAC and PIRSA district offices.

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Some Useful Conversions

Area

1 ha (hectare) = 10,000 m2 (square 100 m by 100 m)
1 acre = 0.4047 ha (1 chain (22 yards) by 10 chain)
1 ha = 2.471 acres

Mass

1 t (metric tonne) = 1,000 kg
1 imperial tonne = 1,016 kg
1 kg = 2.205 lb
1 lb = 0.454 kg

A bushel (bu) is traditionally a unit of volumetric measure defined as 8 gallons.
For grains, one bushel represents a dry mass equivalent of 8 gallons.
Wheat = 60 lb, Barley = 48 lb, Oats = 40 lb

1 bu (wheat) = 60 lb = 27.2 kg
1 bag = 3 bu = 81.6 kg (wheat)

Volume

1 L (litre) = 0.22 gallons
1 gallon = 4.55 L
1 L = 1,000 mL (millilitres)

Speed

1 km/hr = 0.62 miles/hr
10 km/hr = 6.2 miles/hr
15 km/hr = 9.3 miles/hr
10 km/hr = 167 metres/minute = 2.78 metres/second

Pressure

1 bar = 100 kPa (kiloPascals) = 14.5 psi (pounds per sq inch)

Yield

1 t/ha = 1000 kg/ha

Yield Approximations

wheat 1 t = 12 bags	1 t/ha = 5 bags/acre	1 bag/acre = 0.2 t/ha
barley 1 t = 15 bags	1 t/ha = 6.1 bags/acre	1 bag/acre = 0.16 t/ha
oats 1 t = 18 bags	1 t/ha = 7.3 bags/acre	1 bag/acre = 0.135 t/ha

Working with Product Concentrations

Brendan Frischke
SARDI, Minnipa Agricultural Centre

Concentration

Active ingredients or quantity of a particular element can be specified as:

w/w – weight per total weight

w/v – weight per total volume

v/v – volume per total volume

Weight and volume units are specified and can be imperial or metric. Concentrations can also be expressed in the same way as a percentage but has no units, i.e. % w/w.

Here are some examples:

Glyphosate 450 g/L	(w/v or weight/volume)
Diuron 900 g/kg	(w/w)
UAN 32%	(%w/v) – as it is in Australia
UAN 32%	(%w/w) – as it is in North America

Note that the above two UAN products have different concentration; the North American product has more nitrogen per litre.

Some medicines and household chemicals use (v/v) or (%v/v).

Concentrations in w/w can be converted to %w/w simply dividing the active weight by the total weight and multiplying by 100, both weights need to be in the same units.

Example:

Diuron 900 g/kg = (900/1000)*100 = 90% w/w

Concentrations in w/v are converted to %w/v by dividing the concentration in g/L by 10 (1% w/v = 10g/L).

Example:

Glyphosate 450 g/L = 45% w/v

In Practice:

The units required are best decided by the application rate and how the product is to be measured. For instance, you may want to apply 15 kg N/ha from UAN and will measure it using a flow meter and apply a metered volume (i.e. Litres) per hectare. In this case the best units are w/v. Alternatively, for some reason a batch-mixing tank may be used mounted on load cells (cattle scales), here w/w would be needed to know the exact quantity of elemental product in the tank. Sometimes product concentrations are specified in %w/w but you require it in %w/v or vice versa and conversion is required. Phosphoric acid is a good example, which is specified in %w/w, but in the field is measured in litres and applied using litres/ha, %w/v is required.

Converting Units:

The first thing you need to know is the specific gravity, which units the product concentration are specified in and the units required.

Specific gravity describes the density of a substance relative to water. Water has a density of 1kg per 1 litre and a specific gravity of 1 (SG = 1). For a substance with a specific gravity of 1.32, 1 litre weights 1.32 kg (or 1 kg of substance has a volume of 1/1.32 = 0.758 L).

Using UAN as an example:

w/v to w/w

Convert UAN 32% w/v (as it is in Australia) to w/w

32% w/v = 320 g/L = 0.32 kg/L = 32 kg/100L

A% w/v = (A/SG)% w/w

Specific gravity = 1.28

32% w/v = (32/1.28) % w/w = 25% w/w = 0.25 kg/kg

w/w to w/v

Convert UAN 32% w/w (as it is in North America) to w/v

32% w/w = 320 g/kg = 0.32 kg/kg

B% w/w = (B*SG)% w/v

Specific gravity = 1.3

32% w/w = (32*1.3) % w/v = 41.6% w/v = 416 g/L = 41.6 kg/100L

Grains Research & Development Corporation

The GRDC is pleased to welcome you to the 2005 edition of the Eyre Peninsula Farming Systems Summary. The summary continues to set the standard for timely and effective presentation of information that other farming systems groups can only follow.

This results summary reports on the main research, development and extension activities carried out on the Eyre Peninsula in 2005 together with some insights from other similar low rainfall areas working together in the Low Rainfall Collaboration project.

Historically, farming system research and extension has delivered higher profitability to graingrowers through better timing of operations, retention of moisture, better understanding of soil constraints, potential management options and so on.

This has been achieved by having graingrowers working together with the research and extension teams in all aspects of the project.

With the rising costs of fuel and fertilisers combined with the low wheat prices over recent years farming systems projects have a big role to play in maintaining graingrower profitability. Making the task even more of a challenge is reports from ABARE that productivity gains on grain specialist farms had levelled off in the decade to 2001-02 compared to the period to 1989-90.

So what exactly is productivity? Productivity is simply the difference between the income received from the sale of farm outputs and the costs incurred from purchasing the inputs. Productivity gains can come from increasing the amount you produce from a constant set of inputs or from maintaining the amount you produce while cutting costs or reducing inputs.

To remain competitive, Australian graingrowers including those on the Eyre Peninsula will need to increase their farm productivity while maintaining low cost production systems.

The GRDC's investment in this second phase of the farming systems project recognises the importance of the Eyre Peninsula.

In particular the importance of understanding and managing adverse seasonal condition on crop performance and proposed management strategies to reduce the disease impact in low input systems will be of particular benefit in managing risk to improve profitability.

As you will see the project covers a wide range of research work such as canopy management and understanding diseases in low rainfall environments, to soil compaction surveys. The work outlined in this book goes a long way to provide a better understanding of the soil constraints and potential future management options to allow growers in the region to improve yields, productivity and farm income for the benefit of individual grain growers, communities on the Peninsula and the grains industry as a whole.

Each of the activities has been a collaborative effort with continued support from SARDI, the University of Adelaide SAGIT, SANTFA and graingrowers throughout the Eyre Peninsula.

The ultimate success of projects like the Eyre Peninsula Farming Systems rests largely in the hands of local graingrowers, like yourself, getting involved in the research and extension activities on offer and adapting the research findings to your own individual farm business. By doing so farm profitability on the Eyre Peninsula will be maintained by keeping productivity growth ahead of the declining terms of trade.

Again, I hope you find the articles useful and hope that you have a prosperous season in 2006.

Stuart Kearns

GRDC Manager, Validation & Adoption

Section 1

Section editor: Neil Cordon

SARDI, Minnipa Agricultural Centre

Cereals

The total 2005 production figures for EP were approximately 1.53 million tonnes of wheat, 600,000 tonnes of barley, 10,000 tonnes of oats and 10,000 tonnes of triticale.

Cereal Variety Performance, 2005

Research

Oat variety grain yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Echidna's yield.

Variety	2005			7 year average (1999 - 2005)		
	Minnipa	Nunjikompita	Greenpatch	Minnipa	Nunjikompita	Greenpatch
Echidna	100	100	100	100	100	100
Euro	92	94	115	93	87	94
Mitika	90	84	115	103	97	106
Mortlock			117	85	70	90
Numbat	72	69		64	49	80
Possum	97	92	97	102	94	103
Potoroo	105	107	105	101	102	102
Quoll	103	99	109	101	100	101
Echidna's yield t/ha	**2.14**	**1.45**	**4.64**	**1.55**	**1.06**	**3.53**
Date sown	30-Jun	29-Jun	25-Jun			
Soil type	SL/L	SL/LSCL	LS/CL			
Apr-Oct rain (mm)	267	240	438			
pH (water)	8.6	8.7	6.4			
Site stress factors		de	wb			

Soil type: S=sand, L=loam, C=clay, Li=light, M=medium, H=heavy, / = seperates top soil from sub soil
Stress factors: de= moisture stress preflowering, wb=broadleaf weeds
Data source: NVT, GRDC and SARDI Crop Evaluation and Oat Breeding Programs (long term data based on weighted analysis of sites)
More information: Rob Wheeler (08) 8303 9480 or e-mail wheeler.rob@saugov.sa.gov.au

Triticale variety yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Tahara's yield.

Variety	2005				7 year average (1999 - 2005)			
	Greenpatch	Minnipa	Streaky Bay	Wharminda	Greenpatch	Minnipa	Streaky Bay	Wharminda
Everest	101				99	101	96	98
Kosciuszko	114	111	100	111	105	109	106	109
Prime322	96				97	92	93	97
Speedee	105	101	94	86	103	103	97	102
Tahara	100	100	100	100	100	100	100	100
Tickit	106	100	101	106	100	100	102	106
Treat	104				99	99	96	101
Tahara's yield (t/ha)	**5.06**	**1.89**	**1.62**	**1.56**	**3.47**	**1.46**	**1.57**	**1.45**
Date sown	25-Jun	28-Jun	28-Jun	20-Jun				
Soil type	LS/CL	SL/L	SL/LS	S				
Apr-Oct rain (mm)	6.4	8.6	8.5	6.8				
PH (water)	438	267	267	273				
Site stress factors	w		de	de rh				

More information: Richard Saunders (08) 8595 9152 or e-mail saunders.richardj@saugov.sa.gov.au

Wheat variety yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Frame's yield.

Variety	Upper, Eastern and Western Eyre Peninsula														Mid and Lower Eyre Peninsula					
	2005							7 year average (1999-2005)							2005			7 year average (1999-2005)		
	Kimba	Minnipa	Mitchell-Ville	Nunji-kompita	Penong	Streaky Bay	Warram-boo	Kimba	Minnipa	Mitchell-ville	Nunji-kompita	Penong	Streaky	Warram-boo	Cummins	Rudall	Ungarra	Cummins	Lock/ Rudall	Ungarra
AGT Scythe	100	92	81	75	80	95	85	109	110	115	105	108	105	108	92	100	97	104	106	104
Annuello								101	103	101	96	102	96	99	96	92	99	102	98	103
Carinya	99	87	80	65	78	87	91								96	97	99			
Chara								89	95	88	92	95	94	92				99	94	98
Drysdale	96	74	83	64	69	95	87	99	99	103	91	97	98	100	83	84	90	100	98	99
EGA Wentworth	83	83	84	65	80	91	93	103	107	108	97	103	100	104	96	95	98	102	103	102
Excalibur	107	82	80	73	96	109	100	110	109	111	104	110	108	110	101	99	105	103	106	104
Frame	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
GBA Ruby	109	83	72	67	71	89	97	109	108	110	102	104	104	108	91	96	93	103	105	103
GBA Sapphire	88	78	88	64	80	84	88	100	102	103	94	101	95	100	96	94	96	101	99	102
H46	102	72	71	57	64	84	89	110	109	114	102	106	104	109	88	98	92	104	106	104
Janz	94	85	89	70	87	85	93	96	99	97	91	97	92	97	96	93	97	98	96	100
Krichauff	92	91	97	78	95	103	105	105	108	109	100	105	103	106	96	102	93	103	105	102
Kukri	104	84	102	69	83	96	92	96	98	98	88	94	93	94	83	93	91	97	97	98
Pugsley	108	99	108	94	103	94	101	113	112	124	112	113	110	112	108	106	107	105	108	107
SW Odiel	115	81	68	69	79	90	86	99	100	96	89	95	92	98	94	89	89	101	98	97
Tammarin Rock	112	91	75	65	69	94	87	106	109	110	100	105	103	107	92	96	90	104	103	103
Ventura	108	74	90	57	62	89	76								68	87	87			
Wyalkatchem	104	93	78	73	79	101	88	115	114	117	108	111	109	112	87	103	95	107	110	106
Yitpi	103	102	100	95	104	100	95	109	107	115	107	108	107	107	101	101	103	104	104	104
Young	106	83	80	68	77	97	101	108	108	113	102	106	104	109	88	98	96	103	106	104
Frame yield t/ha	**1.10**	**2.13**	**1.38**	**1.71**	**1.53**	**1.62**	**1.58**	**1.33**	**1.51**	**0.85**	**1.08**	**1.33**	**1.31**	**1.59**	**5.11**	**2.50**	**4.11**	**3.81**	**1.98**	**3.25**
Date sown	24-Jun	28-Jun	3-Jun	30-Jun	29-Jun	28-Jun	24-Jun								23-Jun	16-Jun	22-Jun			
Soil type	SCL	SL/L	LS/SC	SL/LSCL	CS/SL/SCL	SL	SCL/LC								S/SC	CLS	SC/MC			
Apr-Oct rain (mm)	236	267	209	240	233	267	247								388	281	345			
pH (water)	8.6	8.6	8.2	8.7	8.7	8.5	8.6								8.1	8.6	8.3			
Site stress factors	lb,s	lb	cr	lb,de	de,lb,m	de,lb	de,lb,y									ys	s			

Soil type: S=sand, L=loam, C=clay, Li=light, M=medium, H=heavy, F=fine,
Site stress factors: cr=crown rot, de= preflowering moisture stress, lb=late break, s=stripe rust, sb= septoria triticii, w= grass weeds, y=yellow spot
Data source: SAFCEP, REML analysis. Long term data based on weighted analysis of sites, Biometrics SA.
More information: Rob Wheeler (08) 8303 9480 or e-mail wheeler.rob@saugov.sa.gov.au

Barley variety yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Schooner's yield.

Variety	Upper Eyre Peninsula										Lower Eyre Peninsula			
	2005					7 year average (1999 – 2005)					2005		1999-2005	
	Darke Peak	Elliston	Minnipa	Streaky Bay	Wharminda	Elliston	Mangalo*	Minnipa	Streaky Bay	Wharminda	Cummins	Wanilla	Cummins	Wanilla
Barque	106	124	112	116	95	113	115	108	112	106	106	120	105	106
Baudin	100	111	106	110	90	105	106	105	109	101	118	123	103	103
Buloke	101	119	107	104	103	114	117	109	113	110	123	138	107	108
Capstan						118	117	116	120	109	127	115	109	108
Dhow	97	107	105	97	87	101	102	100	102	91			99	99
Fitzroy						112	113	110	113	103	115	125	106	105
Flagship™(WI3408)	102	111	98	101	82	109	111	110	112	105	113	108	105	104
Gairdner						112	111	103	112	97	111	113	102	103
GairdnerPlus™(WI3586)	105	136	108	108	86	113	112	106	110	101	117	103	104	103
Keel	117	116	107	106	73	113	114	115	109	109	113	104	107	105
Maritime	109	117	100	118	94	112	122	108	114	109	119	125	107	109
Schooner	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Sloop	106	108	102	97	90	103	104	99	102	97	102	100	100	101
	105	102	107	99	82	103	106	103	104	98	101	108	101	101
Sloop VIC						102	102	95	102	97			100	99
Torrens						92	84	86	88	82	95	100	94	92
Fleet™ (WI3804)	117	127	113	122	96	121	121	115	121	113	114	110	111	108
Yarra	103	123	110	101	98	118	120	116	116	109	125	125	109	108
Schooner's yield (t/ha)	**2.86**	**1.62**	**2.42**	**1.82**	**2.70**	**1.90**	**1.43**	**1.83**	**1.70**	**1.81**	**4.75**	**3.20**	**3.87**	**3.40**
Date sown	23-Jun	27-Jun	28-Jun	24-Jun	17-Jun						23-Jun	26-Jun		
Soil type	S	S/LSC	SL/L	SL	S						S/SC	SL/MC		
Apr-Oct rain (mm)	367	262	267	259	273						388	338		
pH (water)	8.5	8.5	8.6	8.6	6.8						8.1	7.1		
Site stress factors	lb,ns	lb,ns	lb	lb,de	de,lb,r						w	r		

Soil type: S=sand, L=loam, C=clay, Li=light, M=medium, H=heavy, F=fine, / = separates top soil from sub soil
Site stress factors: de=moisture stress pre flowering, lb=late break, r=rhizoctonia, ns/n=net blotch(spot/net), w=WRG competition
Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites) *Mangalo long term data based on 1999-2004, site relocated in 2005
More information: Rob Wheeler (08) 8303 9480 or e-mail wheeler.rob@saugov.sa.gov.au

Searching for answers

Location
Minnipa Ag. Centre

Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2005 Total: 327 mm
2005 GSR: 267 mm

Yield
Potential: 3.14 t/ha

Paddock History
2004: Medic Pasture
2003: Sloop Barley
2002: Stylet Wheat

Soil Type
Sandy Loam / Red Clay Loam

Plot size
10m x 2m x 3 reps

Development of wheat varieties with improved drought tolerance

Research

Dr Steve Jefferies[1] and Willie Shoobridge[2]
Australian Grain Technologies[1], SARDI, Minnipa Agricultural Centre[2]

Key Message

- **Two lines RAC1263 and RAC1262 are undergoing seed increase for possible release in 2007.**

Why do the trials?

The aims of the drought tolerant wheat variety project are to;

- Fast track elite drought tolerant breeders line to commercial release.
- Rapidly eliminate defects in elite drought tolerant lines.
- Evaluate synthetic wheat derivatives and commence introgression.

How was it done?

Fast tracking elite drought tolerant breeders lines.

Four elite drought tolerant lines (RAC1261, RAC1262, RAC1263 and RAC1267) where included in the AGT A4 trials at forty five locations across Australia in 2005 and in all major disease screening nurseries. These four lines and a further six lines were also assessed in replicated experiments at five locations on Upper Eyre Peninsula. RAC1262 was included in all main-season NVT trials in SA, WA, Vic, NSW and Qld. For more background information see previous EPFS articles *(EPFS 2003 pg 22 and 2004 pg 29)*.

What happened?

RAC1263 is a sister line of RAC1262. RAC1263 has very similar yield under drought pressure but is generally higher yielding in other conditions. Based on our laboratory data RAC1263 is not as good quality as RAC1262. We expect that RAC1263 could make the APW grade while RAC1262 has a very good chance of making the AH grade. While RAC1262 has excellent resistance to all the common Australian pathotypes it is rated as MS to the uncommon VPM attacking leaf rust strain. In contrast RAC1263 is rated MR-R to all known field races of leaf rust in Australia and has excellent resistance to all the other rusts. In AGT yield trials at forty two sites across Australia RAC1263 was the highest overall yielding entry.

What does this mean?

RAC1261 has been discarded due to lower overall yield potential. RAC1267 has been discarded, as it is prone to late maturity alpha amylase a condition that causes low falling numbers in the absence of wet harvest conditions.

Pure seed of both RAC1263 and RAC1262 was sown by SARDI Seed Services on approximately eight ha each at Turretfield.

A severe stripe rust epidemic occurred in the Lower North region in 2005. Yield losses of 3.2 t/ha were estimated to have occurred in the absence of fungicide spray at Roseworthy. Under this severe rust pressure it was noted that approximately one plant in every 1000 plants of RAC1262 pure seed had identical plant type but was rated MS-S for stripe rust. The bulk of the crop (999 plants in a 1,000) were rated MR-R even under this severe pressure.

Table 1. Summary of AGT A4 Experiments 2006.

Entry	Description	SA % Yitpi	WA %Wyalk	VIC %Yitpi	SNSW %Sunv	NNSW %Sunv	QLD %Sunv
Agt Scythe	AGT New release	90	95	82	82	83	89
Baxter	Qld Control	77	78	64	89	95	88
Carinya	AGT New release	99	96	120	114	113	103
Carnamah	WA Control	83	98	65	81	84	93
Chara	Vic/SNSW Control	90	91	90	95	98	85
Diamondbird	SNSW Control	83	90	71	97	89	92
Ellison	AGT new release	94	88	89	108	106	87
Frame	SA Control	96	95	94	102	90	82
H45	NSW Control	77	87	56	69	74	106
H46	AGT New release	94	79	95	102	114	109
Janz	Qld/NSW Control	90	95	95	95	100	100
RAC1192	Potential release	98	87	110	107	108	105
RAC1262	Likely release	102	90	114	116	102	104
RAC1263	Potential release	107	96	111	118	112	101
Sunco	NSW Control	84	77	85	100	101	93
Sunvale	NSW/Qld Control	94	85	102	100	100	93
Ventura	AGT New release	90	86	86	114	108	108
WI23322	Potential release	95	96	99	102	94	100
WI24055	Potential release	112	102	120	115	101	96
Wyalkatchem	WA Control	92	92	88	84	91	101
Yitpi	SA/Vic Control	100	100	100	104	92	92
Young	New AGT release	95	93	100	107	107	100

An area of approximately 1.0 to 1.5 ha was cut out (borders mowed) from the remaining crop and intensively rouged for the susceptible off types from which we expect approximately 2 tonne (t) of clean seed. The plan is to grow 30-50 kg of the rouged seed on irrigation as space plants (approx 12 kg/ha) at Narrabri in northern NSW. Stripe rust infection is very common at Narrabri. The aim would be to rouge the space planted crop again during the 2006 winter. We would expect (based on previous experience) to harvest a minimum of 10 t of clean seed by late November and this can be sown under centre point irrigation in Tasmania over the summer of 2006/07. We would expect this to produce between 200 and 300 t of pure seed.

In addition we propose the remaining 1-2 t of seed is split in two seed lots and sown under irrigation in the MIA, and also in a highly reliable, high yielding site in SA. We expect the MIA crop to yield between 5 and 7 t/ha and the SA crop to yield between 2 to 5 t/ha. We would expect a minimum of 100 t of pure seed. In combination these two strategies should produce 300 to 400 t of pure seed ready for a wide scale commercial release for 2007 sowing.

Given the mixed nature of the remaining 6-7 ha of seed, the small quantity of seed available, and uncertainty regarding its AWB classification we will now not be making seed available to growers for 2006 sowing.

Approximately 100 stripe rust resistant single plant selections of RAC1263 are currently growing under irrigation in Horsham. It is proposed that each selection is grown as space plants under irrigation at Narrabri in northern NSW and those uniform for plant type and rust reaction bulked to produce the final seed. This would leave the option for a fast track summer increase and commercial release of 100-200 t in 2007 or a larger increase over winter of 2007 and wide scale release in 2008. The decision can then be based on feed back from AWB on its quality.

Drought Trials 2005

As often is the case in plant breeding when you want to a get a drought affected trial you don't get it and when you don't want it you do get it! Many of the 2005 drought trials conducted on Upper EP in 2005 suffered from periods of drought during the growing season. However the near ideal spring conditions in many areas favoured the longer season varieties such as Yipti, Pugsley and Frame. The Kimba site was the closest to our definition of a drought affected site, ie yield below 1.5 t/ha where the major yield limiting factor was growing season rainfall. At Kimba RAC1262 and RAC1263 were 8% and 9% higher yielding than Yitpi respectively.

Rapidly eliminate defects in elite drought tolerant lines

Adult plant rust resistance genes have been backcrossed into elite lines. The first 148 doubled haploids were grown in the field in 2004 as rows, and had excellent rust infection for selection of resistant lines.

Approximately 60 lines were promoted into AGT S1 trials and disease nurseries in 2005, and an additional 85 doubled haploids grown as rows in 2005. Elite lines with APR leaf rust resistance will be identified and intercrossed.

Evaluate synthetic wheat derivatives and commence introgression

188 sythnetic derivatives were assessed at Roseworthy in 2004 by a national GRDC project for rust resistance, root disease resistance, LMA, and grain yield under drought and irrigation. Eight elite lines were identified and included in crossing, approximately 50 crosses in total.

Acknowledgements

This is an AGT and SARDI collaborative project supported by the South Australian Grain Industry Trust Fund and Premiers Drought Relief Fund.

A new feed barley comes with the first Fleet™

Jason Eglinton and Stewart Coventry

School of Agriculture, Food & Wine Waite Campus, University of Adelaide

Searching for answers

Location
Minnipa Ag. Centre

Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2005 Total: 327 mm
2005 GSR: 267 mm

Yield
Potential: 3.14 t/ha

Paddock History
2004: Medic Pasture
2003: Sloop Barley
2002: Stylet Wheat

Soil Type
Sandy Loam / Red Clay Loam

Plot size
10m x 2m x 3 reps

Key Messages

- **Fleet™ is a new feed variety adapted to the low to mid rainfall environments.**
- **High yield is combined with excellent physical grain quality.**
- **Fleet™ has a superior disease resistance profile.**

Why do the trial?

Feed barley is a significant crop in SA, with feed varieties representing 35% or 860,000 tonne of production in the 2005 season. The new feed variety Fleet™ (WI3804$^{\Phi}$) is an example of combining yield potential with traits from three different sources to improve adaptation to the mid to low rainfall environments. Fleet™ is derived from the cross Mundah/Keel//Barque and combines the plant architecture, phenology, yield potential, disease resistance, sandy soil adaptation, and physical grain quality of these three sources *(Table 1)*. Barque, Keel, and Mundah are important feed barley varieties in southern Australia, and each have unique characteristics suitable for marginal cropping areas in South Australia. Barque is early-mid flowering, has high yield potential *(Tables 2 & 3)* and broad adaptation, however recent virulence changes have rendered it susceptible to scald and net form of net blotch. Keel has early maturity and high yield potential *(Tables 2 & 3)*, with better yield and physical grain quality in a tougher finish *(Table 4; <325mm)*, and a good spectrum of resistance to diseases although susceptible to leaf rust. A number of traits including vigorous early growth makes Mundah suited to the deep sandy soils *(Table 4)* typically characterised by poor fertility, rapid drainage of soil water, water repellent soils, leaching loss of nutrients, erosion, and a high incidence of root borne diseases. Mundah has significantly heavier and plumper grains than Barque and Keel, but a lower yield potential and significant disease deficiencies (CCN, spot form of net blotch, scald). The variety Fleet™ is a direct result of the breeding strategy employed to combine the superior qualities of each variety, to significantly advance the adaptation of barley to marginal cropping environments.

Table 1: Comparison of Barque, Keel and Mundah for key adaptive traits when grown under South Australian conditions. (Disease reaction ratings provided by Hugh Wallwork, SARDI)

Trait Type	Phenotype	Barque	Keel	Mundah	Fleet™
Disease	Cereal Cyst Nematode	R/T	R/T	S/T	R/T
	Leaf Rust	MS	VS	S	MS
	Leaf Scald	S/VS	MR/MS	S	MR/MS
	Powdery Mildew	MR	MR/MS	MS/S	N/A
	Spot form net blotch	R/MR	R/MR	S	MR
	Net form net blotch	M/S	R/MR	MR	R/MR
	Stripe Rust	N/A	MS	N/A	MR
Plant Type	Flowering	Early-mid	Early	Early	Early-Mid
	Stature	Medium	Short	Medium	Medium
	Spikelet	2 row	2 row	2 row	2 row
	Basic Vegatative Period	Mod. Short	Short	Long	Mod. Short
	Photoperiod sensitivity	Sensitive	Sensitive	Insensitive	Sensitive
	Early growth habit	Intermediate	Intermediate	Erect	Erect
	Early vigour	Moderate	Moderate	Very high	Moderate
	Tillering	Very high	High	Moderate	Moderate
Grain Size	Average across environments	Moderate	Moderate	Large	Large
	Sandy soils	Moderate	Moderate	Large	Large

How was it done?

Crossing and population development was completed in 2000; with broad scale yield trials conducted from 2001 onwards. The agronomic profile of Fleet™ has been determined in SARDI SAFCEP and University of Adelaide trials and is presented by long-term averages over the agricultural regions of SA *(Table 2)* and by year *(Table 3)*. Fleet™ has also been assessed in trials specifically investigating adaptation to low rainfall trial environments *(Figure 1)*, and a range of disease nurseries. Fleet™ is early-mid flowering, has good early vigour, erect growth habit, similar in height to Barque, resistance to head loss equal to Barque, and disease resistance profile similar to Keel, with the additional benefit of improved leaf rust resistance.

What happened?

Fleet™ shows outstanding grain yield potential and stability across a range of environments and seasonal conditions *(Tables 2 & 3)*. The key agronomic features of Barque, Keel and Mundah have been successfully combined, with Fleet™ showing improvement over its parental cultivars in terms of broad adaptation. Fleet™ shows yield advantage in the low to medium rainfall environments *(Table 4)* and equivalent yield with high rainfall feed types, indicating its yield stability. When analysed in specifically low rainfall (<350mm) environments, Fleet™ has better yield than Barque and Mundah but not Keel or its sister line WI3806 *(Figure 1)*. Keel *(indicated by ■ in Figure 1)* possesses the highest yield (positive yield effect) and is better adapted to drought stressed environments (negative environment effect). Barque (*) has average yield and better adaptation to higher yielding environments and Mundah (●) has above average yield in favourable environments. The intermediate performance of Fleet™ (▲) indicates high yield potential in the average environment. WI3806 (◆) shows good performance and stability in the low rainfall environments but lacks the disease resistance profile of Fleet™. In three years of evaluation on sandy soils, Fleet™ has exhibited equal or better yield potential to Mundah and Barque *(Table 4)*.

Table 2: Long-term grain yield data for SARDI CVT trials by agricultural region (1998-2004) (SAFCEP data, REML analysis) *2003-2004 only

Variety	*YP	MM	MN	SE	LEP	UEP
Barque	3.26	1.77	3.54	3.73	3.59	1.95
Capstan	3.36	1.81	3.77	3.80	3.68	1.96
Galleon	3.10	1.60	3.41	3.58	3.44	1.80
Keel	3.34	1.77	3.79	3.80	3.66	2.00
Maritime	3.31	1.76	3.64	3.83	3.70	1.92
Mundah	3.11	1.75	3.48	3.57	3.55	1.86
FleetTM*	3.45	1.86	3.74	3.90	3.77	2.02

YP- Yorke Peninsula, MM – Murray Mallee, MN – Mid North, SE- South East, LEP – Lower Eyre Peninsula, UEP – Upper Eyre Peninsula

Table 3: Seasonal grain yield data for University of Adelaide Barley Program yield trials (REML analysis)

Variety	2001	2002	2003	2004	2005
Barque	1.47	1.48	3.11	1.90	3.14
Keel	1.51	1.52	3.23	2.13	3.22
Mundah	1.37	1.31	3.04	1.95	-
Maritime	-	1.41	3.38	1.99	3.11
Capstan	-	1.49	3.17	1.80	3.53
FleetTM	1.61	1.55	3.27	2.03	3.25

What does this mean?

Fleet™ (WI3804$^{\phi}$) will be released as a replacement option for Mundah and Barque. The commercialisation partner will be appointed in February 2006. The new variety is subject to

Table 4: Grain yield of Fleet, parental lines and two other commercial varieties in SARDI S4 trials by rainfall and long term yield data of on sand (SAFCEP data, REML analysis)

Variety	< 325mm		325-450mm		> 450mm		Sandy Soil	
	Yield (t/ha)	*n	Yield (t/ha)	n	Yield (t/ha)	n	Yield (t/ha)	n
FleetTM	1.64	12	3.22	22	3.91	8	1.47	8
Barque	1.59	40	3.07	69	3.67	35	1.47	18
Capstan	1.59	30	3.12	45	3.91	27	1.39	6
Keel	1.66	40	3.15	69	3.75	35	1.39	18
Maritime	1.56	28	3.08	29	3.90	10	1.44	11
Mundah	1.52	14	2.94	42	3.66	27	1.45	18

n is the number of trials

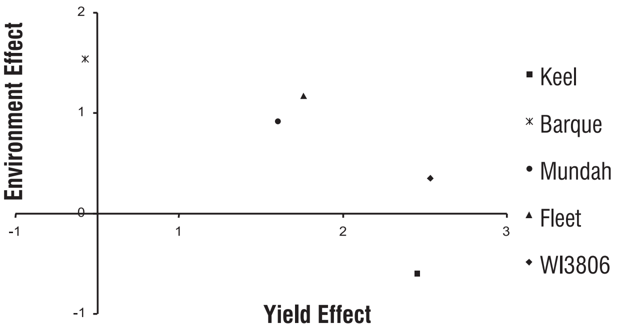

Figure 1: The yield and environmental stability of Mundah, Keel, Barque, and derived genotypes Fleet™ and WI3806. Genotypes expressed as a common effect from the average of 210 lines and 10 low rainfall environments

Plant Breeders Rights, and the name is a registered trademark of the University of Adelaide. Permission to use the trademark will be granted automatically on the purchase of certified seed. The limited quantity of seed will see Fleet™ production restricted to pure seed production in 2006, with broad scale availability planned for 2007.

Acknowledgements

Australian farmers and the Commonwealth Government through the GRDC supported this work. The authors would like to acknowledge the assistance of Rob Wheeler, Hugh Wallwork, field staff at Minnipa, and the University of Adelaide Barley Program staff.

GRDC Grains Research & Development Corporation

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Farmer cereal demos

Demo

Neil Cordon

SARDI, Minnipa Agricultural Centre

Try this yourself now

Location
Cowell – Malcolm Brine Group – Franklin Harbour Ag Bureau

Rainfall
Av Annual: 378 mm
Av G.S.R: 277 mm
2005 Total: 373 mm
2005 G.S.R: 287 mm

Yield
Potential (W): 3.5 t/ha

Paddock History
2004: Pasture
2003: Wheat
2002: Pasture

Soil Type
Reddish brown sandy loam.

Yield Limiting Factors
Late Sowing

Key Messages

- **The established varieties of Yitpi, Wyalkatchem and Frame are still performing well compared to newer cultivars.**
- **Avoid monocultures of wheat varieties to reduce the risk of disease epidemics and resistance breakdown.**
- **Evaluate the performance of barley WI3586 in 2005 trial results and 2006 season.**

Why do the trial?

These trials were instigated by the local Ag. Bureau's to compare current cereal varieties with some not commonly grown in the district. It also enables varieties to be compared in a different environment to the SARDI cereal evaluation sites on Eyre Peninsula.

FRANKLIN HARBOUR WHEAT DEMO

How was it done?

Treatments – Nine wheat varieties were sown in demonstration strips with four check plots.

Measurements – grain yield and quality
Sowing Date – 4th July 2005
Sowing Rate – 60 kg/ha
Fertiliser – 18:20 @ 70 kg/ha

What happened?

Average growing season rainfall coupled with cool weather during grain filling provided good conditions for crop growth and grain production. Varieties yielded up to 81% of the potential. There was a distinct yield and financial advantage from the AH and APW varieties especially Yitpi, Frame, Scythe and Wyalkatchem *(Table 1)*.

What does this mean?

The hard variety, Yitpi, has consistently yielded well in this district and should be considered as a preferred variety for farmers to grow. It's most obvious limitation is susceptibility to stem rust.

The choice of APW cultivars narrows farmers choice down to three, Frame, Scythe and Wyalkatchem with selection made on disease resistances and other agronomic characteristics. Frame is later maturing,

Try this yourself now

Location
Witera – Craig & Nick Kelsh
Group – Mount Cooper Ag Bureau

Rainfall
Av Annual: 350 mm
Av G.S.R: 270 mm
2005 Total: 332 mm
2005 G.S.R: 294 mm

Yield
Potential (W): 3.7 t/ha
(B): 4.1 t/ha

Paddock History
2004: Peas
2003: Wheat
2002: Pasture

Soil Type
Reddish brown loam.

Yield Limiting Factors
Weeds

Table 1: Yield, grain quality and gross income of wheat at Franklin Harbour Ag Bureau site 2005.

Variety	Grade	Protein (%)	Screenings (%)	Test Weight (kg/hL)	Yield (t/ha)	* Gross Income ($/ha)
Yitpi	AH	10.0	2.2	82.0	2.85	434
Frame	APW	10.1	1.7	83.4	2.71	399
Scythe	APW	9.2	1.7	91.4	2.81	392
Wyalkatchem	APW	9.8	0.7	83.2	2.61	386
CL Janz	AH	10.1	0.7	82.4	2.53	384
Ruby	ASW	10.3	0.9	84.4	2.64	356
H 45	APW	9.8	1.7	82.2	2.31	336
Excalibur	ASW	9.1	1.4	80.0	2.68	333
SW Odiel	ASW	9.7	1.5	84.1	2.44	317

Gross Income is Yield x Price (with quality adjustments) delivered to Port Lincoln as at 1st December 2005.

Scythe appears to have lower grain weights and a poor spread of disease resistances, whilst Wyalkatchem is prone to sprouting and susceptible to high-pressure stripe rust out breaks.

The site was foliar sprayed for stripe rust, which could affect varietal rankings especially those with poor resistance levels.

Acknowledgements

Donna Longmire, Elders, Cleve Malcolm Brine for his time, machinery and dedication to the trial.

MOUNT COOPER CEREAL DEMO

How as it done?

Treatments – Five wheat and four barley varieties were sown in demonstration strips with three check plots.

Measurements – grain yield and quality.
Sowing Date – 7th July 2005
Sowing Rate – Wheat (80 kg/ha), Barley (75 kg/ha).
Fertiliser – 18:20 @ 80 kg/ha and urea @ 50 kg/ha.

What Happened?

The plots were sown dry however good growing season rainfall and cool conditions during grain filling assisted crop growth and grain production. Varieties yielded up to 83% of the potential with weed competition limiting full potential.

The best wheats were Wyalkatchem and Yitpi, however the new variety Scythe was disappointing and had lower grain weights.

A new unnamed malt quality barley WI3586 had the highest yield and gross income.

The poor returns for feed barley is reflected in the income for Keel even though it yielded well.

Observations of the barley showed that Keel was shorter than Sloop S.A.

Flagship and WI3586 had no head loss whilst Keel and Sloop S.A. had significant head numbers on the ground.

What does this mean?

Farmers should consider growing Yitpi as their hard variety in this district but be aware of its susceptibility to stem rust, and Wyalkatchem for APW quality due to it's good yielding ability. Wyalkatchem has issues with sprouting intolerance, short coleoptile, slow early growth, eelworm and stripe rust susceptibility. Although later maturing the variety, Frame should be still considered.

Low grain weights appear to be a characteristic of Scythe, which will need to be verified from other trial data.

The barley data indicates that the unnamed WI3586 may be suited to this district and if farmers are intending to change their current malting variety it could be worthwhile to wait for another season's data and consider WI3586. WI3586 is later maturing (nine days later than Schooner) so may have been favoured in 2005 by the late rains.

Table 2: Yield, grain quality and gross income of cereals at Mount Cooper Ag Bureau site 2005

Variety	Grade	Protein (%)	Screenings (%)	Test Weight (kg/hl)	Yield (t/ha)	* Gross Income ($/ha)
Wyalkatchem	APW	9.8	0.9	80.0	2.9	427
Excalibur	ASW	10.4	1.7	76.8	2.9	387
Yitpi	AH	10.4	2.8	78.8	2.5	385
Frame	APW	10.4	1.0	79.6	2.3	347
Scythe	APW	10.4	1.4	75.2	2.3	344
WI 3586	M	10.7	1.0	66.6	3.4	498
Sloop SA	M	10.7	0.9	66.6	2.9	440
Flagship	M	11.7	0.7	65.8	2.8	410
Keel	F	11.1	1.3	60.8	3.2	404

Gross Income is Yield x Price (with quality adjustments) delivered to Port Lincoln as at 1st December 2005.

Acknowledgements

Craig Kelsh for the use of his time and land. Ben Ward for assisting in trial management.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Grains Research & Development Corporation

Canopy management on Upper EP

Jon Hancock
SARDI, Minnipa Agricultural Centre

Research

Key Messages

- **Reduced crop canopies resulted in reduced yield.**
- **Yield was maximised with high seeding rates and occasionally the application of additional nitrogen.**

Why do the trial?

These trials aim to evaluate different methods of manipulating crop canopy development on water use, dry matter production, grain yield and quality. In low rainfall environments, there is concern that excessive early crop growth depletes soil moisture reserves so that plants become drought stressed during the crucial grain fill stage. In a condition known as haying off, grain size and yield is reduced.

In higher rainfall regions, management of crop canopies can be achieved through the strategic application of N fertiliser, however in low rainfall regions, where soil N reserves are often more than adequate for crop requirements, alternative approaches are required.

How was it done?

Trials were sown at Tuckey, Minnipa and Mudamuckla on two contrasting soil types within the paddock on the 16th of June, 24th June and 1st July respectively. The two sites within each paddock were selected from yield maps which identified poorer performing areas (heavy loams – referred to as heavy in this article) and areas with good performance (lighter sandy loams – referred to as loam). Wheat (cv. Wyalkatchem and Yitpi) and mixes of wheat and oats were sown into replicated plots at varying densities *(Table 1)* with 70 kg/ha of 0:20 on a 9" row spacing. Various approaches were implemented early in the season to alter canopy size. Additional N (15 or 30 kg N/ha) was applied as urea, either beneath the seed at sowing or broadcast at the end of tillering. A growth regulator Cycocel 750A® (Chlormequat) was applied at 1 L/ha to treatments at mid and late tillering and the oats were selectively removed through an application of Topik® at late tillering.

What happened?

The 2005 growing season had a late break with a mild finish. The grain yield results *(Table 1)* show that many of the attempts to limit canopy size and conserve soil water resulted in reduced grain yield. A preliminary investigation showed that less than 5 mm of water was conserved up to anthesis through canopy management.

At all sites, there was a positive correlation between anthesis dry matter and grain yield *(Figure 1)*.

Table 1. Grain yield (as % of control) of wheat in canopy management trials, 2005.

Treatment	Tuckey Wyalkatchem		Mudamuckla Wyalkatchem		Minnipa Wyalkatchem		Minnipa Yitpi	
	Heavy	Loam	Heavy	Loam	Heavy	Loam	Heavy	Loam
33% wheat, 67% oats	55	40	44	40	49	62	53	67
67% wheat, 33% oats	79	58	67	71	73	89	89	88
60 plants/m2	85	95	65	87	83	87	76	93
120 plants/m2	101	85	91	104	87	101	97	105
Control (180 plants/m2)	100	100	100	100	100	100	100	100
240 plants/m2	105	105	93	107	111	103	101	109
15kg N/ha applied at sowing	105	106	88	103	104	93	99	98
15kg N/ha applied at GS 30	105	104	87	111	108	104	103	109
30kg N/ha applied at sowing	105	107	98	108	94	93	107	90
30kg N/ha applied at GS 30	107	114	98	110	104	93	100	93
GR applied at GS 22	106	106	90	103	100	102	98	103
GR applied at GS 30	107	103	94	104	94	100	101	91
LSD ($p<0.05$)	6.1	9.5	14.3	9.2	10.4	11.8	11.0	8.3
Control (t/ha)	2.17	1.88	1.12	1.26	1.21	2.01	1.52	2.32

Note: Unless otherwise specified, wheat was sown to achieve a target density of 180 plants/m². GS 22 refers to the growth stage when the main stem and two tillers have formed (around mid-tillering) and GS 30 refers to the start of stem elongation. GR = Growth Regulator.

Searching for answers

Location
Mudamuckla – Peter Kuhlmann

Rainfall
Av Annual: 293 mm
Av GSR: 219 mm
2005 Total: 301 mm
2005 GSR: 239 mm

Yield
Potential: 2.58 t/ha
Actual: up to 1.40 t/ha

Paddock History
2004: Krichauff Wheat
2003: Yitpi Wheat
2002: Frame Wheat
2001: Pasture

Soil Type
Grey Calcareous Sandy Loam / Calcareous Loam

Plot size
10m x 2m x 4 reps

Location
Tuckey – Jason Burton
Tuckey Ag. Bureau

Rainfall
Av Annual: 324 mm
Av GSR: 241 mm
2005 Total: 313 mm
2005 GSR: 281 mm

Yield
Potential: 3.42 t/ha
Actual: up to 2.14 t/ha

Paddock History
2004: Wheat
2003: Canola
2002: Wheat

Soil Type
Sandy Loam / Red Clay Loam

Plot size
10m x 2m x 4 reps

Cereals

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Searching for answers

Location
Minnipa Ag. Centre
Minnipa Ag. Bureau

Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2005 Total: 327 mm
2005 GSR: 267 mm

Yield
Potential: 3.14 t/ha
Actual: up to 2.53 t/ha

Paddock History
2004: Medic Pasture
2003: Sloop Barley
2002: Stylet Wheat

Soil Type
Sandy Loam / Red Clay Loam

Plot size
10m x 2m x 4 reps

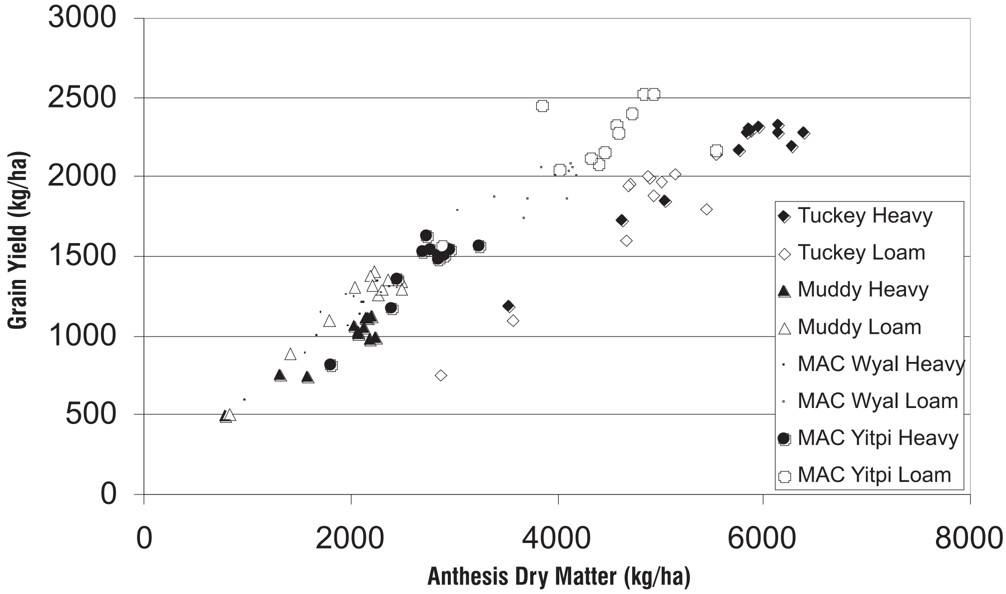

Figure 1. Relationship between anthesis dry matter and grain yield

Any effect of post-anthesis water stress limiting grain fill was more than outweighed by the presence of more heads in crops with larger canopies.

What does this mean?

These trials don't provide any evidence that reduced canopy size leading up to anthesis improves grain yield. In 2005, treatments that reduced canopy growth often led to substantial yield penalties. The most extreme example of this is the wheat and oat mixes, which yielded very poorly. High sowing rates and additional nitrogen applications tended to increase yields last season, however the principle of canopy management and water use will be further evaluated over the next two seasons. Once the analysis of soil water holding capacity is complete, computer simulations will also be used to compare different scenarios over a range of different seasonal conditions.

Acknowledgements

I would like to thank Jason and Julie Burton (Tuckey) and Peter and Julianne Kuhlmann (Mudamuckla) for the use of their land for trial sites. The generosity of Crop Care in providing the Cycocel 750A® for use in these trials is greatly appreciated. I also would like to thank staff of Minnipa Agricultural Centre for technical assistance throughout the season, particularly Wade Shepperd, Michael Bennet, Ben Ward, Trent Brace and Kay Brace. Topik® is a registered product of Syngenta. Cycocel 750A® is a registered product of Crop Care.

Grains Research & Development Corporation

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Best practice

Variable rate trials at Mudamuckla

Demo

Peter Kuhlmann

Farmer, Mudamuckla

Key Messages

- **Standard practice of 60 kg/ha of seed, 4 kg fluid P/ha and 13 kg fluid N/ha gave the best gross margin in 2005.**
- **The best outcomes required moderate levels of seed, phosphorus and nitrogen. Higher inputs often increased yields but always reduced the gross margin.**
- **Low seed rates and no fertiliser meant the crop was not competitive with grass weeds.**

Why was it done?

The opportunity for prescription farming is now a possibility with the combination of variable rate technology on the seeder and fluid fertiliser carts, autosteer and yield mapping.

"Normally" at Mudamuckla the sides of the hills are most productive, followed by the hill tops, then the heavier flats. This trial was designed to start a database of information to answer, " What is the most cost effective level of seeding inputs for the various soil types in an average season?"

Table 1: Treatments, Grain Yield, Grain Quality and Gross Margins.

Treatment	Seed (kg/ha)	P (kg/ha)	N (kg/ha)	Yield (t/ha)	Protein (%)	Screenings (%)	GM ($/ha)
Control	60	4	12	1.59	11.2	4.5	171
Low seed	40	4	12	1.51	11.4	4.5	165
High input	40	8	19	1.79	11.5	5.5	164
Low seed, no urea	40	4	3	1.42	11.2	5.5	163
High P	60	8	13	1.65	11.3	6.1	163
High seed	80	4	3	1.46	11.6	5.4	154
High N	60	4	16	1.48	11.3	5.2	153
High seed, no fert	80	0	0	1.28	11.5	3.3	150
Low seed, no fert	40	0	0	1.15	11.7	5.2	150
High seed + fluid	80	8	5	1.49	11.2	4.3	144
High P, no urea	60	8	5	1.41	11.2	6.3	140
No P	60	0	9	1.19	11.1	4.9	136

Best practice

Location
Mudamuckla
Peter Kuhlmann

Rainfall
Av Annual: 293 mm
2005 Total: 301 mm
Av GSR: 219 mm
2005 GSR: 239 mm

Paddock History
2004 Krichauff Wheat
2003 Yitpi
2002 Spraytopped Pasture

Yield
Potential : (W) – 2.6t/ha

Soil Type
Grey Calcareous Sandy Loam

How was it done?

The trials were sown to Krichauff on the 29th of June into wheat stubble with knife points and press wheels. Strips were sown north-south and were a seeder width wide and 700 m long and traversed a longitudinal dune and a heavier flat.

The control strips were sown on every alternate strip (to allow a direct comparison) using a GPS Ag Autosteer with 2 cm accuracy.

Rates of seed, fluid fertiliser (APP – Ammonium Poly Phosphate) or urea were varied in an attempt to find the best gross margin for the different soil types, as outlined in *Table 1.*

The strips were harvested with a full header front using yield mapping and the grain samples from the various treatments were tested.

What happened?

Good rains in July and early August allowed better early cover to establish where there was higher fertiliser and seeding rates. By early September the crop was drying out and there were minimal visual differences between the strips. Rain in September (96 mm) turned the season around, potential allowing the higher input strips to yield much better than expected given the late seeding date *(Table 1)*. The average results for 2005 indicate that the standard practice (control) produced the best gross margin for the paddock.

The sandier soils on top of the hill were set back by Take-all and Rhizoctonia, had more grass competition and produced the lowest yields. The normally less productive heavier loamy soil in the flats yielded the best in 2005 because of the historical lower disease and grass levels and fantastic spring rains.

The higher seed or fertiliser inputs produced more heads and resulted in smaller grain size, which slightly affected the test weight and screening levels. There was no variation in protein levels.

What does this mean?

- It would not be wise to use only this data from an atypical year like 2005 (late start and a very wet spring) to decide on future input decisions.
- Data from many seasons and different situations will be required to produce a best bet model for an “average” seeding situation.
- Variable rate technology allows growers to reduce the risks and maximise the gross margins on each management zone within each paddock.
- It is relatively easy to do on farm trials like this with the current technology .
- The technical challenge of incorporating different types/brands of yield monitors, guidance, rate controllers and mapping programs into an affordable and workable solution is an issue for most growers.

Acknowledgements

Thanks to “Jock” Rynne who sowed the strips, Andre Eylward who harvested the strips and sorted out the yield data and ABB Grain at Thevenard for the testing of the samples.

ABB

EPARF
EYRE PENINSULA
Agricultural Research Foundation

Almost ready

Location
Minnipa Agricultural Centre

Rainfall
Av. Annuall 325 mm
Av.G.S.R.: 242 mm
2005 Total: 327 mm
2005 G.S.R.:267 mm

Yield
Potential: 3.0 t/ha
Actual: 2.3 t/ha

Plot size
700 m by 12 m

High moisture content harvesting

Research

Brendan Frischke, Brett McEvoy & Kym McEvoy
SARDI, Minnipa Agricultural Centre

Key Messages

- **Wheat grain can be dried using ambient air with high flow aeration.**
- **The drying rate is affected by relative humidity and to a lesser extent ambient temperature.**
- **Benefits are marginal in most years but could be substantial in occasional years of high harvest rainfall.**
- **Capital is best utilised by partially drying grain harvested at high moisture and blending with grain harvested below acceptable limits to clear silos in the shortest time.**

Why do the trial?

To assess the feasibility of using aeration to dry high moisture content grain in the Minnipa environment. To assess whether aeration drying is a practical tool which will allow earlier commencement of harvest.

How was it done?

Two 28 tonne (t) capacity silos were each fitted with three fans and ducts to provide aeration of natural air. The minimum air flow rate for drying is 10 litres/minute/tonne (L/min/t), greater than 20 is preferable. The fans used were 0.37 kw (0.5 hp) single phase electric fans with an approximate flow capacity when loaded of 175-225 L/s. The flow rate is dependant on backpressure which increases as the grain stack height increases. Each fan cost $750 including ducting and costs a maximum of $1.33/day to run (at 15 c/kwhr).

To dry wheat with moisture content up to 15%, two fans would provide adequate air flow, however, as we intended to dry grain as high as 18%, a third fan was installed to give better air flow distribution and reduce the risk of hot spots developing.

Fans were equally spaced around the silo cone. During drying the silo capacity was limited to 60% (17 t) because excessive height (>5 m) can reduce the ability of the fans to push air through the grain stack and dry grain effectively.

Wyalkatchem wheat sown using controlled traffic was selected to harvest grain for the trial. Grain was to be harvested and dried at two stages with moisture contents above the acceptable limit as the crop was ripening and a final stage when the moisture content had fallen below 13% (normal practice). Target moisture contents for the early harvests were 18-20% and then 15-16%.

At each harvest time seven strips the length of the paddock by two header widths were harvested using the controlled traffic sown crop rows as a guide. Grain from each strip was weighed and had moisture content measured using a Riceter® meter before being bulked together and delivered to a drying silo. Sub samples were taken so that moisture could be measured using an Infratec® NIR meter and by oven drying. Samples were also kept in a shade cloth bag and dried within the drying silo with the bulk grain so that replicated post drying quality data could be measured.

Initially drying fans were kept on continuously. Moisture content was measured at the top of the stack at least every second day. Once moisture was below 14% at the top, the fans were switched off by a timer for several hours overnight when relative humidity was expected to be over 80%. This timing was predicted by observing the previous nights hourly data on the bureau of meteorology's web site.

What happened?

The first strips were harvested on 13th November, when average moisture content of random samples measured by the Riceter® meter was below 20% and the number of green heads appeared below tolerance levels on the McEvoy-Frischke guess meter (Editors comment – was this a replicated measurement??). The average moisture content of the strip harvested at the first timing was 18.7% when measured by the Riceter® meter but the Infratec® measured 16.2% and was 15.2% when measured using an oven drying method which takes 48 hours. A total of 14.5 t was stored in a drying silo from the first harvest. The maximum allowable green seeds is 3 seeds per 300, or 1%. Samples from each strip were tested by ABB to measure green seeds. From seven samples tested, two samples had 3 green seeds, three samples had 2 seeds and two samples with 1 green seed.

Grain was removed from the drying silo eleven days after entering and delivered on 24th November in two loads. The first load had 9.08 t at 12.3% moisture, the second had 4.7 t at 10.6% moisture resulting in a weighted average moisture content of 11.7%. The total delivered tonnage of 13.78 t had shrunk from 14.5 t due to moisture loss, a reduction of 5.2%.

While drying, temperature was logged at the top of the wheat stack using an in-situ data logger and temperature and humidity data was provided from the automatic weather station on Minnipa Ag Centre. *Figure 2* shows that after an initial increase due to grain sweating, the temperature in the grain dropped to 15°C from 37°C within the first 24 hours. From this point on, the temperature remained very cool (15-16°C) despite the air temperature being above 25°C during the day. This is due to the evaporative cooling effect and is a good indicator that drying is occurring. When there were short periods of higher humidity, the temperature rose. This indicates that the drying has reduced in efficacy but does not mean it has stopped altogether.

The day following the first harvest had strong winds, temperature up to 37°C and humidity below 10%. It was an excellent drying day, for a crop in the field. The second batch was harvested on 15th November. The average moisture measured in the field with the Riceter® meter was 13.0%. This batch (13.7 t) was stored in the second drying silo as a precautionary measure to ensure the moisture

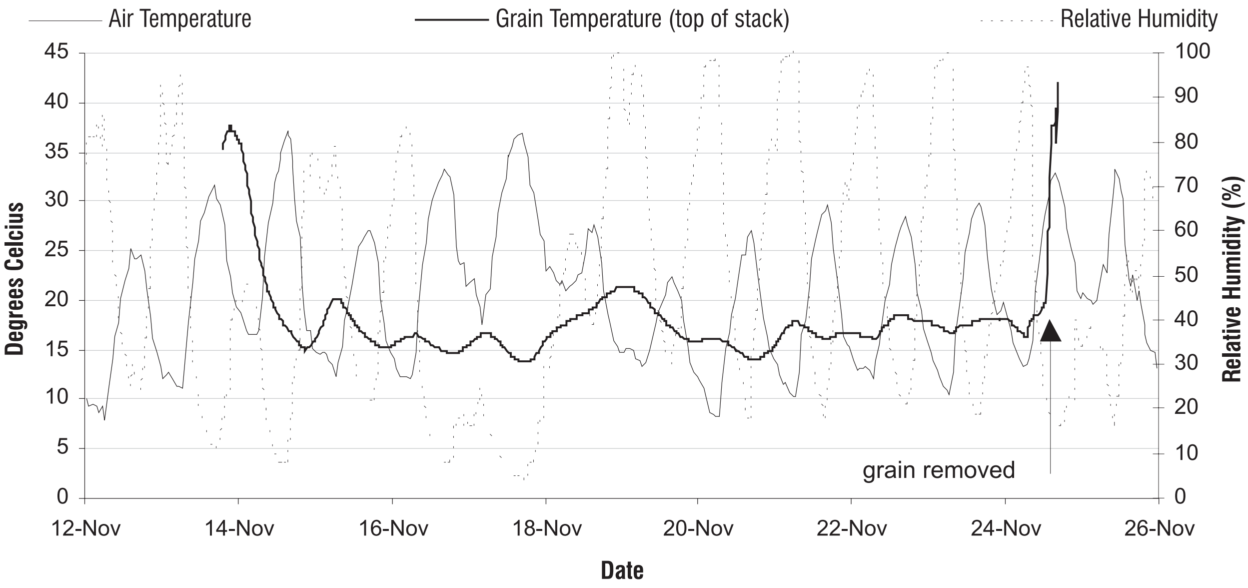

Figure 1: Comparison of relative humidity (%) and air temperature to the temperature recorded at the top of the grain stack during the drying process.

Table 1: Grain yield and quality of wheat harvested at three different moisture contents.

	Harvest Timing 1	Harvest Timing 2	Harvest Timing 3	Significance
Moisture Content at harvest (%) oven method	15.2	10.0	13.2	NA
Yield (t/ha) *adjusted to 12% MC	2.28	2.26	2.29	NS
Protein %	11.9	11.8	11.7	LSD (P=0.08) = 0.17 #
Screenings %	1.4	1.6	1.1	LSD (P<0.001) = 0.13
Test Weight (kg/hL)	79.0	79.6	78.4	LSD (P<0.001) = 0.44

 # protein was significantly different for P<0.1

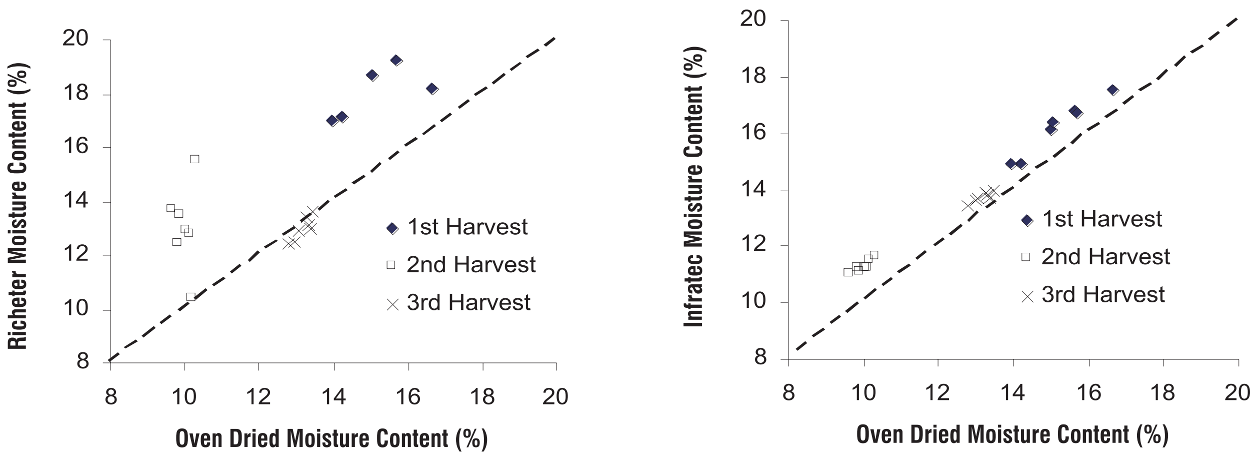

Figure 2: Comparison of measured grain moisture content from Riceter® and Infractec® meters versus oven dried method.

content was below 13%, our preferred limit although 13.5% is acceptable at a cost. Samples kept in sealed containers to retain moisture were tested the following day for moisture content using Infratec® (11.2%) and drying ovens (10.0%). This batch was then kept for seed.

Since the second timing was harvested below the allowable moisture limit and achieved the objective of the third harvest timing, the focus for the third timing was changed to asses earlier commencement of harvesting following a rain event. On the morning of December 2nd, 9.4 mm rainfall was recorded. The final batch was harvested on December 3rd with 23 t being reapt. The average moisture content measured in the field using the Riceter® was 13.0%. During harvest, the moisture content of each strip was lower than

Table 2: Approximate equilibrium grain moisture content (EGMC) of wheat from aeration at specific temperatures and humidities

Temperature (°C)	Relative Humidity (%)				
	30	40	50	60	70
15	9.8	11.0	12.1	13.4	15.0
25	9.0	10.3	11.4	12.8	14.0
35	8.5	9.7	10.7	12.0	13.5

Source - Peter Hughes, DPI QLD

the previous strip with a difference of 1.2% from first to last. This batch was also stored in a drying silo to ensure moisture content was not to high. Moisture contents measured by the Infratec® and drying ovens were 13.7% and 13.2% respectively indicating a short drying period was warranted.

Table 1 shows the yield and grain quality results. Yields shown are based on 12% moisture content and derived by adjusting the wet weight measured at harvest according to the moisture content (MC) measured using the oven drying method. For example, 1000 kg @ 16% MC weighs 955 kg when reduced to 12% MC. In this experiment the harvest yield was the same for all harvest timings. There was a difference in test weight and screenings. However, as they can be affected by harvester set up it is impossible to conclude that they were due to harvest timing. There was an indication that protein declined with delayed harvesting.

What does this mean?

Measuring moisture content

Figure 2 shows the correlation of moisture contents measured by the Riceter® and Infratec® meters against oven dried moisture content. The results show the difficulty in reliably measuring moisture with the Infratec® being much better than the Riceter®. The moisture contents measured at the third timing had far superior correlations than those measurements at the first and second timings. At timings 1 and 2, there were many green and sappy seeds and there would have been large variation in ripeness (and moisture content) between wheat heads and grain within. When there is large variation, larger samples and more of them give more reliable results. The poor performance of the Riceter® meter at early harvests was possibly caused by sappy seeds leaving a residue when crushed. If the residue was not cleaned thoroughly between samples, successive readings may have been artificially inflated.

Grain Drying

Grain drying in silos is much slower than if it were allowed to dry in the field. In the case of the first timing it was eleven days in the silo compared to only one day in the field. There are automated aeration controllers that decide when and when not to run fans to give the fastest drying time.

However, a more simplistic approach is to run fans continuously and use the average humidity and temperature to estimate what moisture content the grain will move towards. *Table 2* shows the moisture contents that wheat would reach if it were held at constant temperature and humidity (equilibrium point).

For the period when the first batch was dried, the average temperature and humidity was 21°C and 47% respectively. This equates to approximately 11.7% MC. As the air passes through grain absorbing moisture slowly increasing in humidity and progressively absorbing water at a slower rate. This results in the grain being drier near the fans and wettest at the top of the stack; what is know as a drying front moves from bottom to top. When there are periods of high humidity the reverse happens and the dry grain at the bottom absorbs moisture from the air reducing the humidity. This drier air can then absorb more moisture from grain once it reaches the drying front. As the average moisture content gets closer to the equilibrium point, drying will get progressively slower. Automatic controllers are effective at drying the final stages by choosing the best quality air. Alternatively it may be more cost effective to dry grain from 14-16% MC to approximately 13.5% (equilibrium at 15°C and 60% RH) and then blend with drier grain as it comes off the header.

Costs

Drying fans on the first harvest batch were run for 24 hours initially and then for 16 hrs/day for days 9, 10 and 11. The total running cost assuming fans were running at full power (which they probably wouldn't) for the period was \$13.30/fan. For 3 fans and 13.8t this equates to \$2.89/t. If the whole of the harvest can be completed without grain down graded due to weather damage then there is a net loss for the year. However in years when grain is down graded due to weather, whatever grain is harvested early (prior to normal ripening) or following rain (before natural drying allows harvest to recommence) could save loses of \$15-\$54/t depending on start grade to finish grade, the worst being AH-preferred (Yitpi) to feed. Even though it will take longer for grain to be delivered than if it were to be allowed to dry naturally, the saving is possible because the grain was reapt when it otherwise couldn't have been.

Acknowledgements

This trial was made possible by the sponsorship from "Kotzur Silos" of Walla Walla, NSW who supplied four aeration fans and ducts. Thanks to Andrew Kotzur who provided valuable guidance during the design of this trial. Also thanks to Lavina Curtis and ABB for testing our samples during harvest.

Search for the holy grain

By Brad Collis

Kindly reprinted from “THE BULLETIN” 17th January 2006, page 18.

A team of gene detectives, led by an Australian, is searching for the seeds of ancient crops - biological treasures for harvests that they hope will succeed against all odds. Brad Collis reports.

The farmer’s tanned, furrowed face is thoughtful. “You should ask the old women,” he says after a pause. He smiles apologetically, dull veins of gold in his teeth. From village to village, farm to farm, others agree. “Ask the old women.” They are helpful and nostalgic and, after an obligatory vodka or two, melancholic.

A team of scientists is high in the mountains of Armenia on a mission the farmers understand. They are, after all, farmers in the land where farming began.

They start calling out the old women, who emerge from lightless kitchens and farm buildings – reliable electricity also just a memory in these remote pockets of the old Soviet empire – and explain their quest. The women hurry away and, with extraordinary generosity, re-emerge with tins, jars and knotted cloth containing biological treasures – the seeds of bygone crops.

Wheat, barley, beans and peas disappear into envelopes, marked with the name of the village, the name of the family and the GPS position – the handheld satellite positioning device an object of wonder to scores of children.

The women wish us well. Some cry, because these visiting scientists seem to understand what they have thought all along: that the traditional varieties were special – the same way other people lament the passing of tomatoes or apples that taste like ... tomatoes and apples before they started being grown for cold storage and mechanised handling.

There is a surrealism to these farmyard meetings, underscored by the dissonant chatter of Australian, Russian and Armenian accents as the team probes for knowledge of yesteryear crops, and asks for a little of the seed that might be hoarded. As we travel over rutted mountain roads, we are also looking for places where ancestral plants might still grow on high plains that haven’t been over-grazed or, hopefully, been mined.

The hunt is on for genes, for lost genetic resources that agricultural scientists say will be crucial for the world to keep feeding itself as climate change and deteriorating agricultural landscapes begin to bite. And no one will be immune, least of all people who today know only how to buy food, not grow it.

And so this small band of genetic detectives is scouring the birthplace of agriculture, the Caucasus – Georgia, Armenia, Azerbaijan and parts of Russia – for remnant storages on farms, and for ancestral wild grasses from which modern crops like wheat and barley were first bred 5000 or so years ago.

The mission is led by a Syria-based -Australian, Dr Ken Street, an agricultural ecologist with the International Centre for Agricultural Research in Dry Areas, and comprises -Russian and Armenian plant -researchers, as well as another Australian, Perth-based Dr Clive Francis from the Centre for Legumes in Mediterranean- Agriculture.

Their work is partly funded by -Australia through the Australian Centre for -International Agricultural Research, a development agency, and the Grains Research and Development Corporation – Australian farmers are as desperate as any for crops that can withstand the grip of droughts, frosts, saline soils, fungal diseases like rust, and global warming.

While a two- or three-degree increase in average temperatures may be perceived by people as merely a comfort issue, a fact not widely appreciated is that a fraction of a degree change can be enough to stop many food plants from flowering and delivering grains and fruits – our food. So the genes that allow the old relatives of modern crops to flourish still in frozen or arid landscapes need to be found and reintroduced.

“We are going back through time, backwards through man-made evolution,” says Street, who has been leading seed-collecting expeditions into Georgia, Armenia, Azerbaijan and Tajikistan over the past five years.

“We are looking for the grasses that were used for bread-making thousands of years ago – at the start of civilisation when people first saw that keeping and sowing seeds from the best plants gradually improved what they were harvesting. We are searching for what our distant ancestors were using; not because they are better but because they have a wider genetic base. A modern wheat plant might have a few hundred parents from a breeding program, but the ancient wild varieties had hundreds of thousands, perhaps millions, of parents.”

The genetic diversity of the Caucasus, and the lure of discovery, is also what keeps pulling Clive Francis back to the region, long after he had intended retiring. “This area is the birthplace of wheat, numerous fruits, vegetables like onions, and a lot of the world’s legumes ... not to mention scores of flowering plants such as tulips and gladioli.”

Gazing across a meadow brimming with plant life, a wind-ruffled soup of botanic diversity, Francis explains that there are 125 species of Astragalus alone in Armenia. Astragalus is part of the legume family – what most people know as peas, beans or lentils. Legumes are his passion and Armenia is Xanadu, a paradise of agricultural opportunity.

“The legumes we grow in Australia are annuals, but there are perennials here ... crop plants that could help us manage our wheat-belt water table and limit the build-up of salinity,” he says.

The collected seed is planted and assessed at the dry-area centre in Syria, and the most promising lines sent to plant breeders in Perth, Adelaide, Horsham and Tamworth for local introduction.

Legumes are becoming increasingly important in Australian agriculture as rotation crops between wheat and barley plantings, because they break potential disease cycles, and they increase soil nitrogen (a crucial nutrient that otherwise has to be applied as chemical fertiliser). Their deep roots improve soil structure and they more closely mimic native plants in the way they help prevent rising water tables that cause most of the wheat-belt's salinity.

Aside from benefiting Australian farmers, subsequent improved generations will also be sent back to the dry-area centre to help agricultural development in developing countries – the group's principal role being poverty alleviation. Legumes' ability to transfer nitrogen from the atmosphere to the soil, and research being done to adapt them to sub-tropical environments, is seen as a low-cost, practical way to restore impoverished soils in hunger-ravaged areas of Africa.

But in contrast with the almost ready-to-use legumes, harnessing the genes from wheat's ancestral grasses is a longer-term proposition (10 to 15 years), although the process could be speeded up using genetic engineering. Wheat's ancestors are too far removed in time to be able to be crossed with modern plants, given that wheat is essentially a man-made crop that doesn't exist in nature. However, while the use of GM technologies would allow researchers to retrieve from ancestral grasses the gene sets capable of delivering traits such as drought - and frost-tolerance comparatively quickly, this can't even be contemplated until the moratoriums on growing GM crops in NSW, Victoria, SA and WA expire in 2008.

The frustration for Australian researchers is that their counterparts in North and South America have no such restrictions on plumbing these genetic resources and are enjoying a handy head-start in the work.

In the past 12 months, Street's seed--collecting missions have become part of an international program developed under the auspices of the Global Crop Diversity Trust, set up as an instrument of the International Treaty on Plant Genetic Resources for Food and Agriculture. This was established only a year ago to try to arrest the erosion of the world's plant genetic resources.

"It's a survival issue," says Street. "For most people around the world that means avoiding starvation, while for farmers in countries like Australia it is economic survival. For example, late-season frosts destroy millions of dollars worth of cereal crops in Australia every year. This is because the genetic origin of Australian varieties mirrors our political and cultural origins: western Europe, which is not the ideal genetic lineage for the Australian environment. By comparison, there are wheat varieties in central Asia and the Caucasus that comfortably tolerate frost and low rainfall. These varieties need to be re-identified, catalogued and made available to Australian plant breeders."

The work by Street and Francis also involves trying to save the once pre-eminent plant collections housed in the crumbling, neglected, botanical institutes of the former Soviet republics in central Asia and the Caucasus.

"The world is losing irreplaceable seed from these collections simply because the local people can't afford to replace water pumps, or stored seed is being eaten by mice," says Street. "This is frightening, because the genetic origins for a very large proportion of the world's food crops, including the crops we grow in Australia, don't exist anywhere else. So we are desperately trying to collect, store, document and manage as much diversity from old varieties and wild relatives before they are gone forever."

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Section 2

Section editor: Willie Shoobridge & Amanda Cook

SARDI, Minnipa Agricultural Centre

Break Crops

The total 2005 production figures for EP were approximately 74,000 tonnes of canola, 21000 tonnes of beans, 39,000 tonnes of peas and 42,000 tonnes of lupins.

Break crop variety evaluation 2005

Field Pea variety trial yield performance at Eyre Peninsula sites

2005 and long term (1998-2005) yields expressed as a % of Parafield's yield.

Variety	2005			1998-2005		
	Minnipa	Rudall	Yeelanna	Minnipa	Rudall	Yeelanna
Bundi	84	84	100	101	99*	100*
Excell	85	90	97	89	90	92
Kaspa	100	82	128	105	104	105
Moonlight	71	62	105	91	92*	98*
Mukta	89	68	111	95	90	100
Parafield	100	100	100	100	100	100
Soupa	86	61	126	95	90	101
Sturt	105	106	90	103	104	100
Yarrum	86	69	122	97	96*	101*
Parafield's yield (t/ha)	**1.51**	**2.21**	**3.71**	**1.50**	**1.85**	**3.11**
Date sown	24-Jun	12-Jun	30-Jun			
Soil type	L/CL	S/CLS	SC/LC			
pH (water)	8.7	6.9	7			
Apr-Oct rain (mm)	267	250	381			
Site stress factors	lb,bs	fr	-			

***Varieties have only had limited evaluation at these sites, treat with caution.**
***** Rudall site includes data from Lock pre 2005***
Soil type S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = over
Site stress factors bs=blackspot, lb=late break (late sown), fr=reproductive frost damage
Data source: SARDI/AFPIP/GRDC & NVT (long term data based on weighted analysis of sites)
More information: Larn McMurray (08) 8842 6265 or e-mail mcmurray.larn@saugov.sa.gov.au

Early season canola yield performance at Eyre Peninsula Sites

2005 and long term (1999-2005) as a % of Ag-Outback and ATR-Stubby

Variety	2005		1999-2005	
	Lock	Minnipa	Lock	Minnipa
AG Outback	100	100	100	100
Kimberley	102	87	99	94
44C11	102	106	109	107
44C73	105	90	95	90
Rivette	97	95	103	103
44Y06	97	95	95	91
45Y77	98	100	95	91
AG Comet	87	95	87	82
Hyola 45	93	86	91	84
AV Opal	97	86	94	88
Ag-Outback yield	**1.49**	**0.95**	**1.26**	**0.85**
ATR Stubby	100	100	100	100
Surpass 501 TT	91	73	96	88
Trigold	100	86	100	94
Trilogy	74	69	85	78
ATR Banjo	93	94	96	92
Boomer	94	85	93	86
Tranby			93	89
ATR-Stubby yield	**1.64**	**0.88**	**1.28**	**0.73**
Date sown	6/15	6/23		
Soil type	S/LS	LS/CL		
A-O rain	293	267		
pH	6.4	8.8		
Stress factors	w(con)			
Polygenic variety	8	0		
Sylvestris variety	17	10		

Abbreviations
Soil type S=sand, C=clay, L=loam, H=heavy, M=medium, Li=light, F=fine, K=course, lime=limestone / divides topsoil from subsoil
Site stress factors: de=moisture stress preflowering, dl=moisture stress post flowering, w=weeds, lo=lodging, sh-shattering, pe=poor establishment, s=sulphur deficiency, ap=aphids, hd=herbicide damage, bl=blackleg, wind=wind loss, ls=late sown, sn=snails, f=frost
Blackleg data: Polygenic variety: ATR-Beacon or Skipton, Sylvestris variety: Surpass 501TT or Surpass 603CL
% plants with significant yield loss

Mid season canola yield performance at Eyre Peninsula Sites

2005 and long term (1999-2005) as a % of Ag-Spectrum and ATR-Beacon

Variety	2005		1999-2005	
	Yeelanna	Mt Hope	Yeelanna	Mt Hope
AG Spectrum	100	100	100	100
AV Sapphire	103	89	97	99
Warrior CL	89	85	85	90
Hyola 61	105	87	90	96
46C04	90	93	99	100
46C76	89	92	90	96
Surpass 603 CL	84	80	81	88
AG Drover	101	103	97	103
Hyola 75	111	105	105	107
AV Ruby	107	95	98	97
AV Jade	105	86	95	95
Skipton	96	84	97	98
RocketCL	84	81	84	89
Ag-Spectrum yield	**2.33**	**2.19**	**2.00**	**2.10**
ATR Beacon	100	100	100	100
ATR Grace	98	96	97	95
Surpass 501 TT	91	80	94	85
ATR Summitt	105	101	101	99
BravoTT	123	117	106	102
Boomer	98	74		
ThunderTT	112	104	101	98
TornadoTT	117	89	104	96
ATR-Beacon yield	**1.83**	**1.66**	**1.94**	**1.80**
Date sown	17-Jun	28-Jun		
Soil type	SL/MC	LS/CL		
A-O rain	342	396		
pH	8.2	6		
Stress factors				
Polygenic variety	3	0		
Sylvestris variety	28	2		

Abbreviations
Soil type S=sand, C=clay, L=loam, H=heavy, M=medium, Li=light, F=fine, K=course, lime=limestone / divides topsoil from subsoil
Blackleg data: Polygenic variety: ATR-Beacon or Skipton, Sylvestris variety: Surpass 501TT or Surpass 603CL
Score = % plants with significant yield loss

Bean variety yield performance at Eyre Peninsula Sites

2005 and long term (1999-2005) yields expressed as a % of Fiesta's yield.

Variety	2005			7 year average (1999-2005)		
	Cockaleechie	Rudall	Minnipa	Cockaleechie*	Lock / Rudall **	Minnipa
Cairo	81	95	111	94	97	97
Farah	99	99	114	101	99	103
Fiesta VF	100	100	100	100	100	100
Fiord	85	79	90	97	92	86
Manafest	83		97	91	93	83
Nura	102	114	89	104	102	105
Fiesta VF yield t/ha	**5.15**	**2.00**	**0.95**	**3.17**	**1.76**	**0.94**
Date sown	29/6	12/6	27/6			
Soil type	CL/MC	S/CLS	L/CL			
pH (water)	8.0	6.9	8.7			
Apr-Oct rain (mm)	355	250	267			
Site stress factors	cs	fr,hd	lb			

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Abbreviations
Soil type: S=sand, C=clay, L=loam, F=fine, M=medium, Li=light, H=heavy, / =divides topsoil from subsoil.
Site stress factors: cs=chocolate spot, fr=frost, hd=herbicide damage, lb=late break, w=weeds.
****Cockaleechie Long Term yield is a composite of Cockaleechie (1998-2004) results.***
**** *Lock/Rudall Long Term yield is a composite of Lock (1999-2004) and Rudall (2005) results.***
Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites).

Lupin variety yield performance at Eyre Peninsula Sites

2005 and long term (1999-2005) yields expressed as a % of Merrit's yield.

Variety	2005			7 year average (1999-2005)		
	Tooligie	Ungarra	Wanilla	Tooligie	Ungarra	Wanilla *
Jindalee	100	91	114	102	105	104
Mandelup	108	106	120	110	106	107
Merrit	100	100	100	100	100	100
Moonah	101	97	111	100	101	101
Quilinock	112	95	130	108	104	104
Wonga	107	87	117	100	100	100
Merrit yield t/ha	**1.82**	**2.69**	**2.43**	**1.48**	**2.37**	**2.74**
Date sown	13/6	16/6	27/6			
Soil type	S/CLS	S/CL	LS/MC			
pH (water)	8.0	8.3	7.4			
Apr-Oct rain (mm)	346	324	338			
Site stress factors	pe,w	pe,sn,w	ls,pe,wl			

More information : Jim Egan (08) 8688 3424 or e-mail egan.jim@saugov.sa.gov.au
Abbreviations
Soil type: S=sand, C=clay, L=loam, M=medium, Li=light, / =divides topsoil from subsoil.
Site stress factors: ls=late sown, pe=poor emergence, sn=snails, w=weeds, wl=waterlogging.
**** Wanilla Long Term yield is a composite of Kapinnie (1999-2002) and Wanilla (2003-2005) results.***
Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites).

SA Chickpea variety trial yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Howzat's (desi chickpeas) or Genesis 090's (kabuli chickpeas) yield.

Variety/Line	2005		1999-2005	
	Cockaleechie	Rudall	Cockaleechie	Rudall**
Desi trials				
Genesis 508	72	64	89	85
Genesis 090#	87	67	100	98
Howzat	100	100	100	100
Sonali	96	76	99	99
Howzat's yield (t/ha)	**2.97**	**0.61**	**1.85**	**0.98**
Kabuli trials				
Almaz	90		84*	
Genesis 090	100		100	
Nafice	75		80*	
Genesis 090's yield (t/ha)	**2.79**		**1.91**	
Date sown	28-Jun	12-Jun		
Soil type	CL/MC	S/CLS		
pH (water)	8	6.9		
Apr-Oct rain (mm)	355	250		
Site stress factors	wl	hds,fr		

*# Kabuli lines ** Rudall site includes data from Lock pre 2005*
**Varieties have only had limited evaluation at these sites, treat with caution.*
Soil type S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = over
Site stress factors wl=water logging, hds=herbicide damage (simazine), fr=reproductive frost damage
Data source: SARDI/CICA/GRDC & NVT (long term data based on weighted analysis of sites)
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SA Lentil variety trial yield performance at Eyre Peninsula sites

2005 and long term (1999-2005) yields expressed as a % of Nugget's yield.

Variety/Line	2005		1999-2005	
	Rudall	Yeelanna	Cockaleechie	Yeelanna
Aldinga	72	70	98	97
Boomer	118			
Digger	90	86	97	98
Matilda	83		96	95
Nipper	103	119	102	103
Northfield	103	67	92	92
Nugget	100	100	100	100
Nugget's yield (t/ha)	**1.70**	**2.47**	**2.23**	**2.35**
Date sown	12-Jun	30-Jun		
Soil type	S/CLS	SL/CL		
pH (water)	6.9	7		
Apr-Oct rain (mm)	250	381		
Site stress factors	fr	bos,w,scm		

Soil type S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = over
Site stress factors w=weed competition, fr=reproductive frost damage, bos=botrytis grey mould severe, scm=sclerotinia moderate
Data source: SARDI/CIPAL/GRDC & NVT (long term data based on weighted analysis of sites)
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Improving the adaptation of field peas for the low rainfall regions

Larn McMurray[1], Willie Shoobridge[2], Tony Leonforte[3] and Brad Bennett[1]

SARDI, Clare[1]; SARDI, Minnipa Agricultural Centre[2]; DPI Victoria, Horsham[3]

Research

Try this yourself now

Location
Minnipa Agricultural Centre, Paddock-North 5 North

Rainfall
Av. Annual total: 326mm
Av. GSR: 241mm
2005 Actual: 334mm
2005 GSR: 264mm

Yield
Potential: 2.01 t/ha

Paddock History
2004: Wyalkatchem wheat
2003: Medic pasture
2002: Kukri wheat

Soil
Loam pH 9.0 over clay loam pH 9.0

Diseases
Moderate levels of black spot

Plot size
1.5m x 10m x 3 reps

Yield limiting factors
Late break (late sown), low seeding rate (15%)

Key Messages

- **The Australian Field Pea Improvement Program (AFPIP) is targeting development of field peas for lower rainfall environments. Promising advanced breeding lines were identified at Minnipa in 2005.**
- **Field peas are the most reliable break crop option in low rainfall environments, but must be well managed.**
- **Early sowing of field peas is essential to maximise yields, however with favourable spring conditions good yields were obtained last year.**
- **Parafield and Kaspa continue to be the best options for low rainfall areas although Kaspa is better suited to the more favourable seasons.**
- **Where frost is a problem Sturt may be an option.**
- **The late wet finish in 2005 may increase the risk of black spot infection in 2006, so soil analysis for black spot levels should be adopted on suspect paddocks.**

Why do the trial?

To expand the field pea industry in low rainfall areas of southern Australia through the development of cultivars that will increase production and economic returns.

Numerous evaluation trials of break crop species in low rainfall areas have consistently indicated that field peas are the best adapted break crop option currently for these environments. Due to these results and the continuing need for a break crop in continuous cropping rotations in low rainfall environments the Australian Field Pea Improvement Program (AFPIP) has refocused its outputs with an increased effort in the medium to low rainfall areas of Australia. Minnipa is now one of 4 key sites in South Australia and 12 across Australia particularly focusing on developing field pea varieties for low rainfall/short season environments. Currently key selection criteria at these sites include resistance to blackspot, shattering, lodging, boron and salinity tolerance and appropriate flowering/maturity time. The breeding program has also been expanded to develop superior varieties with improved tolerance to frost, transient drought and heat stress at flowering/podding.

How was it done?

A replicated Stage 3 pea breeding trial containing 12 commercial entries and 131 advanced breeding lines from AFPIP and a replicated Stage 2 breeding trial containing limited commercial checks and 99 preliminary breeders lines from AFPIP were sown after the opening rains on the 24th of June at Minnipa.

Due to a plot length problem at seeding, plant density was approximately 15-20% less than the targeted 60 plants/m^2 and this may have reduced yields of lines with lower vigour and biomass. The trials were sown with 70 kg/ha of 18:20 and 1.2 L/ha of Triflur-X® and Lexone® at 180 g/ha was applied on the 5th of July, and Select® at 0.3 L/ha on the 5th of August. The trials were harvested on the 15th and 16th of November after being desiccated on the 4th of November with 0.8 L/ha of Gramoxone®.

Scores for establishment, early vigour, flowering, maturity, lodging, shattering, disease resistance and selection potential were recorded during the year and grain yields were measured at harvest. Results were combined with similar trials across NSW, WA, Victoria and SA.

What happened?

The very late break to the season again made it a challenging year for pulse production on the Upper Eyre Peninsula. The opening season rains occurred on the 14th and 15th of June and after a reasonable germination of medic, trials were sown into good levels of soil moisture ten days after the break. This sowing date was some four to six weeks later than the ideal date for field peas in these environments. The delay in the opening rains meant that the sowing date occurred at a time when a high level of blackspot spore releases from the previous years stubbles were occurring and this led to a high level of early infection. Rainfall amounts during July and August were below average and prolonged dry spells between these events meant that disease progression ceased and had little effect on eventual yield. Above average rainfall amounts in spring and generally lower than average temperatures during September and early October allowed for an extended flowering and pod filling window. Despite late rainfall events in early November the field peas still matured relatively quickly and were harvested in mid November. Growing season rainfall was 10% above average and site mean field pea yields were 1.4 t/ha. This average trial yield was exactly the same as the long term mean trial yield for Minnipa, but below previous yields for similar growing season rainfall amounts yet above previous yields for similar sowing dates. These results highlight the importance of favourable spring conditions when sowing field peas after the optimum sowing time.

Commercial line performance Minnipa 2005

There was no correlation between flowering time and grain yield at Minnipa in 2005 unlike previous years. Generally mid flowering and maturing lines were favoured for grain yield with early flowering lines like Bundi and Excell and later flowering lines like Mukta and Yarrum yielding relatively lower (*Table 1*). The white pea type Sturt was the highest yielding commercial variety in 2005, 1% higher than Dunwa and 5% higher than Kaspa and Parafield (*Table 1*). These lines are mid maturing and have similar flowering durations. Sturt was also the highest yielding variety in the National Variety Testing Trial at Rudall. At this site a frost in mid October reduced pod set and grain yield and as found previously Sturt performs consistently better than all other varieties under this stress condition. Sturt has performed similarly to Kaspa at Minnipa over a number of years of evaluation and generally slightly above Parafield. It will provide an option for these areas, particularly where frost may be a concern, providing markets can be found for its small white seed. Kaspa and Parafield performed similarly last year, however the favourable late season conditions are likely to have favoured Kaspa to a greater extent than Parafield. Generally in years where April to October rainfall has been above average Kaspa has yielded higher than Parafield, however the very late sowing date last year may have been detrimental to Kaspa (*Table 2*).

Table 1: 2005 Minnipa selected pea trial yields (as a % of Parafield), 2005 flowering date and long term predicted yield (1998-2005) as a % of Parafield

Variety/Line	2005 Yield	2005 Flowering Date	Long term yield*
Bundi (89-036-*9-8)	84	Sept 9	101 (3)
Dunwa	104	Sept 19	94 (5)
Excell	85	Sept 9	89 (5)
Kaspa	100	Sept 23	105 (6)
Moonlight	71	Sept 16	91 (4)
Mukta	89	Sept 26	95 (7)
Parafield	100	Sept 16	100 (7)
Soupa	86	Sept 9	95 (7)
Sturt	105	Sept 12	103 (5)
Yarrum	86	Sept 21	97 (3)
Parafield's Yield (t/ha)	1.51		1.5

***Number of comparisons in brackets**

Bundi is a newly released early flowering and maturing, white seeded sister line to Kaspa and was considerably lower yielding than Kaspa and Parafield last year. In 2004 this line was the highest yielding variety favoured by the short season and harsh finish, however its instability in yield as shown by its performance over these two years is a concern to growers. Generally evaluation over time has shown that the mid flowering and maturing varieties have proven to be the most reliable options for low rainfall environments in SA.

Table 2: Parafield (P) and Kaspa (K) pea trial yields compared with rainfall and sowing date at Minnipa, 1999-2005

	1999		2000		2001		2002		2003		2004		2005	
	P	K	P	K	P	K	P	K	P	K	P	K	P	K
Yield (t/ha)	0.90	0.81	2.20	2.24	2.46	2.56	1.40	1.40	0.87	0.79	0.92	0.86	1.51	1.52
GSR (mm)	210		299		267		219		204		223		264	
Annual Rainfall	268		389		354		277		263		288		334	
Seeding Date	May 31		June 2		May 29		May 27		June 8		June 1		June 24	

Breeding line performance Minnipa 2005

Seven advanced breeding lines from the Stage 3 trial were higher yielding than Kaspa at Minnipa in 2005, however across all five SA pea breeding sites last year none of these lines averaged higher yields than Kaspa. In the Stage 2 trial 24% of the 99 lines evaluated at Minnipa were higher yielding than Kaspa with a number of these having earlier maturity, increased biomass and better tolerance to boron than Kaspa (*Table 3*). At breeding sites in low rainfall environments of the Mid North and Yorke Peninsula of SA there was a much lower percentage of lines with higher yields than Kaspa than at Minnipa, indicating that Kaspa is not as well adapted to the Upper Eyre Peninsula low rainfall environments as it is in other areas of the state. A particularly pleasing result of the breeding trials last year was that a number of lines were higher yielding than Kaspa across all low rainfall breeding sites in 2005 (*Table 3*) indicating better adapted varieties for these environments this will be widely evaluated next year for potential release.

Table 3: Grain yield (% of Kaspa) of selected lines from S3 and S2 AFPIP trials at Minnipa and across SA in 2005

Stage 3 Breeding Trials			Stage 2 Breeding Trials		
Line	Minnipa	All SA	Line	Minnipa	All SA
89-036*3-6	89	96	01-284-2	92	106
96P403-2	103	86	97-031-6-6	102	101
PX-96-46-2	110	85	01-256-10	90	101
97P695-8	105	81	01-228-2	102	100
00-257*8	108	77	01-303-3	108	99
97P682-4	102	76	01-269-6	112	96
			01-230-14	106	95
			01-478-2	111	93
			96P339-1	111	85
			98P833-2-11	108	79
Kaspa's yield (t/ha)	1.52	2.36	Kaspa's yield (t/ha)	1.6	2.3

General pea performance in 2005

Downy mildew was again widespread in SA last year, and particularly severe in areas where there were prolonged periods of cold temperatures during winter and/or on paddocks with a history of sowing susceptible pea varieties like Parafield and Sturt. In these situations Kaspa was up to 70% higher yielding than Parafield when no seed treatment was applied. Kaspa does not require a seed treatment for downy mildew due to its high level of resistance even though it may show some initial signs of infection. Field peas grown on paddocks where downy mildew has been previously identified should be either resistant types such as Kaspa or treated with a seed dressing for the disease.

Many field pea crops in 2005 suffered from high levels of late black spot infection due to the late and wet finish in most districts. Generally this disease resulted in only low levels of yield loss due to the late stage of infection, however it is likely that there will be a high carryover of black spot spores on stubble and in the soil for the 2006 season. These levels will be of particular concern to growers planning on dry sowing field peas or sowing early after the break of season in 2006. If sowing field peas in these situations a low black spot risk strategy must be employed. This includes using a seed dressing, avoiding sowing close to or down-wind of last year's stubble, sowing in paddocks that have not grown peas for at least four years and avoiding herbicide injury to seedlings.

What does this mean?

Field peas continue to be the best break crop option in low rainfall environments providing they are managed well. They can be successfully grown at later than optimum sowing dates in these environments but are extremely dependent upon favourable spring conditions to achieve average yields.

Kaspa and Parafield continue to be well suited to low rainfall environments, although Kaspa is better suited to the more favourable seasons in these environments due to its later flowering characteristic. Sturt yields similar to Kaspa in low rainfall environments but is more susceptible than this variety to downy mildew, lodging, pod shatter at maturity and metribuzin. However it does appear to yield better than all commercial varieties where frost reduces yields. Growers also must be aware that it is a small white seeded type and that they will need to locate markets for delivery as these seed types cannot be mixed with dun types for bulk delivery.

Advanced breeding lines with considerably higher yields than Kaspa at Minnipa and some with higher yields than Kaspa across all SA's low rainfall breeding sites have been selected for potential release in 2-3 years time. These lines incorporate many of Kaspa's characteristics along with earlier flowering time, boron tolerance and more vigour.

Acknowledgements

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GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Research

Faba beans for a low rainfall break crop

Jim Egan[1], Willie Shoobridge[2], Leigh Davis[2]

SARDI, Port Lincoln[1]; SARDI, Minnipa Agricultural Centre[2]

Try this yourself now

Location
Minnipa Agricultural Centre, Paddock-North 5 North

Rainfall
Av. Annual total: 326mm
Av. GSR: 241mm
2005 Total: 334mm
2005 GSR: 267mm

Yield
Potential: 2.06 t/ha
Actual: 1.0 t/ha

Paddock History
2004: Wyalkatchem wheat
2003: Medic pasture
2002: Kukri wheat

Soil
Loam pH 9.0 over clay loam pH 9.0

Plot size
1.5m x 10m

Yield Limiiting Factors
Late break (late sown)

Key Messages

- **Bean yields of around 1.0 t/ha in MAC trials in 2005 were a bonus after a late June start.**
- **Seasonal conditions did not favour Nura, which prefers an earlier sowing and longer growing season, allowing Farah to win top yielding honours.**
- **Despite its 2005 slip, Nura has been the long-term top yielding variety at Minnipa, as well as in Central EP trials.**
- **A number of breeding lines showed promise in the early generation trials, including lines previously identified in the Minnipa trials as having potential for low rainfall districts, and single plant selection lines taken at Minnipa in 2003.**

Why do the trial?

While faba beans are well-established as a pulse crop option in the medium to high rainfall grain-growing districts, their use in lower rainfall regions is restricted by a lack of suitable varieties. This research program aims to develop better adapted bean varieties for these districts by conducting early generation selection and evaluation of faba bean breeding lines in a low rainfall environment. It is a component of the SAGIT-funded project to develop a range of break crop options better suited to the low rainfall Upper Eyre Peninsula region and other similar environments, and complements the selection and evaluation being undertaken in field peas, canola and mustard. This work is reported in other articles in this EPFS Summary book.

How was it done?

Faba bean lines for field testing on Minnipa Agricultural Centre were provided from the National Faba Bean Improvement Program led by Dr Jeff Paull at the University of Adelaide. Early generation lines, entering yield testing in the field for the first time, were included in the Stage 2 (S2) trial with only one or two replicates per line due to limited seed availability. This trial contained 27 lines, including 6 which had been built up from single plant selections taken at Minnipa in 2003, on the basis of height, vigour, standing ability, maturity time and high level of podding. Fiesta and Fiord check plots were repeated throughout the trial to allow statistical analysis with limited replication of test lines.

More advanced lines which had already shown promise in initial field testing were included in a fully replicated Stage 3 (S3) trial with 39 entries total. This trial contained all entries that are in the SA National Variety Trial (NVT) series, including 7 commercial varieties, so that the results can be used to supplement the NVT variety database now available to growers on its website. The S2 and S3 trials also have a high number of entries in common with other faba bean breeding trials conducted by Jeff Paull's team, SARDI and interstate collaborators across southern Australia, so that line performance data can be pooled across a number of sites for analysis to identify lines worthy of progression for advanced testing.

Both faba bean trials were sown on Minnipa Agricultural Centre on June 27, at a standard rate of 24 seeds/m^2, with 18:20 fertiliser @ 70 kg/ha, following a herbicide application of 1 L/ha Powermax®, 75 ml/ha Striker® and 1.2 L/ha of TriflurX®. A mix of simazine @ 1 L/ha, Powermax® @ 1 L/ha and Striker® @ 75 ml/ha was applied post-sowing/pre-emergence on July 3, and Select® @ 0.3 L/ha on August 5. Decis Options® was applied @ 500 ml/ha on September 26 for budworm control. The trials were harvested on November 28, following desiccation on November 4 with Gramoxone® @ 0.8 L/ha.

Scores for early vigour, height, maturity and general appearance at maturity were recorded during the year, and the date of first flowering was recorded. Height to bottom pods was measured at harvest, along with any comments on shattering or lodging. Grain yields were recorded at harvest, and grain samples retained for seed size measurement. Weight of seed left on the ground following harvest was estimated for selected lines using quadrat pickups - this was largely due to harvest losses, since shattering pre-harvest was minimal except in several susceptible lines.

What happened?

With the opening rains for the season not coming until around mid June, sowing of the bean trials on June 27 was much later than ideal - about 5 weeks later than the suggested cutoff date for beans of around May 20 on Upper EP. However excellent spring rains through to mid-November and mild temperatures in September-October provided an extended growing and finishing period for the beans, allowing many lines to beat 1.0 t/ha. In fact the conditions were so favourable late in the season that many of the later lines remained green into mid-November, and a desiccation spray was necessary to mature seed for harvest.

Grain yield results for the top lines in each trial are shown in *Table 1*, compared with check varieties. Trial site mean yields were 1.01 t/ha in the S3 and 0.71 t/ha in the S2. The yield difference between trials partly reflects the wider yield range in the S2 entries with limited previous testing, but yields were also generally poorer in the S2 trial area.

Farah was the top yielding variety in the 2005 trials at MAC, beating Fiesta by 14%. The new release Nura (tested as Icarus*Ascot/7/3) performed surprisingly poorly, with a yield of only 0.85 t/ha. Nura is generally later flowering (flowered about one week later than Fiesta and Farah at MAC in 2005) and shorter at maturity (2-4 cm shorter to bottom pods than Fiesta and Farah at MAC in 2005), which may have disadvantaged it in the shorter than average 2005 growing season. Seed left behind after harvest was estimated to be about 40% higher in Nura than in Farah and Fiesta, due to its lower pod height.

Table 1: Yield of top faba bean lines in MAC breeding trials in 2005.

Variety/Line	Yield t/ha	% Fiesta	Comments
S3 Trial			
Fiesta	0.95	100	
Farah	1.08	114	
683*834/16	1.25	132	Average 20% > Fiesta in 3 years trials
974*(611*974)/2	1.24	131	
482*1038/30	1.18	125	In 2005 NVT trials as potential release
668*683/34	1.15	122	Average 15% > Fiesta in 4 years trials
S2 Trial			
Fiesta	0.90	100	
611*722/45W-Min	1.19	132	Selection made at MAC in 2003
974*(612*974)/22-Min	1.01	112	Selection made at MAC in 2003
AF03001	1.00	111	

Table 2: Predicted long-term yields (1999-2005) of faba bean varieties at Minnipa Agricultural Centre and Lock/Rudall, expressed as % of Fiesta's yield.

Variety	Minnipa	Lock / Rudall *
Fiesta	100	100
Fiord	86	92
Farah	103	99
Nura	105	102
Fiesta's Yield (t/ha)	0.94	1.76

****Data from SAFCEP S4 trials at Lock 1999-2004 and NVT trial at Rudall 2005***

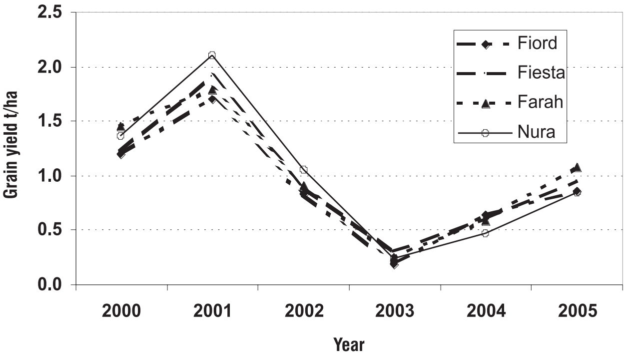

Figure 1: Yield of faba bean varieties at Minnipa Agricultural Centre, 2000 to 2005.

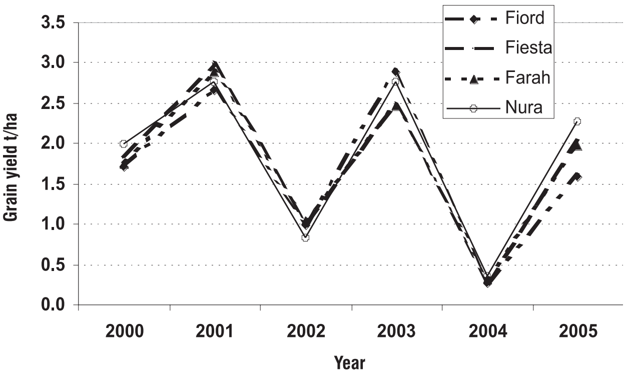

Figure 2: Yield of faba bean varieties at Lock/Rudall, 2000 to 2005.

The top yielding line in the S3 trial was 683*834/16, at 1.25 t/ha (16% above Farah and 32% above Fiesta). This line yielded very well at Minnipa in 2004, and was retained in the low rainfall breeding trials on this basis. It is slightly taller than Fiesta and Farah and has a similar flowering time.

Other lines that have yielded well at MAC in the past several years are 668*683/34 (2%, 5%, 30% and 22% higher than Fiesta in each of 2002 to 2005 respectively), and 482*1038/30 (6% and 25% above Fiesta in 2004 and 2005 respectively). The latter line was included in the 2005 NVT trial series as a potential variety release.

A major point of interest in the S2 trial was the performance of the single plant selection lines taken at MAC in 2003. The top two entries in the trial were these selected lines, the best of which (611*722/45W-Min) yielded 1.19 t/ha, 32% above Fiesta. All six selections were higher than the site mean yield, although it should be noted that these were unreplicated in the trials.

What does this mean?

Faba bean yields of 1.0 t/ha with a late June sowing at MAC are encouraging, but were only made possible by the very kind spring conditions of 2005. Fiesta's long-term average yield at Minnipa (1999-2005) has been 0.94 t/ha, with sowing dates ranging from May 27 in 1999 to June 27 in 2005. *Figure 1* shows how MAC bean trial yields have varied between years from 2000 to 2005, from a low of 0.3 t/ha for Fiesta in 2003 (sown June 8), to a high of 1.9 t/ha in 2001 (sown June 4). These results bring into question the validity of a May 20 cutoff date for sowing beans - such an opportunity hasn't been seen at MAC over the past 7 years, but good yields (1 t/ha or more) have been achieved with sowings into June.

Of current varieties, Nura has the highest long-term yield average at MAC, at 5% better than Fiesta (*Table 2*). This is despite a poor performance in 2005 when the shortened growing season resulted in Nura plants being not as tall as Fiesta and Farah and experiencing greater harvest losses. Data from a large number of trials across southern Australia indicate that Nura is more sensitive to late sowing than Fiesta and Farah, and its yields fall off more sharply with delayed sowing than other varieties.

Results from the Central Eyre Peninsula faba bean trial site at Lock (1999-2004) /Rudall (2005) are also shown for comparison in *Table 2 and Figure 2*. Long-term average Fiesta yield has been 1.76 t/ha in these trials, ranging from 0.26 t/ha in 2004 to 3.0 t/ha in 2001. Nura has again been top variety in these trials (2% above Fiesta long-term), and it had an outstanding result here in 2005 when it yielded close to 2.3 t/ha, compared with 2.0 t/ha for Fiesta and Farah.

Nura was released by the National Faba Bean Improvement Program in 2005, and seed is available from AWB Seeds for the 2006 season. Its main advantages are improved chocolate spot and rust resistance over Farah, but similar to it in other disease and seed quality characteristics. Disease management is expected to be easier with Nura, with ascochyta and/or rust sprays needed only in high risk situations, although these risks are generally low on Upper Eyre Peninsula.

Performance of breeding lines in the 2005 trials at MAC will be reviewed along with results from all other locations, to determine whether they should be progressed or deleted from the program in 2006. Agronomic, disease and seed quality characteristics will be included in the final determination.

Acknowledgements

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Location
Minnipa Agricultural Centre, Paddock-North 5 North

Rainfall
Av. Annual total: 326mm
Av. GSR: 241mm
2005 total: 334mm
2005 GSR: 267mm

Yield
Potential: 2.36 t/ha
Actual: 0.86 t/ha

Paddock History
2004: Wyalkatchem wheat
2003: Medic pasture
2002: Kukri wheat

Soil
Loam pH 9.0 over clay loam pH 9.0

Plot size
1.5 m (8 rows) x 10 m, replicated 3-4 times

Other factors
Late break (late sown)

Canola and mustard - results for 2005

Research

Trent Potter[1], Amanda Cook[2], Leigh Davis[2] and Willie Shoobridge[2]
SARDI, Struan[1], SARDI, Minnipa[2]

Low rainfall canola cultivars

There are several types of canola currently available for low rainfall areas. These include conventional cultivars, triazine tolerant cultivars and Clearfield® canola and each type has advantages and disadvantages.

Trials conducted at Minnipa and other low rainfall sites between 2001 and 2005 tested a range of early maturing canola cultivars. The late break in these seasons resulted in lower yields and oil content. Oil contents of 42% will often be difficult to achieve with triazine tolerant canola, and conventional cultivars that have higher oil content may be affected by brassica weeds.

Early maturing conventional cultivars have been improved over the last few years, with Ag-Outback having a higher grain yield than Monty, but with a lower oil content. Rivette, released in 2001 from NSW Agriculture showed improved yield and oil content. Both Ag-Outback and Rivette are later flowering than Monty. The new conventional cultivars 44C11 from Pioneer, and Kimberley, marketed by Pacific Seeds, are early-mid season cultivars that may fit into the low rainfall area. In 2006, several new conventional cultivars are being released. These include 44Y06 and Hyola 45 which are both early maturing hybrids and the early open pollinated AV-Opal. Yields are included in *Table 1*. The breeding line BLN2026*SL902 that we have developed may also be released, a decision will be made soon about this line.

Table 1: Grain yield (as a % of Ag Outback) in 2005 and long term (1999-2005) of conventional and Clearfield® canola cultivars

Variety	2005		1999-2005	
	Lock	Minnipa	Lock	Minnipa
Ag-Outback	100	100	100	100
Kimberley	102	87	99	94
44C11	102	106	109	107
44C73	105	90	95	90
Rivette	97	95	103	103
44Y06	97	95	95	91
45Y77	98	100	95	91
AG Comet	87	95	87	82
Hyola 45	93	86	91	84
AV Opal	97	86	94	88
Ag-Outback yield (t/ha)	1.49	0.95	1.26	0.85

The only early maturing Clearfield® cultivar has been 44C73 that produced similar yields to the best conventional cultivars. Oil content of 44C73 was relatively low compared to the highest cultivars. Two new early-mid Clearfield® cultivars have been released for 2006. These are 45Y77 (a hybrid) and Warrior CL®. Both may only be suited to early sowings in the lower rainfall areas of EP.

When triazine tolerance has been crossed into canola it has been shown that there is less radiation use efficiency than in the conventional parent and this results in less biomass at maturity. Grain yields have been shown to be up to 25% lower than conventional cultivars and oil content is reduced by 2-5% (a greater reduction in low oil environments). The other result of incorporating the TT trait into a cultivar is that flowering date is delayed by several days. This is probably the major reason why it has been so difficult to select early maturing TT cultivars.

New TT cultivars have been released since 2004 include ATR-Stubby, Tranby, Trigold and Trilogy, all early season cultivars that may be adapted to low rainfall areas. Other early maturing TT cultivars to be released for 2006 include Boomer and ATR-Banjo.

Where do these cultivars fit?

If you are certain that your paddock is virtually free of broad leaf weeds then the best option is to use conventional cultivars. These have higher yield and oil content.

However, the Clearfield® system may be more applicable if you have a brassica weed problem, but the herbicide (On-Duty®) is a group B herbicide that may cause problems if you have resistant ryegrass.

Triazine tolerant canola has been shown in trials to have lower yield than the other canola cultivars and many cultivars have lower oil contents as well. However the cost of

Table 2: Grain yield (as a % of ATR-Stubby) in 2005 and long term (1999-2005) of triazine tolerant canola cultivars.

Variety	2005		1999-2005	
	Lock	Minnipa	Lock	Minnipa
ATR-Stubby	100	100	100	100
Surpass 501 TT	91	73	96	88
Trigold	100	86	100	94
Trilogy	74	69	85	78
ATR Banjo	93	94	96	92
Boomer	94	85		
Tranby			93	89
ATR-Stubby yield (t/ha)	1.64	0.88	1.28	0.73

the TT package is relatively inexpensive. On low rainfall alkaline soils only a low rate of simazine (perhaps 1.5 L/ha) will be able to be used due to carry over problems but this rate has been shown to be very effective at controlling brassica weeds.

Sowing date and conditions during spring have a major effect on canola and mustard yields. Crops in both 2001 and 2002 were sown in late May or early June. With the exceptional season in 2001, high grain yields were achieved. However 2002 was tougher and much lower grain yields were produced. Sowing in 2003 could only occur in early June and the dry finish ensured very low yields. The season of 2005 showed that with late sowing you really are relying on a good spring to get reasonable grain yields. The end of the third week of May could be used as a cut-off point for including canola in the rotation because for later sowings, we are relying on a very favourable spring to ensure good yields. An early break that allows canola to be sown in April is the best option for farmers to grow canola in the rotation in low rainfall areas, so it should be an opportunity crop rather than trying to grow it each year. Mustard is an earlier flowering option and when canola quality mustard is available it may be able to be included more frequentlyin the rotation than canola is now.

Table 3: Oil content (%) of canola cultivars at Lock in 2005.

Cultivar/line	Oil content (%)
Triazine Tolerant	
ATR-Banjo	44.9
ATR-Stubby	41.9
Boomer	41.3
Surpass 501TT	45.0
Trigold	44.0
Trilogy	39.8
Conventional/Clearfield®	
44Y06	42.0
Ag Comet	42.4
Ag Outback	43.6
Hyola 45	42.4
Kimberley	43.8
Pioneer 44C11	43.3
Pioneer 44C73	42.2
Rivette	46.2
AV-Opal	45.0
BLN2026*SL902	45.9

Table 4: Grain yield (t/ha) of canola selections at Minnipa in 2005 (different trials so yields can not be compared between trials)

Cultivar/line	Conventional	Triazine tolerant
Best control	0.92 (44C11)	0.73 (Bravo TT)
Highest yielding line	1.09 (RR001*LA317-MI401)	0.89 (TQ002*MI206-MI427)

Oil content

Over the last few years, oil content has been reduced by the late seasonal break and dry finishes. In 2005, the cool, wet finish allowed cultivars to achieve better oil contents (*Table 3*) at Lock. Data from Minnipa was not available at the time of writing this article. It is likely that oil contents under 40% may often be achieved in the Minnipa environment especially by TT cultivars.

The Future

Mustard (Brassica juncea)

Breeding programs for canola quality *B. juncea* (Indian mustard) commenced in Australia in the late 1970s and early 1980s. The programs aimed at producing canola quality *B. juncea* for lower rainfall environments. *B. juncea* has a number of potential advantages over *B. napus* (canola), including enhanced seedling vigour, blackleg resistance and shatter resistance, plus higher tolerance to drought and high temperature stresses. In order for canola quality *B. juncea* to be used interchangeably with *B. napus* in the market place, it has been important to increase oleic acid levels to match the *B. napus* level of 60%. Early maturing, high yielding Australian canola quality *B. juncea* lines have been crossed with higher oleic acid sources from Canada. While the initial juncea canola cultivars are likely to have similar yields to early *B. napus* cultivars, production costs are expected to be significantly less. Further yield improvements are anticipated with additional breeding. The initial juncea canola cultivars will be conventional, with TT and Clearfield® cultivars expected in 3-4 years. The original aim of the juncea canola breeding program was to have commercial release of juncea canola varieties for 2006. Unfortunately, seed production problems have delayed this for one more season. It is now likely that there will be enough seed for small scale commercial production in 2007. Treat juncea canola as a lower cost of production canola due to direct heading etc. rather than a wonder crop for low rainfall areas.

In addition to juncea canola we are also attempting to select mustard lines that can be released as an oil source for biodiesel. Selections have been taken at Minnipa and Lameroo over the last two years and some show promise.

Canola

We are attempting to select canola lines that are better adapted to low rainfall conditions in SA. Single plants have been selected from our trials at Lameroo in the southern Mallee since 1998, and also at Minnipa since 2002, and lines with the highest oil content are yield tested at Lameroo and Minnipa. The aim is to test elite lines from these sites in trials throughout Australia and to release cultivars of conventional and TT canola with high yield and increased oil content. Increased yields have been achieved in both triazine tolerant and conventional canola lines (*Table 4*) and oil content has also been increased (*data not shown*).

Acknowledgements

Funding support from SAGIT for break crops development on Upper EP is gratefully acknowledged. Thanks to all Minnipa staff who assisted with these trials.

Searching for answers

Location
Closest town: Poochera
Cooperator: Bill, Paul and Shaun Carey

Rainfall
Av. Annual total: 328 mm
Av. GSR: 258 mm
2005 total: 339 mm
2005 GSR: 276 mm

Yield
Potential: 2.2 t/ha
Actual best: 1.5 t/ha

Paddock History
2004: Barley
2003: Pasture

Soil
Grey sandy loam

Plot size
10 m x 1.5 m

Brassicas for biodiesel: Mustards again struggle relative to canola

Research

Nigel Wilhelm
SARDI, Minnipa Ag Centre

Key Messages

- **Mustards have again struggled to outperform canola but with current canola prices, canola would be very acceptable to biodiesel producers.**
- **Seeding rates for canola or mustard can be very low under upper EP conditions.**

Why do the trial?

Biodiesel is a generic name for fuels obtained by esterification of any vegetable oil or animal fat. The end product is a fuel with very similar properties to pure diesel, but with much better emissions performance and is renewable. Biodiesel can be made from crop-sourced oils and there is the potential for a new market for oilseeds in SA in the future now that a biodiesel plant has been built in Port Adelaide.

The 2005 trial is part of our third year of trials investigating the potential of mustard and canola for biodiesel production in SA. We believed, at the start, that mustard represented the best potential match of farmers' requirements for a reliable and profitable crop and the biodiesel industry for a cheap source of vegetable oil (canola was too expensive at the time !). Mustard for biodiesel production is a particular opportunity for low rainfall farming districts because -

- (Relatively) high yielding lines exist which produce oil of a quality which has little other use than as a source for biodiesel (and hence is cheap for the industry to purchase).
- Mustard performs well in low rainfall environments where farmers have few options for other break crops.
- Large areas of low rainfall cropping land may be suitable for mustard production, especially with further development of the crop.

How was it done?

Three conventional mustard lines were compared to two canola-quality mustard lines and three currently recommended canola varieties for Upper Eyre Peninsula. Several different agronomic treatments were also imposed on one mustard line to assess their impacts on yield (these are described in the table of results). A late seeding and half-seeding rate treatment for mustard and canola was also included to assess their impact on yield. The trial was seeded at Chandada on 27 June with the late seeding plots sown eleven days later on 8 July. The basal fertiliser treatment was 60 kg/ha of 17:19 Zn2.5 applied with the seed (@ 3 kg/ha).

Measurements - grain and oil yield (oil analyses not yet completed).

Table 1: Performance of mustard and canola lines with different agronomic treatments at Chandada in 2005.

Crop Type	Treatment	Grain Yield (kg/ha)
Mustard JP028	Standard	1.54
JN056	Standard	1.01
Canola quality (juncea) JR042	Standard	1.45
Canola quality (juncea) JR050	Standard	1.01
Wild turnip	Standard	0.69
Canola 44C73	Standard	1.40
Rivette	Standard	1.40
Stubby	Standard	1.04
Stubby	Half seeding rate[a]	1.03
Stubby	Late seeding[b]	0.91
Mustard JQ10	Standard	1.20
JQ10	Fluid fertiliser[c]	1.20
JQ10	Jockey® seed dressing[d]	1.13
JQ10	Half seeding rate[a]	1.21
JQ10	Late seeding[b]	1.19
	LSD (P=0.05)	0.07

a *Treated in the same way as STANDARD except seeded at 1.5 kg/ha.*
b *Treated in the same way as STANDARD except seeded 11 days later.*
c *Treated in the same way as STANDARD except fluid fertiliser was used at seeding instead of granular at the same nutrient rates.*
d *Treated in the same way as STANDARD except a Jockey® seed dressing was used.*

What happened?

All plots established well except for the wild turnips, which again suffered from high levels of hard seededness.

Comparing the different mustard lines to the three canola varieties, all at standard agronomy, the best mustard produced 1.54 t grain/ha, outyielding the best canola by only 10% (*Table 1*). Given that mustards still tend to have lower oil extractions than canola, we are expecting that this small yield advantage will barely offset the lower oil extraction to result in similar oil yield to canola (our grain quality assessments will check this).

As has been experienced with many crops this year, the excellent spring protected crops from what would normally be classed as a late start. In this trial, even delaying seeding for a further eleven days had little impact on grain yield. As was also found in 2004, mustard exhibited better tolerance in this respect than canola because its yield was maintained with the delayed seeding but Stubby canola lost nearly 10%.

Halving the seeding rate of mustard had no impact on yield compared to the standard of 3 kg/ha. The other agronomic options tried in this trial had no impact on yield under the conditions experienced last year.

Wild turnip was included in the trial because it is such a vigorous weed and is an oilseed. However, for the second time running, we have failed to produce a decent germination of the weed. Usual story - you can't get rid of it in your paddocks, but we can't get more than a whimper out of it when we want it to grow !

What does this mean?

Similar to the results from trials of this type in 2003 and 2004, as well as a whole range of trials undertaken by others in 2005 across upper EP, canola performance was either not far behind, or bettered, the mustards in low rainfall districts. This appears to be occurring because the performance of current canola varieties in low rainfall areas is so much better than it was ten years ago. The good performance of canola leaves little margin for mustard to outperform canola in returns to the farmer (given that the biodiesel industry is unlikely to pay canola prices for its feedstocks). However, we have every reason to believe that the same gains realised with canola over the last 10 years could also be realised with mustard in the future, which would put mustard back into first place with a comfortable margin. Another future scenario is that canola prices remain modest, fuel prices remain high and new canola releases (eg hybrids and GMs) continue to improve productivity in low rainfall districts. Under these circumstances there may be no need for mustards because canola could be grown and be available for selling into either the biofuels market or any other market which returns similar prices.

Reducing the seeding rate of canola or mustard has been tested frequently in this trial programme and has usually shown that there has been little or no loss in yield. Given that canola and mustard seed is expensive (and is likely to become even more so with the advent of hybrid lines, and perhaps GMs in the future), reducing seeding rates may be an important strategy for reducing input costs (and hence some of the risk) for these break crops in low rainfall districts. This may not be a strategy you will want to try as a first time grower but after you have gained some confidence with establishing the crop, it may be a very attractive option. Mustards continue to be more tolerant to late starts or delayed seeding compared to canola so they do have an advantage in this respect.

The best yields in this trial of 1.4-1.5 t/ha reinforce the findings from 2004 that reasonable returns from a canola or mustard break crop may now be possible under a typical run of seasons on upper EP (given that a break even result may still be enough for a break crop to justify its spot in a cropping rotation).

Acknowledgements

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Leigh Davis, Willie Shoobridge and Mandy Cook at Minnipa Ag Centre for running the trials

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Break Crops

Searching for answers

Location
Minnipa Agricultural Centre, Paddock-North 5 North

Rainfall
Av. Annual total: 326mm
Av. GSR: 241mm
2005 total: 334mm
2005 GSR: 267mm

Yield
Potential: 2.36 t/ha
Actual: 0.71 t/ha

Paddock History
2004: Wyalkatchem wheat
2003: Medic pasture
2002: Kukri wheat

Soil
Loam pH 9.0 over clay loam pH 9.0

Plot size
2 ha blocks of each line, unreplicated

Other factors
Late break (late sown)

Mustard and canola yields across the Eyre Peninsula

Research

Jim Egan[1], Brendan Frischke[2], Brian Purdie[1] and Ashley Flint[1]
SARDI, Port Lincoln[1]; SARDI, Minnipa Agricultural Centre[2]

Key Messages

- **Late sown canola and juncea canola plots achieved around average yields across the Eyre Peninsula in 2005, thanks to an extended spring growing season with mild temperatures and late rains.**
- **Juncea canola lines failed to match the yield of canola varieties at 4 of the 5 sites where they were sown for comparison. On average juncea canola yields were 10% lower than canola.**
- **Financial comparison of the two crops at Minnipa showed a $25/ha better return from a canola variety (44C73) than from the juncea canola line (JR046), on the basis of higher yield and oil content.**

Why do the trial?

Mustard (*Brassica juncea*) lines with canola quality oil, termed juncea canola, have been developed by the Victorian Department of Primary Industries. Advantages claimed for mustard over canola (*Brassica napus*) include lower costs of production, mainly through the ability to direct head rather than windrow, better seedling vigour and greater yield stability over a range of seasonal conditions. Previous trials have indicated that mustard tends to outyield canola when yields are below 1 to 1.5 t/ha. With the first commercial varieties of juncea canola expected to be available in the next two years, growers were very interested in seeing how juncea canola measures up against canola varieties in a range of environments across the Eyre Peninsula.

How was it done?

Comparisons of juncea canola lines with canola varieties were made at five sites across the Eyre Peninsula in 2005, in large unreplicated demonstration blocks at two sites (Minnipa Agricultural Centre and Kimba) and in small replicated plots adjacent to canola National Variety Trials (NVT) at three (Lock, Mt Hope and Yeelanna). In the large blocks, a single juncea canola line (JR046) was compared with a canola variety suited to the locality, while in the small plot trials two lines (JR046 and JR049) were tested against a suitable canola variety. At a sixth site (Rudall), the two mustard lines were compared without a canola check. The small plots were the standard crop evaluation dimensions of 10 m long by 1.5 m (8 rows) wide, replicated three times.

While neither of the two juncea canola lines tested in these trials will be released as commercial varieties, due to lines with better oil quality now in advanced stages of the breeding and evaluation program, they are representative of the yields and oil content likely to be achieved with the first varieties.

General details of the comparison sites are given in *Table 1*. All trials were direct headed, although a desiccation spray was applied to the small plot trials to ensure that all lines and varieties at these sites could be harvested at the same time. Grain samples were retained from all sites for oil analysis, but only the Minnipa results are available at present.

Specific management details for the 2 ha demonstration blocks of 44C73 canola and JR046 juncea canola on MAC are:

- Sown on June 16 with knife points and press wheels, both lines at 5 kg/ha with 60 kg/ha DAP (18:20).
- Spray treatments:
- June 16 (IBS) - Sprayseed® @ 1L/ha + Triluralin @ 0.8 L/ha
- June 25 (pre-crop emergence) - Sprayseed® @ 1.2 L/ha + Oxen® @ 75 mL/ha (to control dense germination of marshmallow)
- July 2 - Lorsban® @ 0.75 L/ha + Fastac Duo® @ 100 mL/ha @ 50 L/ha
- July 27 - Targa® @ 375 mL/ha + 0.5% Hasten® + 0.1% Chemwet 1000® @ 50 L/ha
- September 26 - Fastac Duo® @ 200 mL/ha @ 50 L/ha.

What happened?

Yield results for all sites are shown in *Table 1*. With the very late break to the season across the Eyre Peninsula, most sites were not sown until the second half of June. The farmer-sown demonstration at Kimba was the earliest into the ground, on June 3 after some local thunderstorm rain. Despite such a late break, yields held up reasonably well, saved by the abnormally mild temperatures and late rains of spring giving extended growing conditions. No shattering was observed in either canola or juncea canola plots at any of the sites, despite harvest being delayed at several of these. Significant mustard weed contamination was present in the juncea canola plots at Rudall.

Canola outyielded the juncea canola line/s at four of the five sites where these were compared. Only at Lock did both JR046 and JR049 give marginally higher yields than Kimberley canola, although these differences were not statistically significant. The overall average yield advantage of canola over the juncea canola lines was 10%, and ranged from 1% below to 24% higher than the yield of JR046. The two juncea canola lines showed very similar yields on average. There was no evidence that the juncea canola performed comparatively better than canola at the lower yielding sites.

Table 1: Yield of Juncea canola lines compared with canola varieties at Eyre Peninsula sites in 2005.

Variety/Line	Minnipa	Kimba	Rudall	Lock	Mt Hope	Yeelanna
Canola variety	44C73	ATR Stubby	None	Kimberley	Kimberley	Spectrum
Canola yield	0.71	0.79	-	1.73	2.11	2.50
JR046 mustard	0.64	0.73	1.53	1.75	1.97	2.01
JR049 mustard	-	-	1.40	1.83	1.80	2.19
Date sown	June 16	June 3	June 12	June 15	June 28	June 17
Apr-Oct rain (mm)	267	226	250	293	396	342
Comparison type	2 ha blocks	1 acre blocks	Replicated small plots	Replicated small plots	Replicated small plots	Replicated small plots

The grain analysis results from the Minnipa demonstration blocks show higher oil content in the canola (40.1% compared with 38.3% in JR046) and lower protein (18.5% versus 21.8%).

What does this mean?

Economic comparison of canola and juncea canola based on the Minnipa results of 10% higher yield and 1.8 percentage points higher oil content for the 44C73 canola, and comparable costs of production (both were direct headed with minimal shattering losses), indicates a $25/ha better gross return from the canola. The very kind grain filling conditions late into spring may have favoured the canola over juncea canola, although both would have made a financial loss had spring conditions been even slightly less gentle.

Other trial results on page 49 confirm the superior yields from canola varieties over juncea canola in the 2005 season. As stated by Potter *et al.* in their article on page 42, the initial juncea canola lines are likely to have similar yields to early canola varieties, but yields should improve with further breeding. The role and fit of juncea canola and other mustard types (e.g. biodiesel oil quality types) into Upper EP farming systems will emerge with further evaluation over the next few years.

A final comment (or maybe an early warning sounding?) comes from Neil Cordon, Extension Agronomist at Minnipa: "During the year we noticed lesions on the mustard (up to full ground cover) which was not as evident on canola. It was identified as the bacterium *Pseudomonas syringae* and pathologists have suggested that it doesn't cause significant yield loss with plants tending to grow away from the problem. Time and experience will tell if they are correct, especially if the mustard industry develops and the disease pressure increases."

Acknowledgements

Funding support from SAGIT for break crops development on Upper EP is gratefully acknowledged. Our thanks to Wayne Burton and the Victorian Department of Primary Industries for supplying seed of juncea canola lines for small plot and large block comparisons. Trevor Cliff kindly took on the task of sowing and caring for the demonstration blocks on his farm at Kimba.

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Using granular and fluid fertilisers with canola at Streaky Bay

Research

Leigh Davis[1] and Jim Egan[2]

SARDI, Minnipa Agricultural Centre[1]; SARDI, Port Lincoln[2]

Key Messages

- **Ag-Outback, the best of the canola varieties tested at Streaky Bay, yielded 0.81 t/ha although sown in late June.**
- **The Juncea canola line JR046 yielded lower this season at Streaky Bay (0.60 t/ha).**
- **Varieties ranked similarly with both granular and fluid fertilisers.**
- **Fluid fertilisers did not produce higher yields than granular fertiliser, but input costs were much higher.**

Why do the trial?

The performance of canola and Juncea canola (mustard) in low rainfall environments has improved considerably over the past five years, allowing canola to be grown in low rainfall areas with highly calcareous soils. Coastal land may be a good option for canola because of the cooler ripening conditions from sea breezes. The aim of this trial was to test if canola and Juncea canola can be successfully grown on the highly calcareous low rainfall coastal country at Streaky Bay and to compare the performance between fluid and granular fertilisers.

How was it done?

A selection of four canola varieties (Ag-Outback, Rivette, Clearfield®44C73 and ATR-Stubby) and one Juncea canola (mustard) line (JR046) were sown on the 24th June. Nutrients were applied either in the granular or fluid form consisted of 36 kg N/ha, 9kg P/ha and 6 kg S/ha placed beneath the seed. Other chemicals applied to the trial through the year are listed in *Table 1*.

The triazine tolerant variety, ATR-Stubby and Clearfield®44C73 did not receive their specific herbicide treatments and were treated as conventional canola. This may have reduced their yield because of weed competition.

What happened?

Considering the late start to the season and delayed sowing, the trial yielded very well to average 0.68 t/ha. Growth was very slow early in the season and poor yields looked certain. Good late rains in September dramatically increased plant growth (and yield) and showed that canola can respond well to rain after being stressed. During the growing season the canola also had competition from soursob and Lincoln weed.

There were marked yield differences between varieties, although the best three canola lines were quite similar (*Table 2*). Ag-Outback was the highest yielding variety across the fertiliser types, averaging 0.81 t/ha. Clearfield®44C73 and Rivette produced similar yields. ATR-Stubby yielded very poorly at this site, due to the yield penalty of the incorporated triazine tolerance gene and also weed competition. The Juncea canola line, JR046 was well down on the best canola yield, averaging 0.60 t/ha across fertiliser types. This may be due to the earlier flowering time of this line, therefore it was unable to take advantage of the late rains. Trials this year, page 49, also showed Lontrel® can damage and reduce the yield of mustard.

The ranking of varieties was very similar for both granular and fluid fertilisers. There were no significant yield differences between the granular and fluid fertiliser types this year, although the yield with fluid fertiliser was slightly higher than granular.

Searching for answers

Location
Streaky Bay- Ken Williams
Streaky Bay Ag Bureau

Rainfall
Av. Annual: 298mm
Av. GSR: 243mm
2005 Total: 289mm
2005 GSR: 259mm

Yield
Potential: 2.24 t/ha

Paddock History
2004: Spray Topped
2003: Grassy Pasture
2002: Barley

Soil Type
Highly calcareous grey loamy sand

Plot size
1.5m x 10m x 3 replicates

Other factors
Late break to season, moisture stress, soursob and Lincoln weed competition.

Table 1: Chemicals applied to canola trial at Streaky Bay in 2005

Application	Product Name & Rate	Date
Knockdown	Powermax®@1L/ha, Striker®@75ml/ha & TriflurX®@1.2L/ha	24 June
Insecticide	Lorsban®@1L/ha	26 June
Grass/Medic	Select®@300ml/ha + Lontrel®@150ml/ha	11 August
Insecticide	Decis Options®@500ml/ha	15 September
Dessication	Gramoxone®@1.2L/ha	14 November

Table 2: Yield of canola varieties with granular and fluid fertilisers, Streaky Bay, 2005.

Variety	Granular fertiliser Yield (t/ha)	Fluid fertiliser Yield (t/ha)	Mean Yield (t/ha) of fertiliser types
Ag-Outback (Conventional Canola)	0.74 a	0.87 a	0.81 a
44C73 (Clearfield)	0.75 a	0.82 a	0.78 a
Rivette (Conventional Canola)	0.73 a	0.75 ab	0.74 a
JR046 (Juncea Canola)	0.52 b	0.68 b	0.60 b
ATR-Stubby (TT Canola)	0.44 b	0.50 c	0.47 c
Mean of all varieties	0.64	0.72	0.68
LSD (p<0.05)	0.13	0.13	0.09

What does this mean?

The costs of using the two fertiliser systems are very different, with fluids costing $189/ha and granular $53/ha to deliver the same level of nutrients. However cheaper fluid fertiliser options are available to supply the same nutrients with expected responses on this soil type as Dr Bob Holloway's work has shown.

While the yield of canola in this environment is encouraging, especially in view of the very late sowing, it is still well short of the French and Schultz potential of 2.24 t/ha. The better yields of the canola varieties than the Juncea canola line JR046 this season, throw into question the potential value and role of mustards in low rainfall environments such as Upper EP. Other research results suggest that mustards can match or better canola only when yields are below about 1-1.5 t/ha. The mustard line JR046 will not be released as a Juncea canola variety due to its high allyl glucosinolate levels, but other lines with more acceptable quality are currently in seed increase and are expected to be released in 2007. In the meantime, and until Juncea canola lines can demonstrate their advantages in low rainfall environments, canola can be a viable option for these districts, with well-recognised benefits as a cleaning break crop.

Acknowledgements

Thanks to Ken, Dion and Kym Williams for the use of their land and input they provided. Also thanks to Willie Shoobridge and Wade Shepperd for help managing the trial.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Break Crops

Lontrel® on mustard

Trent Potter[1], Jim Egan[2], Willie Shoobridge[3] Leigh Davis[3] and Amanda Cook[3]

SARDI, Struan[1], Port Lincoln[2] and Minnipa Agriculture Centre[3]

Research

Searching for answers

Location
Minnipa Agricultural Centre, Paddock-North 5 North

Rainfall
Av. Annual total: 326mm
Av. GSR: 241mm
2005l total: 334mm
2005 GSR: 267mm

Yield
Potential: 2.36 t/ha
Actual: 0.86 t/ha

Paddock History
2004: Wyalkatchem wheat
2003: Medic pasture
2002: Kukri wheat

Soil
Loam pH 9.0 over clay loam pH 9.0

Plot size
1.5 m (8 rows) x 10 m, replicated 3-4 times

Other factors
Late break (late sown)

Key Messages

- **Lontrel® was shown to reduce grain yield in mustard at Minnipa in 2005.**
- **Early application had less effect on mustard than later application.**
- **The best time for weed control was the worst time for damage to mustard.**

Why do the trial?

With both mustard for biodiesel and juncea canola (food quality mustard) likely to be commercialised in the next two years it is important the range of agricultural chemicals, that are currently used on canola, are shown to be relevant for mustard. Most chemicals appear to be equally as safe for mustard as for canola but questions exist for Lontrel®. In 2004, Lontrel® was applied to mustard trials at Minnipa and some twisting of stems was observed and it was thought that yield had been reduced. Therefore, it was decided to undertake a trial in 2005 to determine the effect of differing rates and timing of application of Lontrel® on mustard.

How was it done?

Mustard (JR046) was sown on June 27th. Rates of Lontrel® chosen were 100 ml/ha (Low), 150 ml/ha (Recommended) and 300 ml/ha (High) with times of application being, 10% plants at 2 true leaves, all plants at 2 true leaves, all plants at 3-4 true leaves and all plants at 4-5 true leaves. Early spray application occurred on 27th July, mid application occurred on 2nd August, late application occurred on 5th August and very late application occurred on 16th August.

What happened?

There seemed to be few visual symptoms of damage on mustard under any rates or timings of application of Lontrel®. However, low rates of application of Lontrel® produced grain yields significantly lower than the untreated control, but there was no significant effect of application timing.

As application rate increased, there was a decrease in grain yield and also there was an effect of application timing. It appears that very early application or very late application may be safer for Lontrel® on mustard. However, the best application time for weed control would be at the 2-4 leaf stage when the majority of weeds were at the best time for control. At this stage the mustard suffered more damage from Lontrel®.

What does this mean?

This trial needs to be undertaken again in 2006 but it certainly suggests that Lontrel® may not be a safe herbicide to use on mustard. Oil content is being measured to determine if chemical application rate or timing also had any effect on grain quality.

Table 1: Effect of time of application and rate of Lontrel® on mustard at Minnipa in 2005.

Treatment (rate and time)	Yield (t/ha)	% of site mean
300 ml/ha, early (less than 10% at 2 true leaf stage)	0.66	95
300 ml/ha, mid (all mustard at 2 true leaf stage)	0.48	70
300 ml/ha, late (mustard at 3-4 true leaf stage)	0.61	88
300 ml/ha, V late (mustard at 4-5 true leaf stage)	0.59	85
150 ml/ha, early	0.71	103
150 ml/ha, mid	0.64	93
150 ml/ha, late	0.63	91
150 ml/ha, V late	0.73	106
100 ml/ha, early	0.78	113
100 ml/ha, mid	0.75	109
100 ml/ha, late	0.73	106
100 ml/ha, V late	0.78	113
Control (no spray)	0.86	125
Site mean	0.69	
CV %	6.20	
LSD p=(0.05)	0.064	

Acknowledgements

Funding support from SAGIT for break crops development on Upper EP is gratefully acknowledged. Our thanks to Wayne Burton and the Victorian Department of Primary Industries for supplying seed of JR046 juncea canola for the trial. Thanks to all Minnipa staff who assisted with this trial.

Section 3

Section editor: Neil Cordon

SARDI, Minnipa Agricultural Centre

Pastures

Angel survives summer SU residues

Research

Craig Bell[1], Jake Howie[1], Ben Ward[2], Ron Sly[3]

SARDI Pastures, Waite Campus[1], Minnipa Agricultural Centre[2], Mallee Research Station, DPI, Walpeup[3]

Key Messages

- **Angel shows excellent tolerance to summer SU herbicide application.**
- **After using SU herbicides for summer weed control Angel can be grown with minimal effect on pasture productivity.**

Why do the trial?

To test the tolerance of the new strand medic, Angel, to sulfonylurea (SU) herbicide residues from a summer weed application.

Our work has focused on Angel's tolerance to SU herbicide residues from the previous year (eg. 10-12 month break). Farmers asked the question, "How will Angel tolerate SU residues from a summer application?" (Eg. 3-6 months) as they noticed significant damage in their regenerating legume pastures following a summer applied SU herbicide.

How was it done?

Two low rainfall, alkaline soil sites were selected: Wirrulla and Walpeup in the Victorian mallee. Herbicide treatments of metsulfuron-methyl and triasulfuron were applied at 3.5 and 7 g/ha and 9 and 18 g/ha respectively to simulate a summer sulfonylurea herbicide application (i.e. 50 & 100% typical summer application rates). Herbicide treatments were applied in January and February to allow for an approximate period of 3-4 months until the normal break of the season. Angel and Herald were then sown dry at Wirrulla on the 2nd June and Walpeup on the 24th May in the soil residues. To measure the herbicide effect on the medic we have taken emergence counts, visual scores and dry matter cuts to determine the production difference.

What happened?

Plant establishment for both cultivars was good at both sites (Wirrulla 252 plants/m^2, Walpeup 416 plants/m^2). Following the emergence counts we took visual scores, comparing all herbicide treatments to the 'nil' treatments and then took dry matter cuts to confirm the score data. The figures below show the visual scores and dry matter cuts from Wirrulla and visual scores from Walpeup that demonstrate the good tolerance of Angel to the SU residues.

Although the break to the season did not occur until mid June, the very dry soil conditions in the interim would have contributed to the persistence of SU residues in the soil. Results from Wirrulla (scored 24th August and dry matter sampled 21st September) show the robust tolerance of Angel to SU residues compared to that of Herald. Angel's production was unaffected in the 100% treatment whereas Herald was

Best practice

Location
Wirrulla – Craig Rule
Nunjikompita Ag Bureau

Rainfall
2005 Total - 299mm
2005 GSR -241mm
Av Annual - 300mm
Av GSR - 208mm

Soil Type
Alkaline sandy loam

Location
Walpeup- Ron Sly

Rainfall
2005 Total - 338 mm
2005 GSR -219 mm
Av Annual - 342 mm
Av GSR - 224 mm

Soil Type
Alkaline red sandy loam

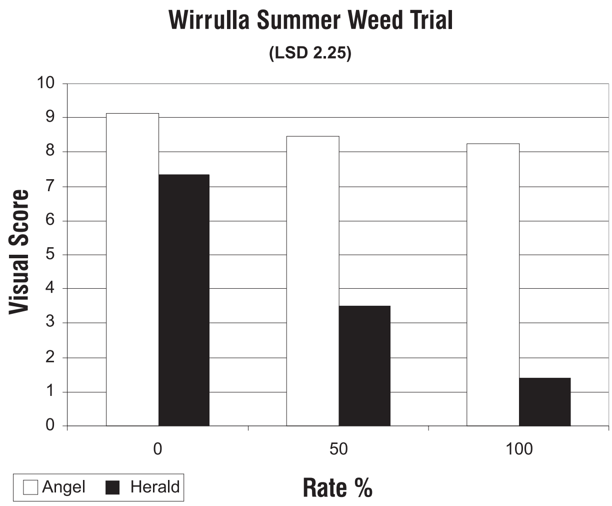

Figure 1: Effect of SU herbicide applied at 0, 50 & 100% rate upon Angel and Herald dry matter production at Wirrulla (visual score 0-10).

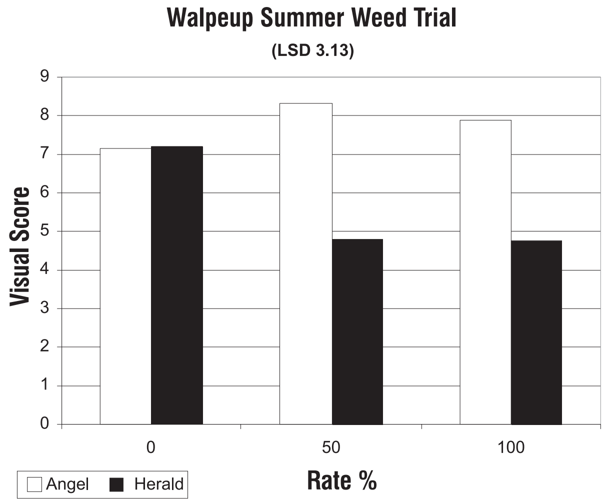

Figure 2: Effect of SU herbicide applied at 0, 50 & 100% rate upon Angel and Herald dry matter production at Walpeup (visual score 0-10).

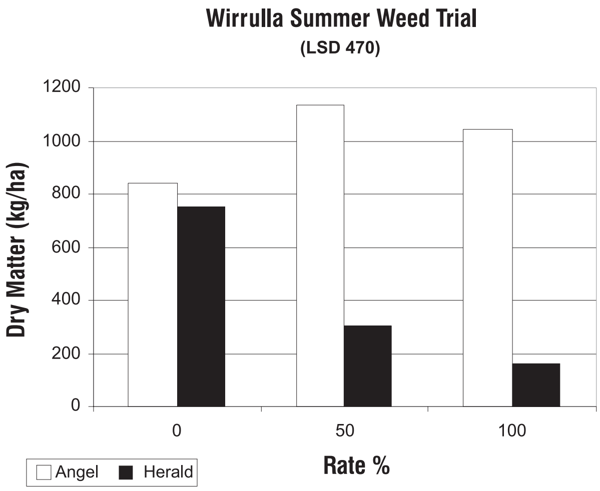

Figure 3: Effect of SU herbicide applied at 0, 50 and 100% rate upon Angel and Herald dry matter production at Wirrulla (kg/ha).

reduced by >80% (*Figures 1 and 3*). The results from Walpeup (scored 29th August) showed a similar trend with Angel unaffected but a significant reduction in Herald's production. Like Wirrulla, the results show the excellent tolerance of Angel to the short-term SU residues. Although not significant, there was a trend in both the Wirrulla and Walpeup dry matter data suggesting improved Angel performance in the treated plots that may be a result of some weed suppression.

What does this mean?

These findings are significant for dryland farming where summer weeds are an issue for example Lincoln weed, in the coastal districts of Eyre Peninsula and Caltrop and Skeleton weed, in the Murray Mallee. These weeds are usually controlled with a summer application of metsulfuron or triasulfuron before being left to pasture, however SU residues can have a devastating effect on the growth of susceptible legumes as demonstrated by the Wirrulla data. The research shows that Angel has good tolerance to SU residues applied during summer compared to intolerant cultivars and farmers can be confident that by growing Angel medic either as regenerating pasture or sowing for the first time that pasture productivity will be maintained.

Acknowledgements:

Thanks to Craig Rule for the use of his land.

The funding of this work by GRDC is gratefully acknowledged.

Grains Research & Development Corporation

SARDI
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Location
Mallee Research Station

Rainfall
Av. Annual: 342 mm
Av. GSR: 224 mm
2005 Total: 338 mm
2005 GSR: 219 mm

Soil Type
Alkaline reddish brown sandy loam

Controlling Angel strand medic in-crop Part II

Craig Bell[1], Jake Howie[1] and Ron Sly[2]

SARDI Pastures Group, Waite[1], Mallee Research Station, DPI Walpeup[2]

Key Messages

- **Angel can be controlled in cereal and pulse crops by a range of commonly used herbicide mixtures.**
- **Angel is not controlled well by triasulfuron.**
- **Farmers now have a viable pasture legume that can increase productivity in the presence of SU residues.**

Why do the trial?

The aim of this trial was to demonstrate that the tolerance of Angel to sulfonylurea (SU) residues doesn't extend to other chemical groups. Angel is a new strand medic with excellent tolerance to SU residues however this tolerance has raised concerns about chemical resistance and the ability to control Angel in a cropping system. This article outlines the results of a range of herbicide mixtures that can be successfully used to control Angel in cereals and pulse crops. Previous articles (*EPFS 2002, pg 52, EPFS 2003, pg 45 and EPFS 2004, pg 61 (Part I)*) showed the tolerance levels of Angel compared to its parent Herald, and the use of herbicides to control Angel in a cereal.

How was it done?

In 2004, herbicide control trials were established to test the effectiveness of a range of herbicides on Angel (cf. Herald). The treatments and results from the trial can be found in *EFPS 2004 Summary, pg 61*. In summary, the most effective control at both sites was achieved by 2,4-D, MCPA and dicamba with both cultivars controlled by over 70%. To broaden the range of control options for Angel and also provide potential control options for a variety of broadleaf

Table 1: Herbicide treatments for Angel control trial in wheat at Walpeup, 2005.

Treatment Number	Chemical Name	Trade Name	Application Rate	Application Date
0	Nil		-	-
1	2,4-D amine (250g/l) + Dicamba (100g/kg)	Banvel D®	400 g/ha	2nd August
2	Carfentrazone-ethyl (400g/kg) + MCPA (500g/kg)	Affinity/MCPA®	50 g/ha + 500ml/ha	2nd August
3	Dicamba (80g/kg) + MCPA (340g/kg)	Banvel M®	1 L/ha	2nd August
4	Bromoxynil (140g/kg)+Dicamba (40g/kg)+MCPA (280g/kg)	Broadside®	1.5 L/ha	2nd August
5	Bromoxynil (200g/kg) + MCPA (200g/kg)	Bronco MA®	1.4 L/ha	2nd August
6	Diuron (900g/kg) + MCPA (500 g/kg)	Diuron/MCPA®	280g/ha + 350 ml/ha	2nd August
7	Triasulfuron (750g/kg)	Logran®	20 g/ha	2nd June
8	Triasulfuron (750g/kg)	Logran®	20 g/ha	2nd August

Table 2: Herbicide treatments for Angel control trial in field peas at Walpeup, 2005.

Treatment Number	Chemical Name	Trade Name	Application Rate	Application Date
0	Nil		-	-
1	Metribuzin (750 g/kg)	Lexone DF®	280 g/ha	2nd August
2	Cyanazine (500 g/L)	Bladex®	3 L/ha	2nd August

weeds that may occur in crop, a similar trial using herbicide mixtures was set up in 2005 at Walpeup, Victoria. The trial was sown on the 20th May at 10kg/ha in a split plot into wheat. Pre-emergent herbicide treatments (triasulfuron) were applied on the 20th June and the post-emergent treatments on the 2nd August. Plant establishment counts, visual scores (28th August) and dry matter production (7th October) samples were taken to determine what affect the herbicides had on the cultivars. The treatments used in the trial are listed in *Table 1* below and all herbicides were applied at their recommended rates.

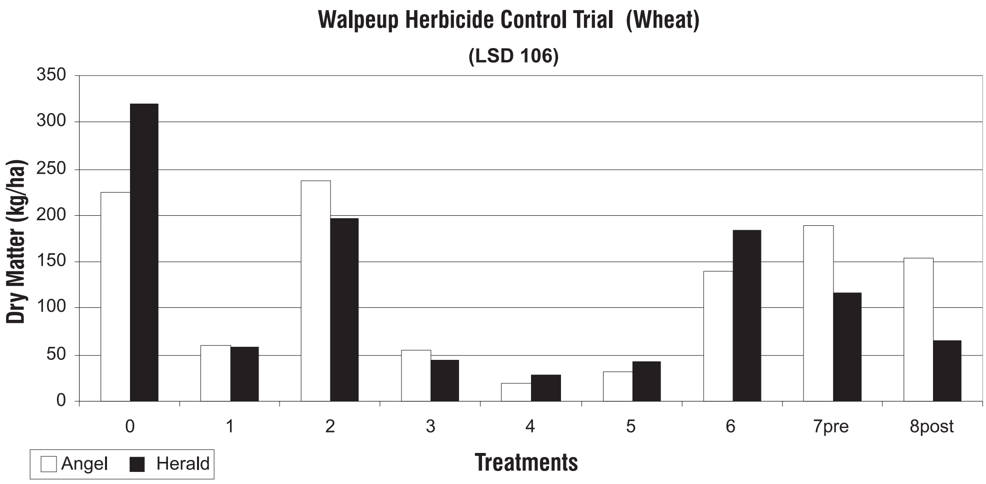

Figure 1: Effect of herbicide application upon dry matter production (kg/ha) of Angel and Herald in wheat at Walpeup, 2005 (LSD=106, P=0.05). For chemical treatments applied (0-8) refer to Table 1.

In addition to assessing control options for Angel in cereal, a trial was established to determine control options for Angel in field peas with post-emergent treatments applied on the 2nd August when peas were at the fifth node stage. Plant establishment counts, visual scores (28th August) and dry matter production (7th October) samples were taken to determine what affect the herbicides had on the cultivars. The treatments used in the trial are listed in *Table 2* and all herbicides were applied at their recommended rates.

What happened?

The 2005 results complement the 2004 experimental results where Angel was controlled in a crop with commonly used herbicides. However, this experiment provides a list of commonly used herbicide mixtures with the ability to control Angel and a range of broadleaf weeds and options to control Angel in pulse crops.

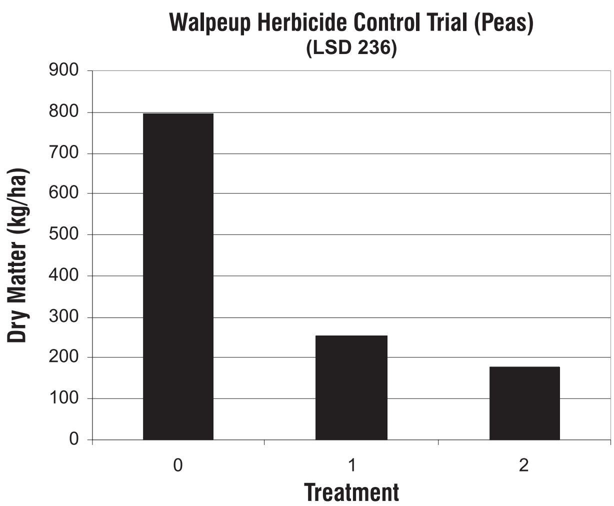

Figure 2: Effect of herbicide application upon dry matter production (kg/ha) of Angel and Herald in field peas at Walpeup, 2005 (LSD=236, P=0.05). For chemical treatments applied (0-2) refer to Table 2.

Plant Establishment: Both Angel and Herald emerged relatively evenly in good numbers at Walpeup with an average of 377 plants/m^2.

Visual Score: The visual score results from both the cereal and pulse crop trials returned similar results to the dry matter production sampling. Due to this similarity, only the dry matter data has been included in this article.

Dry Matter: The herbicide mixture options (*Figure 1*) mostly provided good control of Angel and Herald in crop with the most effective herbicides achieving control from 73% - 92% control compared to the nil plots. The pre-emergent and post-emergent SU treatments (triasulfuron) achieved control of Herald (63-80%), but were less effective on Angel (16-32%). The carfentrazone/MCPA (2) and diuron/MCPA (6) treatments didn't achieve adequate control of either Herald or Angel which was unexpected and may have been due to the age of the herbicides used in the experiment.

The herbicide control options (*Figure 2*) for medics in pulses are limited but options 1 and 2 were effective in controlling both cultivars (68% -78% respectively) compared to the nil plots.

What does this mean?

The results from the trial show that Angel and Herald can both be controlled effectively in-crop by a range of commonly used herbicide mixtures, to an acceptable level (>75%). These herbicide mixtures provide farmers with the additional benefit of controlling a wider range of broadleaf weeds (including medic) common in cereal crops, an option not always available with single herbicides. The results however do show that Angel is not well controlled by triasulfuron. If farmers wish to control Angel in crop (post-em) with sulfonylurea's they would be advised to use alternative SU herbicides such as chlorsulfuron (Glean®), metsulfuron-methyl (Ally®), iodosulfuron-methyl-sodium (Hussar®) and sulfosulfuron (Monza®).

What now?

The Minnipa and Netherton 2004 trials provided information on commonly used broadleaf herbicide options to control Angel in a cereal crop. The Walpeup 2005 trial results confirmed the ability to control Angel in a cereal crop with mixtures of these herbicides and also provided information on control options for Angel in pulse crops. These results will now be used to develop an agronomic package for Angel to provide farmers with the best possible advice on how to best control Angel in the cropping phase.

Acknowledgements

The funding of this work by GRDC is gratefully acknowledged.

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Best practice

Location
Minnipa Agricultural Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2005 Total: 327 mm
2005 GSR: 267 mm

Soil
Sandy Loam

Medics and Root Lesion Nematode

Barbara Morgan[1], Ross Ballard[1] and Ben Ward[2].

SARDI, Pasture Pathology[1], SARDI, Minnipa Agricultural Centre[2]

Key Messages

- **A comprehensive data set is now available that shows medics generally limit the multiplication of root lesion nematode (Pratylenchus neglectus). Having said this, there are some subtle differences between the different varieties, with Caliph consistently delivering the best level of nematode control.**
- **Medics are likely to incur root damage and yield loss where nematodes are present. Larger than expected losses in herbage production of about 30% were measured at 30 nematodes/gram of soil. Even at lower nematode numbers significant production losses occurred. Efforts to develop tolerant varieties to prevent these losses are well underway.**
- **Medics can be considered to have reasonable resistance but poor tolerance to root lesion nematode.**

Why was it done?

In last years article (*EPFS 2004 Summary, page 80*), we reported on *Pratylenchus neglectus* multiplication in pasture trials that had been set-up on heavier soil types at Two Wells (Mid North) and Maitland (Yorke Peninsula). Whilst nematode multiplication was low under medic, the question remained as to whether similar outcomes were likely on the lighter soils such as occur on Eyre Peninsula. The Eyre Peninsula trials were also designed to enable the calculation of yield loss against nematode number.

How was it done?

Two pasture trials were sown at Minnipa Agricultural Centre and Smoky Bay in 2004. Previously (in 2003) we had attempted to produce a spectrum of nematode levels at each site using resistant and susceptible cereals.

At the Minnipa field site nine medics (five commercial cultivars and four breeding lines selected for tolerance) along with susceptible Machete wheat and resistant Tahara triticale were sown in 2004.

At Smoky Bay, we decided to have a more intensive look at the cultivars Toreador and Herald, so we included eight entries of each, along with susceptible Machete wheat and resistant Tahara triticale.

The number of root lesion nematodes was determined in the

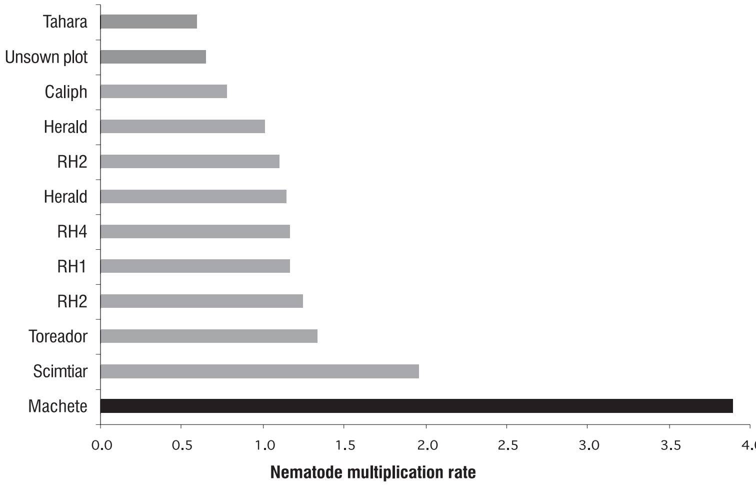

Figure 1: Multiplication rate of Pratylenchus neglectus under various annual medics and cereals at Minnipa Agricultural Centre. The RH lines are medic breeding lines that have been selected for reduced root damage by the nematode.

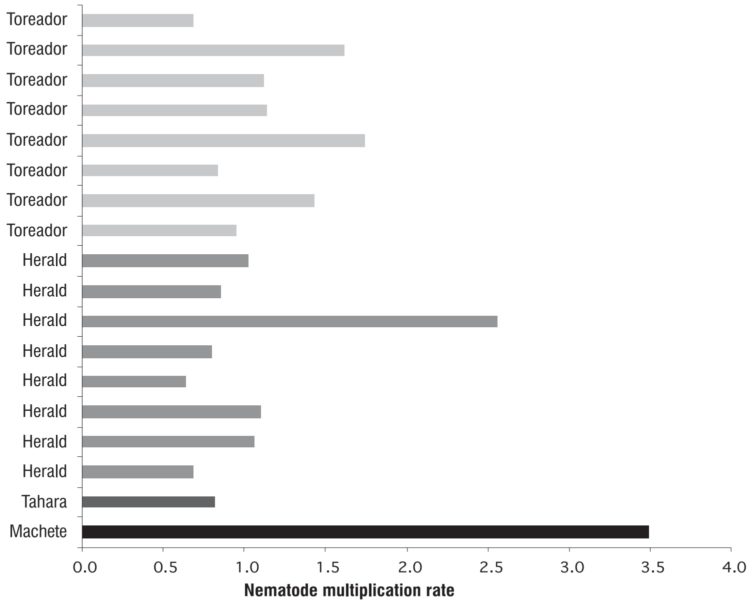

Figure 2: Multiplication rate of Pratylenchus neglectus under multiple entries of Toreador and Herald medic: Machete wheat and Tahara triticale at Smoky Bay.

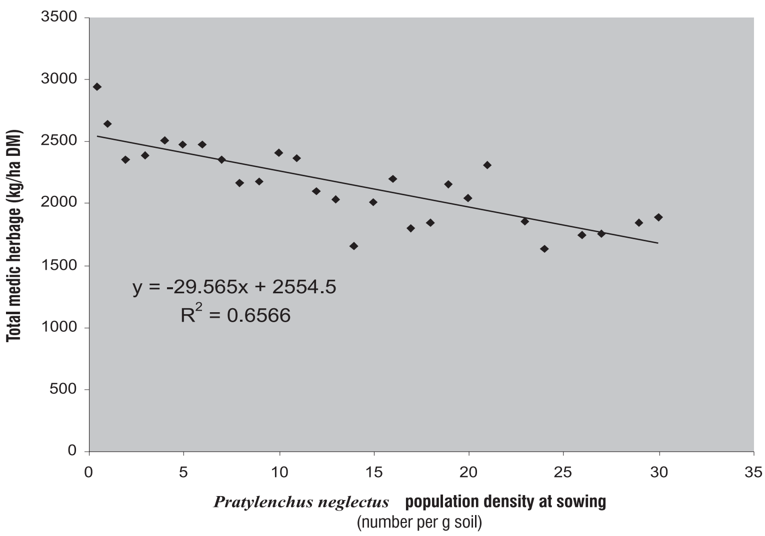

Figure 3: Effect of Pratylenchus neglectus density in the soil at sowing on the herbage yield of annual medics (kg/ha DM). Data points are the mean of all medic genotypes from Minnipa and Smoky Bay for each level of Pratylenchus.

soil under each cultivar of medic and cereal, prior to sowing and again in the autumn of 2005. All soil samples were analysed by SARDI's Root Disease Testing Service. The root lesion nematode multiplication rate was calculated by dividing final nematode numbers measured in 2005 by the initial nematode number measured before sowing in 2004. Two pasture cuts were taken from each plot in spring to provide an estimate of total dry matter production.

What happened?

Results from the Minnipa and Smoky Bay field sites highlighted again that the medics generally limit the multiplication of *P. neglectus* in the soil (*Figures 1 and 2*).

Machete wheat (susceptible) resulted in relatively high rates of nematode multiplication of 3.9 at Minnipa and 3.5 at Smoky Bay.

Tahara triticale (resistant) resulted in relatively low rates of nematode multiplication of 0.6 at Minnipa and 0.8 at Smoky Bay.

The nine medic entries at Minnipa resulted in a comparatively low mean nematode multiplication rate of 1.2, but ranged from 0.8 for Caliph to 2.0 for Scimitar. Similarly, at Smoky Bay, the eight Herald entries resulted in a low mean multiplication of 1.1, but we point out that this is likely to be a slight over-estimate due the higher multiplication by one Herald entry that we believe is an errant result. Toreador at Smoky Bay resulted in a mean multiplication of 1.1.

The 2004/05 findings are consistent with our previous findings in two regards. First, they confirm that generally medics limit nematode multiplication. Second, they similarly rank the medic varieties, with Caliph consistently resulting in very low nematode multiplication.

The two trials have also provided some excellent information on the impact of *Pratylenchus neglectus* on medic yield (*Figure 3*). Across the two sites there was a clear relationship between the level of nematodes at sowing and herbage yield. At 30 nematodes/gram of soil yield losses were substantial at about 30%. It should also be noted that the losses appear linear, so that even a 10 nematodes/gram of soil, significant but subtle losses are still likely to occur.

What does this mean?

These studies reinforce our initial findings that annual medics will generally limit nematode multiplication in the farming system, with some subtle differences between cultivars emerging. Caliph has resulted in some of the lowest nematode multiplication. Their ability to limit nematode multiplication has now been demonstrated across a range of soil types.

Unfortunately nematodes are still able to damage medic root systems. While we have been able to demonstrate this vividly in the greenhouse, these trials are the first to quantify the extent of losses that can occur in the field. The losses are larger than we expected, but will increase our efforts to develop tolerant varieties. This aspect of our work has been underway for some years, with some very promising material likely to be available for detailed field evaluation in 2007. In the meantime, growers seeking to maximise N inputs by growing medic would be best targeting paddocks with low nematode numbers to ensure optimum medic production.

Acknowledgements

The authors would like to gratefully acknowledge the support of the GRDC, SAGIT and SARDI for their financial inputs and the staff of Minnipa Agricultural Centre for their ongoing technical support.

Thanks to the Blumson family for the use of their land at Smoky Bay.

GRDC Grains Research & Development Corporation

SAGIT

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Best practice

Location
Murdinga
Leigh and Jenny Gosling, Murdinga/Lock Farmers Group

Rainfall
Av. Annual: 368 mm
Av. GSR: 280 mm
2004 Total: 303 mm
2004 GSR: 204 mm
2005 Total: 376 mm
2005 GSR: 315 mm

Paddock History
2003: Wheat
2002: Pasture
2001: Barley

Soil Type
Light grey non-wetting siliceous sand

Plot size
200m x 1.6m

Date Sown
16th June 2004

Fertiliser
Goldphos® (0:17:0:17) @ 50kg/ha at sowing

AWI pasture demonstration

Jake Howie[1], Ben Ward[2]

SARDI Pastures Group, Waite Campus[1], Minnipa Agricultural Centre[2]

Key Messages

- **Annual medics are the proven pasture legumes for neutral to alkaline soils.**
- **A mixture of Toreador and Herald for predominantly lighter soils (and Caliph for heavier soils) will cover a wide range of seasonal conditions and soil types.**
- **Broadstrike® was effective in controlling broad-leaved weeds and contributed to a doubling in background medic seed reserves.**

Why do the trial?

To demonstrate and evaluate the performance of a diverse range of pasture legumes species and cultivars in the medium rainfall zone of EP.

Australian Wool Innovation (AWI) recognises the wide choice of pasture cultivars available to farmers but are concerned that the uptake of new varieties is being hampered by a lack of large scale demonstrations (cf. breeders plots) and a resulting lack of awareness of their various merits. This site (and another on a red brown earth in Jamestown) was established to demonstrate a diverse range of pasture species and cultivars in large plots over a transition of soil type and thus to better appreciate the general differences in adaptation between different species.

How was it done?

A sloping site was chosen to provide a transition of soil texture and depth from swale to sandy rise. In the swale the soil profile was: 0-20 cm sand, pH (kit) 6-6.5; 20-40 cm sandy clay, pH 9.5 over a limestone layer. On the sandy rise the profile was: 0-60 cm sand, pH 6.5-8; 60-80+ cm sandy clay loam, pH 9-9.5. It was hoped that the reasonably neutral surface pH would enable the majority of species a reasonable chance to express their potential.

Strips (200m long) of 29 pasture legumes (*Table 1*) were sown along this transition in mid-June 2004, representing five genera and 15 species. The soil was damp with pockets of non-wetting soil.

In the 2004 establishment phase, the main points noted were 'percentage ground cover' and general competitiveness against the background population of naturally regenerating medic (mostly Harbinger). Broadstrike® (25 g/ha) was applied (mainly to suppress capeweed) and Targa® (300 ml/ha) was applied to control grasses (mainly ryegrass and barley grass).

In 2005 the regeneration (plants/m^2) resulting from the 2004 seed-set was assessed and pod reserves for selected cultivars were estimated from vacuum harvests. The background pod reserves were also assessed, both inside the trial area ('plus' Broadstrike®) and in the regenerating grazed pasture outside ('minus' Broadstrike®). There was a high background contaminant of medic across the whole site, which was also measured when assessing the competitiveness of the few remaining competitive cultivars. The site was grazed after August prior to full flower and seed-set.

What happened?

By October of 2004 there had been a quick sorting out of the least adapted species with the background medic out-competing all of the clovers (*Trifolium* spp.) and the serradellas in dry matter production, resulting in no or very little apparent seed-set. Biserrula established well enough to set some seed but in general the only species to make an impact were the Medicago spp. with lucerne establishing successfully and all of the annual medics.

In the 2005 regeneration phase, plant establishment was measured in July (*Table 1*) with only Biserrula and *Medicago* spp. troubling the scorers, confirming the inability of the *Trifolium* spp. to compete with the background medic. The annual medics all regenerated in reasonable numbers with

Table 1: Pasture legume entries sown at Lock, sowing rate (SR) and regeneration in 2005 on sand and swale.

Variety	Genus	Species	SR (kg/ha)	2005 (plants/m^2)	
				sand	swale
Casbah	Biserrula	pelecinus	10	43	85
Mauro	Biserrula	pelecinus	10	35	25
Aokau	Hedysarum	coronarium	10	0	0
SARDI 7	Medicago	sativa	5	15	33
SARDI 10	Medicago	sativa	5	33	58
Toreador	Medicago	tornata	10	150	340
Herald	Medicago	littoralis	10	188	288
Caliph	Medicago	truncatula	10	140	325
Mogul	Medicago	truncatula	10	78	365
Jester	Medicago	truncatula	10	115	230
Paraggio	Medicago	truncatula	10	118	318
Scimitar	Medicago	polymorpha	10	193	363
Cavalier	Medicago	polymorpha	10	115	308
Santiago	Medicago	polymorpha	10	155	310
Background	Medicago spp.	litt/trunc etc	-	255	355
Prima	Trifolium	glanduliferum	7	-	-
Frontier	Trifolium	michelianum	7	-	-
Prolific	Trifolium	resupinatum	7	-	-
Cefalu	Trifolium	vesiculosum	7	-	-
SARDI Rose	Trifolium	hirtum	10	-	-
Hykon	Trifolium	hirtum	10	-	-
Caprera	Trifolium	incarnatum	10	-	-
Urana	Trifolium	subterranean	10	-	-
Dalkeith	Trifolium	subterranean	10	-	-
York	Trifolium	subterranean	10	-	-
Rosedale	Trifolium	subterranean	10	-	-
Antas	Trifolium	subterranean	10	-	-
Cadiz	Ornithopus	sativus	10	-	-
Erica	Ornithopus	sativus	5	-	-
Marguerita	Ornithopus	sativus	5	-	-

a distinct trend for the swale to have about double the plant numbers of the sandy rise. However by late August when there was good dry matter production, most of this was background medic. This had swamped most of the medic strips, with the notable exceptions of Herald and Toreador (and to a lesser extent Caliph), which maintained good cover right to the top of the rise. Pod reserve measurements confirmed the amount of background medic and the relative ability of Herald and Toreador to compete (*Table 2*). The performance of the medics in general (including background) supports the findings from previous work on the Eyre Peninsula summarised by Neil Cordon (*EPFS 2004 Summary, page 59*) that medics are the most reliable pasture legume option for the low-to-medium rainfall, neutral-to-alkaline soils.

The good performance of Herald in competing with a dominant background was notable, however the real star was Toreador, which in two years had grown to >40% of the total medic population. Toreador was specifically selected for use on lighter soil types and should be grown much more widely but poor seed supply has restricted its adoption up till now.

Table 2: Actual (pure) and percentage (%) of total (incl. background medic contaminant) pod reserves (kg/ha) for Toreador and Herald cf. average background pod reserves, sampled in 2005 from sand and swale areas.

	Pod Reserves (kg/ha)			
	Sand		Swale	
	actual	total	actual	total
Toreador	585 (41%)	1426	814 (42%)	1940
Herald	475 (29%)	1638	486 (18%)	2670
Av. background (+ herbicide)	-	1803	-	2531
Av. background (- herbicide)	-	1035	-	1122

Although not directly comparable (because of grazing and rotation differences) it was also noteworthy that the background medic within the trial site (which had the benefit of an additional broadleaf weed control in 2005) had a greatly reduced capeweed burden and finished the season with 75-125% more pod reserves than the background medic in the surrounding pasture (*Table 2*). In assessing the value of this, the cost of the herbicide needs to be weighed against future potential pasture productivity gains.

What does this mean?

The results confirm earlier work that annual medics remain the best adapted pasture legumes for most of the EP low-to-medium rainfall, neutral-to-alkaline soils. They also confirm the inability of clovers (*Trifolium* spp.) biserrula and serradellas to compete with weeds and medics on these soil types.

Toreador was the standout performer and as I've said often before, should be much more widely grown and would be an excellent companion in a mixture with the reliable Herald across much of the dune/swale topography and lighter EP soil types.

NB. *For the heavier soils, also throw in a barrel medic such as Caliph, Parabinga, Mogul, Paraggio or Jester depending on average rainfall and hardseededness requirements.* Hopefully Toreador seed supply will be much improved this year.

Weed control of existing pasture stands may be more cost effective than sowing new varieties especially if the soil seed reserves are already reasonable (say > 800 kg/ha pod or > 200 kg/ha seed). The ability of new cultivars sown at 5-10 kg/ha to successfully compete with a pre-existing background of over 200 kg/ha is limited to only the very best adapted cultivars.

Acknowledgements

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Goldphos® - registered product of Hifert.

Broadstrike® - registered product of Dow Agro Sciences

Targa® - registered product of DuPont

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

australian wool innovation limited

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Section editor: Emma McInerney

SARDI, Minnipa Agricultural Centre

Livestock

Try this yourself now

Sheep nutrition

Information

Brian Ashton

Rural Solutions SA, Pt Lincoln

Key messages

- **Nutrition of stock is similar to nutrition of crops.**
- **Supplement with the most limiting nutrient first.**
- **Molafos® is an energy supplement with minerals and urea.**
- **Redgut can occur on pure medic pastures.**
- **Straw is useful if fed with high energy grain.**

At the EP Farming Systems meetings last year a number of issues were raised on nutrition of sheep. Nutrition is a complex subject and people have lots of different ideas about it. Unfortunately there is also a lot of confusion.

The principals of nutrition of stock are the same as nutrition of your crops.

- You need to know the needs of the crop, or sheep, you are feeding.
- You need to know what is limiting the crop, or sheep, from achieving the target you have set.

For example; your crops need nitrogen, phosphorus and a range of minerals to achieve the potential. It's no good supplying extra nitrogen if phosphorus, or some other mineral, is the limiting factor.

Sheep require energy, protein, fibre, minerals and vitamins.

Energy

Energy is supplied by all feeds. Grains are high in energy while straw is the other extreme - very low. Energy is most often the limiting nutrient. Aim to feed the cheapest source of energy first and then look at the other nutrients.

Protein

Adult sheep, that are not growing, only need about 8% protein. This means that protein is not normally the limiting nutrient when just aiming to maintain condition.

On the other hand, sheep that are growing need protein to grow muscle, blood and tissue. The faster they are required to grow, and the higher the energy level, the more protein is needed. Younger sheep also require more protein.

If you are aiming to grow lambs quickly, a high energy and high protein ration is needed. Protein can be increased by adding a grain legume, medic hay, a pre-mix or urea. Urea is not a protein but sheep can create protein from it (provided they have enough energy).

Fibre

As discussed in the "Lot feeding sheep" article, *EPFS 2005 Summary, page 64*, sheep need some fibre (roughage) for proper function of the rumen.

Fibre can also be deficient in lush pure legume pasture. Lambs will crave roughage and will even put their heads through the fence to get some grass. If you see this happening the lambs are at risk of the disease "Redgut". It is called this because if you open the lamb up the gut is red with blood due to twisting of the intestines. I believe a lot of lambs on EP suffer from "sub-clinical" Redgut (i.e. we don't see deaths but the lambs don't do well).

Always feed lambs well on cereal hay before they go into these pastures. Also feed hay while they are in there or run them in another grassy or weedy paddock once every three or four days. As an added precaution inject the lambs with vitamin A, D and E every six to eight weeks. This may help because ammonia toxicity is also implicated in the disease.

Farmers on EP have lost up to thirty five prime lambs due to Redgut but there could be much more loss due to "sub-clinical" Redgut. We would like to do research on this issue so contact us if your lambs are not doing well on a pure medic pasture.

Minerals and vitamins

When feeding high rates of cereal grains, for over a month, the sheep will become deficient in calcium and sodium. Add 1.5% stocklime and 0.5% salt (unless the water is salty) to the grain.

The trace elements likely to be deficient on EP are copper *(see article EPFS Summary 2005, page 108, Copper in the Farming System)* and cobalt. With finishing rations it is recommended to add 0.1% mineral mix just to cover these and other minerals. Many people add selenium, which is only a problem in areas with acid soils and high rainfall. The vast majority of EP has ample selenium.

Some people add minerals to the water, which is cheap and easy to do. If a mineral, eg copper, is deficient this can have a big benefit but you need to know what the response is from. I would prefer to see people treat for what they know is deficient.

Molafos®

This is a commercial product that is molasses with urea and minerals added. The main use of this supplement is to supply energy. However, it is expensive per unit of energy compared to cereal grain - which is readily available on EP.

Molafos® has a place where other sources of energy, or minerals, are not practical. It may also increase the utilisation of other poor quality feed.

Straw

Straw is produced in abundance on cereal farms and there have been many trials trying to improve it's value. The quality of straw varies but is better in dryer areas and in dryer years. Unfortunately, even with good straw stock can't eat enough to meet their energy requirement.

If straw is fed with grain it is a very useful feed. The grain provides the energy that straw lacks, while the straw provides the fibre that the grain lacks.

Adding urea to straw will increase the protein level. However, protein will not be the limiting nutrient. The energy requirement must be met before there will be any benefit from the urea.

Lupins

Lupins are high in energy, high in protein and low in starch (so they don't cause grain poisoning). They are just about the ideal supplement.

Even if you don't grow lupins yourself, they could be valuable to your sheep. Weaners fed as little as 1 kg of lupins a week over summer, assuming there is dry feed available, will do really well. For as little as $5/head the weaners could get through the summer in much better condition. Lupins can be fed once a week and broadcast in the thickest area of stubble, once the sheep are used to them. If you are in doubt, do a trial. Split a mob and feed half. This would be a good Bureau trial if a number of members did it.

Magic nutrient solutions

It is common for farmers to be tempted by products that claim to be a magic solution to nutritional problems in stock. Most of these products sound too good to be true and usually are. The simple facts are that energy is usually the limiting nutrient. There is no cheap and easy source of energy or we would already be using it.

Comparing feeds

When you are comparing alternative feeds first work out the cost of each feed per unit of energy. If barley costs $140/t, the cost for each kilogram is 14 cents. From published tables we know that on average each kilogram (fresh weight) of barley contains 11.3 MJ of energy. Therefore, each MJ of energy costs 1.2 cents (14c per kg divide by 11.3 MJ per kg).

For the energy value of other grains and pastures see page 40 of "Feeding and managing sheep in dry times". For a copy contact the Roseworthy Information Centre on 1800 356 446, or your local PIRSA Office.

First always compare feeds on a "cost per unit of energy" basis because some feeds cost four times other feeds on this basis. Cost per tonne can be very misleading.

Next work out if you will need to add anything to the feed to meet the needs of the sheep (protein, fibre or minerals).

Then look at practical issues such as handling, weed seeds, management (eg. the risk of grain poisoning) and wasteage.

RURAL SOLUTIONS SA

Cereal grazing on EP

Research

Emma McInerney

SARDI, Minnipa Agricultural Centre

Key Messages

- **Edillilie crops show huge potential to recover from grazing and value add to cereals.**
- **Edillilie crops responded to late N application with higher DM production and grain yield.**
- **Barley was the highest producer of DM at Minnipa.**
- **Two other G&G regions conducted cereal grazing trials - see the "Sharing Info" section of this book.**

Why do the trial?

Oats have typically been the cereal of choice for undersowing legume based pastures or to graze as a standing crop, as its a relatively cheap option. The question is, can we utilise wheat or barley to increase production during this phase?

The EP G&G trial was designed to compare different cereal varieties for dry matter production (DM/ha), recovery from grazing and the impact of grazing on grain yields. Basic gross incomes (GI) on all varieties indicate whether the cost of loss of production (grain) is compensated by the value of grazing.

The practice has benefits to the whole system including:

- Potential to fill the Autumn feed gap.
- Allow medic and slow growing pastures time to get away before putting stock in.
- Provide an opportunity to value add to crops if commonly grown cereals have the ability to recover from grazing.
- Risk management - back up option if pasture feed runs out.
- To maintain weed control of continuously cropped paddocks and also maintain or increase the proportion of cropping land.

How was it done?

Trial sites: Minnipa Agricultural Centre and Edillilie.

Seeding: Direct drilled, 22 cm (MAC) and 26 cm spacings (Edillilie), 24th June.

Seeding rates: MAC - traditional wheat varieties sown at 48 kg/ha, winter wheat at 64 kg/ha, barley at 77 kg/ha and oats at 67 kg/ha. Edillilie - traditional wheats sown at 52 kg/ha, winter wheats at 69 and 58 kg/ha, barley at 82 kg/ha and oats at 72 kg/ha.

Fertiliser (applied at seeding): 60 kg/ha of 18:20:00 at MAC, 75 kg/ha of 18:20:00 plus 40 kg/ha urea at Edillilie.

One Wyalkatchem treatment (+N) received a late urea application of 40 kg/ha at MAC and 76 kg/ha at Edillilie to assess production responses to extra nitrogen.

The varieties trialled are commonly used and adapted to both districts except Wedgetail and Whistler winter wheats, which are high rainfall dual purpose varieties.

One half of the trial plots were "grazed" by mower at late tillering - early jointing on 10th September, to approximately 5-6 cm height. DM cuts were also done at this time.

Harvest: 10th December.

What happened?

In the interest of providing crops with the best chance of establishment, the trials weren't sown until after the very late opening rains, which meant they were not capable of filling the early feed gap. Its recommended that cereal grazing crops go in as early as possible to let medic or other slow growing pastures get away, and to give the cereals the best chance of recovery. At both MAC and Edillilie, Barque, Keel and Wallaroo produced the most feed *(Tables 1 & 2)*. Grazing should occur when the crop reaches approximately 800-1000 kg DM/ha. The trials were cut to 5-6 cm height, not below the "white" or growing point, which would disadvantage recovery.

Its difficult to draw conclusions on the practice of grazing cereals at Minnipa *(Table 1)*, except the certainty of risk! Barley performed the best at MAC for DM and grain yield. The cut Barque stands out for producing the most DM and recovering to produce the third highest overall grain yield. Wallaroo was the only variety that could comfortably be risked for grazing and return better income than if grown only for seed. The +N treatment did improve DM and yield but the additional cost of fertiliser put the total gross income (GI) behind Wyalkatchem with one N application. It must be noted that plot yields at MAC were well below what the paddock achieved, partially attributed to pre-emergent herbicide damage.

Like MAC, grain yields at Edillilie were all sacrificed at the expense of "grazing", yet the majority of varieties recovered enough to still produce a higher total income than the "ungrazed" *(Table 2)*. The cut Wyalkatchem +N stands out with the highest GI total and recovered from grazing to yield very closely to uncut Yitpi and Wallaroo. The late finish advantaged all yields particularly Wedgetail, which wouldn't be expected to perform so well in a shorter growing season.

What does this mean?

Cereal grazing at Edillilie appears to have the potential for not only providing a feed source, but also throwing a few extra dollars in the pocket. Paddock scale trials using livestock to remove the pasture instead of a mower would

Searching for answers

Location
Minnipa Agricultural Centre

Rainfall
2005 Total: 327 mm
2005 GSR: 267 mm
Ave Total: 325 mm
Ave GSR: 242 mm

Yield
Potential: (W) 3.1 t/ha
(B) 3.5 t/ha
Actual: (W) 1.64 t/ha

Paddock History
2002: Barque barley
2003: Pasture
2004: Yitpi wheat
Soil Type: Sandy loam

Location
Edillilie - S. Nelligan

Rainfall
2005 Total: 547 mm
2005 GSR: 459 mm
Ave Total: 460 mm
Ave GSR: 370 mm

Yield
Potential: (W) 7.0 t/ha
(B) 7.4 t/ha

Paddock History
2002: Wheat
2003: Barley
2002: Canola

Soil Type:
Loam

give us more insight into management of these crops. In lower rainfall zones, more trials are needed to assess how to best to use cereal crops as a tool to maximise feed availability and match demand with supply.

Considerations: value placed on feed is open to interpretation. The assumption has to be made that the feed is really required and will serve a purpose such as carrying more stock, finishing stock or filling a feed gap. The 2005 harvest saw lower than average grain prices, which could distort the GI's, but also makes it an appealing option considering the good returns of sheep.

Further trials are needed to address fertiliser timings and rates at Edillilie given the obvious crop response. Other variables that need assessment include seeding time and rate, grazing time(s) and intensity.

Acknowledgements

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The trial work at Edillilie would not have been possible without the co-operation of Shane Nelligan. Technical support from Terry Blacker, Port Lincoln and Ben Ward, Minnipa Agricultural Centre is also gratefully acknowledged.

*Table 1. Crop production and gross income for cereal grazing trial, Minnipa, 2005**

Variety	Mgt	Grain Yield (t/ha)	DM prodn (kg/ha)	Gross income Grain ($/ha)	Gross income DM ($/ha)	Gross Income Total ($/ha)
Barque	cut	1.22 e	1424 c	150	117	267
	uncut	1.81 f		225	0	225
Keel	cut	0.94 c	1260 b	114	103	217
	uncut	1.94 g		243	0	243
Wallaroo	cut	0.79 b	1110 b	74	91	165
	uncut	1.12 e		106	0	106
Wedgetail	cut	0.76 b	574 a	126	47	173
	uncut	0.94 c		157	0	157
Wyalkatchem	cut	0.57 a	551 a	95	45	141
	uncut	0.99 d		169	0	169
Wyalk + N	cut	0.51 a	697 a	64	57	121
	uncut	1.10 d		165	0	165
Yitpi	cut	0.75 b	554 a	141	45	187
	uncut	0.99 d		186	0	186
LSD (P< 0.05)		0.15	244			

*Table 2. Crop production and gross income for cereal grazing trial, Edillilie, 2005**

Variety	Mgt	Grain Yield (t/ha)	DM prodn (kg/ha)	Gross income Grain ($/ha)	Gross income DM ($/ha)	Gross Income Total ($/ha)
Barque	cut	2.97 a	2697 b	371	221	592
	uncut	4.66 e		582	0	582
Keel	cut	2.98 a	2808 b	372	230	602
	uncut	4.60 e		575	0	575
Wallaroo	cut	2.59 a	2500 b	244	205	449
	uncut	3.33 b		313	0	313
Wedgetail	cut	3.87 d	1670 a	577	137	714
	uncut	4.44 e		656	0	656
Whistler	cut	3.80 c	1671 a	514	137	651
	uncut	4.58 e		593	0	593
Wyalkatchem	cut	3.03 b	1860 a	478	153	631
	uncut	4.51 e		690	0	690
Wyal + N	cut	4.11 d	2390 b	631	196	827
	uncut	5.18 f		778	0	778
Yitpi	cut	4.05 d	1664 a	600	136	737
	uncut	4.28 d		637	0	637
LSD (P< 0.05)		0.43	300			

*

- ***Treatments followed by same letters are not statistically different from each other.***
- ***'cut' means plot was both "grazed" and harvested, 'uncut' plot was harvested only.***
- ***Grain GI is yield x base price (with quality adjustments), $5 premium for Yitpi, freight and levies deducted, sourced AWB Jan 06. The GI for +N treatment less the cost of additional urea. Production costs were not included in any GIs.***
- ***GI's for DM based on widely accepted $30 sheep GM per DSE per year and assumption that 1 DSE consumes approximately 1 kg green feed per day. The alternative is to evaluate cost of either leaving a paddock out for pasture or buying in fodder.***
- ***DM reflects amount of Food On Offer (FOO) - never completely utilised by stock as wastage always occurs.***

Try this yourself now

Italian ryegrass - A high input & productive pasture option

Greg Secomb and Daniel Schuppan

Rural Solutions SA, Port Lincoln

Extension

Livestock

Key Messages

- **Italian ryegrass *(Lolium multiflorum)* is a productive pasture system on the LEP.**
- **It is a high input system and requires careful management to fully utilise the feed produced.**
- **The boundaries of what was considered suitable for growing Italian ryegrass are being pushed.**
- **If you're not grazing it - you're wasting it!**

Why try Italian ryegrass?

During season 2005 it was estimated that there was in excess of 500 hectares of Italian ryegrass (mostly cultivar Tetila) planted on the Lower Eyre Peninsula. Much of the interest evolved out of a small two-hectare paddock grown at Edillilie in 2004 where some really quite amazing production figures were achieved.

This prompted more than forty farmers in the region to try it in 2005 to see if they could reproduce the results on their own farm. As can be seen from the article, Comparison of LEP Grazing Systems, page 65, the Italian ryegrass pastures using Tetila cv. have performed extremely well again.

Italian ryegrass isn't new - in fact its been around for many years and used extensively in the dairy industry. What is new is that we are beginning to push it's agronomic boundaries, and growing it out of what has been considered the traditional growing areas. If you read most of the marketing and technical material, the recommended rainfall zones for this ryegrass is 550 mm and above.

What we need to remember is that this is an annual ryegrass. Therefore, its main growing period is during winter - the same time we get our rainfall on the Eyre Peninsula. We may not get the same production off this species as they do in the high rainfall districts, but it has been shown that it certainly outperforms most of the annual pasture systems currently grown on the EP, even in a lesser rainfall environment. What we don't know is how far we can push this stuff out of its “high rainfall comfort zone”. One paddock was grown successfully north of Ungarra in 2005 with about 350 mm of rainfall. We do have to keep in mind that we did have a very kind spring! We are not in a position to be able to recommend Italian ryegrasses across the EP - all the experience has come from farmers that have been willing to give it a go - and so far the results have been encouraging.

How do you grow Italian ryegrass?

Nutrition

There is more to growing Italian ryegrass successfully than getting the right rainfall. Considering it's pedigree in the dairy industry it is adapted to a high nutrition location. It needs high fertiliser inputs to reach it's capability.

A guide for growing it on the EP would be to apply about 80 kg/ha of DAP at seeding. Additional nitrogen should be applied as 100 kg/ha of urea pre-drilled, or at very early post emergence. Then, after grazing apply additional urea at about 50 kg/ha.

Seeding Rates

The general recommendation for Italian ryegrass is to be sown at 25 kg/ha. This should probably be reduced in lower rainfall districts (i.e. $<$ 400mm), but not below 15 kg/ha.

If planning to mix in an annual legume (eg. Frontier Balansa) then the ryegrass component of the blend should be around the 15-18 kg/ha mark. Too higher rates of ryegrass will choke out the clover due to its slower growth rate compared to the ryegrass.

With late start to the season in 2005 many people dry sowed their Tetila Italian ryegrass pastures. From all accounts the results from doing this were extremely good - provided there is good seed to soil contact (eg. sown using press wheels).

Italian ryegrass should be sown deep enough to ensure it is covered by 5-10 mm soil - in practise this may mean setting your combine to up to 50 mm depth (dry sowing) or 30 mm depth if soil is moist. Italian ryegrass seedlings are vigorous and will germinate through 50 mm soil, so you cannot sow it too deep!

Grazing

Grazing management is the key to maximising the high amount of feed being produced by this pasture system. Italian ryegrasses are very high quality feed. Tetila ryegrass is even higher quality feed as it is a 'tetraploid', meaning that it contains double the number of chromosomes. This trait means that it has more water-soluble carbohydrates making it more palatable and more digestible for livestock. In fact during 2005, we had reports of livestock trying to get through fences trying to get back in to paddocks because of their preference for this feed!

Grazing can commence in early winter once the plant has reached the three-leaf stage - as long as the roots securely anchor the plant so that stock cannot pull it out. During winter the pasture should be maintained at around 3-4 cm (~ 1200 kg DM/ha) and in spring 5-6 cm (~ 1500 - 1800 kg DM/ha). Ryegrass, in common with all other grasses (including perennial grasses), will only support three leaves per tiller. If it reaches the stage of growing the fourth leaf, the first leaf will die off to support the new leaf growth and if the fifth leaf emerges, then the second leaf will die off to support the new growth etc. This means that if you allow Italian ryegrass to mature beyond three leaves per tiller you are wasting feed. It should also be noted the Tetila ryegrass has prolific tillering ability with more than 20 to 50 tillers per plant not uncommon, provided adequate nitrogen fertiliser has been applied at or near to seeding.

Stocking rates are dependent on plant growth, and can vary from 10-20 DSE per ha in winter and up to 40-50 DSE per ha in spring. Stocking pressure should be increased during stem elongation to prevent flowering and seed set.

Ideally Italian ryegrass should be rotationally grazed to allow the plants to achieve maximum growth. It is far better to have several smaller paddocks than to have one larger paddock. Electric fencing has been used successfully to sub-divide paddocks into smaller units to improve grazing management.

Figure 1: Gross Margins of Tetila Italian ryegrass pasture against an unimproved annual pasture.

Tetila Italian Ryegrass Pasture Gross Margin 2005			
Expenses			
	Kg/ha	**$/kg**	**$/Ha**
Ryegrass Seed	25	1.65	$41.25
DAP	80	0.44	$35.20
Urea 1	100	.415	$41.50
Urea 2	50	.415	$20.75
Total Extra Expenses/Ha			**$138.70**
Income			
*12 DSE @ **$29.00		**Total Income/Ha**	**$348.00**
Gross Margin/Ha			**$209.30**

Unimproved Pasture Gross Margin 2005		
Income		
4 DSE @ $29.00		**$116.00**
Gross Margin/Ha		**$116.00**

***The DSE figure is an average figure obtained from the Grazing Systems survey data.**

**** $29.00 Gross Margin/DSE is obtained from the 2005 Farm Budget guide.**

What can happen?

Gross margin examples in *Table 1* give a comparison of a Tetila Italian ryegrass pasture against an unimproved annual pasture

What does this mean?

Firstly you will realise that Italian ryegrass is an expensive pasture system to grow - comparative to many of the cropping enterprises. These figures are the extra 'above and beyond' what you would be spending on your pasture system, but these expenses are accounted for in the $29/DSE gross margin.

The important thing to note is the higher stocking rate. The driver of profit for this system is to be able to utilise all the feed that you grow. It is no good growing this pasture if you do not have the livestock to be able to utilise the extra feed that you will be growing.

The experience of growing Italian ryegrass on the lower EP has been really exciting. This type of pasture is creating some real opportunities for mixed farming enterprises. Farmers have recognised that with Italian ryegrass in their system they can maintain stock numbers on a reduced area, allowing for more paddocks to be available for cropping. This pasture opportunity can be a real and practical measure to increase whole farm profitability.

Grain & Graze Profit through knowledge

RURAL SOLUTIONS SA

Best practice

Lot feeding sheep

Information

Brian Ashton

Rural Solutions SA, Pt Lincoln

Key Messages

- **There is increasing interest in improving the nutrition of sheep.**
- **Confinement feeding to reduce the risk of soil erosion is very beneficial and quite simple.**
- **Lot feeding to finish sheep is more difficult but is definitely an option.**
- **Look into finishing options before you commit yourself.**

There has been increased interest in lot feeding in recent years. The workshops hosted by Grain & Graze at Cleve, Piednippie and Ceduna were very successful, with 260 people attending. These workshops covered lot feeding but also general nutrition of sheep - ewes in the paddock, weaners, etc. Grain & Graze is keen to run more nutrition workshops.

People see lot feeding as a way to add value to their low priced grain and utilise existing resources on the farm - eg hay, straw or labour. Some want to bring sheep back into the farm system but maintain their level of cropping.

The reality is that a feedlot is just a management tool. It is one option for producers. At times it will be economic but at other times it will be uneconomic or there would be better options.

Confinement feeding for maintenance

Lot feeding, or confinement feeding, as a way to avoid erosion and overgrazing in droughts, or manage late breaks, is a simple process. It is almost always economic and certainly a vital management option in areas with fragile soils.

I strongly recommend that farmers in districts prone to soil erosion set themselves up for confinement feeding. This means having a yard set up, having feed on hand and having the confidence to lock sheep up whenever further grazing would damage the pasture or create an erosion risk.

Lot feeding for production

Lot feeding to finish lambs is more difficult and you need to work the economics out carefully before you start. However, some farmers on EP have made a real success of it in recent years. They have finished both Merino and cross-bred lambs.

The keys to a successful finishing feedlot

- Work out the economics first.
- Aim to take the lambs into a higher price per kg bracket or sale period.
- Don't rush the grain introduction.
- Have a balanced ration, high in energy and protein and with the correct additives.
- Include good roughage at the start and during times of change.
- Avoid any stress.
- Monitor the progress - weigh twenty tagged lambs every three weeks.
- Contract some of the lambs and keep in contact with your agent. Sell over-the-hooks, if possible.
- Time shearing to maximise the skin value.

Grain only rations

Some farmers choose a ration that contains no hay or straw. This is a high-risk ration. Sheep are ruminants and are not suited to grain-only rations. Roughage is needed so the animal chews its cud and creates saliva. Long fibre in straw also stimulates the rumen wall and improves digestion.

While grain-only rations may appear to work, a percentage of animals will be suffering from "sub-clinical" acidosis (these sheep are suffering grain poisoning but it may not be obvious). There will also be more deaths from urinary calculi (water belly).

As a guide, I recommend 20% hay, or 15% straw, in the ration. The easiest way to do this is to feed it daily, or every second day, on the ground, but there are other options. While it is another job, the sheep should be checked daily anyway - it's not a big job and well worthwhile.

Target production levels

The other issue of concern is that some people are quoting fantastic growth rates and feed conversion ratios. There will always be some sheep that give fantastic results. However, budgets should be done on what is normal. This is important - especially if the lambs are contracted.

For first cross lambs it's reasonable to budget on a feed conversion rate (FCR) of 6:1 (6 kg of feed for each kg of live-weight gain) and 250g of growth a day. Lambs with high estimated breeding values (EBVs) for growth, on good rations, with good management will do better than these rates. However, don't budget on it! Consider it a bonus.

Summary

Finishing lambs successfully in a feedlot is not a simple exercise. Look into it carefully and compare it to other options such as supplementing with lupins in the paddock, fodder crops, lucerne, or selling to a specialist finisher.

Confinement feeding to avoid erosion or damage to the pasture is quite simple.

References

There are a number of books available on lot feeding. A new one that covers all types of feeding is; "Feeding and managing sheep in dry times". For a copy, contact the Roseworthy Information Centre on 1800 356 446, or your local PIRSA office.

RURAL SOLUTIONS SA

Survey

Comparison of Lower EP grazing systems

Greg Secomb, Brian Ashton, Daniel Schuppan
Rural Solutions SA, Port Lincoln

Key Messages

- **There is a large variation in the performance of pastures in terms of stocking rate on the Eyre Peninsula.**
- **Improved pasture systems are achieving livestock carrying capacity well above district practice.**
- **High performing pastures have a role, even in a cropping dominated system.**
- **Use this survey to workout how you are performing.**

Why do the survey?

A renewed interest in livestock as part of the production system has seen a much keener interest in pastures. Improved pasture and perennial pasture systems have been promoted in recent times with good experiences from the few that have tried them. In 2005 the area sown to Tetila Italian ryegrass increased significantly.

A survey was conducted to capture how different pasture systems are performing.

How was it done?

The survey calculated a paddock's stocking rate based on DSE (dry sheep equivalent) for the winter grazed time only. The logic is that the real measure of a pasture is the number of stock that are carried, and so we measure this in "grazing days". We realise that pastures can be over or under-grazed and that grazing at some times is more valuable than at other times (eg. break of season vs spring time).

Farmers provided data from one or two paddocks on their properties to complete a 'Grazing Days' record. Simple records were kept: the number of stock, type of stock, date entered into paddock and date removed from paddock.

The DSE results for each pasture type were then plotted against the annual rainfall received for 2005.

To provide some sort of benchmark, we have also plotted the "Reg French Grazing Potential" to give an indication of how the pasture systems have performed.

The Reg French theory (based on stocking rate experiments) for potential stocking rate is:

For every 25 mm of annual rainfall, over 250 mm, the potential is a stocking rate of 1 DSE.

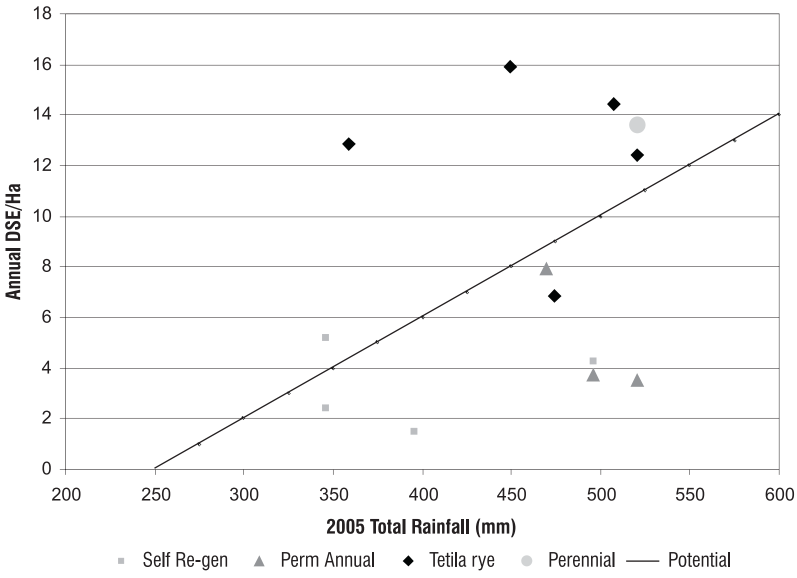
For a 400 mm rainfall district:
400 mm - 250 mm = 150 mm
150 mm / 25 mm = 6 DSE

Therefore the potential stocking rate in a 400 mm annual rainfall district is 6 DSE/ha.

What happened?

The graph below *(Figure 1)* shows the results of surveys completed by farmers in different areas of the lower EP. Plot marker shapes indicate the type of pasture. The position on the graph is determined by the total annual rainfall received in 2005 and the annual DSE stocking rate supported on that pasture during 2005. The solid line represents the "Reg French stocking rate potential".

Figure 1: Comparison of Grazing Systems for Lower Eyre Peninsula in 2005.



Grazing System
Self Re-gen: A self regenerating pasture on a crop stubble from the previous year
Permanent Annual: Paddocks that are continual pasture with annual species
Tetila Rye: Paddocks that have been sown with Tetila Italian Ryegrass
Perennial: Perennial grass species such as Cocksfoot, Phalaris etc
Potential: The Reg French "theoretical" potential stocking rate

The Tetila ryegrass paddocks in this survey have shown their ability to produce vast quantities of feed.

As can be seen from the graph, they generally produce extremely well and are able to support stocking rates well above the "theoretical potential".

The other thing to note is that in the higher rainfall zones unimproved (self-regenerating and permanent annual pastures) pastures perform quite poorly compared to what they should be able to produce according to the French Grazing potential.

What does this mean?

This work is all about getting you to ask questions and to start assessing your pasture performance.

There is no doubt there is a lot of variation within the results, between rainfall, pasture type and paddock type. They all have an influence on what you can actually achieve.

What does arise from this survey is that there are people out there with very high performing pasture systems - which in turn are resulting in very profitable livestock enterprises.

This work is ongoing, and we are very keen to hear from producers, anywhere on the Eyre Peninsula, that have grazing records for the 2005 season. We want to get as many as we can to build up a clear picture of what different pasture systems are achieving.

Please contact Emma McInerney at Minnipa Ag Centre, 8680 5104 or Greg Secomb or Brian Ashton at Rural Solutions SA, Port Lincoln: 8688 3400

Acknowledgements

Thanks to all the farmers involved in keeping records to help out with this survey.

Thanks also to Tim Prance of Rural Solutions SA, for providing advice and technical assistance to the Grain & Graze project throughout 2005. Greatly appreciated.

Grain & Graze
Profit through knowledge

RURAL SOLUTIONS SA

Best practice

Perennial pastures: where do they fit on EP?

Extension

By David Davenport

Rural Solutions SA, Port Lincoln

Key Messages

- **Perennial pastures have provided both economic and environmental benefits on specific soil/climate combinations on Eyre Peninsula.**
- **Profitability of perennial pastures is highly dependant on grazing management.**
- **Areas not productive for cropping or annual pastures due to issues such as salinity and waterlogging can be highly productive with appropriate perennial pastures.**
- **Perennial pastures should be considered as part of a farm plan integrating annual pastures and stubbles.**

Why focus on perennials?

Perennial pasture systems have been promoted on Eyre Peninsula due to their productive capacity and ability to address issues such as dryland salinity, waterlogging and wind erosion. Perennials have a longer growing season than annual pastures providing feed at critical times. Also, the longer growing season combined with deeper root systems than annual plants results in perennial species using more water therefore reducing potential for waterlogging and recharge of saline groundwater systems.

Despite these advantages perennial pasture species have not been widely used on Eyre Peninsula, and in the last 6 years a program to demonstrate and evaluate the capacity of a number of species in different soil/climate systems on EP has been undertaken.

What has been done?

Lucerne development

A lucerne "Topactive" workshop series was developed in 2000 and a number of workshops have been held in lower and eastern Eyre Peninsula. These workshops provided information to growers on areas suitable for planting lucerne, establishment techniques, and fertiliser and grazing management.

While there have been some failures, (particularly on sandy soils in lower rainfall areas) there are also many success stories. A landholder on Lower EP in 450 mm rainfall area has established (and maintained over five years) excellent lucerne stands in four paddocks. During these years he has averaged 2-3 grazing periods prior to shutting off paddocks for a hay cut (averaging approximately 2.5 t/ha) with another grazing following haying. Due to late rains in 2005 he obtained two hay cuts totalling 4-4.5 t/ha and is still obtaining some grazing on these paddocks. Since establishing lucerne he has significantly increased stocking rates and has leased his cropping program so he can have a greater focus on livestock.

There have also been successful lucerne stands established on sandy soils at Wanilla, Edillilie, Karkoo, Lock, Mangalo, Miltalie, Arno Bay, Waddikee and elsewhere. Successful lucerne pastures on EP require:

- Appropriate soil type – soils should be neutral to alkaline pH, not saline or waterlogged. Where rainfall is below 425 mm sands and loamy sands are most suitable.
- Sowing rates of 4-6 kgs/ha.
- Weed and pest control is essential both in paddock preparation and pasture maintenance.
- Rotational grazing – usually on a 6-8 week cycle during the growing season.
- Maintenance application of 10-15 kg/annum of phosphorous and 1 kg/ha of copper every 3-4 years. Potassium may be required where soil values are less than 120 ppm.

This program has assisted with increasing the area of lucerne established across EP from an estimated 1,000-1,500 ha to 15,000-20,000 ha.

Saline pasture

With the support of catchment/landcare groups a number of demonstrations and promotions of saline grazing systems have been developed on lower and eastern EP. These sites have mainly focussed on the development of puccinellia pastures on strongly saline and waterlogged areas where other pasture species cannot grow.

Results have shown that establishment in the first year is largely determined by weed competition and rainfall. However, even sites with poor establishment have demonstrated the ability to thicken up in subsequent years. The result is that there are a number of highly productive puccinellia pastures on what were previously saline scalds.

Stocking rates on well managed puccinellia pasture can be as high as 10 DSE/ha. Feed analysis taken from a site a Tumby Bay in October *(refer in Table 1)* has also shown that feed quality is excellent. Other testing has also shown that feed quality will not deteriorate as much as other pasture species in summer. Also dry puccinellia will remain at values equivalent to cereal hays and is like having a hay stack in the paddock.

Demonstrations have also been developed using puccinellia in association with saltbush and balansa clover. Data on these sites is expected to be available later this year.

Table 1: Puccinellia Feed Analysis, Tumby Bay.

Moisture	73.3%
Dry Matter	26.7%
Crude Protein (N x 6.25)	20.0% of dry matter
Neutral Detergent Fibre	53% of dry matter
Metabolised Energy	10.4 MJ/kg DM

Phalaris, Cocksfoot, Fescues

Productive pastures of these grass species are mainly restricted to districts with greater than 450 mm rainfall/annum. Generally they are planted in association with clovers or medics often in combination with each other. These species are more tolerant of waterlogging and soil acidity than lucerne and are easier to establish and utilise. The ability of these species to reduce waterlogging has been demonstrated at Edillilie where paddocks that could not normally be driven on with four-wheel-drive vehicles in winter can now be driven on using conventional vehicles.

Successful cocksfoot/phalaris stands have been established on lower EP with stocking rates in the order of 12 DSE/ha. In common with other perennials these species are best rotationally grazed. Heavy stocking is required during late winter-early spring to maintain clover percentage and prevent feed growing rank. In the Adelaide Hills these pastures are often cut for silage and provide excellent grazing following cutting.

Phalaris, Cocksfoot, Fescue pastures require:

- Soil pH above 5 (CaCl)
- Maintenance application of 10 kg/ha of phosphorous per annum or 1 kg per DSE carried.
- Red legged earth mite and lucerne flea control.

Veldt grass

Veldt grass is a grass species that will tolerate lower rainfall levels (down to 250 mm per annum) than many other perennial pasture species. On Eyre Peninsula it has been mainly seen as an option to fix "problem" sites such as unstable dunes, however, veldt grass can be highly productive if managed correctly.

Weed control is important prior to establishment. Veldt prefers sandier soils and sowing into stubbles or pasture residues will reduce wind erosion potential. Fertiliser should be applied to established veldt at 1 kg phosphorus per ha per DSE and 25 kg/ha of nitrogen in late autumn or early winter.

In common with other perennial species rotational stocking is required to maximise production. Once established, veldt pastures should be grazed to maintain growth between 2-3 cm (800 – 1000 kg/ha dry matter) and 6-8 cm height (1800 – 2500 kg/ha dry matter). Small paddocks with high grazing pressures of 50-100 DSE/ha for short periods are most suited to achieving this aim.

Where to now?

Monitoring and evaluation of these pasture species is continuing with particular emphasis on improving grazing management to deliver the productive potential of these pastures. There is also more work being undertaken on how perennial pastures complement annual pastures and cropping systems.

A "Prograze" course has been run previously on the Eyre Peninsula by Tim Prance (Pasture Agronomist Rural Solutions SA) and there are plans to establish another two groups this year. The course comprises eight workshop/field days looking at issues such as pasture maintenance, grazing management, animal health etc. Any interested farmers can contact Daniel Schuppan on 8688 3010.

RURAL SOLUTIONS SA

Managing native pastures for productivity and sustainability

Extension

Di Ancell

Rural Solutions, Port Lincoln

Key Messages

- **Native grasslands have value for pasture, sustainable land management and conservation.**
- **Native grasses can provide low input high quality pastures.**
- **Rotational grazing with appropriate rest periods is the best way to manage native pastures.**
- **Specific grazing strategies cannot be prescribed until further monitoring has been done.**

Why are native pastures important?

Native grasslands may have trees!

Grasslands consist of a wide variety of native grasses and low-growing plants with few, if any, trees or shrubs. Generally native grasslands occur in areas which have not been cultivated and have, had limited fertiliser application or grazing pressure. Native grasslands on Eyre Peninsula once covered large areas of the region and were often associated with Sheoaks *(Allocasuarina verticilllata)*, Peppermint Box *(Eucalyptus odorata)* and Mallee Box *(Eucalyptus porosa)* woodlands. Grasslands can still be found in areas of the Cleve, Koppio and Tumby Hills and along the west coast from Sheringa through to Streaky Bay.

Potential for agriculture/sustainable land use

Native grasses can provide low input, high quality pasture if managed appropriately. As native grasses are perennial, their deep root systems are able to utilise water throughout the year and are able to respond rapidly to summer rain with new green growth. These attributes provide good ground cover all year, protecting soils from erosion and reducing recharge in catchments, which is important for salinity control. Native pastures also respond rapidly by re-sprouting after fire, grazing or summer drought.

Table 1 indicates the high feed quality of native grasses in comparison to introduced pastures. Native grasses such as Wallaby, Windmill and Kangaroo grasses are comparable in feed quality to many high-input grazing systems (such as Lucerne, Clover and Phalaris).

Table 1: Feed comparisons of native and introduced pastures

Species	Digestibility %	Protein	Metabolisable energy
Wallaby Grass-Elliston	60.7	20.6	8.7
Windmill grass	35-68	7-12	
Kangaroo Grass	54-75	5-17	
Lucerne*	65	12-24	8-11
Sub-clover*	60	8-20	6-11
Phalaris*	65	17	9.3
Oldman Saltbush	63-82	15-20	9-12

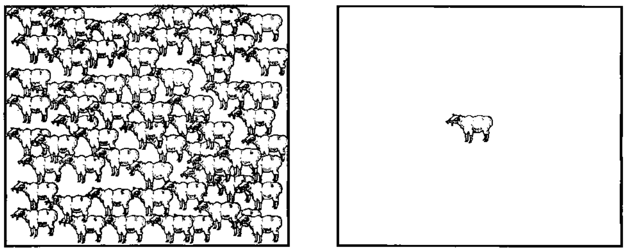
**introduced species.*

How do we manage native pastures?

Grazing Management

No grazing is as detrimental as over-grazing to maintain native pastures. The best way to manage native pastures, as for other pastures, is to rotationally graze rather than set stock. This means reducing the paddock size to increase the stocking rate, grazing for short periods (a few weeks) to allow more even utilisation of pasture. Stock are then moved to another smaller paddock. The number of grazing days and the length of rest periods for the pasture to recover are important variables to consider and manage. Over-grazing occurs due to animals grazing too long, not from too many animals. The aim of rotational grazing is to lift productivity, increase perennial species (native grasses) and reduce weeds and annuals in the pasture. Paddocks need to be monitored for pasture growth and productivity, and stock moved according to pasture condition.

Figure 1: Rotational vs Set Stocking



100 sheep in 100 ha for 1 day = 1 DSE *1 sheep in 100 ha for 100 days = 1 DSE*

Both these diagrams *(Figure 1)* depict the same carrying capacity of one Dry Sheep Equivalent (DSE) per hectare. The diagram on the left depicts a higher density of grazing for a shorter period. This allows stock to more evenly utilise the feed in the paddock (rotational or cell grazing). The diagram on the right is standard set stocking, where stock graze in lower densities for an extended period and are more able to selectively graze the pasture. This selective grazing means that the most palatable plants are grazed out first. This allows annuals and weeds to grow and reproduce at the expense of the better quality, more palatable perennial species which stock favour. Gradual decline in the pasture quality and productivity is the consequence.

Grazing trials will help us manage them better

Grazing trials in the Mid-north

Rotational grazing in the mid north lifted productivity from 2.5 DSE to 3.7 DSE on native grass pastures. Rotational grazing also lead to a decrease in annuals and weeds; an increase in pasture growth; and an increase in perennial native grasses.

Grazing trials –Eyre Peninsula

Several sites have been established on the West Coast and lower Eyre Peninsula which have a number of years of data (see article, Managing sheoak grassy woodlands, page 70). Monitoring for an extended period is required to know with any confidence if trends are a result of grazing management rather than, say, seasonal variation. Another complication is the effect of the added grazing pressure by native herbivores (kangaroos) on resting paddocks. This information will be important for managing native grasses in the region for the future.

Other uses of Native Grasses

Native grasses have other values and uses such as:

- Low grass cover for firebreaks (if grazed or slashed)
- Groundcover in revegetation sites
- Site rehabilitation (mining, quarry sites)
- Stabilisation of banks in watercourses, road cuttings
- Low maintenance lawns & verges
- Wildlife habitat (eg. Diamond Firetail Finch)

Acknowledgments:

Jodie Reseigh and Brett Bartel, Consultants, Rural Solutions SA

Further information

Further information about managing native grasslands can be obtained from Jodie Reseigh, Rural Solutions SA Clare (08) 88426 257, Brett Bartel Rural Solutions SA Adelaide (08) 82269771 or Di Ancell Rural Solutions SA Pt Lincoln (08) 86883412.

RURAL SOLUTIONS SA

Managing sheoak grassy woodlands

Jodie Reseigh[1], Brett Bartel[2] and Di Ancell[3]

Rural Solutions SA Clare[1], Adelaide[2] and Port Lincoln[3]

Key Messages

- **Landholders are improving the management of sheoak grassy woodlands for conservation, biodiversity and production outcomes.**
- **Trial sites are monitored annually for a number of attributes including: presence of species; numbers of native perennial grass plants; and contribution of dominant species to total dry weight of pasture.**
- **Initial monitoring of the trial sites generally reflects seasonal variation.**
- **Ideally long term (7-10 years) of data collection is necessary to demonstrate trends, and management practices.**

Why do the trial?

The project aims to investigate management options for sheoak grassy woodlands to improve conservation, biodiversity values and to maintain or improve productivity of perennial grazing systems on Eyre Peninsula.

Set stocking or continuous grazing of livestock on pastures dominated by native grass species has resulted in the pastures becoming degraded, predominately with the loss of desirable perennial grasses. Perennial grasses persisting under set stocking or continuous grazing regime are often prostrate and very small in size. In many cases annual species such as wild oats, barley grass and saffron thistles have replaced these native perennial grasses. Overall there has been a decline in productivity and biodiversity of these pasture systems.

Native grasslands are one of the most threatened native ecosystems in Australia. This project aims to demonstrate that conservation of these systems is possible without compromising productivity. With appropriate rotational grazing systems it may be possible to improve productivity from these areas, while increasing the biodiversity values. This article follows on from a previous article by Brett Bartel 'Native grassland grazing demonstration sites' published in *EPFS 2002, pages 50-51*.

How was it done?

A total of three properties are included in the grazing trial. Two are located in the Elliston area, where monitoring began in 2001, and a property at Louth Bay where monitoring commenced in 2004.

At each property, the trial area has been subdivided into smaller paddocks to enable the implementation of a rotational grazing regime. Landholders aim to graze the paddocks at high stocking densities (greater than 150 DSE/ha) for short periods of time (1-20 days), with appropriate rest periods (overall stocking rate is $\sim$ 1 DSE/ha/annum). The rest period is important in allowing the perennial grass species to recover before being grazed again. Average stocking rates in the rotationally grazed areas are generally similar to, and in some cases higher than, the district average.

At each property, a number of rotationally grazed paddocks and a control paddock (a paddock set stocked or continuously grazed) are monitored annually for changes in pasture composition and productivity. This allows comparisons to be made between the trial and control paddocks, and to monitor comparative changes over time. Within each paddock one 100 metre long transect has been established and the following pasture attributes measured:

Presence/Absence

At 4.5 m intervals along each transect the presence of all plant species is recorded in a 50 x 50 cm quadrat (15 quadrats). This indicates species frequency and diversity within the paddock.

Number of native perennial grass plants per quadrat

The number of native perennial grass plants present per quadrat along each transect is recorded. The numbers of native perennial grass plants per quadrat is an indication of the condition of the pasture as perennial grasses provide stability to pastures.

Available pasture mass

Pasture cuts are taken on each property to determine a pasture height/weight relationship. This information forms a basis for a relationship between pasture height and dry matter. Landholders can then use this information to calculate the available pasture mass from a measure of plant height; this information can assist landholders in determining appropriate stocking rates.

Contribution of dominant species to total dry weight of pasture

In each quadrat the dry weight rank of the dominant plant species is visually assessed. This will give a measure of species contribution to total pasture dry weight relative to other species in the pasture.

Photo points

Photo points will be established at each site to monitor visual changes in composition of the pasture.

What happened?

General overview

Due to the relatively short length of time that the trial has been running, few conclusions can be drawn about the influence of rotational grazing on pasture composition and biomass. Variation in the pasture composition and biomass reflects seasonal fluctuations, although a few trends can be interpreted.

Generally control paddocks with set stocking or continuous grazing annual grass weeds such as wild oats and brome species dominated the pasture biomass, reflecting the seasonal availability of feed in set stocked paddocks. In rotationally grazed paddocks annual grass weeds also contributed to the pasture biomass but to a lesser extent - with native grasses, medics/clovers and annual broadleaved weeds also contributing.

The study has established that a number of native and introduced species contribute to the biodiversity of sheoak grassy woodlands on the Eyre Peninsula *(Table 1)*. Greater than 30% of all species surveyed were native, including many species of spear grasses *(Austrostipa species)* and wallaby grasses *(Austrodanthonia species)*. Introduced species include clovers and medics *(Trifolium and Medicago species)* and perennial weeds such as Lincoln weed *(Diplotaxis tenuifolia)* and Horehound *(Marrubium vulgare)*.

Table 1. Proportions of native and introduced plant species and total species, recorded 2001-2005, in EP Grazing Trials.

	Property 1 Elliston	Property 2 Elliston	Property Louth Bay
Percentage of native species	32	34	46
Percentage of introduced species	68	66	54
Total number of species	59	53	56

Stocking rates

Overall stocking rates of trial paddocks that are rotationally grazed are generally similar and in some cases higher than the district average of 1 DSE/ha. The difference is that paddocks are grazed with higher stocking densities for a shorter period of time, with periods of rest, allowing the pasture grasses to recover from the defoliation and regrow.

Need for long term monitoring

Changes in native grassy ecosystems as a result of improved management are likely to be long term. As a result little quantitative information has arisen from the first five years of monitoring, and results generally reflect seasonal variation. Continued monitoring is essential to utilise and support the existing data and information, and gain a better understanding about the management of sheaok grassy woodland ecosystems.

The change in grazing management resulted in an initial short term variation in plant species composition, diversity and biomass. However longer term successional changes will occur and monitoring must be continued to capture this and the longer term changes from rotational grazing.

Acknowledgements

This project acknowledges the assistance of Eyre Peninsula NRM staff. The EP NRM Board and the Natural Heritage Trust have funded the project

Further information

Further information about this trial and the results can be obtained from Jodie Reseigh, Rural Solutions SA Clare (08) 88426 257, Brett Bartel Rural Solutions SA Adelaide (08) 82269771 or Di Ancell Rural Solutions SA Pt Lincoln (08) 86883412.

Prevention of Annual Ryegrass Toxicity (ARGT)

Information

Daniel Schuppan
Rural Solutions SA, Port Lincoln

Cause of Toxicity

Livestock grazing Wimmera ryegrass are at a high risk of death due to Annual Ryegrass Toxicity (ARGT). The disease occurs when the ryegrass has been infected by both a nematode and a bacterium. The bacterium starts producing a toxin around flowering time and the level increases just prior to the grass drying off and remains until the plant material has been weathered away.

A number of farmers grew Italian Ryegrass in 2005, which is a host for the nematode and bacterium but is at lower risk to stock due to being later maturing. Guard⊕ and Safeguard⊕ ryegrass are varieties that are resistant to ARGT and provide an option if you want annual ryegrass pastures safe from ARGT.

Preventative Measures

If an ARGT outbreak has previously occurred in the district it is important that you take preventative measures to reduce the possibility of stock losses. Preventative practices recommended include:

- Heavy grazing in early spring to reduce the amount of ryegrass reaching maturity and ensure that the pasture is utilised before becoming toxic.
- Cutting hay or topping before the seed-heads reach the danger stage (hay with infected seed-heads is toxic and can poison stock when fed out).
- Topping, or spray topping with an herbicide such as Paraquat®, or Roundup® before flowering (graze heavily to reduce regrowth).
- Test ryegrass plants to detect problem paddocks and identify safe paddocks.
- Remove stock before the danger period.
- Don't introduce hungry sheep to a suspect paddock.
- Check stock daily.

Symptoms of ARGT

If you have not taken any preventative measures and you are grazing a paddock with Wimmera ryegrass it is important to check stock daily as deaths can occur within 3 to 4 days, or up to several weeks after being introduced to a toxic paddock. To observe the first signs of poisoning, make the animals run 100 to 200 m. Affected animals will lag behind, may display a trotting horse gait with head arched back, and may fall to the ground and go into nervous convulsions followed by death. It is important to move affected stock immediately to a clean paddock as quietly as possible and do not stress them.

Testing for Safe Paddocks

The current test used is an ELISA test, which is also used for detecting ARGT in export hay. It is designed to identify the presence of bacterium and safe paddocks. The test however is unable to measure the degree of infection, and just because the bacterium is detected doesn't mean the stock will be affected. The ARGT test requires 200 g of pre-flowering ryegrass or 1 kg of mature ryegrass seed-heads. Do not include plant roots or soil in the sample. Collect the samples first from the boundary of the paddock and then zig-zag across the rest of the paddock. Sample bags are available at PIRSA offices and cost $50 per paddock.

For further information or if an outbreak occurs please contact Daniel Schuppan or Brian Ashton, Livestock Consultants, Rural Solutions SA, Port Lincoln on 8688 3400.

RURAL SOLUTIONS SA

Section 5

Section editor: Jon Hancock
SARDI, Minnipa Agricultural Centre

Rotations

Minnipa farming systems competition

Extension

Michael Bennet
SARDI, Minnipa Agricultural Centre

Best practice

Location
Minnipa Agricultural Centre

Rainfall
Av. Annual total: 325 mm
Av. GSR: 242 mm
2005 Total: 327 mm
2005 GSR: 267 mm

Yield
Potential (Wheat): 3.1 t/ha
Potential (Peas): 2.1 t/ha

Soil
Sandy Loam

Plot size
3 ha

Key Messages

- **Kaspa peas performed exceptionally well despite a late start.**
- **Researchers win yet another strategic battle but fall short on the war effort.**
- **Consultants fell short of snatching the lead back from their clients.**

Why do the trial?

The farming systems competition aims to compare the impact of broad scale management decisions in four paddocks on Minnipa Agricultural Centre. The competition was in its fifth growing season in 2005.

How was it done?

The competition is divided into four separate teams, each with a separate three hectare paddock to assign management. The teams are local farmers "The Not Too Cocky Cockies", local consultants "De$parately $eeking $olutions", district practice and the Minnipa researchers "Starship Enterprise."

What happened?

The 2005 season was a departure from the typical situation in the farming systems competition. The farmers, consultants and district practice took a well earned break from their intensive cereal phase to bring grassy weeds under control. The farmers decided to treat their paddock like their own farm and sowed a medic pasture. The district practice paddock was left for a regeneration of weeds while the courageous consultants sowed Kaspa peas. In an effort to make some money, the research paddock went for a second cereal.

During 2005, the method of gross margin calculation was changed to reflect more accurate figures. An increase in machinery expenses/hectare was applied across the board. In the past, grazing gross margins were calculated on an agistment basis of 25 cents per head per week. This season the pasture gross margins were calculated on a basis of a livestock gross margin of $30/DSE/year which increased the gross value of the livestock component to the competition. We have no desire to retrospectively calculate this, as district practice may take a greater lead from the researchers!

Table 1: RDTS Risk Rating Pre Sowing 2005

Paddock	CCN	Takeall	*Prat. thornei*	Crown Rot	Common Root Rot
Consultants	BDL	BDL	BDL	Medium	Medium
Farmers	BDL	BDL	Low	High	Low
Researchers	BDL	BDL	BDL	Low	Low
District Practice	BDL	BDL	Low	High	Low

What did we learn last year?

Team 1
The Farmers (Not Too Cocky Cockies)

Team motto: To farm profitably today, while giving our kids the chance to do the same tomorrow.

2005 turned out to be an unspectacular, but consolidating year for our competition paddock. Before the year started, our focus was on gaining some much needed grass control. We were leaning towards a pulse crop to achieve this, while at the same time adding a bit to our running gross margin. Once again this option was limited by a very dry start, and by the time the season had broken in mid June, we had decided to go with the cheaper option of a sown medic pasture. The medic seed was bought at commercial price and sown at a moderate rate, and only a small amount of fertiliser was applied so costs were kept to a minimum (*Table 2*). We achieved a good germination and, although growth was slow to start with we finished up with a reasonable stand of medic. The grasses were sprayed out with Targa® at the appropriate stage and escapes were tidied up with sheep and a spray top.

We believe that we achieved good grass control while gaining some nitrogen input from the medic and combined with past practices, the paddock is well set up to start making money again.

In summary, our efforts in 2005 could be viewed as a lost opportunity considering the ideal spring rainfall for crops, but this was a very rare event and the risks at the break of the season were high (no benefit of hindsight then). To balance this, pea prices are well down at present and a decent gross margin figure would have been difficult to achieve with this option, despite good yields. The future will show that the discipline shown by the cockies group in 2005 can triumph in the long term over loose decision making by the other teams. Our running gross margin is still very healthy and we hold a competitive edge over our opposition.

2006 Plans

Given last seasons treatment of the paddock, it is set up for a hard wheat variety, probably Yitpi which fetches a $5/t premium. Hopefully the timing of the break to the season will be reasonable this year to give us a chance for a knockdown control over any remaining weeds before sowing. Paddock management will be straightforward and will include a dry 'tickle' with a prickle chain before the season break and sowing with no till points and controlled traffic. A generous maintenance level of phosphorous will be applied at seeding with a small amount of starter nitrogen. Broadleaf weeds such as soursob and marshmallow will need to be monitored and dealt with as the season progresses.

With low commodity prices at the moment, good management and containment of input costs will be paramount.

Team 2
The Advisers (De$parately $eeking $olutions)

Team motto: If we get trounced, please blame Ed Hunt.

What did we learn last year?

Well, we did sow Kaspa peas on the 15th June after four cereal crops. Let's cut to the chase, what a great decision! We achieved a yield of 1.57 t/ha or 72% of potential. If we add in the 0.5 t/ha peas on the ground post harvest we achieved 96% of our potential.

The peas grew well all year, but we did experience some herbicide damage two weeks after spraying Targa® and Hasten® for grass control especially where there was overlap of the spraying operation but we had no control over that. There is evidence of Kaspa peas being sensitive to metribuzin especially where press wheels are used, which leaves an ideal area for herbicide concentration.

We were pleased the way the peas yielded and finally the amount of money we made (*Table 2*).

2006 Plans

We now know that the farmers and researchers are looking over the fence and thinking, “we had better be careful or they may buy us out!” The most obvious crop would be a hard wheat for 2006, but wait! We are thinking of Guar, which we can't comment on as those pesky spies will probably do anything to tarnish our unique farming technique and bottom line.

Team 3
The Researchers (Starship Enterprise)

Team motto: Boldly going where no man has gone before.

What did we learn last year?

In 2004 a management committee was instigated to try to streamline the decision making process for the research team. This panel includes Jon Hancock, Nigel Wilhelm and Michael Bennet. One member of staff at MAC didn't appreciate the mocking of his agronomic expertise, which led to a defection from the research team. With no more to say, Fish left the up and coming research team to buddy up with the consultants. We wish Fish and the consultants all

Figure 1: Michael Bennet (MAC), Scott Forrest (Farmer - Minnipa), Neil Cordon (MAC) at the 2005 MAC Field Day addressing the crowd at the Farming Systems Competition Paddock.

the best for the future and look forward to the cutting edge nature of the competition in the future.

Not to disappoint the growing group of fans, the research team was humbled in 2005 (again!) by yet another decision making blunder. A lack of nitrogen left their Wyalkatchem's protein flat as well as suffering in yield. The enterprising researchers did not manage to make great returns from AWB's Golden Rewards program with only an $8/t increase! This is a stark contrast to the previous season when the author was suggesting for extra (unwarranted) N applications! With stripe rust a concern during spring, the “other teams” were sitting pretty with their non wheat rotations. A spray for caution plus a lack of infection kept the rust at bay.

2006 Plans

The research team will have to take a break from the sowing on the opening rain tactic that was adopted a few years ago. Waiting for a good germination will place some pressure on the grassy weeds and marshmallow which are present in our paddock. As for cropping options for the season, there are several options up our sleeve. We are certainly keen to continue with our current profitable cropping regime, however we will need to pay closer attention to weed and nitrogen levels. Weed management is a major concern for our operation. Our memories are still tainted by the wild oat episode in 2001 and have no desire to let barley grass take over like in the neighbour's paddock.

The options under consideration currently include triticale for hay or perhaps a competitive wheat crop. At this stage Wyalkatchem has been shelved, as we may be able to squeeze another wheat out of the rotation if we avoid such a poorly competitive variety. Growing Angel medic for certified seed might be another useful option to make use of our recent SU history, however the full implications of growing certified medic seed need to be investigated.

Acknowledgements

AWB for their continued support with the competition. Brendan Frischke, Brett and Kym McEvoy for their enduring patience while dealing with teams that can't make a decision until the seeder is in the gateway.

Table 2. Farming Systems Competition Summary, 2005

Date		Farmers	Consultants	Researchers	District Practice
2001		Yitpi Wheat Yield 2.75t/ha Prot- 13.6%, Scrn 5.6% & TW-75.4 kg/HL GM = $599.77/ha	Yitpi Wheat Yield 2.77t/ha Prot- 11.6%, Scrn- 4.6% & TW- 75.4 kg/HL GM = $571.66/ha	Wheat Hay GM = $207.1/ha	Yitpi Wheat Yield 2.79t/ha Prot- 12.3%, Scrn- 4.9% & TW- 75.6 GM = $574.71/ha
2002		Krichauff Wheat Yield – 1.48 t/ha, Prot – 12.4%, Scrn – 1%, TW – 77.2, % Pot Yield – 68%, GM = $315.73	Krichauff Wheat, Yield – 1.25 t/ha, Prot – 11.8%, Scrn – 3.3%, TW – 74.4, % Pot Yield – 58%, GM = $231.09	Barque Barley, Yield – 1.36 t/ha, Prot – 11.4%, Scrn – 34.8%, TW – 72.6, % Pot Yield – 53%, GM = $195.36	Grazed pasture GM = -$3.70
2003		Krichauff Wheat Yield – 1.21 t/ha, Prot - 13%, Scrn - 4.1%, TW – 76 kg/HL, Pot Yield – 66%, GM = $163.06	Krichauff Wheat Yield – 0.99 t/ha, Prot – 12.1%, Scrn - 5.6%, TW – 77.2 kg/HL, Pot Yield – 54%, GM = $117.60	Rivette Canola Yield – 0.50 t/ha, Oil – 40.7%, Foreign Matter – 5.7%, TW – 64.2 kg/HL GM= $89.92	Yitpi Wheat Yield – 0.85 t/ha, Prot – 14.3%, Scrn - 5.9%, TW – 78.6 kg/HL, Pot Yield – 46%, GM = $117.37
2004		Wyalkatchem Wheat: Yield- 1.01 t/ha, Prot- 13.3%, Scrn 7.8% & TW-74 kg/HL GM = $84.38 /ha	Keel Barley: Yield- 1.35 t/ha, Prot- 12.4%, Scrn- 32.8% & TW- 58.4 kg/HL GM = $67.48 /ha	Yitpi Wheat: Yield- 1.25 t/ha, Prot- 11.7%, Scrn- 6.6% & TW- 77.2 kg/HL GM = $132.21 /ha	Krichauff Wheat: Yield- 0.82 t/ha, Prot- 16.3%, Scrn- 26.9% & TW- 68.2 kg/HL GM = $40.93 /ha
Running Gross Margin, after 2004		$ 1106.05 ☺	$ 966.35 ☺	$ 612.05 ☹	$718.53 ☺
2005 Management	31/5	Toreador Medic @ 5 kg/ha		Logran @ 25 g/ha	Regenerated Pasture
	15/6		Kaspa Peas @ 100 kg/ha + DAP @ 50 kg/ha	Wyalkatchem @ 50 kg/ha + DAP @ 50 kg/ha	
	25/6		Lexone @ 180g/ha	Sprayseed @ 1 L/ha + BS1000	
	19/7	Targa @ 275 ml/ha + Tigrex @ 75 ml/ha + Hasten + BS1000 + Ammonium Sulphate	Targa @ 375 ml/ha + Hasten + BS1000 + Ammonium Sulphate	Affinity @ 60 g/ha + MCPA 500 @ 500 ml/ha	
	17/8			1.5 kg/ha Zinc sulphate	Roundup @ 600 ml/ha
	26/10		Fastac Duo @ 200ml/ha	Turret @ 500 ml/ha	
	29/10	Paraquat 250 @ 400 ml/ha	Paraquat 250 @ 800 ml/ha		
	25/11	793 grazing days GM = $ 11.29/ha	319 grazing days Kaspa Peas: Yield- 1.57t/ha, GM = $ 82.98 /ha	Wyalkatchem Wheat: Yield - 1.98 t/ha, Prot- 9.8% & Scrn 3.2% GM = $ 107.78 /ha	764 grazing days GM = $ 53.35/ha
Running Gross Margin, after 2005		$ 1117.34 ☺	$ 1049.33 ☺	$ 719.83 ☹	$771.88 ☺

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Section 6

Section editor: Jon Hancock

SARDI, Minnipa Agricultural Centre

Disease

Stripe rust management strategies for 2006

Extension

Hugh Wallwork

SARDI, Plant Research Centre, Waite

Key Messages

- **The most susceptible varieties need to be replaced with less susceptible alternatives.**
- **Providing the S and VS varieties are removed, stripe rust can be managed effectively on the Eyre Peninsula.**
- **Do not forget the risks with stem rust and leaf rust, which may become problems in different seasons. Yitpi and Wyalkatchem should not be grown in coastal areas where stem rust is a risk.**
- **Early spraying helps to keep inoculum levels down and the rust under control.**
- **Fungicide-treated fertilisers and seed treatments provide options for early control where the risk of stripe rust is high.**

2005 season summary

Stripe rust was the most significant cereal disease for 2005. Crops around the whole state were infected with a large proportion requiring spraying, some twice. Where infection was poorly controlled losses were severe. Head infection also occurred in some varieties, particularly H45 and Wyalkatchem. The principle causes for the problem were cool conditions with frequent long dews throughout winter and much of spring coupled with large areas sown to susceptible varieties. There is little evidence that the rust survived in SA over the summer as infection was found in August fairly uniformly over a wide area at much the same time. This suggests that inoculum was blown in from eastern Australia where the epidemic had started earlier. Had infection started earlier in the season, as on the EP in 2004, the outbreak would have been more severe.

Throughout most of the season the only strain detected was the WA strain. Reports of infection in Pugsley and Kukri were all accounted for by these varieties not being pure for resistance. Pugsley has a proportion of plants that are quite susceptible whereas Kukri has a similar proportion with varying reactions.

Higher than expected infection was observed on many varieties during August and September. This was due to the ideal conditions for infection and in some cases because of the early growth stage at which stripe rust was observed. In most cases rankings of varieties remained the same with Frame, Yitpi, Kukri and Pugsley providing some of the best levels of resistance among the commonly grown varieties.

Wyalkatchem was found to be highly susceptible during August and September with adult plant resistance (APR) kicking in much later than with other varieties. It is likely that resistance in this variety is affected more by temperature with higher temperatures promoting resistance. The rating of this variety remains as MS-S although this is a compromise between it being VS early in the season and almost MR-MS under higher temperatures later in the season.

At the end of the season the VPM strain of stripe rust, which is virulent on Camm and Pugsley, was detected in the lower north.

Fungicides

Stripe rust within crops can be controlled very effectively with timely applications of fungicide sprays. This was well illustrated in 2005 where early applications kept many crops almost free of damage from stripe rust. Where fungicides are less effective however is controlling stripe rust in crops where infection has already taken hold, in controlling head infection and in keeping inoculum levels low enough to prevent new mutations occurring. Again in 2005 this was well illustrated; despite timely control of rust in most crops, the level of rust in the environment remained high enough to require repeat spraying and towards the end of the season led to some severe head infection. Also late in the season a new strain of stripe rust was detected that is a mutant derivative of the WA strain.

So, although fungicide sprays can work effectively if applied early as a protectant, they are not a solution to the rust situation. They should only be seen as a temporary means to alleviate the current problem.

Application of fungicides on fertilisers has proven an effective means of keeping rust out of crops up until flag leaf emergence in some cases. The level of control depends to some degree on the level of resistance in the variety, crop growth and seasonal conditions. The main problem is the early upfront cost and/or the problems of applying the fungicide safely when it is in powder form. The lack of available safe and reliable applicators is a concern, although this can be overcome if the industry can coordinate itself to support the production of applicators by a company such as Loxton Engineering who have said they will commence manufacture of suitable applicators once they know that 50 orders will be placed.

Seed treatments based on triadimenol and triticonazole provide control for up to eight weeks, which in most instances will make little difference unless the stripe rust has oversummered nearby. Previously, over summers with similar rainfall, some rust has survived on the EP so some caution is required. Seed treatments based on fluquinconazole will last much longer than other seed treatments and perhaps for a similar period as the fertiliser-applied fungicides. The cost of these treatments however remains quite high at present.

Leaf and stem rust

Whilst little was seen of these rusts in 2005, there is a good possibility that given the right environmental conditions and chance survival of rust somewhere, that one of these rusts will flare up again in the near future. For this reason growers need to remain vigilant in ensuring that not too large an area is sown to varieties susceptible to these rusts. Whilst at present it is not possible to grow varieties resistant to all three rusts, growers should avoid any varieties VS to any one rust and spread their risks across the rusts by growing a mix of varieties.

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A review of stripe rust principles

Extension

Neil Cordon
SARDI, Minnipa Agricultural Centre

Over the last two years there has been a lot of research and demonstration work to evaluate various strategies to reduce the risk of and control stripe rust.

The following points are a summary of trends, thoughts and experiences from the past work with acknowledgement to Birchip Cropping Group, Central West Farming Systems Group, York Peninsula Alkaline Soils Group, Ag Consulting Company, LANDMARK - Cummins and Lincoln Rural Supplies – Cummins.

Key Messages

- **With all strategies, the level of control and economic yield response depends on the level of varietal resistance, disease pressure, crop growth stage, yield potential and seasonal conditions.**
- **Genetic resistance is the most outstanding form of stripe rust control, as susceptible varieties with high disease pressure can face yield reductions as high as 75%.**

Fungicide Amended Fertilisers and Seed Treatments:

- The higher the yield potential (greater than 3 t/ha), the higher the likelihood to get economic responses to early season treatments.
- Early season treatments provide options for early control especially if the risk of early infection is high, i.e. stripe rust has oversummered near by. Differences between seed treatments and fertiliser treatments are inconsistent, and their use may depend on ease of use, cost and safety.
- Using an up front seeding fungicide still requires monitoring of crops for stripe rust, as a follow up foliar fungicide may be needed.
- Seed treatments can provide protection for up to eight weeks (end of tillering).
- Fluquinconazole seed treatment appears to last longer than other seed treatments and may extend for a similar period as fertiliser treatments.
- Low rates of fluquinconazole, (300 ml/ 100kg) gave the same protection as the recommended rate, (450 ml/ 100kg) however it is unlikely to control take all.
- Fungicide amended fertilisers can provide control for up to sixteen weeks (early boot formation).
- Flutriafol fertiliser treatment appears to last longer than triadimefon products.

Foliar Fungicides

- An early spray done on time is more important than fungicide choice at stem elongation. All reduce the percentage leaf area infected with pustules.
- Triadimefon rates need to be at least 1 L/ha, as lower rates were subject to reinfection approximately eighteen days later.
- A longer period of retained green leaf area using epoxiconazole, was not seen in six New South Wales trials.
- Trials at Birchip and Yorke Peninsula indicated that azoxystrobin/cyproconazole foliar treatments at 200 ml/ha gave effective control and protection.

Late Foliar Fungicides

- Spraying to control stripe rust inside the head is a waste of money, as there is no opportunity for the chemical to get inside and it can not translocate across the glumes surrounding the grain.
- Spraying Yitpi late in the season (from flowering through to the soft dough stage), has not led to significant yield increases or quality improvements.

Table 1:Variety and stripe rust trial at Lock, 2005.

Variety	Stripe Rust Rating	Screenings (%)	Grain Yield (t/ha)
Pugsley	R *	0.5	3.0
Kukri	MR	0.9	2.1
Yitpi	MR/MS	0.8	2.8
Frame	MR/MS	0.5	2.9
Wyalkatchem	MS/S	0.5	2.5
Krichauff	S	1.5	2.0
Westonia	VS	1.5	1.6

***** Rating for WA strain*

Screenings

- The effect of stripe rust on screenings depends on varietal susceptibility, and the yield potential leading to grain filling with the protection of green leaf (i.e. higher the potential yield, the greater the effect on grain quality).
- The following replicated variety trial conducted by LANDMARK-Cummins at Lock, was not sprayed for stripe rust, which had high stripe rust pressure starting from early boot formation. There was no large effect on screenings however there was a large effect on yield.

General Observations/Thoughts

- Up front protection is a strategy to be given more weight if boggy conditions prevent foliar application.
- Triadimefon addition to fertiliser is not registered in South Australia. Farmers have however suggested that their crops are very even, and that it may be controlling some other root or leaf disease.
- In low yielding environments (less that 2 t/ha) it appears that the best option to control stripe rust is a strategic timely foliar fungicide spray.
- The additional suppression of some root diseases (eg. Take -all) by some fungicides maybe a factor in selecting a particular stripe rust control strategy.

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Foliar spraying pays off

Demo

Neil Cordon
SARDI, Minnipa Agricultural Centre

Best practice

Location
Tuckey - Adam & Rex Crosby

Rainfall
Av Annual: 322 mm
Av GSR: 245 mm
2005 Total: 356 mm
2005 GSR: 306 mm

Yield
Potential: 3.9 t/ha

Soil Type
White, siliceous sand over clay.

Key Messages

- **Monitor paddocks regularly and be prepared to use fungicides in crop to control stripe rust.**
- **Fungicide protection of stripe rust on susceptible varieties is a practical and profitable option.**
- **To reduce yield losses from outbreaks of stripe rust foliar fungicides need to be applied early.**

Why do the trial?

To evaluate the effectiveness of a foliar fungicide application for stripe rust control.

The Crosby family at Tuckey sprayed to control stripe rust and left an area of a paddock unsprayed. Part of each section was harvested and the grain weighed with the Minnipa Agricultural Centre weigh bin to determine the yields.

How was it done?

The paddock was sown on the 10th June to Westonia wheat at 70 kg/ha with 19:13:0 fertiliser, applied at 70 kg/ha. On the 24th of September, the crop was sprayed with AURORA 250EC® (propiconazole) at 300 ml/ha for stripe rust control. The water rate was 80 L/ha.

Table 1: Grain yield, quality and gross income for fungicide demo at Tuckey, 2005.

Treatment	Protein (%)	Screenings (%)	Test Weight (kg/hL)	Grain Yield (t/ha)	Gross Income ($/ha)
No Spray	12.5	4.3	61	1.17	116
Fungicide	11.0	2.1	72	1.98	177

What happened?

The yields were only 51% of potential with late sowing, stripe rust and frost limiting yields. The fungicide spray produced and extra 0.81 t/ha of grain and $61/ha extra income *(Table 1)*.

Both samples were frost affected and were classified as feed quality. Grain was priced at $99/t. However, due to low test-weights, the nil treatment should have been discounted further.

What does this mean?

This farmer demonstration shows the economic yield advantage from controlling stripe rust with a foliar fungicide. The farmer commented that their timing was approximately ten days later than ideal, due to delays in getting the plane. This demonstration supports other research that fungicide sprays need to be early and timely to achieve optimum stripe rust control and maximise yield responses.

Acknowledgements

Adam and Rex Crosby for the wisdom to obtain yield data.

AURORA 250EC® - registered product of Farmoz.

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Searching for answers

Location
Wharminda Ag Bureau

Rainfall
Av. Annual total: 306 mm
Av. GSR: 235 mm

Yield
Actual: 1.2 t/ha to 1.9 t/ha

Soil
Land System: Dune swale
Major soil type description: Siliceous sand over clay

Diseases
Crown rot hopefully

Plot size
20 m x 1.5 m

Other factors
Copper deficiency is an issue in the trial area. Barley grass, brome grass and ryegrass were present in patches through the trial, with some wild oats present also. Late start, poor early rains and a reasonable finish from early grain fill. Lack of stress during grain fill meant minimal development of crown rot symptoms.

Crown rot management trials on EP

Research

Margaret Evans and Hugh Wallwork
SARDI, Plant Research Centre, Waite Campus

Key Messages

- **Grass free pasture generally will not increase soil levels of crown rot.**
- **Wheat after two years of pasture (the first year grass free) yielded best.**
- **Cereal/pasture rotational options are unlikely to be a good management tool for reducing soil levels of crown rot on Eyre Peninsula, unless a number of grass free pasture years are used and this is unlikely to be economic.**

Why do the trials?

To assess the effects of crop type and rotation on crown rot development and survival on eastern EP.

Crown rot is an increasing problem with closer cereal rotations and increased stubble retention. Yield and quality are generally worst affected where there is adequate moisture at the start of the season followed by moisture stress at the end of the season. This means crown rot control will be assisted by development of rotations which avoid inoculum build up and development of crop management strategies which reduce moisture stress at the end of the season.

How was it done?

This trial was in its third and final year in 2005, with wheat sown over all plots to allow comparison of disease expression after the different rotation treatments. Soil samples, disease scores and harvest details were taken for all plots.

Disease scoring scale for main stems:

0 No visible signs of crown rot.
1 Some discolouration on first internode.
2 First internode significantly discoloured, with or without minor second internode discolouration.
3 First internode completely discoloured, second and third internodes significantly discoloured.
4 Internodes completely discoloured.
5 Internodes very darkly discoloured and shrivelled.

The trial was sown on 16th June (Wyalkatchem at 50 kg/ha) with 50 kg/ha DAP (18:20) and was harvested on 11th December.

What happened?

Crown rot symptoms were minimal during 2005, with average disease scores ranging from 1.05 to 1.16. There were no significant differences between rotation treatments. Wyalkatchem yielded best after a two year pasture break, with no significant differences in yields after the other rotation types.

There were no significant differences in soil inoculum levels between treatments. Soil inoculum levels were highly variable from plot to plot and this may have masked differences between treatments. Because of this variability, median (not mean) values are presented and trends are discussed rather than significant differences. Continuous cropping increased soil levels of crown rot, while before and after a grass free pasture, crown rot levels generally remained about the same or increased slightly.

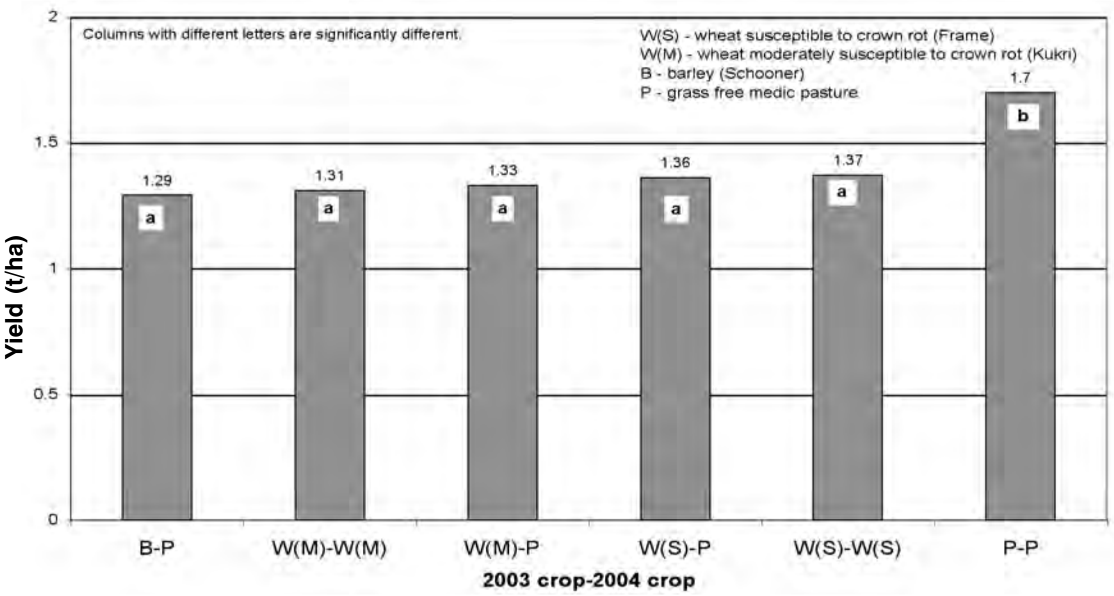

Figure 1: Rotation effects on 2005 yield of Wyalkatchem wheat.

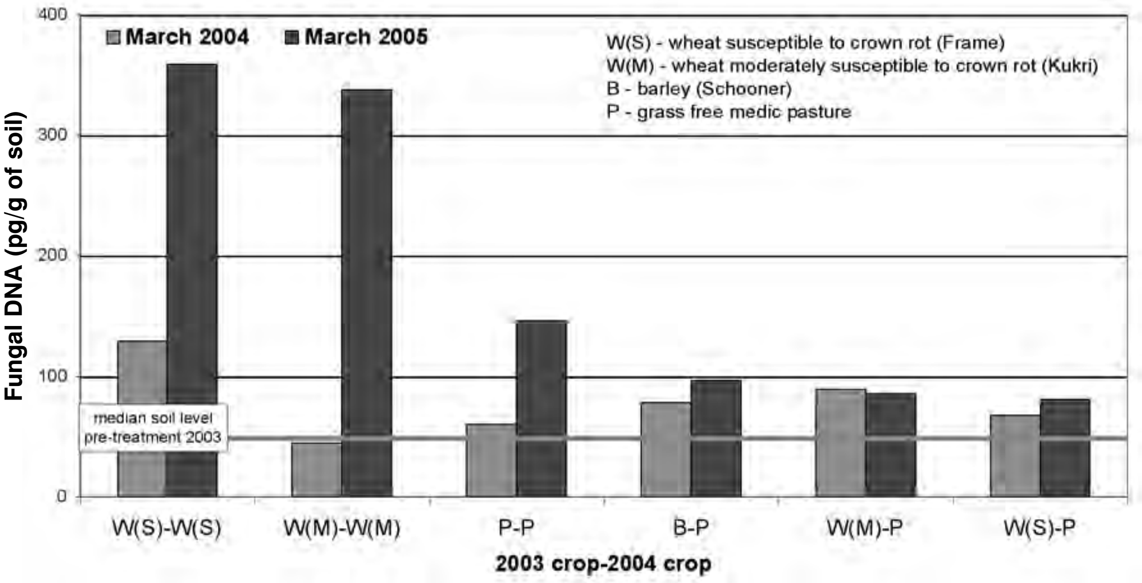

Figure 2: Median soil levels of Fusarium pseudograminearum after different rotations.
Low crown rot risk for bread wheat, high risk for durum: 0-100 pg DNA/g soil.
Medium crown rot risk for bread wheat: 100-300 pg DNA/g soil.
High crown rot risk for bread wheat: more than 300 pg DNA/g soil.

What does this mean?

As expected, continuous cereal seemed to build soil levels of crown rot more than rotations including a grass free pasture phase. However, grass free pasture did not result in a reduction of crown rot levels, possibly due to the slow break down of cereal stubble (which hosts the crown rot fungus) under the dry conditions common at Wharminda. This indicates the cereal/pasture rotational options commonly used on Eyre Peninsula are unlikely to significantly reduce soil levels of crown rot. A number of grass free pasture years may be effective, but this is unlikely to be economic.

This year we will be reconsidering the crown rot research program on Eyre Peninsula. The program is likely to include sampling paddocks and existing trials and perhaps a trial to examine effects of timing and rates of nitrogen application. We are particularly interested in the aspects of stubble breakdown and how grassy weeds affect disease build up. If you have any suggestions for future crown rot management research on Eyre Peninsula, please contact Margaret Evans on 8303 9379.

Acknowledgements:

This work was funded by GRDC and would not have been possible without the assistance of Michael Bennet (Minnipa Agricultural Centre) and Jose Alvarado (Plant Research Centre). The SARDI Diagnostic Group provided support in testing soil samples.

Grains Research & Development Corporation

Disease

Research

Searching for answers

Seed treatments for *Rhizoctonia* control

Joanne Crouch[1], Brian Purdie[1] and Claire Daniel[2]
SARDI, Port Lincoln[1] and Chemtura Australia Pty. Ltd.[2]

Key Messages

- **Fungicide seed treatments reduced visual root damage symptoms in wheat at one of two trial sites in 2005.**
- **Despite reduced Rhizoctonia root damage, grain yield was not increased. Reliable use of fungicide seed treatments for suppression of Rhizoctonia has still to be demonstrated.**

Why do the trial?

Previous research on *Rhizoctonia*, reported in the *EPFS 2004 Summary (pages 77-78)*, has confirmed the major importance of this disease on Eyre Peninsula. Grain yield losses of up to 60% in heavily infected paddocks have been attributed to *Rhizoctonia*, highlighting the need for effective management strategies. The fungicides carboxin and thiram are widely used throughout Europe and USA for *Rhizoctonia* control, and these are available locally in the registered product Anchor®. Trials were carried out to therefore to determine the effectiveness of Anchor® seed treatments on wheat for the suppression of *Rhizoctonia*.

How was it done?

Trials were conducted adjacent to NVT trials at Wharminda and Elliston. Wyalkatchem wheat was sown at both sites treated with varying rates of Anchor® and a comparison of Dividend™ seed treatments and an untreated control, as

Searching for answers

Location
Elliston
Nigel and Debbie May

Rainfall
Av. Annual: 410 mm
Av GSR: 340 mm
2005 Total: 447 mm
2005 GSR: 367 mm

Potential Yield
Potential: 5.1 t/ha

Paddock History
2004: Pasture
2003: Barley
2002: Barley

Soil Type
Highly calcareous loamy sand, pH(water) 8.5

Plot size
1.5m x 10m x 3 replicates

Location
Wharminda - Peter Forrest and Dave Herron

Rainfall
Av. Annual: 320 mm
Av GSR: 258 mm
2005 Total: 317 mm
2005 GSR: 273 mm

Yield
Potential: 3.3 t/ha

Paddock History
2004: Wheat
2003: Pasture
2002: Barley

Soil Type
Non-wetting sand over a sandy clay, pH(water) 6.8

Plot size
1.5m x 10m x 3 replicates

Yield limiting factors
Late sowing, moisture stress at Wharminda.

Table 1: Grain yield of Wyalkatchem wheat with fungicide seed dressings in 2005.

Treatment	Active Constituent	Wharminda	Elliston
(Rates per tonne seed)	(g/L)	Yield (t/ha)	Yield (t/ha)
Control (untreated)		0.66	1.76
Anchor® @ 2.5 L	Carboxin 200 g + Thiram 200 g	0.61	1.72
Anchor® @ 4.0 L	Carboxin 200 g + Thiram 200 g	0.62	1.64
Anchor® @ 5.0 L	Carboxin 200 g + Thiram 200 g	0.66	1.65
Dividend™ @ 1.3 L	Difencoazole 92 g + Metalaxyl-M23 g	0.64	1.69
Site mean		0.64	1.69
LSD		0.08	0.10

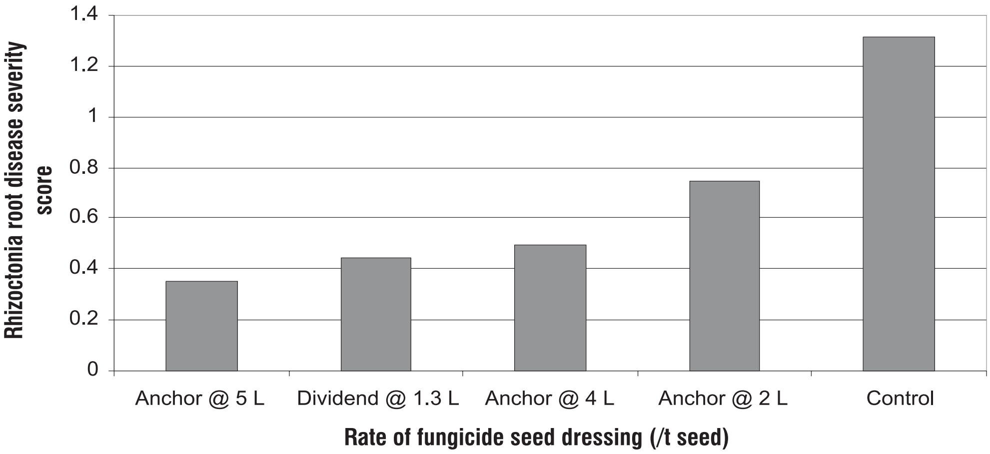

Figure 1: Rhizoctonia root disease severity score on Wyalkatchem wheat with fungicide seed dressings at Wharminda in 2005.

detailed in *Table 1*. Wharminda was sown on June 20 at a rate of 70 kg/ha and Elliston on June 23 at 75 kg/ha. Both trials received a fertiliser application of 23:16:0 + 2.5% Zn drilled with the seed at the rate of 100 kg/ha. Post-emergence visual scores of above-ground symptoms (bare plot score) and *Rhizoctonia* root disease severity, based on the TOPCROP crop monitoring system (0=no damage, 3=severe damage), were recorded at each site in early August, 8 weeks after sowing. Grain yield data were also recorded at both sites.

What happened?

Low disease levels at Elliston resulted in negligible damage and caused no visual disease effects either above ground or in root growth. Thus no differences in final grain yields were observed (*Table 1*).

At Wharminda no above ground visual responses were observed, although crop growth was poorer than expected across all treatments. However early visual responses were apparent in root growth. Early root growth scores showed that all fungicide treatments significantly reduced the level of root damage compared with the control plots (*Figure 1*). The highest rate of Anchor® (5 L/t of seed) showed the healthiest root systems. However these early root growth differences did not carry through to final grain yield, which was the same for all treatments (*Table 1*). A DNA root analysis at Wharminda confirmed a moderate level of *Rhizoctonia* organisms, with other diseases being low.

What does this mean?

Although the use of fungicide seed treatments reduced early visual root damage symptoms at Wharminda, this did not carry through to final grain yields. The mild spring conditions in 2005 may have allowed the wheat plants in all treatments to produce similar amounts of grain, despite the impaired root systems on untreated plants.

Wheat yields at both sites were well below the French and Schultz potential, largely due to the later than optimum sowing. Wharminda also experienced moisture stress in the early stages of crop growth. The sandy soil types at both sites are generally considered to be better suited to barley production than wheat. This was borne out by the 2005 experience with Elliston and Wharminda averaging 1.86 t/ha and 2.35 t/ha respectively, consistently out yielding the wheat at both sites.

The effectiveness and reliability of fungicide seed dressings as suppression strategies for *Rhizoctonia* in wheat remains to be shown.

Acknowledgements

Scott Lane and Claire Daniel of Chemtura Australia Pty. Ltd. for supplying the product and assisting with trial monitoring.

Nigel and Debbie May, Peter and Annie Forrest and Dave Herron for making their land available for these trials. Dividend® is a registered product of Syngena and Anchor® is a registered product of Chemtura.

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Dividend™ demo's

Neil Cordon
SARDI, Minnipa Agricultural Centre

Key Messages

- **The seed dressing, Dividend™ does not control Rhizoctonia but offers some suppression capabilities, which can lead to economic yield increases.**
- **Seed dressings should not be relied on to control Rhizoctonia.**
- **The role of Dividend™ in the control of Pythium needs to be investigated further in its interactions with other diseases.**

Why do the trials?

To determined the effect of the seed dressing, Dividend™ on the root disease Rhizoctonia and Take all and grain yield in cereals.

Syngenta Crop Protection Pty. Ltd. released their seed dressing, Dividend™ in 2004, registered in Australia to control Pythium, Flag Smut and Loose Smut in wheat and seed borne Net Blotch, Covered Smut and Loose Smut in barley.

The active ingredient of Dividend™ is Difenoconazole and Metalaxyl - M.

Previous articles *(EPFS 2004, page 78)* suggested that yield improvements due to Dividend™ were inconsistent and no difference in Rhizoctonia root damage between treated and untreated treatments. Emergence after 21 days was also not affected by the use of Dividend™.

How was it done?

Sites were selected at Streaky Bay and Mount Cooper where single demonstration strips were sown to Sloop SA barley. A control strip of Foliarflo® at 1.5 ml/kg seed was sown adjacent to seed treated with Dividend at 1.3 ml/kg seed at both sites.

The Streaky Bay site was sown on the 20th June 2005 to Sloop SA at 70 kg/ha with 18:20 fertiliser at 85 kg/ha.

Measurements here included pre sowing DNA root disease test, post emergent root disease scoring, grain yields and quality.

At Mount Cooper the plots were sown dry on the 7th July 2005 to Sloop SA at 75 kg/ha with 38 kg N/ha and 16 kg P/ha. Only grain yield and quality measurements were recorded at this site.

What happened?

Pre-sowing root DNA analysis indicated low levels of all diseases except for Rhizoctonia where risk levels were rated as medium at Streaky Bay. There was also little difference in the post emergent root score Rhizoctonia infection between the treatments, however, visually the Dividend™ strip appeared to have less expression of disease.

The Mount Cooper site showed better early growth (up to head emergence) on the Dividend™ treated strip. At both sites there was no influence on grain quality as both treatments went malt one (Mount Cooper) and malt three (Streaky Bay).

The Dividend™ treatment produced an extra $17/ha (Mount Cooper) and $40/ha (Streaky Bay), *Table 1*.

Plant counts at Streaky Bay showed higher numbers (172/m²) for the Dividend™ treatment compared to the Foliarflo® of only 150/m².

What does this mean?

The yield and financial gain from using a seed dressing like Dividend™ provides confidence for farmers to use such a product especially where Rhizoctonia is a major root disease. The jury is still out as to whether the yield response is due to suppression of Rhizoctonia or reduction of Pythium levels.

The influence of Pythium in cereals on Upper Eyre Peninsula should be evaluated in future research.

Replicated trials conducted by Jo Crouch (SARDI Pt Lincoln) during 2005, page 81 evaluated a range of seed dressings for Rhizoctonia control on wheat with no grain yield increase in this season.

Acknowledgements

Lyndon May of Syngenta Crop Protection for supplying the product and assisting in plant monitoring.

Phillip Wheaton and Craig Kelsh for conducting demos and providing the land.

Dividend™ - registered trademark of Syngenta Crop Protection Pty. Ltd.

Foliarflo® - registered product of Crompton.

Table 1: Barley yields and gross income at Mount Cooper and Streaky Bay, 2005.

Treatment	Mount Cooper			Streaky Bay		
	Treatment ($/ha)	Yield (t/ha)	*Gross Income ($/ha)	Treatment ($/ha)	Yield (t/ha)	*Gross Income ($/ha)
Dividend	3.71	3.0	451	3.46	2.9	392
Foliarflo	4.84	2.9	434	4.51	2.5	352

Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005

Try this yourself now

Location
Witera - Craig & Nick Kelsh
Mount Cooper Ag Bureau

Rainfall
Av Annual: 350 mm
Av GSR: 270 mm
2005 Total: 332mm
2005 GSR: 294mm

Yield
Potential (B): 4.1 t/ha

Paddock History
2004: Peas
2003: Wheat
2002: Pasture

Soil Type
Reddish brown loam

Location
Streaky Bay - Phillip Wheaton
Streaky Bay Ag Bureau

Rainfall
Av Annual: 298 mm
Av GSR: 243 mm
2005 Total: 413 mm
2005 GSR: 341 mm

Yield
Potential (B): 5.0 t/ha

Paddock History
2004: Medic Pasture
2003: Wheat
2002: Grassy Pasture

Soil Type
Grey calcareous sand.

Yield Limiting Factors
Late sowing

Disease suppression - what is it?

Searching for answers

Research

Amanda Cook[1], Alison Frischke[1] and David Roget[2]

SARDI, Minnipa Agricultural Centre[1], CSIRO Sustainable Ecosystems, Adelaide[2]

Key Messages

- **Disease suppression is the ability of the soil microbial population to compete with and inhibit plant pathogens such as *Rhizoctonia* and Take-all.**
- **MAC paddock N12 showed good levels of disease suppression using a bioassay and will be used as a control soil.**

Why do the trial?

Soil microbes play a very important role within our farming systems by breaking down stubble, changing nutrients into a form which plants are able to use and improving soil structure by forming aggregates or glues. These glues hold soil together providing soil stability and influence the soil physical structure such as water infiltration. Soil microbes also breakdown herbicides and pesticides that are applied to our crops.

Soil microbes can also help to control diseases within our soils. Disease suppression is the ability of the soil microbial population to compete with and inhibit plant pathogens such as *Rhizoctonia* and Take-all. The disease suppressive activity in the soil will depend on the activity of the microbial population and the composition.

Trials by David Roget and Gupta at Avon showed the level of disease suppression can be changed by management practices *(Roget and Gupta, GRDC 2005 Update, Southern Region)*. Management practices to increase disease suppression included full stubble retention, limited grazing and higher nutrient inputs to meet crop demand, which also increased plant water use efficiency. These management practices increased carbon input to the soil, which is the food source of the microbes, and changed the activity and composition of the microbial population.

Soil was collected from several paddocks on EP to determine if we had the ability to run bioassays (or experiments) to assess the level of disease suppression in soils at MAC.

How was it done?

During the last nine months three bioassays were run, each taking six weeks within the growth room at MAC. The bioassay involve taking topsoil (0-10cm) from paddocks, placing it into containers with three treatments, (Nil, added *Rhizoctonia*, added *Rhizoctonia* and a carbon source) which were watered and kept at 10-12°C, with a 12-hour light/dark regime for two weeks. Five wheat seedlings were then planted in each pot and grown for another four weeks, then washed and the root disease levels scored. The bioassay gives an indication of the ability of the microbial population in the soil to respond to added carbon and compete with the pathogen, therefore lowering the level of disease on the seedlings.

What happened?

The first bioassay at MAC was run concurrently with a bioassay at CSIRO, in Adelaide, and similar results were achieved although the watering regime at MAC needed to be increased as the plants were water stressed. The MAC paddock N12 (continuously cropped) showed good levels of disease suppression so will be used as a control for the bioassay in the future. The bioassay works well on red soils but has not been used widely on grey soil types. The second bioassay included several grey soils and a nutrient mix was also added as a treatment, although this had no effect on the final result. The third bioassay, with good reproduction of the results again confirmed our confidence to run the bioassay on a large number of soils this year.

What does this mean?

As part of the Eyre Peninsula Farming Systems Project we want to determine the current level of disease suppression that exists in soils on Eyre Peninsula and assess the opportunities to improve current levels. This year we plan to conduct a survey and use the bioassay on different soils and farming systems over Upper EP. We hope to identify if disease suppression is present, on what soil types, and under what type of farming system.

Acknowledgements

Thank you to SAGIT and GRDC for funding this project. Thanks to John Coppi for answering lots of questions, and Nigel Wilhelm for his input and ideas. A big thank you to Wade Shepperd for collecting soil, and helping set up and maintain the bioassays.

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CSIRO

SAGIT

Long term disease suppression trial at Streaky Bay

Amanda Cook[1], Alison Frischke[1] and David Roget[2]

SARDI, Minnipa Agricultural Centre[1], CSIRO Sustainable Ecosystems, Adelaide[2]

Searching for answers

Location
Streaky Bay - K, D and K Williams
Streaky Bay Ag Bureau

Rainfall
Av. Annual: 298 mm
Av. GSR: 243 mm
2005 Total: 289 mm
2005 GSR: 259 mm

Yield
Potential: 3.3 t/ha
Actual: 0.8 to 2.4 t/ha

Paddock History
2004: Barley - Keel
2003: Brassica - Rivette, Wheat - Excalibur
2002: Grassy pasture

Soil
Highly calcareous grey loamy sand

Plot size
60m x 1.48m

Other factors
Late break to season, moisture stress, grass and Lincoln weed competition

Key Messages

- **Before seeding the *Rhizoctonia* inoculum levels were lower after canola than after wheat, using the DNA based root disease testing service (RDTS).**
- **Including a Brassica in the system may lower the gross margin in the year of the canola phase but the advantage in the following cereal crop is significant.**

Why do the trial?

Trials at Avon by David Roget showed that management practices can influence the development of disease suppression (*Roget and Gupta, GRDC Update, Southern Region 2005*). Full stubble retention, limited grazing and high nutrient inputs have led to increased disease suppression. Including Brassica species within the rotation has also lowered disease inoculum levels. A long term trial was established at Streaky Bay last year to determine if disease suppression is achievable and whether soil microbial populations can be influenced by rotation and inputs, in a grey calcareous soil.

How was it done?

The trial was established in 2004 and was sown into a grassy pasture with 8 kg/ha zinc sulphate applied and worked in before seeding. In 2005 the trial was sown on 24th June with a knock-down of 1 L/ha of Roundup®, 1 L/ha Treflan® and 100 ml/ha Hammer® pre-seeding and 5 gms/ha of Ally® later in the season to control Lincoln weed.

The root disease inoculum was measured using DNA-based bioassays at the start of the season, and root disease was visually scored six weeks after sowing. Plant dry matter and yield data were also collected.

What happened?

The rhizoctonia inoculum levels prior to seeding were lower after canola than after wheat (*Table 2*), which supports results found by Alan McKay and Leon Mudge through long term RDTS at Miltaburra (*EPFS Summary 2004, pg 75*). The visual root disease score showed less *Rhizoctonia* damaged barley plants grown after canola than after wheat. The DNA bioassay also showed *Pratylenchus neglectus* numbers increased under the canola rotation although this hasn't affected grain yields in this trial. The *Rhizoctonia* damage on barley roots early in the season, were visually assessed and whilst

Table 1: Rotations and treatments used in the trial.

Rotation	Fertiliser	2004	2005
District Practice	14 kg P/ha and 16 kg N/ha applied as DAP @ 60 kg/ha	Excalibur Wheat @ 55 kg/ha	Keel Barley @ 60 kg/ha
Intensive Cereal District Practise Inputs	16 kg P/ha applied as MAP @ 60 kg/ha	Excalibur Wheat @ 55 kg/ha	Keel Barley @ 60 kg/ha
Intensive Cereal High Inputs	20 kg/ha P applied as APP, 18 kg/ha N as UAN and TE (Zn, Mn, Cu)	Excalibur Wheat @ 55 kg/ha	Keel Barley @ 60 kg/ha
Brassica Break District Practise Inputs	MAP @ 60 kg/ha	Rivette Canola @ 5 kg/ha	Keel Barley @ 60 kg/ha
Brassica Break High Inputs	20 kg/ha P applied as APP, 18 kg/ha N as UAN and TE (Zn, Mn, Cu)	Rivette Canola @ 5 kg/ha	Keel Barley @ 60 kg/ha

Table 2: The root disease inoculum levels measured by DNA-based bioassays and RDTS risk rating at the start of the 2005 season (BDL = Below Detection Level).

Rotation	Rhizoctonia	Take-all	Common root rot	Pratylenchus neglectus	Prat. thornei	Fusarium pseud.	CCN
District Practice	High (114.5)	Low (27.2)	Low (144)	Low (13)	Low (4)	Low (40)	BDL
Intensive Cereal District Practise Inputs	High (120)	Low (36)	Low (200)	Low (17)	Low (3)	Low (30)	BDL
Intensive Cereal High Inputs	High (105)	Low (48)	Low (208)	Low (14)	Low (3)	Low (87)	BDL
Brassica Break District Practise Inputs	Medium (57)	Low (22)	Medium (375)	Medium (60)	Low (1)	Medium (199)	BDL
Brassica Break High Inputs	Low (40)	Low (21)	Low (245)	High (65)	Low (3)	Low (119)	BDL
LSD ($p<0.05$)	36.4	*NS	NS	NS	NS	NS	NS

NS = non-significant

Table 3: Measurements taken during the 2005 season.

Rotation	2005 Rhizoctonia Root scores (0-5)	2005 DM (g/plant) 16 Aug	2005 Weed Score (0-9)
District Practice	2.9	0.20	7.0
Intensive Cereal District Practise Inputs	2.9	0.17	7.0
Intensive Cereal High Inputs	2.8	0.26	6.0
Brassica Break District Practise Inputs	2.5	0.24	2.0
Brassica Break High Inputs	2.5	0.45	2.0
LSD (p<0.05)	NS	1.60	1.4

Table 4: Yield, Input Costs and Gross Margins

Rotation	2004 Yield (t/ha)	Input Costs ($/ha)	2004 GM ($/ha)	2005 Yield (t/ha)	Input Costs ($/ha)	2005 GM ($/ha)	Overall GM ($/ha)
District Practice	1.33 Excalibur Wheat	78.10	108.10	0.88 Keel Barley	60.15	50.73	158.83
Intensive Cereal District Practise Inputs	1.39 Excalibur Wheat	78.10	116.5	0.81 Keel Barley	60.15	41.91	158.41
Intensive Cereal High Inputs	1.82 Excalibur Wheat	248.26	6.54	1.16 Keel Barley	230.31	-84.15	-77.61
Brassica Break District Practise Inputs	0.43 Rivette Canola	120.8	9.06	2.08 Keel Barley	60.15	201.93	210.99
Brassica Break High Inputs	0.56 Rivette Canola	290.96	-121.84	2.43 Keel Barley	230.31	75.87	-45.97
LSD (p<0.05)	0.16			0.16			

GM calculated using prices - Wheat $140/t and Canola $302/t for 2004 season, and Barley $126/t for Feed 1 in 2005.

there were no stastically significant differences between treatments (*Table 3*) the canola treatments consistently gave lower root damage levels of around 14%. This result was consistent with the RDTS bioassay result.

It was found that the yield of barley after canola was more than twice that after wheat. As well as disease benefits, the value of canola prior to barley was also due to improved grass control by using grass free chemicals in the canola phase, hence lower grassy weed pressure (*Table 3*).

Using high rates of fluid fertilisers increased yields in both seasons. The fluid fertiliser used in this trial aimed to push the system to a higher level rather than be economical which is reflected in the overall gross margin. Plant tissue tests, taken to establish any trace element deficiencies showed that most nutrient levels were adequate, except for manganese which was low across all treatments.

The gross margins show that including a Brassica in the system lowers the gross margin in the year that it is grown but it's advantage to the following cereal crop is significant (*Table 4*).

What does this mean

The reason for the lower *Rhizoctonia* inoculum levels after the canola phase compared to cereals needs further investigation in future trials. This trial is still in the early stages and will be sown and monitored for disease levels and disease suppression in the future.

Acknowledgements

Thank you to SAGIT and GRDC for funding this project. Thanks to Ken, Dion and Kym Williams for allowing us to have trials on their property, and thanks to Wade Shepperd for all his help this year.

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Brassicas and *Rhizoctonia* at Miltaburra

Amanda Cook
SARDI, Minnipa Agricultural Centre

Searching for answers

Location
Closest town: Miltaburra
Cooperator: L,M, C & D Mudge

Rainfall
Av Annual: 306 mm
Av GSR: 212 mm
2005 Total: 316 mm
2005 GSR: 270 mm

Yield
Potential: 2.4 t/ha
Actual: 0. 1-0.3 t/ha canola

Paddock History
2005: Safflower/Canola trial
2004: Wheat
2003: Wheat

Soil
Grey calcareous soil

Diseases
Rhizo we hope!

Plot size
12m x 5 reps

Key Messages

- **Previous results at Miltaburra strongly suggest that canola in the rotation can reduce *Rhizoctonia* levels.**
- ***Rhizoctonia* inoculum levels and root disease testing in-crop during 2005 supports this.**

Why do the trial?

This trial was conducted to investigate the role of Brassica species on the incidence of *Rhizoctonia* in an environment where root diseases are a major constraint. Alan McKay and Leon Mudge had some very interesting results from the farm of the Mudge family at Miltaburra (*EPFS Summary 2004, pg 75*) which strongly suggest that canola or forage brassicas in the rotation markedly reduce *Rhizoctonia* inoculum levels. These observations will be investigated with field trials to test the impact of Brassica options, varieties and management, on root disease levels in the following cereal crop. Root diseases in the cereal crop will be monitored using the RDTS soil analysis and plant root scores.

How was it done?

Brassica Trial

In the first year of this trial a large selection of management and rotation options were established. The trial was sown on the 23rd June with 70 kg/ha of 17:19 and 50 kg/ha urea. Chemicals used were 1 L/ha of Roundup®, 1 L/ha Treflan® and 100 ml/ha Hammer® pre-seeding. Post seeding the trial received 800 ml/ha Simazine®, 1 L/ha Lorsban® and 100 ml/ha Fastac Duo®.

The rotational options in this trial included high and low glucosinolate mustards, canola varieties (Stubby, Rivette and Eyre), vetch, wheat and a chemical fallow.

The management options in canola (Stubby) included early and late removal of grasses, no grass control, Terrachlor, Apron® and Maxim XL® seed dressings. Fertiser treatments included fluid and granular with or without trace elements.

The root disease inoculum was measured using the Root Disease Testing Service (RDTS) at the start of the season, plant dry matter and yield data were also collected.

In Crop Monitoring

Root disease inoculum levels were monitored in two commercial wheat crops at Miltaburra; wheat following wheat and wheat following canola. This was to follow up on the initial monitoring that Leon Mudge and Alan McKay had already undertaken on this farm which suggested that brassicas are suppressing root diseases. DNA-based bioassays were taken seven times during the season; pre-seeding, post-seeding, one month post-seeding, early spring, mid spring, late spring and harvest. Root disease infection was also estimated by root scores in early spring to complement the RDT bioassays.

What happened?

Brassica Trial

Initial RDTS score levels showed high level of *Rhizoctonia* in the trial area. Grain production was very low, due to wind or galah damage to the canola in spring (many pods were on the ground), and therefore yields were only between 100-300 kg/ha. There were no differences in grain yield between treatments probably due to the low yield. DNA inoculum levels will be measured at the start of this season.

In Crop Monitoring

Disease inoculum levels were measured using the RDTS and show initial *Rhizoctonia* levels were higher in wheat following wheat than wheat following canola (*Table 2*). By early spring the inoculum levels of *Rhizoctonia* had increased to similar levels regardless of the previous crop. Root scores were used to estimate the average root disease infection early spring, and were 3.3 for wheat on wheat and 2.4 for wheat on canola.

The CCN levels were higher in wheat on wheat compared to wheat on canola as expected. The higher *Pratylenchus neglectus* levels after canola compared to wheat early in the season was not expected as canola is a good host for *P. neglectus*, but no better than wheat, and this may be possibly due to the Rhizoctonia affect on the wheat crop.

What does this mean?

The trial will be sown to barley, a very susceptible crop to *Rhizoctonia*, to determine if the treatments have affected disease levels. *Rhizoctonia* infection will be estimated in the barley crop, root disease inoculum levels will be estimated by DNA-based bioassay, and final yield measured. The first year of a new trial of similar design to the rotation and

Table 1: The root disease inoculum levels measured by DNA-based bioassays and RDTS risk rating at the start of the 2005 season.

Rotation	Rhizoctonia	Take-all	Common root rot	Pratylenchus neglectus	Pratylenchus thornei	Fusarium pseud.	CCN
District Practice	High (132)	Below Detection Level	Low (18)	Low (16)	Below Detection Level	Below Detection Level	High (15)

Disease

Table 2: The root disease inoculum levels measured in different rotations by DNA-based bioassays and RDTS risk rating during the 2005 season. (BDL = Below Detection Level)

Rotation	Date	Rhizoctonia	Take-all	Common root rot	Pratylenchus neglectus	Fusarium pseud.	CCN
Wheat on Canola	23 June	Med. (41)	Low (27.2)	Low (250)	Low (4)	Low (10)	BDL
	30 June	BDL	Low (35.5)	Low (272)	Low (8)	Low (8)	BDL
	27 July	BDL	BDL	Med. (348)	Low (3)	BDL	BDL
	2 Sept	High (166)	BDL	Low (71)	Low (4)	BDL	BDL
	20 Sept	High (151)	BDL	Low (110)	Low (10)	BDL	BDL
	19 Oct	High (140)	BDL	Low (67)	Low (10)	BDL	Low (1)
	20 Nov	High (139)	BDL	Med. (405)	Low (1)	BDL	Low (1)
Wheat on Wheat	23 June	High (154)	BDL	Low (220)	Low (10)	Low (8)	Med. (6)
	30 June	High (118)	BDL	Low (119)	Med. (22)	Low (3)	Low (4)
	27 July	High (109)	BDL	High (724)	Low (1)	BDL	Med. (6)
	2 Sept	High (150)	BDL	Low (223)	Low (3)	BDL	Low (3)
	20 Sept	High (148)	BDL	Low (188)	Low (14)	BDL	Low (2)
	19 Oct	High (151)	BDL	Low (126)	Low (5)	BDL	BDL
	20 Nov	Med. (52)	BDL	Low (272)	BDL	BDL	BDL

management trial will also be set up and conducted in 2006 so that it can be completed in 2007.

Previous results at Miltaburra strongly suggested that canola in the rotation can reduce *Rhizoctonia* inoculum levels, leading to a one year increase in wheat yield following a canola crop, which is supported by the RDTS in-crop monitoring last season.

We are still not certain what is causing the canola and *Rhizoctonia* interaction, so further research is needed to determine if it due to a short term change in the soil microbiology or related to the amount of root mass during spring. A canola crop may have less root material to host the disease resulting in lower *Rhizoctonia* inoculum levels for the following crop.

Acknowledgements

Thank you to SAGIT and GRDC for funding this project. Thanks to Mudges for allowing us to have trials on their property, and thanks to Nigel Wilhelm, Alan McKay and Wade Shepperd for all their help this year.

Grains Research & Development Corporation

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SAGIT

Extra $81/ha by grass freeing pasture

Neil Cordon
SARDI, Minnipa Agricultural Centre

Demo

Best practice

Location
Port Kenny - Nathan and Ken Little
Group - Mount Cooper Ag Bureau

Rainfall
Av Annual: 375 mm
Av GSR: 305 mm
2005 Total: 342 mm
2005 GSR: 297 mm

Yield
Potential: 3.74 t/ha

Paddock History
2004: Pasture
2003: Barley
2002: Wheat

Soil Type
Grey, calcareous, sandy loam

Yield Limiting Factors
Late sowing, nitrogen deficiency

Disease

Key Messages

- **Farmer initiated demonstrations are a useful technique to provide confidence for the adoption of new technology.**
- **An extra $81/ha was achieved by grass freeing a pasture.**
- **Cereal eelworm (CCN) can still cause major problems in a farming system, if rotations allow for multiplication of eelworm cysts.**

Why do the demo?

To evaluate the yield response in wheat to grass management in pasture the previous season.

Mr Nathan Little, a farmer from Port Kenny who identified that his cereal yields, especially wheat following pasture were inferior to the district average and grass freeing was one management tool not yet being adopted on the property.

How was it done?

A single demonstration strip was sprayed with Targa® @ 300 ml/ha in a grass based medic pasture during 2004.

The whole paddock was also spray topped with Nuquat® @ 700 ml/ha.

Trident wheat @ 65 kg/ha was sown in June with 18:20 fertiliser @ 70kg/ha.

Measurements - grain yield and quality.

What happened?

The wheat growth throughout the season was visually thicker and denser on the grass-freed plot, which yielded (*Table 1*) 0.68 t/ha higher than the control plot. This was 73% of potential yield which was similar to district yields this season.

What does this mean?

The simple management strategy of grass control in pasture produced an extra $81/ha with yields that are comparable to the district.

The economic yield increases attributed to total grass control in pastures has been well documented since these types of herbicides were introduced to agriculture in 1978. It is difficult to identify the reasons for the large yield increase, however a good "punt" would be the cereal eelworm break achieved in 2004, given the rotation of Trident wheat, sloop barley and grassy pastures with a wild oat component. Poor medic growth in 2004 and little difference in grain proteins would suggest its not a nitrogen response, and there was no visual difference with in-crop grass levels between plots.

Acknowledgements

Nathan and Ken Little for having the wisdom to conduct the demonstration and obtain yield data.

Targa® - registered product of DuPont.

Nuquat® - registered product of Nufarm.

GRDC Grains Research & Development Corporation

SAGIT

Table 1: Grain yield, quality and gross income for wheat at Port Kenny, 2005

Treatment	Screenings (%)	Protein (%)	Grain Weight (kg/hL)	Yield (t/ha)	* Gross Income ($/ha)
Grass Free	1.0	9.7	76.0	2.74	387
Control	1.3	9.3	79.8	2.06	306

**** Gross Income is Yield x Price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005***

Cereal variety disease tables

Hugh Wallwork, SARDI, Plant Research Centre, Waite

Table 1: Disease rating of current wheat varieties

Wheat	Rust			CCN		Septoria tritici blotch	Yellow leaf spot	Root lesion nematodes				Crown rot	Common root rot	Black point	Quality in SA
								P. neglectus		P. thornei					
	Stem	Stripe	Leaf	Resistanc	Tolerance			Resistance	Tolerance	Resistance	Tolerance				
Annuello	R	MS	MR	R	I	S	S	MS-S	MI	S	–	S	–	MR	Hard
Bowie	R#	R/MS#	MR	MR-MS	MT	MS	S	MR	MT	MS	MI	S	S	MR-MS	Soft
Camm	R#	R/S#	MR	S	MI	S	S	MS	–	–	–	S	MS-S	MS	APW
Carnamah	MR	MS-S	MS	S	–	S-VS	MS	MS-S	MI	MR-MS	–	S	MS-S	–	APW
Chara	MR	MS	R	R	MI	MS-S	MS-S	MS-S	MT	MR	MT	S	S	MS	Hard
Drysdale	MR-MS	MS	MS	S	–	MS-S	MS-S	MS-S	–	–	–	–	–	MS	APW
Frame	MR-MS	MR-MS	MS	MR	MT	MS	S-VS	MS-S	MT-T	S	MI	S	S	S	APW
GBA Ruby	MR-MS	R	MR	S	–	MR-MS	MR	MS-S	–	MS	–	–	MS	–	ASW
GBA Sapphire	R	MS	MR-MS	S	I	MS	MR-MS	MS-S	–	MS	–	S	MS-S	MS	APW
H45	MR	VS	MR	S	I	VS	R-MR	MS	MT-T	–	–	S	S	MS	APW
H46	MS	MS	R	S	MI	VS	R-MR	MS	–	MS	–	–	MS	–	APW
Janz	R	MR-MS	MS	S	I	MS	S	MS-S	MI	S	MI	MS-S	MS-S	S	Hard
Krichauff	MR	S	S	S	MT	MS	MS	MR	MT	MS	MI	S	MS	MR	ASW
Kukri	MR	MR	R	S	I	MR	MS	MR-MS	MT	MS	–	MS	S	MS	Hard
Machete	MR	MS-S	MS	S	I	S-VS	S-VS	S	I	S	I	S	VS	MR	Hard
Pugsley	MR#	MR/S#	MR	MS	MI	MS	S	S	MT	MS	–	S	MS	MR	APW
Scythe	MR	MS-S	MS-S	S	–	MS-S	S	MS	–	MS-S	–	–	MS	MR	APW
SW Odiel	MR-MS	MR-MS	MR-MS	MS	MI	VS	S-VS	S	–	MS	–	–	MS-S	S	ASW
Trident	R#	R/S#	MR	S	MI	S	S	MS-S	–	MR-MS	MI	S	MS-S	MS	ASW
Ventura	R	R	R-MR	S	–	MS	MS	–	–	MR	–	MS	MS	–	–
Westonia	S	VS	S	S	–	S	MS	MS-S	MT	MS	–	S	–	MS	APW
Wyalkatchem	MS	MS-S	MR	S	MI	MR-MS	MR	MR	MT-T	MR-MS	–	S	S	MR-MS	APW
Yitpi	S	MR-MS	MS	MR	MT	MS	S-VS	MR-MS	MT-T	MS	–	S	MS	S	Hard
Young	MR	MR-MS	MR-MS	R	–	MS	MR-MS	S	–	MR-MS	–		MS-S		APW
RAC1262	MR	R	MS	MS	–	S/VS	MS	MS	–	–	–		MS		–
WI23322	MR	MR/MS	MS	MR	–	MR/MS	S/VS	MS-S	–	–	–		MS		–

Table 2: Disease rating of current barley varieties

Barley	Scald	Spot form net blotch	Net form net blotch	CCN		Powdery mildew	Leaf rust	Barley grass stripe rust	Root lesion nematodes				BYDV	Common root rot	Black point§
									P. neglectus		P. thornei				
				Resistance	Tolerance				Resistance	Tolerance	Resistance	Tolerance			
Barque	S-VS	R-MR	MS	R	T	MR	MS	–	R-MR	T	MR	MT	S	S	S
Baudin	MS-S	MS-S	MR	S	T	S	VS	MR	–	–	–	–	MR	MS-S	MS
Buloke	MR	MS-S	MR	–	T	–	MS-S	–	–	–	–	–	S	S	S
Capstan	MR/S#	MS	MR	R	T	MR	MS	MS	MR	T	–	–	S	S-VS	MS
Dhow	MS	S	MR	R	T	MS	S	MS	MS	T	R	–	S	S	MR-MS
Flagship	MS	MR-MS	MR	R	T	–	MS	MS	R	–	–	–	S	S	S
Fleet	MR-MS	MR	MR	R	T	–	MS	MR	–	–	–	–	S	S-VS	S
Gairdner	R/S#	S-VS	MR	S	T	R-MR	MS	–	MR	T	MR-MS	–	MR	MS-S	MS
Gairdner Plus	R/S#	MR	MR	R	T	–	S	–	–	–	–	–	S	MS-S	MS
Keel	MR-MS	R-MR	MR	R	T	MR-MS	VS	MS	MR	T	MR	–	S	S	S-VS
Maritime	MS-S	MR-MS	R	R	T	S	MS	S	MR	T	–	–	S	S	S
Mundah	S	S	MR	S	T	MS-S	S	–	MR-MS	–	–	–	S	S	MR
Schooner	MS-S	MS-S	MR	S	T	S	S	–	MR-MS	T	R	MT	S	S	MS-S
Sloop	S	S-VS	MR	S	T	S	S	MS	MS	T	MR	–	S	S	MS
Sloop SA	S	S-VS	MR	R	T	S	S	MS	MS	MT	R	–	S	S	MS-S
Sloop Vic	S	S	MR	R	T	MR	MS-S	–	MS	MT	R	–	S	–	MS
Yarra	S/VS	MS	MS	R	T	S	R	–	–	–	–	–	S	S-VS	S
WI3416	S	S	MR	R	T	–	S	–	–	–	–	–	S	S	S

#These varieties may be susceptible if alternative strain is present.

§ Black point is not a disease but is a physiological response to certain humid conditions

Key to symbols used
R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible,
T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, – = uncertain

Disease

Table 3: Disease rating of current durum varieties

Wheat	Rust			CCN		Septoria tritici blotch	Yellow leaf spot	Root lesion nematodes				Crown rot	Common root rot	Black point	Quality in SA
								P. neglectus		P. thornei					
	Stem	Stripe	Leaf	Resistanc	Tolerance			Resistance	Tolerance	Resistance	Tolerance				
Durum															
Kalka	R	R-MR	MR	MS	MT	MS	MR	MR-MS	–	R	–	VS	MS	–	Durum
Tamaroi	R	MR	R	MS	–	S	MR	MR-MS	MI	R	MT	VS	MS	MR-MS†	Durum

†Tolerance levels are lower for durum receivals.

#These varieties may be susceptible if VPM strain is present.

§ Black point is not a disease but is a physiological response to certain humid conditions

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible,
T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, – = uncertain

Table 4: Disease rating of current tritacle varieties

Wheat	Rust			CCN		Septoria tritici blotch	Yellow leaf spot	Root lesion nematodes				Crown rot	Common root rot	Black point	Quality in SA
								P. neglectus		P. thornei					
	Stem	Stripe	Leaf	Resistanc	Tolerance			Resistance	Tolerance	Resistance	Tolerance				
Triticale															
Abacus	R	MR	R	S	T	–	R	R-MR	MT	R	MT	S	MS	–	Triticale
Speedee	R	MS	R	–	–	–	–	–	–	–	–	S	–	–	Triticale
Tickit	R	MR	R	R	–	–	R	MR	MT	R	–	S	MS	–	Triticale
Tahara	R	R	R	R	T	R	R	R-MR	MT	R	MT	S	MS	–	Triticale
Treat	R	MR	MR	MS	–	–	R	MR-MS	MT	MR	–	S	MS	–	Triticale

Section
7

Section editor: Nigel Wilhelm

SARDI, Minnipa Agricultural Centre

Nutrition

As I am sure you are acutely aware, many fertiliser prices have increased substantially for this growing season and fertilisers continue to hold their place as one of the major input costs to our farming enterprises.

The thread running through this year's section is one of fine tuning. The majority of articles address the role of fluid or suspension fertilisers. While fluid fertilisers is hardly a new topic, you will find some very useful messages about where this technology is heading, how they can be very effective for supplying micronutrients to crops and some cautionary tales that no fertiliser is a silver bullet.

You will find several articles from the fluid fertiliser team which summarise the potential for fluid fertilisers to improve the nutrition (and profit ?) of crops and also some articles which highlight that under broadacre conditions, these potentials are not always realised. While you are checking these articles out, keep in the back of your mind that "informed sources" in and around the fertiliser industry predict that the industry will not move heavily into suspension products because it is very difficult to maintain their quality during storage and transport.

There is a very timely update about managing copper in your crop and livestock enterprises. Large areas of the EP were copper deficient when the country was first opened up but widespread applications of copper (eg bluestone/super mixes) in the 1950s and 60s overcame this problem for many years. However, these applications may now be starting to run out so do yourself a favour by refreshing your knowledge on managing copper.

You will also find an article which summarises a nitrogen trial conducted in the Cleve Hills in 2005. This article includes some very useful guidelines about managing N in our current cropping systems, especially in the context of canopy management strategies in low rainfall districts.

Happy reading.

Try this yourself now

Extension

Fluid vs. granular fertiliser economics - hitting a moving target

Bob Holloway, Dot Brace and Ian Richter

SARDI, Minnipa Agricultural Centre

Comparing fertilisers

The fluid fertiliser project CSO-231 funded by GRDC is due to finish in March this year. Our experiments in 2005 at Cungena, Port Kenny and Warramboo repeated the same trends that we have seen on the grey highly calcareous soils over the past nine years. Generally, fluids are three to seven times more effective than granular fertilisers in providing P to crops on these soils, if the needs for other nutrients are also met. But what does this mean?

Performance wise, two different fertilisers providing the same nutrients can only be thoroughly compared using a rate response trial. In this way, the differences in crop performance over a range of rates (eg of P) can be compared and it is then possible to look at the “relative effectiveness” of one fertiliser with respect to the other. Another way of looking at it is that you can see how much P as say fluid, it would require to produce the same yield as a granular fertiliser. This is the most realistic way to compare fertilisers and you can work out substitution values for one fertiliser compared with another. For instance, Fig. 1 shows the response of Yitpi wheat to fluid and granular fertiliser at a range of P rates from 0 to 20 kg P/ha at Port Kenny last year.

The fertiliser relative effectiveness is established by comparing the different amounts of each fertiliser to produce the same yield. For example, to produce a yield of 1.1 t/ha at Port Kenny required 10 kg P/ha as granular fertiliser, or 3 kg P/ha as fluid. Because it required 3.3 times less P as fluid, the fluid P fertiliser is 3.3 times more effective than granular. This sort of information is likely to be very important in the future as it is expected that world stocks of phosphate rock will be depleted in 50-100 years.

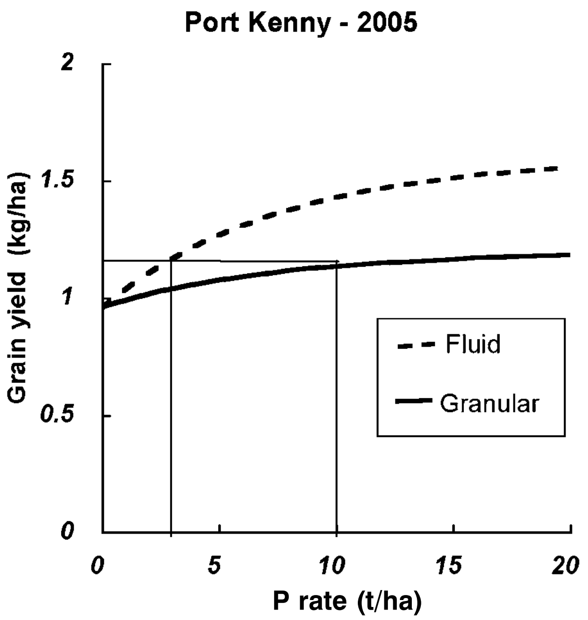


Fig. 1 Response curve of Yitpi wheat to increasing rates of P applied as fluid or granular fertiliser, Port Kenny 2005.

While the relative effectiveness of the two types of fertilisers is important, it doesn't help farmers who really want to know which is the most profitable form of fertiliser. However, from the two response curves you can compare the extra cost of using fluid against the extra income gained from its use for each rate of P. This will reveal how the two kinds of fertiliser compare economically.

“Fluid fertilisers aren't economical!”

Because fluid fertilisers are currently more expensive per unit (kg) of P than granular fertilisers, it may be considered that they cannot be economical, even on the grey highly calcareous soils of Eyre Peninsula where they have performed best. The current situation with the relative prices of fluid and granular fertilisers is a “Catch-22”. Fluid prices are not likely to fall until there is an established market and there is not likely to be an established market until prices fall. So fluid prices are higher, but are they uneconomically higher? Using the graph in *Fig. 1*, we compared 17:19 Zn 2.5 with a solution of phosphoric acid, urea and zinc sulphate hepta-hydrate. We assumed that the price of the 17:19 Zn 2.5 was $515/tonne delivered to Port Kenny. The 2006 price may be higher than this. The 2006 delivered price for 81% phosphoric acid is $850/tonne compared with $1160/tonne ex store in 2005. This decrease in price does indicate that fluids should not be 'written off” as too expensive without actively searching the options that may be available. We decided to use the 2006 price in the first example to reflect the current picture as closely as possible. The cost of P in the 17:19 Zn 2.5% is $2.71/kg, and in the phosphoric acid, $3.20/kg. However, the 17:19 Zn 2.5 also contains “free” N and Zn, if the cost of the P is considered only. To make a solution of phosphoric acid, urea and zinc sulphate, the cost of the urea and zinc also have to be added to the total fluid cost. We graphed the costs for the two fertiliser types and these are shown in *Fig. 2*. Using *Fig. 1*, we also calculated the difference in yield at each P rate between the two fertilisers and its value at a current wheat price of $135/tonne net of transport, levies and compulsory charges. This gives the marginal gross return to fluid fertilisers above granular at each rate of P applied. If the extra cost of the fluid fertiliser is subtracted from this, it leaves the net marginal return to fluid fertiliser. The marginal net return is a simple way of looking at the economics of the fertilisers alone.

When is fluid unprofitable compared with granular?

Fig. 3 shows what happens if the cost of phosphoric acid rises to $1450/tonne ($600/tonne increase) and the cost of 17:19 Zn 2.5 rises to $600/tonne ($85/tonne increase). The cost of P in 17:19 Zn 2.5 would then be $3.16/kg and in phosphoric acid, $5.50/kg. In this case, fluid costs per hectare escalate rapidly as the P rate increases, while the extra income due to fluid remains the same. This means that the marginal net income falls much more rapidly than in the example in *Fig.2*. After 10 kg P/ha, the marginal net income falls below zero and at this point granular becomes more profitable. Even so, fluid remains a more profitable option up to 10 kg P/ha although the actual returns are fairly low, the highest return being about $10/ha at 5 kg P/ha. At a fluid P cost of $7.50/kg in phosphoric acid, ($1920/tonne for 81% acid) granular is economically superior to fluid at all P rates above 3 kg P/ha. For fluid P to remain more profitable than granular up to an application rate of 10 kg/ha at a P cost of $7.50/kg, the net wheat price would need to increase to $190/tonne.

Speculation on the future

Discussion with the fertiliser industry indicates that it would be financially possible to produce a fluid fertiliser for SA such as 9:17 Zn 0.5% (w/v%) with a cost of P in this product of $4.12/kg P, delivered, and because the product contains N and Zn, the amounts of urea and zinc sulphate required to add the same nutrient ratios as in 17:19 Zn 2.5% are less than with the phosphoric acid alone. When this product is compared with 17:19 Zn 2.5%, the results are shown in *Fig. 4*. As *Fig. 4* shows, a change in the price of fluid P to a reasonable parity with granular means that the fluid is more profitable at all rates of P which would normally be applied to the calcareous soils.

Another way of comparing the two types of fertiliser is to consider the marginal returns to the investment in fertiliser, calculated from the response curves. These are shown in *Fig. 5* and are based on the same information used in *Fig. 2*. The marginal return is positive as long as the value of the yield produced at that rate of P is above the cost line. In the case of the granular fertiliser, the two lines cross at a P rate of 7.5 kg/ha (a). At P applications greater than this, the extra fertiliser costs more than the extra yield it produces and it becomes uneconomical. In the fluid example, the break-

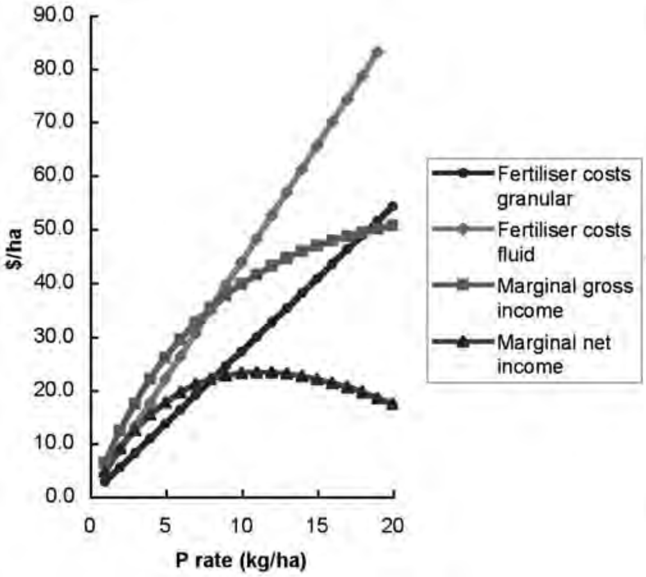


Fig. 2 . The effects of increasing P rate on costs of fluid and granular fertiliser, on the marginal gross income of fluid above granular at a wheat price of $135/tonne and on the marginal net income due to fluid fertiliser.

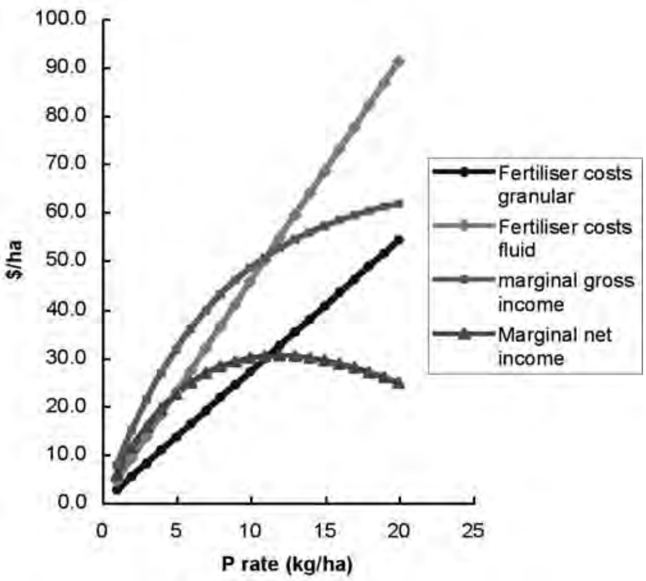


Fig. 4 Effects of fluid P price ($4.12/kg) and P rate on costs and marginal gross and net income with fluid and granular fertiliser.

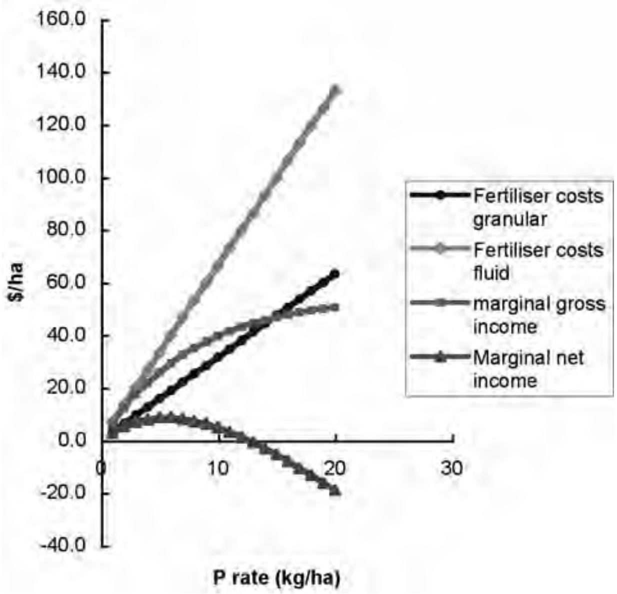


Fig. 3 Effects of fluid P price ($5.50/kg) and P rate on costs and marginal gross and net income with fluid and granular fertiliser.

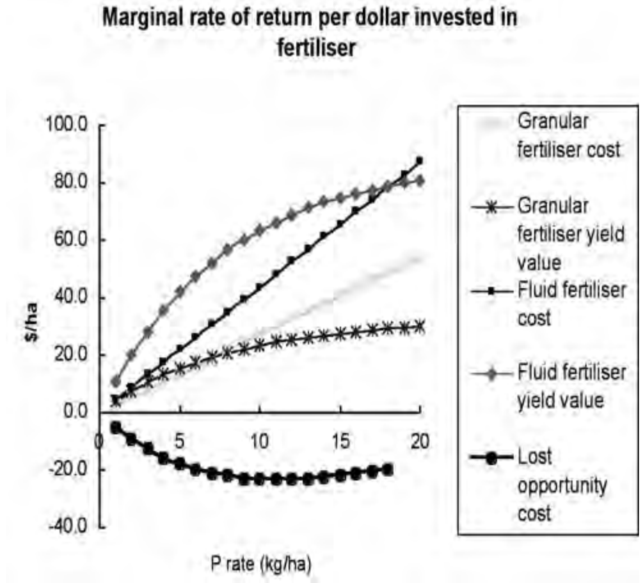


Fig. 5 Marginal rates of return for fluid and granular fertiliser based on response curves from Port Kenny 2005.

even point is 18.5 kg P/ha (b). Obviously, the risk involved in investing such a large amount in fertiliser ($80/ha) would need to be taken into account and would depend on rainfall, the reliability of the area etc. Most farmers have an upper investment limit for fertiliser anyway and from the graph the relative rates of return of the two fertilisers can be compared at various application rates at any investment level per hectare. Another comparative indicator in *Fig.5* is the opportunity cost, the loss of income from choosing granular over fluid at each rate of P applied. There is a loss of income accompanying the use of granular at each rate of P, which is the extra income earned through using fluid as an alternative.

What does this mean?

P-rate response curves from a yield trial with fluid and granular fertilisers provide useful information on how the two fertilisers perform over a range of P application rates. This can be combined with fertiliser prices and wheat prices to produce graphs that indicate which of the two forms of fertiliser are likely to be most profitable at each rate of P. Because the marginal net increase varies with each rate of P, it is important to have a range of P rates to compare the two fertilisers.

While the marginal net income remains above zero in the figures, fluid fertiliser is more profitable than granular.

In the example in *Fig.5*, it becomes uneconomical to use granular at more than 7.5 kg P/ha. There is also a very small gap between the granular costs and income. The danger is that a small increase in the price of granular P could place the cost line above the income line at all application rates on the calcareous soils.

These conclusions are based on a trial from Pt Kenny in 2005. We consider this to be typical of rate response trials on the grey calcareous soils but not all trials or comparisons have shown the same level of agronomic efficiency that has been achieved with fluid P in this trial. So, in considering the economic value of fluid P it should be acknowledged that the relative performance of fluid P may not always be this good.

The other issue not mentioned here is the set up costs for fluid fertilisers. Conversion to an all-fluid application system involves costs, which will vary with the sophistication of the changes.

Even in the current circumstances, with low wheat and relatively high fluid P prices, fluid fertilisers can still be profitable alternatives to granular fertiliser on the grey highly calcareous soils.

Acknowledgements

The authors would like to sincerely thank GRDC, SAGIT and the Fluid Fertiliser Foundation of the USA, (particularly its president, Dr Larry Murphy), for the financial support to conduct a sustained research program over a long period of time by today's standards. We would also like to thank the companies CSBP (Ian Maling, Frank Ripper), Tessenderlo-Kerley (Mike Buffington, Dr. John Clapp), Liquid Systems (Peter Burgess), Agrichem (Andrew Lymburn, Doug Hughes and Owen McCarron), Incitec-Pivot (Ian Laube, Charlie Walker, Orville Hildebrand, Roy Hildebrand) and Fertisol (John Kirk, George Palmer and Des Andriske) for their extremely helpful contributions to our research program. (Some of these employees are no longer with the company listed.) We would also like to thank the following people who, over the past ten years, have contributed greatly to the fluid fertiliser research program by allowing us to use their properties as sites for research: Reg and Dot Brace and family of Emerald Rise, Ken and Edna Gerschwitz and Malcolm and Alice Baldock of Black Hill, Myles and Kylie Tomney of Cungena, the Mudge family of Miltaburra, Tim and Tracey van Loon of White Well, Andrew and Jennifer Polkinghorne of Lock, Ian and Gladys Morgan of Yandra, Keith and Julie Tree of Elliston, the Guerin family of Port Kenny and the O'Brien family of Kyancutta. To all of you, thanks so much - you were great.

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Fluid Fertilizer Foundation

Fluid fertilisers – no silver bullet!

Demo

Neil Cordon
SARDI, Minnipa Agricultural Centre

Key Messages

- **For the second successive year, broad-acre demonstrations have shown that fluid fertilisers banded at seeding did not offer large economic yield increases on Eyre Peninsula.**
- **The small gross margin increases that were obtained with fluid fertilisers may not overcome the practical implications of changing to fluid fertilisers, and therefore adoption may not be very enticing.**
- **At sites where trace element deficiencies did not appear to exist, adding a trace element to either granular or fluid NP fertiliser did not produce an economic yield advantage.**

Why do the trials?

The aim of the work was to compare fluid fertilisers with granular fertilisers using farmers sowing machinery and the fluid delivery cart built by the EPFS project to apply the fluid fertilisers.

This is a continuation of demonstrations conducted in 2004 as reported in *EPFS 2004 Summary, Page 105*, where the economic advantages of using fluid N and P at seeding were inconsistent.

During 2004 and again in 2005 it was apparent that the equipment and technology to deliver fluid based fertilisers in the seed zone is readily available and easy to adapt to existing seeders.

A focus this year was to evaluate the addition of trace elements to N and P through the delivery system.

How was it done?

Fluid fertiliser "brews" were premixed and transported to each site where demonstration strips (approx 1 ha) with a range of treatments were applied as part of the farmer's sowing operation.

The sites were at Nundroo (B. Smith), Tooligie (B. Pearce), Cowell (R. Elleway) and Streaky Bay (N. Trezona). These farmer co-operator sites were similar to those of 2004.

Treatments were selected on the basis of the co-operator's existing granular product application rate; fluid fertilisers were compared on the basis of similar cost per hectare, similar nutrients per hectare and a combination of granular N and P with fluid trace elements.

The fluid treatments were placed up to 2 cm below the seed whilst granular placement was as the farmer generally used, normally with the seed.

Fluid products used were mainly phosphoric acid in combination with urea dissolved in water.

Other products were ammonium poly phosphate, technical grade MAP and urea ammonium nitrate.

Trace elements were all in the powdered sulphate form dissolved in water.

Water rates are shown in the results tables for each site.

At the Streaky Bay site a foliar fertiliser from ARCHEM® Australia was compared to the other treatments.

At some sites a nil fertiliser treatment was also measured for dry matter and grain yield.

Sampling for dry matter and plant nutrient levels was conducted later than ideal with Streaky Bay, Cowell and Tooligie sampled (flag leaf) on the 28th September as awns were emerging. Nundroo was sampled early September at the end of tillering.

Measurements:

Dry matter production, plant nutrient levels, grain yield and quality.

Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

What happened?

The late start to the season meant sites were sown late, which limited yields to between 51% (Tooligie) to 81% (Streaky Bay) of potential, with frost also reducing yields at Tooligie.

During September when sites were sampled, a visual appraisal showed:

- Nil strips had less growth.
- Little difference between plus trace elements and nil trace elements regardless of them being applied with a fluid or granular fertiliser.
- Fluids at similar nutrient levels to granular with or without trace elements had the best growth and tended to be more advanced.

Dry matter cuts *(see tables)* supported the visual observations at all sites.

Samples for plant nutrients levels and grain quality measurements were taken and are available. At all sites all the

Almost ready

Location
Nundroo:
Bryan and Kia Smith.

Rainfall
Av Annual: 340 mm
Av G.S.R: 230 mm
2005 Total: 303 mm
2005 G.S.R: 281 mm

Yield
Potential: (W) 3.22 t/ha
Paddock History
2004: Chemical fallow
2003: Barley
2002: Wheat

Soil Type
Light brown, calcareous sand.

Soil Test
Ext P - 32 mg/kg, Ca CO_3 - 73%

Variety
Krichauff @ 80 kg/ha

Date Sown
21st June 2005

Y.L. Factors
Late sowing.

Location
Toogilie:
Brett and Chris Pearce.
Lock / Murdinga farmers group

Rainfall
Av Annual: 375 mm
Av G.S.R: 290 mm
2005 Total: 414 mm
2005 G.S.R: 309 mm

Yield
Potential: (W) 3.98 t/ha
Paddock History
2004: Pasture
2003: Wheat
2002: Pasture

Soil Type
Greyish brown calcareous sandy loam.

Soil Test
Ext P - 21 mg/kg, Ca CO_3 - 29%

Variety
Wyalkatchem @ 80 kg/ha

Date Sown
7th July 2005

Y.L. Factors
Late sown, frost.

Table 1. Dry matter at awns peeping, grain yield and gross income for fertiliser demonstration at Streaky Bay 2005.

Treatment	Nutrients Applied (kg/ha)					Water rate L/ha	Fert. Cost $/ha	D.M. yield t/ha	Grain Yield t/ha	Gross Income $/ha
	N	P	Cu	Zn	Mn					
Granular Control	9	10	-	-	-	-	22.15	1.52	1.24	175
Fluid–Same Cost/ha	2.4	5.4	-	-	-	100	22.15	1.37	1.31	187
Fluid-Same Nutrients	9	10	-	-	-	100	51.44	1.83	1.39	173
Granular plus FL TE*	9	10	0.5	1	2	100	33.23	1.18	1.23	163
Fluid plus FL TE	9	10	0.5	1	2	230	62.52	1.83	1.40	164
Foliar ARCHEM 705®	trace	trace	-	-	-	-	16.37	1.22	1.16	168
Granular + ARCHEM 705®	5	5	-	-	-		27.45	1.35	1.13	152
Nil	-	-	-	-	-	-	-	1.36	-	-

***FL TE = Fluid trace elements**

Table 2. Dry matter at end of tillering, grain yield and gross income for fertiliser demonstration at Nundroo 2005.

Treatment	Nutrients Applied (kg/ha)					Water rate L/ha	Fert. Cost $/ha	D.M. yield t/ha	Grain Yield t/ha	Gross Income $/ha
	N	P	Cu	Zn	Mn					
Granular Control	12	13	-	-	-	-	29.90	1.35	2.10	276
Fluid–Same Cost/ha	5	9	-	-	-	100	29.90	1.05	2.10	279
Fluid-Same Nutrients	12	13	-	-	-	150	67.67	1.16	2.30	275
Granular plus FL TE*	12	13	0.5	1	2	100	40.98	1.35	2.13	272
Fluid plus FL TE	12	13	0.5	1	2	220	78.75	1.28	2.29	260

***FL TE = Fluid trace elements**

Table 3. Dry matter at awn peeping, grain yield and gross income for fertiliser demonstration at Cowell 2005.

Treatment	Nutrients Applied (kg/ha)					Water rate L/ha	Fert. Cost $/ha	D.M. yield t/ha	Grain Yield t/ha	Gross Income $/ha
	N	P	Cu	Zn	Mn					
Granular Control	9	10	-	-	-	-	21.50	1.63	1.17	96
Fluid–Same Cost/ha	2.4	5.4	-	-	-	110	21.50	1.52	1.20	99
Fluid-Same Nutrients	9	10	-	-	-	100	51.18	2.12	1.12	61
Granular plus FL TE*	9	10	0.5	1	1	100	30.21	1.60	1.14	84
Fluid plus FL TE*	9	10	0.5	1	1	230	59.89	1.71	1.18	58
Nil	-	-	-	-	-	-	-	1.23	-	-

***FL TE = Fluid trace elements**

Table 4. Dry matter at awns peeping, grain yield and gross income for fertiliser demonstration at Tooligie 2005.

Treatment	Nutrients Applied (kg/ha)					Water rate L/ha	Fert. Cost $/ha	D.M. yield t/ha	Grain Yield	Gross Income $/ha
	N	P	Cu	Zn	Mn				t/ha	
Granular Control	17	18	-	-	-	-	39.60	1.70	1.82	254
Fluid–Same Cost/ha	10	9	-	-	-	100	39.60	1.85	1.77	251
Fluid-Same Nutrients	22	15	-	-	-	100	141.48	2.45	2.03	194
Granular plus FL TE*	17	18	0.5	1.0	2.0	100	50.68	1.73	1.53	198
Fluid plus FL TE	25	11	0.5	1.0	2.0	250	81.99	2.18	1.82	216
Nil	-	-	-	-	-	-	-	0.92	1.08	173

***FL TE = Fluid trace elements**

treatments had an inconsistent effect on these following measurements.

- Tissue Cu, Zn, Mn, P and S.
- Grain protein, screenings and test weights.

The sites at Streaky Bay and Nundroo would normally be considered highly responsive to fluid fertilisers due to high levels of calcium carbonate, 64% and 73% respectively.

For the second successive year at Streaky Bay the fluid treatment of same cost/ha had a higher yield *(Table 1)* and gross income ($12/ha) than the granular control. Fluid applied with the same level of nutrients had the highest yield but cost reduced its gross income.

Addition of trace elements either with granular or fluid fertiliser did not increase yields so reduced the gross incomes.

The foliar treatment ARCHEM 705® had the lowest dry matter production, grain yields and gross income.

The Nundroo site *(Table 2)* showed the fluid fertiliser had the highest yield but cost reduced its gross income to be less than the granular control. Addition of trace elements either with granular or fluid fertiliser did not increase yields and thus reduced income.

The Cowell site had a calcium carbonate level of 5.4%, which would suggest it would not be responsive to fluid fertilisers. Yield data *(Table 3)* supports this, as differences between treatments were not large. Once again trace elements either with granular or fluid fertiliser did not increase yields or income.

Tooligie has a calcium carbonate level of 29%, which should be responsive to fluid fertilisers. For the second successive year there was no economic yield response to fluid fertilisers. All treatments had higher yields and income than the nil plot.

Trace elements with fluid N & P had higher yields and income than trace elements with granular N & P.

Addition of trace elements either with granular or fluid fertiliser did not increase yields.

What does this mean?

Water rates are required to be high (>100 L/ha) for some fluid mixes to overcome saturation issues and this reduces the attraction of this technology. There was little response to fluid trace elements when added to either granular or fluid N & P. This was also supported by both grain and dry matter yields. Replicated trials reported in this book on page 102 also show that in non responsive situations there is no point in the addition of trace elements to either a fluid or granular based N and P fertiliser.

The improved efficiency of fluid phosphorus was evident at all sites where lower rates of P (up to half rates) achieved similar or slightly higher yields than the granular control. The size of the yield increases however, rarely paid for the extra cost of the fluid fertilisers. This is probably why many farmers deem it not attractive to change their current program of using granular fertilisers.

The degree of economic yield improvements in these demonstrations (including those from 2004) is very inconsistent and does not make it attractive to change even on calcareous soils.

Note: Where soils are trace element deficient the use of a fluid delivery system with either granular or fluid based N & P is an alternative method of supplying trace elements to a system.

Acknowledgements

Special thanks to the farmer co-operators, who stopped sowing and assisted in setting up their machines.

Thanks to Bob Holloway and Ben Ward for providing guidance, advice and assisting in the work.

Liquid Systems SA, GRDC and National Heritage Trust all had a part in funding the work.

ARCHEM 705® - registered product of ARCHEM Australia Pty. Ltd.

Grains Research & Development Corpora

Natural Heritage Trust

Almost ready

Location
Cowell:
Ron and Eddie Elleway.
Franklin Harbour Ag Bureau

Rainfall
Av Annual: 282 mm
Av G.S.R: 195 mm
2005 Total: 273 mm
2005 G.S.R: 180 mm

Yield
Potential: (T) 1.54 t/ha

Paddock History
2004: Fallow
2003: Pasture
2002: Wheat

Soil Type
Light brown, sandy loam.

Soil Test
Ext P - 19 mg/kg, Ca CO_3 -5.4%

Variety
Tahara @ 100 kg/ha

Date Sown
29th June 2005

Y.L. Factors
Late sown.

Location
Streaky Bay
Neville & Dion Trezona
Streaky Bay Ag Bureau

Rainfall
Av Annual: 286 mm
Av G.S.R: 210 mm
2005 Total: 261 mm
2005 G.S.R: 196 mm

Yield
Potential: (W) 1.77 t/ha

Paddock History
2004: Pasture
2003: Barley
2002: Wheat

Soil Type
Grey, calcareous sand.

Soil Test
Ext P - 31 mg/kg, Ca CO_3 - 64%

Variety
Trident @ 50 kg/ha

Date Sown
28th June 2005

Y.L. Factors
Late sown, Rhizoctonia.

Micronutrients on grey calcareous soils – do they work?

Research

Dot Brace, Bob Holloway & Ian Richter
SARDI, Minnipa Agricultural Centre

Try this yourself now

Location
Cungena
Cooperator: Myles & Kylie Tomney

Rainfall
Av annual: 284 mm
Av GSR: 239 mm
2005 total: 274 mm
2005 GSR: 234 mm

Soil
Grey highly calcareous sandy loam
Calcium carbonate: 35%
pH: 8.8
Colwell P: 34 mg/kg
Resin P: 4 mg/kg
Organic carbon: 0.7 %

Plot size
2 m x 20 m

Location
Port Kenny
Cooperator: Laurie & Simon Guerin

Rainfall
Av annual: 375 mm
Av GSR: 305 mm
2005 total: 428 mm
2005 GSR: 351 mm

Soil type
Grey highly calcareous sandy loam
Calcium carbonate: 54%
pH: 8.8
Colwell P: 53 mg/kg
Resin P: 4 mg/kg
Organic carbon: 2.0 %

Plot size
2 m x 20 m

Key Messages

- **Wheat grown on grey highly calcareous soils responded to zinc and manganese applications.**
- **Micronutrients were most effective when they were applied in a fluid form, which provided economical yield responses.**
- **There was no response in grain yield when granular micronutrients were applied as a dry blend with granular NP fertiliser or as a coating on granules.**

Why do the trial?

In 2004, experiments were conducted at Cungena and Port Kenny to assess the role of micronutrients in suspension fertilisers on calcareous soils. Various granular products were converted to suspensions and the best performer of these was a suspension made from a mixture of granular 13:15 Mn 6 and 17:19 Zn 2.5. Because the highest yielding treatment was the only treatment which had both Zn and Mn mixed in the suspension it appeared that the inclusion of the micronutrients in the suspension may have had a major effect on the result, but this could not be clearly concluded from the results, see *EPFS 2004, page 92*.

The 2005 experiments conducted at Cungena and Port Kenny were designed to clearly define the role of micronutrients in a suspension.

How was it done?

All suspensions were made using DAP based granular products mixed with clay and sulphuric acid. The suspensions were applied through a John Blue® squeeze pump at 170 L/ha. In the fluid treatment, Suspension + Separate *(see Table 1)*, the fluid micronutrients were applied as a clear liquid solution at 127 L/ha through a second pump. At Cungena, application rates were 10 kg P/ha, 15 kg N/ha, 1 kg Zn/ha and 2.5 kg Mn/ha. Rates at Port Kenny were the same except for N, which was applied at 25 kg/ha. Yitpi wheat was seeded at 60 kg/ha on 21st June and 24th June at Cungena and Pt Kenny, respectively. There were four replicates of each treatment.

Six weeks after sowing, at early tillering, 25 whole plants were sampled at random from each plot. These plants were then analysed for nutrient content.

Plots were harvested at both sites with a small plot harvester in December.

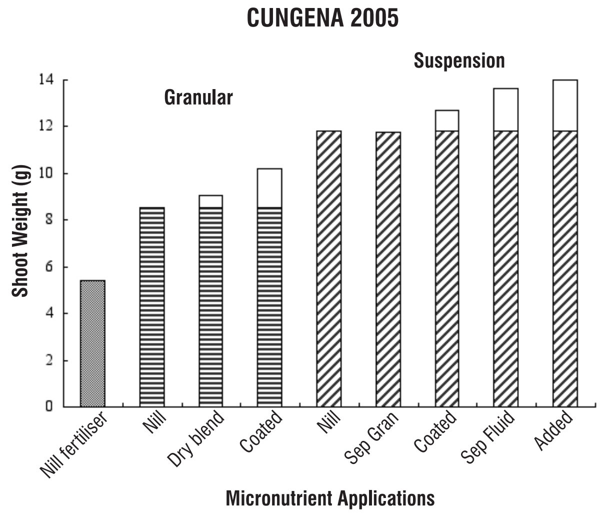
What happened?

Whole shoot concentrations of Zn, Mn and Cu were adequate in shoots at Cungena but generally 30% higher where the micronutrients were applied in fluid form. P concentrations were similar with all treatments - the mean P concentration in tissue was 2678 mg P/kg. At Port Kenny, Cu concentrations were low but adequate for whole shoots. Cu was not applied in the micronutrient solution and the highest concentration (7.4 mg Cu/kg) in shoots was recorded in the nil fertiliser treatment and 4.4 mg Cu/kg in the Suspension-added treatment. The dilution of the Cu with the treatments with more shoot growth indicates that at this site, Cu should be applied with both Zn and Mn. Mean tissue concentrations at the site were 25.5 mg Zn /kg, 38.7 mg Mn/kg and 2581 mg P/kg. Grain yield was more closely associated with uptake of P, Zn and Mn. Uptake is the total content of the nutrient in the plant or the grain and is calculated by multiplying the weight of the plant, or the grain, by the concentration of the nutrient. It shows how much of the nutrient has got into the shoot or grain and reflects the availability of the nutrient for plant growth.

At Cungena, there was a 38% increase in shoot growth at early tillering with suspension compared with granular, in the absence of

Table 1: Products applied at sowing.

FERTILISER	MICRONUTRIENT APPLICATION	PRODUCT
Granular	**Nil**	DAP
Granular	**Dry Blend**	DAP with Zn Mn granules
Granular	**Coated**	19:13 Zn 1.2 Mn 3.3
Suspension	**Nil**	DAP into suspension
Suspension	**Separate Granular**	DAP into suspension with Zn Mn granules applied separately
Suspension	**Separate Fluid**	DAP into suspension with Zn Mn clear liquid applied separately
Suspension	**Added**	DAP with Zn Mn granules into suspension
Suspension	**Coated**	19:13 Zn 1.2 Mn 3.3 (coated granular product) into suspension
Nil fertiliser		



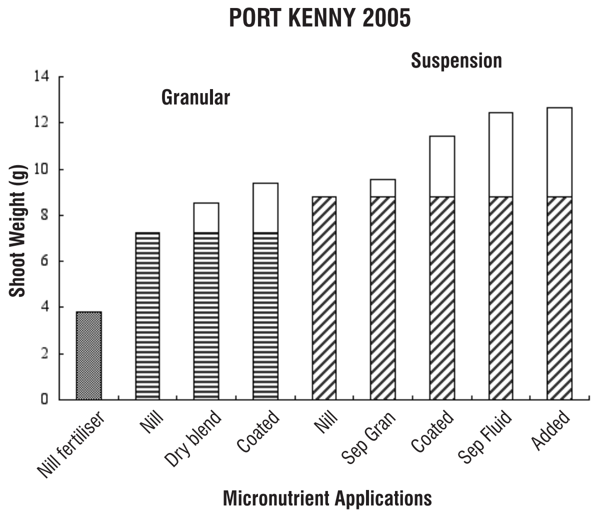
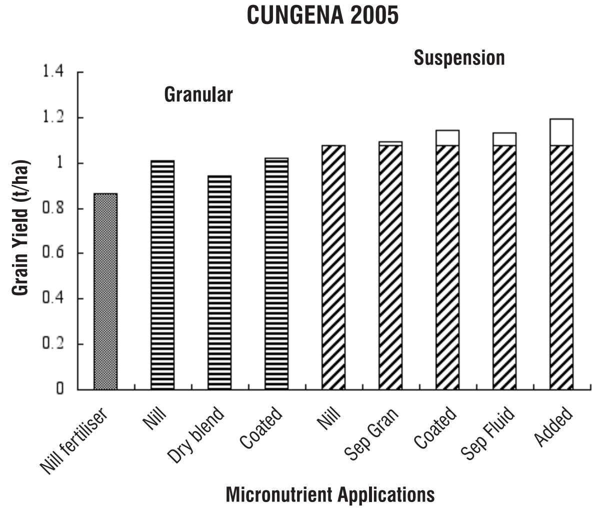


Fig 1. Response in shoot dry weight at early tillering to applications of granular and suspension fertilisers with and without added micronutrients. The hatched bars show the response in shoot dry weight, with the micronutrient response added as the clear top portion of the bar.



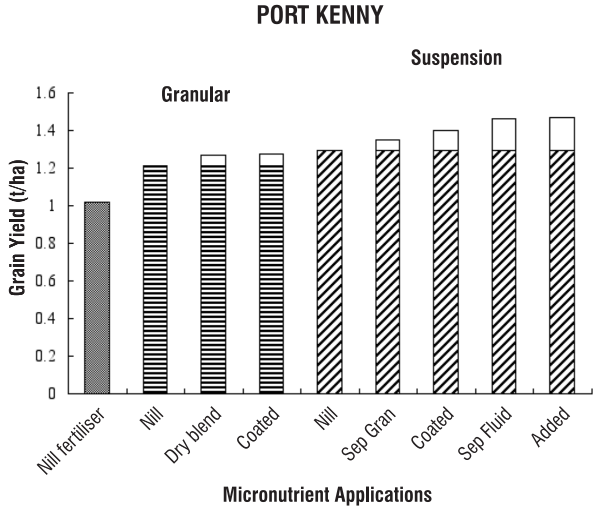


Fig 2. Response in grain yield to applications of granular and suspension fertilisers with and without added micronutrients. The hatched bars show the response in shoot dry weight, with the micronutrient response added as the clear top portion of the bar.

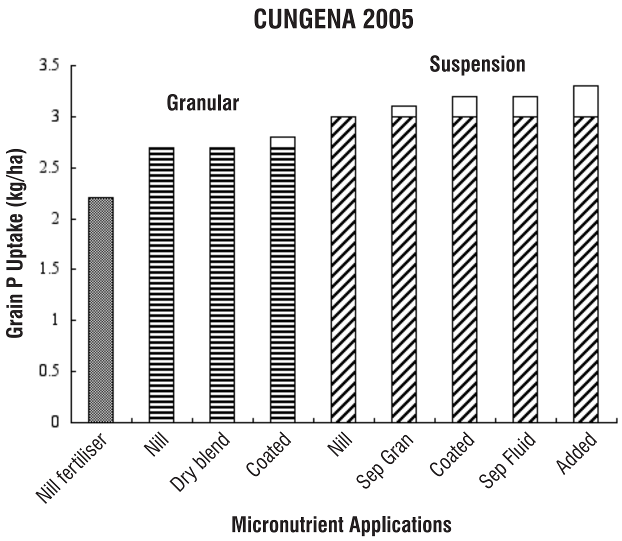


Fig 3. Response in P uptake in the grain to applications of granular and suspension fertilisers with and without added micronutrients. The hatched bars show the response in P uptake, with the micronutrient response added as the clear top portion of the bar.

micronutrients. When micronutrients were added, the greatest response in shoot growth occurred when they were mixed with the suspension (in the case of fluids) or coated on the granule (in the case of granular). The relative response to micronutrients was 40% greater when they were added to the suspension than when they were applied as a granular coating. The overall combined increase in shoot growth with suspension plus added micronutrients, was 39% greater than the coated granular response.

At Port Kenny, there was no increase in growth due to suspension above granular in the absence of micronutrients. The relative response to micronutrients was 81% greater when they were mixed with the suspension or applied as separate solution in combination with the suspension than when applied as a granular coating. The overall combined increase in shoot growth through suspension with added micronutrients compared with coated granules was 35%.

The relative benefits of micronutrients were higher at Port Kenny than at Cungena. At both sites, adding micronutrients separately to the soil in granular form was ineffective in promoting shoot growth.

At Cungena, there was no increase in grain yield with the base suspension compared with the base granular fertiliser.

Adding micronutrients to the granular fertiliser separately or by coating produced no grain yield response. Including micronutrients in the suspension increased grain yield by 11% above the base suspension. There was a 17% difference in grain yield between the suspension mixed with micronutrients and the coated granular treatments. The form in which the micronutrients were applied also controlled P uptake in grain, *Fig 3*.

At Port Kenny, the application of coated granules did not increase grain yield above the non-micronutrient granular treatment. In the suspension group, the addition of micronutrients as coated granules (converted to suspension), increased grain yield above the basal (non-micronutrient) suspension by 14%. The overall grain yield response between the best suspension and granular treatments was 15%. The results are interesting in that the sites would have been considered non responsive to micronutrients if the experiment had been carried out with the granular forms of micronutrients only.

What does this mean?

The addition of micronutrients to a DAP suspension increased grain yields above the coated granular treatments by 17% at Cungena and by 15% at Port Kenny. The use of granular micronutrients as a separate addition to basal granular or a separate granular application with suspension NP fertiliser was ineffective in producing a micronutrient response on grey highly calcareous soils of Eyre Peninsula. This is probably to do with the poor distribution of micronutrient granules in the row. The application of NP suspensions increased wheat grain yield above NP granular in the absence of micronutrients by 7% at Port Kenny, but not at Cungena. The addition of micronutrients as a coating increased shoot growth in the granular treatments at Port Kenny only but had no effect on grain yield at either site. The results support our conclusion that best practice for cereal production on the highly calcareous soils of SA should involve the use of NP fluid fertilisers containing micronutrients, principally Zn, Mn and probably Cu, depending on the availability of a fluid P source at a reasonable price parity with granular.

Acknowledgements

Our thanks to SAGIT, GRDC and the Fluid Fertilizer Foundation for supporting this work.

GRDC Grains Research & Development Corporation

SAGIT

SARDI South Australian Research and Development Institute

Fluid Fertilizer Foundation

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Fluid delivery of trace elements - Part II

Research

Neil Cordon

SARDI, Minnipa Agricultural Centre

Key Messages

- **Trace elements can be added to a farming system via a fluid delivery mechanism.**
- **Economic yield increases to trace elements did not occur in non responsive situations regardless of whether they were applied to fluid or granular N and P fertilisers.**

Why do the trials?

The equipment and technology to deliver fluid solutions into the seed zone efficiently and effectively has been well documented in previous *EPFS summaries; 2004, page 99 and 2003, pages 93 & 98*.

Although research has shown consistent yield increases to fluid P fertilisers on the low rainfall, highly calcareous soils of Eyre Peninsula, the adoption of the technology has been poor.

However, fluid delivery technology can also be used to supply trace elements to crops. If farmers see the technology as a viable means of delivering trace elements banded below the seed but with granular based N and P fertilisers at seeding then it could lead to the wider adoption of fluid fertilisers generally.

These trials were established to evaluate the yield response to trace elements using a fluid delivery system compared to other techniques.

Some work done by A. Frischke *(EPFS 2004, page 96)* showed that there was no yield advantage by applying trace elements in solutions, and the addition of N and P to the trace element solution did not offer any advantage in nutrient uptake. However, in other studies (both on EP and in other areas) fluid delivered trace elements have been very effective at improving nutrient levels in treated crops.

How was it done?

Replicated trials were established at Tuckey and Piednippie on similar soil types to those in 2004.

Tuckey was sown on 29th June at 61 kg/ha with Yitpi wheat and Piednippie was sown on 28th June at 60 kg/ha with Wyalkatchem wheat.

Treatment details are given in *Table 1*.

Base fertilisers used were 18:20, phosphoric acid, urea and trace elements in the sulphate form.

Measurements: YEB nutrient concentrations, grain yield and quality.

Table 1: Treatment description and applied nutrients at Piednippie and Tuckey, 2005

Treatment Details	Piednippie					Tuckey				
	Applied Nutrients (kg/ha)									
	N	P	Cu	Zn	Mn	N	P	Cu	Zn	Mn
Granular N&P – control: nil TE*	12	13	-	-	-	-	-	-	-	-
Granular N&P with coated TE	12	13	0.5	1	3	13	14	1	1	1
Granular N&P with seeding fluid TE	12	13	0.5	1	3	13	14	1	1	1
Granular N&P with foliar TE	12	13	0.05	0.22	0.93	13	14	0.05	0.22	0.62
Fluid N&P: nil TE	12	13	-	-	-	13	14	-	-	-
Fluid N&P with seeding fluid TE	13	13	0.5	1	3	13	14	1	1	1
Fluid N&P with foliar TE	12	13	0.05	0.22	0.93	13	14	0.05	0.22	0.62

TE = Trace Elements

Table 2: Grain yield and gross income of Yitpi wheat at Tuckey with different fertiliser treatments, 2005

Treatment	Fertiliser cost $/ha	Grain Yield t/ha		Gross Income $/ha
Granular N&P – control: nil TE	31.85	2.35	a	393
Granular N&P with coated T.E.	48.99	2.20	cd	347
Granular N&P with seeding fluid T.E.	44.11	2.31	ab	370
Granular N&P with foliar T.E.	34.28	2.33	ab	379
Fluid N&P nil T.E.	72.56	2.21	cd	328
Fluid N&P with seeding fluid T.E.	84.82	2.12	d	304
Fluid N&P with foliar T.E.	74.99	2.24	bc	329
L.S.D. (P = 0.05)		0.09		

TE = Trace Elements
Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

Table 3: Grain yield and gross income of Yitpi wheat at Piednippie with different fertiliser treatments, 2005

Treatment	Fertiliser cost $/ha	Grain Yield t/ha	Gross Income $/ha
Granular N&P – control: nil TE	29.58	1.44	190
Granular N&P with coated TE	48.15	1.32	154
Granular N&P with seeding fluid TE	43.08	1.40	169
Granular N&P with foliar TE	32.75	1.42	182
Fluid N&P nil TE	67.67	1.49	159
Fluid N&P with seeding fluid TE	81.17	1.60	163
Fluid N&P with foliar TE	70.84	1.54	167
L.S.D. (P = 0.05)		N S	

TE = Trace Elements
Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

What happened?

Tuckey: The late break to the season delayed sowing and limited the crop's ability to reach yield potential.

During the season there were no visual differences between treatments.

There was no trend in treatment effects on grain quality and tissue nutrient concentrations.

Tissue trace elements levels were adequate, which indicates that the yields should not have increased with trace element applications.

The highest yield *(Table 2)* and gross income was the granular control, which was higher than fluid fertiliser with the same rate of N and P. There was no difference between granular control and granular N and P with fluid trace elements at sowing. This also was the case when N and P were applied in the fluid form. The fluid trace elements were better than trace elements applied incorporated into the granular fertiliser.

Try this yourself now

Location
Tuckey - Jason Burton.
Tuckey Ag Bureau.

Rainfall
Av Annual: 324 mm
Av G.S.R: 241 mm
2005 Total: 313 mm
2005 G.S.R: 281 mm

Yield
Potential: (W) 3.42 t/ha

Paddock History
2004: Medic Pasture
2003: Wheat
2002: Vetch
Soil Type
Red sandy clay loam.

Soil Test
Ext P - 28 mg/kg, Ca CO_3 - 8%

Plot size
20m x 2m x 4 reps

Yield Limiting Factors
Late sowing.

Location
Piednippie - Simon Patterson.
Streaky Bay Ag Bureau.

Rainfall
Av Annual: 368 mm
Av G.S.R: 280 mm
2005 Total: 305 mm
2005 G.S.R: 267 mm

Yield
Potential: (W) 3.14 t/ha

Paddock History
2004: Pasture
2003: Pasture
2002: Wheat

Soil Type
Calcareous grey, sandy loam.

Soil Test
Ext P - 24 mg/kg, Ca CO_3 a 49%

Plot size
20m x 2m x 4 reps

Yield Limiting Factors
Late sowing, Brome grass competition.

Piednippie: Brome grass competition and a late break to the season (late sowing) meant yields were only 51% of potential yield of 3.14 t/ha. Good rainfall during the growing season and cool weather during grain filling provided ideal conditions for crop growth and production.

The treatment with fluid N and P plus foliar trace elements appeared to have the best vegetative growth during the season.

Similar to the Tuckey site there was no trend in treatment effects on grain quality and tissue nutrient concentrations.

Tissue trace element levels were all adequate which indicates that the site was non responsive.

There were no significant yield differences between the treatments, which meant that the cheaper granular control had the best gross income *(Table 3)*.

What does this mean?

- In non-responsive situations there is no point in adding trace elements either to a fluid or granular based N and P fertiliser.
- For the second successive year the addition of N and P to the trace element solutions did not appear to enhance trace element uptake.
- Fluid fertilisers did not have an economic yield advantage on the Tuckey soil type.
- Delivery of trace elements to the farming system is possible in the fluid form through a fluid delivery system. This can be done at lower water rates and provide the farmer a greater degree of flexibility for trace element addition on a paddock and/or soil type basis which can not be achieved with granular products impregnated or coated with trace elements.
- The lower cost foliar applied trace elements offer the cheapest approach to trace element application whilst still providing financial returns.

Acknowledgements

Special thanks to Wade Shepperd, Leigh Davis, Ben Ward and Jon Hancock for sowing and managing the trials, the Burton and Patterson families for provision of trial sites.

Grains Research & Development Corporation

Response to fluid P on non-calcareous soils: a glasshouse study

Searching for answers

***Thérèse McBeath[1], Mike McLaughlin[1,2], Mark Conyers[4], Mike Bolland[5], Roger Armstrong[6], Mike Bell[7], Enzo Lombi[2], Bob Holloway[3] and Caroline Johnston[2]**

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Why do the trial?

Several low pH soils were found to be more responsive to fluid P fertiliser than granular types in a glasshouse study (McBeath et al., 2005). This prompted us to repeat the work using a much wider selection of acidic and neutral pH soils collected from the major grain cropping regions of Australia.

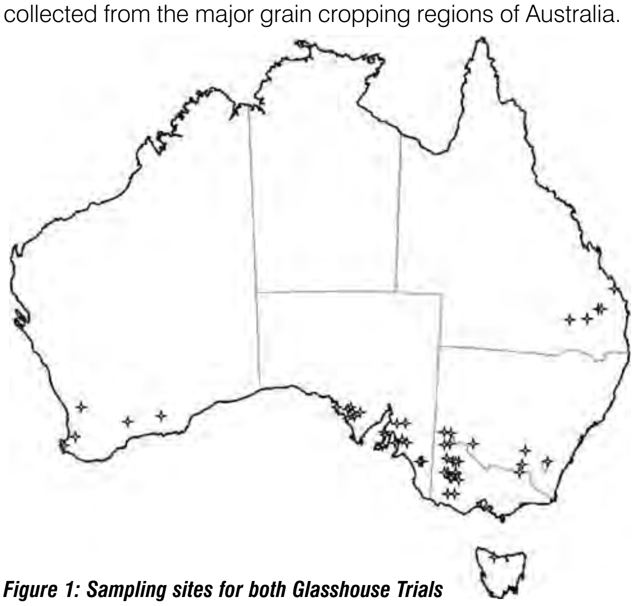

Figure 1: Sampling sites for both Glasshouse Trials

The soil sampling sites for both of these glasshouse trials combined is shown in *Figure 1*.

By testing soils for response to fertiliser type from across the grain cropping regions of Australia and combining this data with comprehensive soil characterisation, we aimed to develop criteria that would identify soils where fluid P fertilisers were more likely to outperform granular forms. This information could then be used to subsequently validate this response under field conditions – this is important in Australia as fluid fertilisers currently cost more per unit nutrient than granular forms.

How was it done?

Soils

Twenty eight soils were collected from SA, WA, Vic, NSW, Qld, Tas and ACT (0-10 cm).

We measured a range of soil characteristics including: pH, Colwell P, Bray P, resin P, phosphorus buffering index, exchangeable cations, total metals and P, calcium carbonate content, organic carbon content and particle size analysis. We measured these soil characteristics to try to determine if there are soil characteristics or a set of soil characteristics that have a strong influence on the response of wheat to fertiliser type.

Biomass

We compared the response of wheat (cv. Yitpi) to two fluid P fertilisers (ammonium polyphosphate (APP) and technical grade monoammonium phosphate (TGMAP)), one granular P fertiliser (monoammonium phosphate (MAP)) and a control of no P added. P was applied at a rate equivalent to 12 kg/ha and banded below the seed. All other nutrients were balanced and mixed throughout the pot. Wheat was grown to mid tillering (4 weeks of growth). Plant measurements were made of dry weight, tissue P and cation content, and plant P uptake.

What happened?

Biomass

93% of soils were responsive to P, while in 21% of soils wheat was more responsive to a fluid P source than to a granular P source. This equated to 15-50% increases in biomass of fluid over granular at mid tillering *(Table 1)*. The data showed that there were a range of soils from various locations and with a range in soil pH in which wheat responded more to fluid fertiliser compared to the equivalent rate of granular product.

Table 1. Soil, response to fluid P fertiliser over granular, phosphorus (P), ratio of fluid treatment dry matter to granular and soil pH.

Soil	State	Fluid Response	P Response	Fluid/Granular	Soil pH
Otterbourne	ACT	n	y	0.87	5.07
Balranald	NSW	n	y	1.00	8.87
Culcairn	NSW	APP	y	1.25	5.91
Kelley	NSW	n	y	1.10	8.10
Terrora	NSW	n	y	0.98	6.74
Tudgey	NSW	TGMAP	y	1.20	8.13
A10-Kingaroy	QLD	APP	y	1.20	6.46
Bauer-Kingaroy	QLD	n	y	1.12	6.67
Blackdow-Condamine	QLD	n	y	0.96	8.90
Nebri-Drillham	QLD	n	y	1.10	8.71
Bordertown-Exp2	SA	n	y	1.00	6.77
Illanson	SA	TGMAP	y	1.12	5.64
Jacka	SA	n	y	1.14	7.60
Keith-Exp2	SA	n	y	0.97	5.73
Lenswoood-Exp2	SA	n	y	0.91	6.03
Monarto	SA	n	y	1.06	7.04
Sandilands	SA	n	y	1.19	8.20
Warramboo-Exp2	SA	Y	y	1.66	8.95
Ulverstone	TAS	n	y	1.13	5.62
Birchip field site	Vic	TGMAP	y	1.19	8.66
Dooen	Vic	n	y	0.93	8.53
PV13-Hamilton-Exp2	Vic	n	y	0.76	5.24
Boathaugh	WA	n	y	1.10	6.51
Collie	WA	n	y	1.19	6.07
Fleming Gravel Sand	WA	n	y	1.00	6.27
Karri Loam	WA	n	y	1.11	6.95
Mt Barker Loam	WA	n	y	0.94	6.73
Newdegate	WA	n	y	1.21	5.38

Soil Characteristics

We tried modelling our soil characteristic data against fertiliser responses and found that calcium carbonate content was the only characteristic that helped to predict the better effectiveness of fluids on some soils.

In our soil characterisation we also evaluated some common tests for potentially available P.

While we found that Resin P and Colwell P were better predictors than other tests (data not shown) of fluid or granular response over the control we did not find that these characteristics helped us to predict whether a soil was more responsive to fluid P fertiliser as compared to granular.

What does this mean?

After evaluating almost 60 different soils from all over Australia we found that calcium carbonate content was still the dominant factor determining a greater response to fluid P fertiliser as compared to granular. No soil test for potentially available P gave us any indication that wheat grown in a given soil type was more likely to respond to fluid P fertiliser as compared to granular.

The next stage of this project is to evaluate fluid against granular products in the field with multiple sites located in WA, Vic, Qld and NSW. These field trials will be conducted in the 2006 growing season. We will also be providing on our website (www.fluidfertilisers.com.au) protocols for growers who would like to make meaningful test strip comparisons on farm.

Acknowledgements

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Searching for answers

Research

P, Zn and Mn fluid and granular fertilisers: movement and availability

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Why do the trial?

Phosphorus

Previous work has shown that there are differences in efficiency between fluid and granular P fertilisers in calcareous soils. The mechanisms behind these differences are still being investigated. A great technique (CT scanning commonly used in medicine) recently became available with the potential to add new information to our current understanding of the movement of solutes that affect nutrient availability around the point of fertiliser application.

Zinc and Manganese

Micronutrient deficiencies are a frequent problem in the alkaline cropping soils of southern Australia (Coventry et al., 1998). As a result broadscale applications of Zn and Mn as fertiliser are common. A common way of supplying Zn and/or Mn has been to coat the NP fertiliser granule and therefore apply it in solid form. This method of inclusion of Zn and/or Mn in conventional NP fertiliser has been driven mainly by the effectiveness of the resultant fertiliser. However, field studies have shown an increased response to fluid Zn compared to granular fertilisers in the calcareous soils of Eyre Peninsula (Holloway et al., 2002).

We have compared the movement and potential availability of Mn and Zn when supplied as a fluid or granular product in a calcareous and non-calcareous soil.

How was it done?

Phosphorus

CT scanning technology was used to investigate density changes in soil around the point of fertiliser application.

Zinc and Manganese

Soils were placed in Petri dishes and fertiliser was placed in the centre of each dish.

There were five fertiliser treatments:

1. MAP and Zn
2. Monocalcium phosphate and Mn
3. Acidified APP and liquid -Zn and -Mn
4. TGMAP and liquid -Zn and -Mn
5. Suspension P and liquid -Zn and Mn

After 35 days, concentric rings of soils were collected outwards from the fertiliser placement point (0-7.5 mm, 7.5-13.5 mm, 13.5-25.5 mm, and 25.5-43 mm). Availability of Zn or Mn was determined by using 65 Zn and 54 Mn radioisotope techniques.

What happened?

Movement of Phosphorus

Fertiliser granules are highly hygroscopic (tendency to absorb moisture) and even a simple photo *(Figure 1A)* shows the granule drawing water towards it. The problem with this in a highly P fixing soil is that the soil solution contains high levels of cations like calcium which have the ability to fix the P in the fertilizer at the point of application preventing this P from moving, and from being available for plants. CT scanning confirms the hygroscopicity of the granule. Water has a density of 1 and an average soil has a density of 1.3. *Figure 1B* shows a low-density spot at the point of the granule fertilizer application suggesting that soil water (lower density) has been drawn into the granule. Where the P was applied as a liquid *(Figure 1C)* there are no density changes.

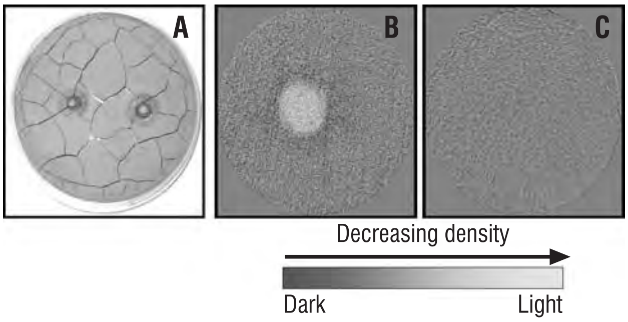

Figure 1: A, Photo of the highly hygroscopic fertilizer granules in the Petri dish drawing water towards the point of application, B, a density scan shows low density (due to greater % water) at the point of granular application), C, a density scan shows uniform density where fluid is applied.

Movement of Zinc and Manganese

Manganese from fluid fertilisers moved further through soil, away from the point of application *(Figure 2A)*, compared to a granular source of Mn. The movement of Zn away from the point of fertilizer application was restricted regardless of the source of Zn in both soils *(Figure 2C)*.

Potential Availability of Zinc and Manganese

The availability of the Mn from the fertiliser was much greater with the fluid formulation *(Figure 2B)*.

The availability of fluid Zn applied with fluid P or suspension P was significantly higher compared to granular fertilizer *(Figure 2D)*, indicating fluid or suspension Zn is fixed less than granular in these soils. Less fixation of fluid Zn provides an explanation for the better crop response to fluid Zn fertilizers observed in field trials conducted by Dr. Bob Holloway's team. Inclusion of Zn and/or Mn with P in granules does not seem to be a very effective way of supplying these micronutrients to crops, especially in alkaline soils.

What does this mean?

- The movement of water towards the P fertiliser granule forming precipitates in calcareous soils is preventing the movement of P away from the point of application.

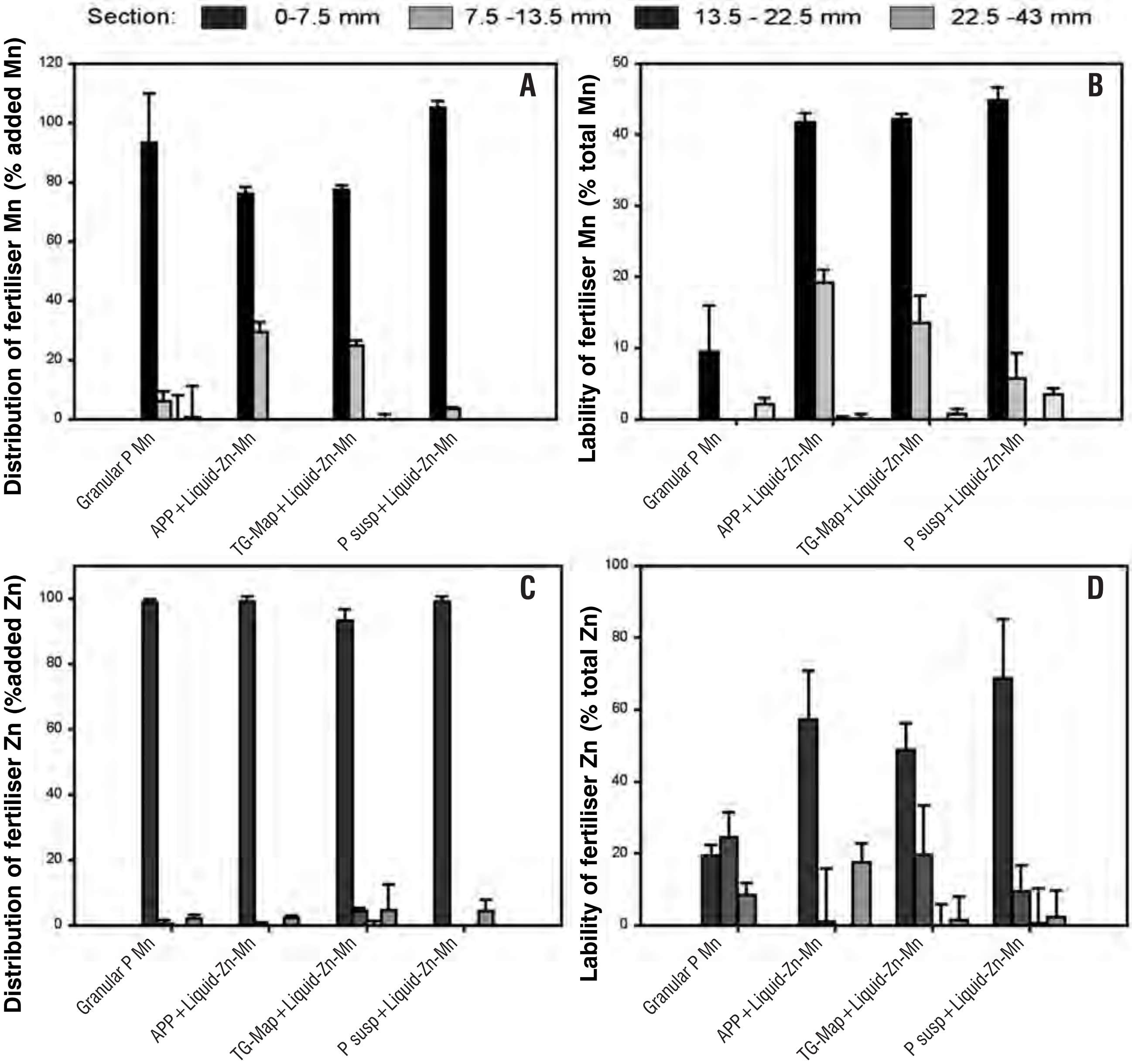

Figure 2A, Distribution of fertiliser Mn (% added Mn) 2B Availability of fertiliser Mn (% of total) 2C Distribution of fertiliser Zn (% added Zn) 2D Availability of fertiliser Zn (% of total).

- The potential availability of Mn and Zn mixed with NP fluid fertiliser, was enhanced in comparison to granular Zn and Mn mixed with NP granular fertilizer.
- Inclusion of Zn and/or Mn with P in granules does not seem to be very effective in terms of potential micronutrient availability
- We are continuing this work with a greater range of trace elements and in more soil types.

Acknowledgements

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Abbreviations:

P- phosphorus, N-nitrogen, Zn-zinc, Mn-manganese, MAP-monoammonium phosphate, APP-ammonium polyphosphate, TGMAP-technical grade (liquid) MAP

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Copper in the farming system

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Key Messages

- **Copper (Cu) deficiency can have a major impact on livestock, pasture and crop production.**
- **Cu deficiency in crops and pastures will indicate deficient soils.**
- **Cu deficiencies in stock may be caused by deficiency in the pasture or by an induced deficiency.**
- **It is essential that you know the Cu status on your farm.**

The causes of Cu deficiency on the various sections of the farming system are not straight forward. For instance, a Cu deficiency in stock does not always mean that your soils are Cu deficient. However, if your crops or pastures are deficient, your stock will certainly be deficient.

Soil Types

Cu has a high residual life because it is relatively immobile in the soil, is only slowly fixed and is not readily leached.

Soils most prone to Cu deficiency are those high in organic matter (eg peat soils), clay minerals, soil oxides (ironstone soils), leached acid soils and, to a lesser extent, calcareous sands.

Soils which become water logged reduce root activity thus limiting the plants ability to take up copper from the soil.

Copper and Livestock

Function of Copper in Livestock

Stock need Cu for growth, nerve function, immune function, fertility and pigmentation of hair and wool. Collectively, this means that Cu deficient stock will perform poorly, in particular young sheep will suffer from ill thrift. Deficient sheep can also succumb to other diseases and parasites, eg. worms. The effects on production can be dramatic.

Deficiency Symptoms

- Ill thrift – stock do not look well and do not grow well. Some scour.
- Swayback in lambs – the back ends of lambs “fall over” when they run. They may not be able to stand and may not recover when treated.
- Falling disease in cattle.
- Anaemia – pale membranes around the eyes and the mouth.
- Fragile bones.
- Steely wool – the wool loses its crimp and is shiny and weak.
- Loss of pigmentation – black wool loses its colour and hides look pale.

Causes of Deficiency

The causes in livestock are:

1. Cu deficient soils –where the soil is naturally low in Cu, the result is low Cu levels in the pasture. Pastures with tissue levels of Cu above 4 mg/kg are unlikely to be deficient for stock.
2. Wet season effect on pasture – In wet years, pasture growth in late winter/spring is so lush that the Cu in the pasture is diluted and animals grazing them become deficient.
3. Induced deficiency – reduced absorption of Cu into the blood stream can be caused be high intakes of molybdenum (Mo) or sulphur (S). Induced deficiency is most common on EP on alkaline calcareous soils (mostly because of the presence of cruciferous type weeds (eg Lincoln weed or mustard) which are high in S and also medics which are high in Mo).

Generally Cu deficiency occurs in livestock in spring and more often in good years.

Deficiency Detection

Cu deficiency in livestock is most reliably detected with veterinary assistance. Some farmers on EP are a long way from veterinary help but it is still important to assess the Cu status of your property. Is it deficient, marginal or OK? The options are;

- Ask neighbours, on similar soil types, if they have had blood Cu tests done on their livestock.
- Blood test young stock (that have not been treated with Cu) in the spring of good years. A vet or Animal Health adviser can do a blood test. It may be easiest to take five good and five poor animals to the vet. The cost is minor considering the value of stock at present.
- Give 30 stock numbered tags at marking time and treat half of them. Weigh them whenever they are in the yards to see if there is a difference. Repeat this for a few years to make sure that you strike some good years.
- Blood test any stock showing symptoms (animals with swayback can be tested by PIRSA free of charge). If a blood test is not practical, treat some of them with Cu to see if there is a response.

Livestock Treatment

- If the deficiency is due to low soil Cu levels, Cu fertilizer is the most efficient long-term treatment. This is out lined in the cropping section.
- A copper sulphate drench will correct a deficiency in sheep for up to six weeks. Mix 150 g in 5 L of water and give sheep 1mL per 3 kg of liveweight, eg. hoggets get 15 mL each.
- Permatrace® Cu capsules correct the deficiency for 12 months.
- Cu injections (in cattle only) correct the deficiency for 3 to 6 months.
- Copper sulphate in the water trough is cheap and easy but not ideal. Sheep drink very little in winter when Cu is most needed. However, if you choose this approach, then you need to supply 20 g of copper sulphate per 100 sheep per week. Dissolve the copper sulphate in water in a bottle, or other container, and place the bottle under the ballcock of the trough once a week.

Any treatment should be given early in the winter, before the most likely time for a deficiency to occur.

Copper Toxicity

- Toxicity can occur if livestock get too much Cu. Only use one treatment method at a time and do not overdose.
- Issues that cause liver damage can also cause Cu toxicity. For example, potato weed is not high in Cu but contains a poison which causes permanent liver damage. Since the liver stores Cu, the damaged liver releases large amounts of Cu into the blood system, resulting in Cu toxicity. Other diseases, such as lupinosis, also damage the liver. Do not give Cu to stock with liver damage.

Copper and Plant Production

Deficiency Symptoms

Early symptoms in plants are difficult to diagnose with more visual characteristics often not appearing until maturity.

Symptoms appear in the youngest leaves first with delayed leaf emergence, die back of leaf tips, wilting and stunted growth. Late symptoms in crops include white heads, delayed maturity, and production of late tillers. The whole head can die off suddenly while the stem remains green for some time.

In legumes, cupping and wilting of all but the older leaves can occur. The leaves tend to be more erect in growth and eventually the margins of the wilting leaves die.

Functions of Copper in the Plant

Copper is required early for tiller and root development as well as later for grain development.

Cu has three main functions.

Firstly as an important ingredient in photosynthesis and a number of other physiological processes which are linked to plant growth.

Secondly Cu is essential for pollen viability, which is linked to grain production.

Thirdly Cu plays a role in lignin formation, which is important to provide strength to structural components, and provide armour against disease infections.

Causes of Deficiency

The most common causes are soils being either naturally low in Cu or having properties which "lock up" the Cu.

Seasonal conditions, herbicide interactions, varietal inefficiencies and root diseases can affect plant uptake, which can lead to Cu deficiencies.

Other considerations:

- Cu deficiency is exacerbated by high nitrogen levels e.g. Cu deficiency increases in severity in wheat grown after lupins.
- Dry seasons tend to enhance the problem because roots cannot take up Cu in the dry topsoil.
- Poor root development (disease / herbicide pruning) reduces the plant's ability to extract soil Cu.
- There is a Cu/Zn interaction in situations where both nutrients are in deficient supply, applications of Zn (without Cu) can reduce yields even further, and therefore the Cu deficiency needs to be corrected as well.
- Crops vary in their tolerance to Cu deficiency with tolerance decreasing from rye through to triticale, oats, barley, bread wheats and finally durums.

Monitoring and Detection

Field symptoms can provide an indication of Cu deficiency but this is not a very reliable approach. Often by the time the symptoms are apparent, substantial yield penalties have already occurred.

Soil and grain analysis are limited in their ability to predict whether a soil is Cu deficient. If used they should be supported with evidence from a tissue test and paddock Cu test strips.

Tissue analysis has the three roles of;

1. Diagnosing a suspected Cu deficiency.
2. Identifying a Cu deficiency before visual symptoms.
3. Monitoring the levels of Cu in a system or rotation.

Tissue values below indicate deficiency is most likely:

Cereals	2 mg/kg
Canola	4 mg/kg
Lupins	2 mg/kg
Field Beans/Peas	3 mg/kg
Pasture Legumes	3.5 mg/kg

These values are from sampling the YEB (youngest emerged blade) or YOL (youngest open leaf) of the plant.

Crop Removal

Cereals - 7 g Cu/t

Pulse - 8 g Cu/t

Canola - 8 g Cu/t

Copper Application

Strategies to overcome the effects of deficiencies need to be carefully considered as up to 20% yield loss can occur without any field symptoms.

I. Soil Applied Copper (at least 1 kg Cu/ha)

In situations where Cu deficiencies are primarily due to low soil Cu reserves and there is a requirement to provide a long term residual benefit then at least 1 kg Cu/ha needs to be added to the system. This is best achieved by either:

- Soil sprays prior to sowing (4 kg/ha of copper sulphate).
- At sowing with N and P based fertilisers.

Since soil applied Cu has a high residual value, one application will last many years.

Generally if the soil Cu history is good and Cu plant levels are adequate up to head in boot stage then there should be ample copper to assist in grain formation regardless of stresses applied.

Other considerations

- Since Cu is immobile in the soil it should be mixed thoroughly in the soil to increase the likelihood of plant roots coming into contact with it.
- Soil sprays prior to sowing may have limited application in no-till situations.
- Dry blended Cu based granular fertilisers are not as effective as those coated or impregnated into the fertiliser granular.

II. Foliar Sprays (at least 100 g Cu/ha)

These foliar sprays of Cu will only fix the problem for the current growing season and a more permanent soil applied treatment will be required to provide longer residual effects if crop deficiencies are primarily due to low soil Cu reserves.

Foliar Cu is best applied whenever symptoms first appear or between late tillering and booting, however crops can respond as late as the flowering stage.

Research over a range of soil types and seasons has shown that the optimum economic rate needed to correct a Cu deficiency in crop is a foliar spray of Cu at 100 g/ha. Cu can be purchased as powdered sulphates, liquid sulphates, liquid oxides and liquid chelates.

Lower rates may be used where a Cu boost is required rather than correcting a known deficiency.

During your comparisons of the various products, factors such as ease of mixing, crop safety, effect on spray equipment, compatibility with other chemicals and cost per hectare needs to be factored in.

Foliar copper plays an important role in overcoming in crop deficiencies and they are generally low cost, low risk and offer the opportunity of significant financial returns.

III. Seed Coating

This technique is being used to supply a range of nutrients in close proximity to the seed, however issues with Cu toxicity need to be addressed, and it may not supply adequate levels of Cu to correct a deficiency.

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Almost ready

Location
Cleve Hills
Closest town: Mangalo
Cooperator: Paul Briese
Group: Crossville Ag Bureau

Rainfall
Av. Annual total: 340 mm
Av. Growing season: 248 mm
Actual annual total: 352 mm
Actual growing season: 279 mm

Yield
Potential: 3.4 t/ha
Actual: 3.1 t/ha (best yielding treatment)

Paddock History
2004: Wheat
2003: Barley

Soil
Land System: Low hills with medium textured red soils
Major soil type description: Red loam over red clay

Plot size
6 rows x 25 m

Which fertiliser N strategy is the best for cereals in the Cleve Hills ?

Research

Nigel Wilhelm[1] and Terry Blacker[2]
[1]SARDI Minnipa Ag Centre, [2]SARDI Pt Lincoln

Key Messages

- **Three years of N trials in the Cleve Hills district showed no evidence that N responses in cereals were different to other parts of the state. Standard N decision support tools should be relevant to Cleve Hills farming systems.**
- **Canopy management concepts resulted in grain yields and quality similar to (but no better than) more standard approaches.**
- **Low seeding rates matched yields of standard seeding rates but showed similar responses to extra N.**
- **Under current cropping systems, a wide range of N strategies can be equally effective, so choose the one which is most convenient and cheapest for you. Foliar applications of N appear to be a bit riskier than the alternatives.**

Why do the trial?

This trial was conducted to compare the effects of different N fertiliser options on grain yield and quality of wheat in the Cleve Hills environment.

It is a response to the needs of farmers in the Cleve Hills who were having a lot of trouble delivering high protein wheat to the silo and they were keen to know if they could change their N fertiliser management to solve this problem.

Part of this trial also tested the impact of the "Canopy Management" concept to wheat production under low rainfall conditions. This is a strategy imported from high production zones overseas and involves delaying applications of N onto the crop until the crop is running up. Decreasing the seeding rate of the wheat and use of a growth regulant was also included in this trial as alternatives to delayed N for reducing the early vigour of a cereal crop.

See *EPFS 2002 page 107, EPFS 2003 page 95 and EPFS 2004 page 102* for summaries of similar information from previous years.

How was it done?

The trial was seeded on 23 June with Clearfield Janz wheat at 70 kg/ha as the standard seeding rate (45 kg/ha was used for the low seeding rate). All plots were seeded with 75 kg/ha of 18:20 as a base fertiliser. N treatments at tillering were applied in early August between showers and second node stage treatments were applied in early September prior to light showers. Chlormequat (a growth regulant) was applied to appropriate treatments and Midas® to the whole trial at the end of tillering (a week prior to second node stage N applications) and immediately prior to some light showers.

Treatments – see *Table 1*.

Measurements – establishment and dry matter production at tillering for selected treatments, grain yield, grain protein and screenings.

What happened?

Results are summarised in *Table 1*.

Establishment

All plots established well with plant numbers averaging about 200 plants/m^2 at rates of N less than or equal to 21 kg N/ha at seeding. A high rate of seeding N (43.5 kg N/ha) decreased establishment by 10%.

Decreasing the seeding rate of wheat reduced plant numbers by almost 50% but by the end of tillering, dry matter production was the same as with the standard seeding rates (eg compare treatment 14 with treatment 1 and treatment 5 with treatment 2).

N status of the site

This trial was seeded into wheat stubble (after barley in 2003) and the site had low reserves of N in the profile (only 64 kg N/ha in the top 60 cm a few weeks after seeding). Wheat growth in the trial was progressively increased by increasing rates of N. Shoot growth at tillering was nearly doubled by an extra 30 kg N/ha at seeding.

Grain yield was also progressively increased by increasing rates of extra N. With only the N supplied in 18:20 @ 75 kg/ha at seeding, wheat yielded 1.84 t/ha but yields increased to 2.14 – 2.42 t/ha with an extra 15 kg N/ha, depending on the type of application. Another 15 kg N/ha added a further 0.2 t/ha (more or less) but adding an extra 90 kg N/ha to the N supplied in 18:20 increased yields to just over 3 t/ha.

Grain proteins were generally low in this trial. Without any extra N, grain protein was 9.2%. Adding an extra 15 or 30 kg N/ha, regardless of when or how it was applied, barely increased grain protein from this base level with most grain proteins being about 9%. Only when an extra 90 kg N/ha was applied did grain proteins increase substantially from the levels in treatment 1, to a level of 11.2%.

Screenings were very low in this trial, with all treatments resulting in screenings less than 2%.

Effectiveness of N applications

Many of the treatments in this trial allowed direct comparisons of the impact of timing of N on grain yield of wheat. The clear pattern in this trial was that timing of the application of N (as urea) had almost no impact on effectiveness. For example, treatments 7 – 9 are all the same except that 30 kg N/ha of urea was either applied at seeding, tillering or second node. Grain yields differed by less than 3% but all lifted yields by more than 0.5 t/ha from the control of no extra N (treatment 1).

Treatments 4 - 6 compared the effectiveness of three N sources when applied at 15 kg N/ha at the second node stage of wheat. These results show that broadcast and streambar applied urea were equally effective in terms of grain yield but foliar applied urea was slightly poorer.

Grain proteins were not affected by timing or method of N application.

Table 1. Fertiliser treatments and performance of wheat in the Cleve Hills in 2005. N rates are in kg N/ha. Screenings were < 2.0 mm.

Treatment	N and canopy management strategy	N with 18:20 at seeding	Seeding N	Tillering N	Second Node N	Total N	Plants per sq m	Dry matter at tillering (t/ha)	Grain yield (t/ha)	Grain protein (%)	Screenins
1	No extra N	13.5				13.5	197	0.76	1.84	9.2	1.0
2	Extra N at seeding only	13.5	15			28.5	186	0.98	2.23	8.9	0.8
3	Extra N at tillering only	13.5		15		28.5			2.24	8.8	0.8
4	Extra N at second node only	13.5			15	28.5			2.35	9.4	1.3
5	Extra N at second node only - streambar urea	13.5			15	28.5			2.35	9.3	1.2
6	Extra N at second node only - foliar urea	13.5			15	28.5			2.14	8.9	1.1
7	Extra N at seeding only	13.5	30			43.5	179	1.44	2.46	8.9	1.0
8	Extra N at tillering only	13.5		30		43.5			2.40	8.6	0.8
9	Extra N at second node only	13.5			30	43.5			2.44	9.6	0.9
10	Extra N at seeding and tillering	13.5	7.5	7.5		28.5	200		2.35	9.3	1.0
11	Extra N at seeding and second node	13.5	7.5		7.5	28.5			2.42	9.2	0.9
12	Extra N at seeding and tillering	13.5	15	15		43.5			2.51	9.6	0.9
13	Extra N at seeding and second node	13.5	15		15	43.5			2.56	9.3	1.0
14	Canopy manag - low seed + second node N only	13.5			15	28.5	110	0.67	2.17	9.3	1.1
15	Canopy manag - low seed	13.5	15		15	43.5	124	0.90	2.40	9.7	0.8
16	Canopy manag - chlormequat @ late tillering	13.5	15		15	43.5		0.96	2.41	9.0	1.0
17	Canopy manag - low seed + chlormequat	13.5	15		15	43.5	126	0.90	2.44	9.7	0.9
18	Canopy manag - low seed + second node N only	13.5			30	43.5			2.43	9.7	1.0
19	Luxury N	13.5	30	30	30	103.5			3.07	11.2	1.2
	LSD (P=0.05)						17	0.17	0.13	0.8	0.3

Canopy Management

As mentioned in the previous section, delaying the application of extra N to second node stage did not confer any great benefits in terms of grain yield; yields were very similar to those achieved with earlier applications at the same rate of N.

Decreasing the seeding rate of wheat did not appear to confer any extra N efficiencies because grain yields were either the same or lower with the same N applications (eg treatment 14 vs treatment 4 or treatment 18 vs treatment 9). However, a lower seeding rate would result in a cheaper crop to grow.

The use of chlormequat had little impact on grain yield of wheat.

What does this mean?

Under the conditions of this trial where mid season applications of N were always followed by substantial rains and the season finished with a decile 8 spring, delayed applications of N were equally effective with seeding N. However, they were no better, so at best they were a viable alternative to seeding N (although remember that seeding N does not require a separate operation) with an advantage that they are not an upfront cost.

This trial is another in a long series of trials we have conducted over the last few years in higher production areas which have found that foliar applications of N were no more effective or reliable than broadcast urea for in-crop applications. There has been no support for the idea that if you foliar apply the N then you can cut N rates back and get the same benefits as a higher rate of broadcast (or streambar-applied) N.

This trial was characterised by a strong response in grain yields to N applications due to low N reserves in the soil profile and a wet spring to allow high yields to be achieved. However, under these "ideal" conditions, canopy management approaches (delayed N applications to second node stage, decreased seeding rates) were no better than more standard approaches of some N at seeding following by a top up of N at tillering, or all the N at seeding. One advantage of delayed applications of N is that there will be more opportunities for holding off on the application all together (because of adverse conditions) whereas an advantage with earlier N applications is that there will be more opportunities for applications to be effective (because of suitable weather conditions). Generally, delayed applications of N will benefit grain protein levels more than seeding or early applications but this effect is often not large (and was barely present at all in this trial).

The upshot is that in our current cropping systems (with early seeding, good weed and disease control) there is a great deal of flexibility in the way that extra N can be effectively applied. None are vastly superior to any other, so often the final choice comes down to the actual cost of the N used (including the cost of the operation) and what type of operation (and timing) fits most conveniently into each farming enterprise. We have seen this general pattern in almost all the N trials we have conducted over the last few years across a range of soil types and under a wide range of seasonal conditions.

While this trial showed quite low protein levels in wheat, this is entirely consistent with the conditions at the trial site and the responses to N observed in terms of grain yields and proteins are also similar in nature to responses observed in other districts. The last three years of N trials in the Cleve Hills area have not revealed any N response behaviours in cereals to suggest that farmers in this district are facing N problems peculiar to their particular environment. The proteins were low in this year's trial but if sufficient N was applied, grain proteins were increased to market acceptable standards. The rates of N required to cause such a lift in grain protein were similar to those required in other districts. The results from this programme suggest that standard N decision support tools used in southern Australia should also be relevant to the Cleve Hills district.

Acknowledgements

Thanks to Paul Briese and their families for use of their paddock for the trial. Teararse Blacker for his untiring and constructive criticism.

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NutriSmart® trials and demo's

Neil Cordon and Bob Holloway
SARDI, Minnipa Agricultural Centre

Searching for problems

Location
Haslam: John Linke

Rainfall
Av Annual: 286 mm
Av G.S.R: 210 mm
2005 Total: 261 mm
2005 G.S.R: 196 mm

Paddock History
2004: Pasture
2003: Pasture
2002: Wheat

Soil Type
Grey, calcareous, sand.

Yield Limiting Factors
Late sown

Location
Bookabie:
John & Andrew Mahar

Rainfall
Av Annual: 284 mm
Av G.S.R: 221 mm
2005 Total: 272 mm
2005 G.S.R: 237 mm

Paddock History
2004: Wheat
2003: Pasture
2002: Pasture

Soil Type
Grey, sandy loam.

Yield Limiting Factors
Late sown, moisture stress.

Key Messages

- **The use of alternative fertiliser products in a farming system must be carefully considered, to avoid productivity and economic losses, especially if the products have not been locally tested.**
- **In 2005, NutriSmart® did not offer productivity gains when compared to other fertiliser treatments.**

Why do the trials?

The demonstration strips were initiated by farmers, who had purchased a product called NutriSmart®, and wanted to evaluate its performance in cereals. Its performance was compared to their regular granular based fertiliser program.

The replicated trials were an addendum to Bob Holloway's fluid fertiliser program at the request of the company that sells NutriSmart®.

The work aimed to test whether the product was effective in improving yield on calcareous soils.

How was it done?

Single demonstration strips were sown with NutriSmart® to compare with a farmer's control paddock or granular product.

Those sites were at Bookabie, Haslam and Courela on Upper Eyre Peninsula.

The recommended rate for cropping is 150 to 300 kg/ha, however the farmers were advised to use the rates listed in *Table 1*.

All fertiliser was applied with the seed at sowing time with trial details shown in *Table 1*.

The replicated sites were at Port Kenny and Cungena where the NutriSmart® had 18:20 blended with it. To ensure Nutrismart® and granular treatment nutrients balanced, additional nitrogen and zinc was included in the form of urea and zinc sulphate to the Nutrismart® treatments.

NutriSmart® is a product which has six micro-organisms (yeasts) contained in a granule – the technology is aimed to harness specific biological processes and release fixed P.

Measurements: Grain yield and quality with plant nutrient levels and dry matter yields at pre head emergence at selected sites.

What happened?

Visual observations throughout the growing season identified the NutriSmart® strips as being lighter in colour and having less vegetative growth than the farm practice. At head maturity the visual differences were not so apparent.

At Courela, there was less dry matter, lower yield and less gross income with NutriSmart® compared to 18:20, *Table 2*.

Tissue test data also showed little difference between the plots.

At Haslam the farm practice of 10:22 produced an extra $44/ha income compared to the NutriSmart® plot whilst at Bookabie the yields were the same giving NutriSmart® an income advantage of $3/ha. The Bookabie site suffered from moisture stress in September, which may have favoured the Nutrismart® plot, which had less vegetative growth come harvest time.

The replicated work at Cungena and Port Kenny *(Table 4)* showed that the granular product had the highest yields and

Table 1: Demo and trial details at Pt Kenny, Cungena, Bookabie, Haslam and Courela in 2005.

Site	Date Sown	Sowing Rate kg/ha	Wheat Variety	NutriSmart Rate kg/ha	Granular Rate kg/ha
Bookabie	25 June	70	Krichauff	65	DAP @ 65
Haslam	23 June	70	Trident	70	MAP @ 70
Courela	28 June	50	Trident	50	DAP @ 50
Port Kenny	24 June	65	Yitpi	50	DAP Zn 2.5% @ 53
Cungena	20 June	65	Yitpi	50	DAP Zn 2.5% @ 53

Table 2. Grain yield and quality, dry matter at late tillering and gross income for NutriSmart® at Courela 2005.

Treatment	Protein%	Screenings %	Test Weight kg/hL	Fert. Cost $/ha	D.M. yield t/ha	Grain Yield t/ha	Gross Income $/ha
NutriSmart®	12.3	1.3	77.8	21.5	1.09	1.19	170
18:20:00	12.2	1.9	76.6	22.15	1.52	1.24	175

Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

Searching for problems

Location
Streaky Bay: Neville Trezona

Rainfall
Av Annual: 286 mm
Av G.S.R: 210 mm
2005 Total: 261 mm
2005 G.S.R: 196 mm

Paddock History
2004: Pasture
2003: Barley
2002: Wheat

Soil Type
Grey, calcareous, sand.

Yield Limiting Factors
Late sown.

Location
Simon Guerin.
Mount Cooper Ag Bureau.

Rainfall
Av Annual: 375 mm
Av G.S.R: 305 mm
2005 Total: 428 mm
2005 G.S.R: 351 mm

Soil Type
Grey, calcareous, sand.

Plot Size
2m x 20m x 4 reps

Yield Limiting Factors
Late sown.

Location
Myles Tomney

Rainfall
Av Annual: 284 mm
Av G.S.R: 239 mm
2005 Total: 275 mm
2005 G.S.R: 234 mm

Soil Type
Grey, calcareous, sandy loam.

Plot Size
20m x 2m x 4 reps

Yield Limiting Factors
Late sown.

Table 3. Grain yield, quality, and gross income for NutriSmart® at Haslam and Bookabie 2005.

Treatment	Protein %	Screenings %	Test Weight kg/hL	Fert. Cost $/ha	Grain Yield t/ha	Gross Income $/ha
Haslam						
NutriSmart®	11.4	3.3	79.8	29.54	0.84	97
10:22:00	12.0	2.9	78.2	31.64	1.11	141
Bookabie						
NutriSmart®	12.1	1.1	79.2	27.95	1.11	139
18:20:00	12.2	1.6	78.9	29.38	1.11	136

Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

Table 4. Grain yield, quality and gross income at Port Kenny and Cungena 2005.

Treatment	Applied Nutrients (kg/ha)			Protein %	Screenings %	Grain Yield t/ha	Gross Income $/ha
	N	P	Zn				
Cungena							
NutriSmart®/DAP	15	10	1.3	13.7	1.5	0.77	116
DAP Zn 2.5%	15	10	1.3	14.0	1.3	0.92	143
Nil	-	-	-	13.2	1.5	0.69	125
				LSD (P = 0.05)		0.07	
Port Kenny							
NutriSmart®/DAP	25	10	1.3	13.2	3.0	1.19	186
DAP Zn 2.5%	25	10	1.3	13.3	3.0	1.28	206
Nil	-	-	-	12.6	3.2	1.07	184
				LSD (P = 0.05)		0.07	

Gross Income is yield x price (with quality adjustments) less on farm treatment costs delivered to Port Lincoln as at 1st December 2005.

gross income. There appears to be little influence between treatments on grain quality.

What does this mean?

This season's demonstration and replicated trial work shows no yield advantage of using the product NutriSmart® when compared to the traditional granular fertiliser at farm rates on calcareous soils on Upper EP when applied at similar rates.

This independent data suggests that in its current formulation and at the rates used, the NutriSmart® product is unsuitable for this environment.

Acknowledgements

Andrew and John Mahar, John Linke and Neville Trezona for having the initiative to try this product so data can be obtained to assist fellow farmers. Simon Guerin and Myles Tomney for allowing access to their property for trial work.

NutriSmart® - registered product Fertico Pty. Ltd.

Grains Research & Development Corporation

SAGIT

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Section
8

Section editor: Sam Doudle
SARDI, Minnipa Agricultural Centre

Soils

Compaction and deep ripping - answers to some frequently asked questions.

Extension

Sam Doudle, Nigel Wilhelm, Neil Cordon
SARDI, Minnipa Agricultural Centre

Compacted soils are widespread across the Eyre Peninsula. However, there are no exact rules to say whether a yield benefit from deep ripping will occur for a soil with a certain level of compaction, let alone estimate how large the benefit might be, under what seasonal conditions it will occur or how many seasons it will last for.

The effect of soil compaction is complicated because many other factors also influence the outcome on plant root growth and final yield. These include depth of compacted layer, seasonal conditions, soil nutrition, subsoil toxicities and soil borne disease, etc.

Soil compaction and deep ripping is an area of soil management that still requires further work to improve our understanding so that the benefits of remedial work can be predicted accurately. This work needs to include an understanding of the interactions outlined above. We know that compaction reduces plant productivity but alleviating compaction reliably and economically is still more an art than a science. However some of the information we do know follows.

Q 1. How can I identify if I have a soil compaction issue?

Two ways, one will give an actual figure and the other will give an indication.

The accurate way

1. When soil is as wet as it is likely to get (‘field capacity’) use a penetrometer to accurately measure soil resistance.
2. You will also need to characterise the soil layers, and measure bulk density and soil moisture to accurately interpret the penetrometer reading.

   Note: A resistance pressure of 2500 kPa (at soil moisture field capacity) is considered to restrict root growth.

OR

The rough way

1. Dig holes, look at crop and pasture roots, if they are not growing well deeper in the profile you may have a compaction problem.
2. Try pushing a flux-free welding rod into the wet soil with the palm of your hand. Try and calibrate your hand and welding rod first by using the welding rod technique in a paddock with a similar soil where you know you don’t have a compaction problem or in nearby grassland or vegetation that hasn’t been cropped so you can feel what an uncompacted soil feels like. Then go back to your area under investigation and compare the two. Take note of what depth the welding rod becomes hurtful to push (potentially the compacted area).
3. Dig a hole and check out what the soil is like at the depth where you reckon that compaction might be. Sometimes a change in soil texture (eg the subsoil changes into a heavier clay) can cause the rod to be harder to push and this will trick people if they don’t dig down and take a look.

Q 2. What soil measurements are required to identify any issues that may limit ripping benefits?

- Test for subsoil toxicities (boron, salt, sodicity). If these are present as well as compaction it would be hard to tell what is causing the greatest restriction to root growth without conducting your own deep ripping investigations.

Q 3. What soil types are best suited to deep ripping?

- Soils that don’t have solid or large rocks within the rip depth.
- Soils that have a compacted layer that restricts root access to otherwise available deeper moisture or nutrients, ie. soil profiles without subsoil toxicities such as salt, boron or sodicity.

- Sandy soils naturally compact and will not self-correct (unlike many clay soils).

Q 4. Does the benefit of deep ripping vary according to seasonal conditions?

- Research work on EP suggests that the greatest benefits occur in drier years.
- Why? The strength of soil reduces as it gets wetter so the wetter the soil the easier it is for roots to grow (unless there is more water than the soil can hold, ie exceeding the field capacity and the roots start drowning). This means that in a wetter season roots can grow more easily through a compacted layer to take advantage of the subsoil moisture underneath (they may not even need to access that deeper moisture if the topsoil provides sufficient consistent moisture). Dry seasons mean that plants will benefit greatly from extra soil moisture down deep in the profile.

Q 5. When is the best time to deep rip?

- Depends on soil type and soil moisture. Generally, the drier the soil and the heavier the texture the more horse power you need to pull the ripping machine. However, ripping dry soils that have a structure, eg clays, will allow the ripping process to fracture the soils further from the ripping tine (making more mess, but also disturbing more of the soil profile).
- Soils should not be ripped when they are wet because there will be little shattering, the tractor will cause severe compaction which may not be completely overcome by the ripping operation and the ripping tines may cause smearing (which will only add to compaction issues).

Q 6. What are the negative effects of deep ripping?

- Deep ripping can leave the soil surface very rough and very loose leading to sowing depth problems at seeding time.
- Techniques to prepare the ripped soil for seeding on sandy soils can leave the ground exposed to wind erosion, eg rolling or harrowing.
- Soils that had been previously clay spread are not as prone to wind erosion.
- On heavier soils ripping can create huge clods that needed to be broken up before seeding. Having another pass to improve the soil surface for sowing between ripping and sowing is undesirable as it adds to the expense and could start repacking the rip lines via machinery tracks.
- These issues could be minimised by using a one pass deep ripping and sowing machine such as that built by the Buckleboo Farm Improvement group in 2004.
- Wide gaps between ripping lines (50 cm or more) will reduce the impact of these consequences but compacted layers may not be fully ameliorated.
- Deep working narrow points on modern seeders is another strategy which can ameliorate shallow compacted layers without causing other management problems.
- There is evidence to suggest that having a compacted layer above high levels of subsoil constraints may be a good thing as it restricts the plant roots travelling into soil that would further stress the plant under dry conditions. However, this theory needs further investigation.

Q 7. Is there a preferred crop choice to sow on newly ripped country?

- Deep ripping doesn't generally change the range of crops that can be grown (unless it is combined with clay spreading).
- A good understanding of subsoil toxicities and the influence of deep ripping is required. If plant roots can reach a subsoil toxic layer more quickly then susceptible plants may suffer more than in the past, eg. barley may show more severe symptoms of boron toxicity.
- There is some evidence that lupins will benefit less from deep ripping than cereals or canola.
- There is no evidence that primer crops (crops with strong tap roots) grown in the first year after ripping can extend the benefit of deep ripping.

Q 8. How long do the effects of deep ripping last and does that vary according to soil type?

- Work conducted over 6 years by the EPFS showed that deep ripping to 40 cm on sandy soils only had a major yield benefit in the year of ripping.
- Deep ripping benefits can often be seen for many years when pipelines or other underground infrastructure have been laid. In most of these cases the soil has been massively disturbed and mixed up, which leads to a texture change preventing the ripped area from rapidly returning to its original compacted state (or else your pipe is leaking providing some subsoil irrigation!). These effects are usually seen on heavier soil types and are more visual in drier seasons.
- Clay delving is another example of where the soil profile has been massively mixed up, allowing the ripping benefits of the rip lines to last for much longer.
- Investigations are needed to see if traditional deep ripping benefits can be extended by changing to a controlled traffic farming system which reduces re-compaction opportunities across the paddock.

Q 9. What is an average cost of deep ripping?

- The contract price for deep ripping in WA is approx $40/ha but some advisers recommend a price as high as $80/ha.

Q 10. Do sheep create deep compaction issues?

- Sheep are not heavy enough to cause deep soil compaction.
- Sheep will compact wet soil, especially the heavier soils, but the compaction they cause is usually quite shallow (within normal cultivation depths).

Q 11. What deep ripping yield increases have been achieved on various soil types?

- Five years of EPFS investigations at Wharminda on a shallow sand over sodic clay soil showed that deep ripping alone increased yields in three years out of five by an average 0.3 t/ha. The two years with no ripping response had above average rainfall.

- Yield increases averaging 0.3 t/ha from ripping occurred in the Kelly and Balumbah districts (south of Kimba) in each of the two years trials were conducted on deep sand (between 40 cm to 1 m+) over sodic clay.
- Demo's at Buckleboo in 2002 (very low rainfall year) across 3 soil types in the same paddock showed no response to ripping on sand and grey calcareous soil and a major yield penalty (0.3 t/ha) on heavy red soil with a toxic subsoil.
- Other demo's at Buckleboo in 2004 gave a ripping response only on the sandy/loam soil type (0.2 t/ha), not on the sand, red or grey sites.
- David Malinda (SARDI researcher at the Waite) regularly achieved 10% higher yields with deep working seeding points at Halbury in the mid north on a red brown earth (425 mm rainfall and 3-5 t/ha crops) and at Waikerie (1-1.5 t/ha crops).
- **The key message here - we still don't have enough information to accurately predict yield responses and their magnitude.**

Q 12. How far apart should deep ripping tines be placed?

- For most operations, deep ripping tines are placed between 30 and 50 cm apart.

Q 13. What tractor horse power is required to pull a deep ripper?

- This depends on many factors including soil type, number of tines, depth of ripping and soil moisture. A broad rule of thumb is 20 to 50 horse power per tine at a working depth of 40 cm.

Upper EP soil compaction survey …finally!

Sam Doudle, Ben Ward, Nigel Wilhelm
SARDI, Minnipa Agricultural Centre

Searching for problems

Location
From Nundroo to Cowell and south to Elliston across to Arno Bay

Key Messages

- **18 of 19 properties surveyed across UEP in 2004 had more compacted soil under their cropping land than under their adjacent uncropped land.**
- **This survey provides even more justification for further work on soil compaction to determine its impact on profit and sustainability across UEP.**

Why do the trial?

During the 2003 round of EPFS farmer meetings, nearly every group nominated soil compaction as an issue they wanted the EPFS project to look into. The project helped farmers from Buckleboo, Ceduna, Streaky Bay, Piednippie and Koongawa set up or monitor their own deep ripping demo's so they could begin to test whether soil compaction may be an issue for them *(dig out the 2003 EPFS book, pg 121 for the results of those demo's)*.

In addition to these demo's the project undertook to do a soil compaction survey across a range of soil types on UEP in 2003. Unfortunately the person who volunteered (that would have been me…der!) had bitten off a bit much in 2003, so the field work for the compaction survey wasn't conducted until the end of August 2004.

The most reliable thing we could say about soil compaction in 2003 from our limited experience and knowledge was that it probably existed across a whole range of farmed soils but we had no clear ideas about where exactly it was, how bad it was, whether it was causing yield loss or even whether it was providing a buffer protecting roots from subsoil constraints where they existed?

The 2004 UEP soil compaction survey was designed to start investigating this issue on a broad scale with the hope that we would get enough information to build a case for new funding to start researching and answering the plethora of questions surrounding soil compaction.

How was it done?

One of the trickiest parts of this survey was working out how to do it, that's why I'll spend a bit of time explaining that, so you can see what this survey is and isn't! After consulting all sorts of specialists in the area then coming back and going through the practicalities of what they all wanted we came up with the following method.

Survey aim - The aim of our survey was to get a feel for how soil strength has changed over time across UEP soils, ie how did soils that had experienced agriculture compare with those that hadn't.

Participants - We asked each group to nominate someone in their area who could find a good example of a cropped paddock directly next to some scrub or native grassland. We needed the soil profile in both areas to be as similar as possible so we could just compare the difference that agriculture had made to the soil.

One person was nominated and samples taken from their property from the groups in each of these districts: Nundroo, Charra, Goode, Mudamuckla, Nunjikompita, Minnipa (x 2), Streaky Bay, Mt Cooper, Elliston, Warramboo, Murdinga, Wharminda, Crossville, Arno Bay, Cowell, Waddikee, Tuckey, Buckleboo.

Survey Technique - We set up transects in both the cropped and uncropped areas as close together as possible, hoping that would ensure the most similar soil characteristics. We walked along the transect taking 10 penetrometer measurements, one every couple of metres, with a mark left at each location. We then dug a hole and used the soil profile in that hole to describe the soil from that transect. The hole was chosen from a location where the penetrometer reading seemed most representative for all ten taken along the whole transect. The layers, texture, pH & carbonate were recorded to a depth just below where we had taken the penetrometer readings. From each soil layer we also took soil samples to test for bulk density and soil moisture. Each of these locations was recorded using a Trimble dGPS.

So after two weeks of traipsing all over the countryside we ended up with tonnes of data and tonnes of soil samples. We sent one set of soil samples off to Soil Water Solutions (a consulting company) for bulk density, field capacity and wilting point measurements and the other set of samples were kept at MAC for soil moisture measurements.

Our penetrometer allowed us to download the data straight into the computer saving a lot of time, frustration and eliminating transcription errors.

Why we chose this technique - To determine if a soil is causing a barrier to root growth using soil resistance methods, such as a penetrometer, you are supposed to have that soil wetted up to field capacity when you take the readings. This is because the drier the soil the more resistance it provides to a growing plant root. From the scientific literature, a level of 2500 kPa of resistance will restrict root growth. However, these measurements are always taken when the soil is at field capacity because scientists have settled on resistance at field capacity as a standard so that different measurements can be compared. As you might imagine, this survey was big and complicated enough without arranging with 19 people from one end of the Peninsula to the other to choose 2 x 10 transects, water them overnight then allow them to drain, taking the chance that we may or may not have approved of their selection on our arrival!

This is where our very own Dr Bob came to the rescue. Bob began investigating soil compaction on EP during his PhD in the early 90's. He came across the same field capacity stumbling block and his answer to it was relatively simple – don't worry about it because soil under scrub is almost always drier than soil in the cropped area. This means that if the two soils are actually the same, then the scrub soil should give higher penetration resistances anyhow. Therefore if the cropped soil provides higher penetration resistances then we can be very confident that, in fact, the cropped soil is more compacted. Perhaps that would have made more sense to you if I'd explained it in Latin, but suffice to say that we had a back up plan to verify our results without having to take the readings at field capacity, which was just as well because the soil was quite dry during the first week of sampling at end of August in 2004. Then we had around 50 mm of rain which made the 2nd week of sampling much easier on us (from a pushing the penetrometer in perspective that is)!

The end result - Two graphs of information per property were generated. One graph has four pieces of information; the soil moisture under the scrub, soil moisture under the crop, the theoretical field capacity and the theoretical wilting point (the last two both developed from soil tests and lab analysis). These four pieces of information allowed us to not only confirm that the scrub measurements were indeed drier than the crop but we could also see how much moisture our

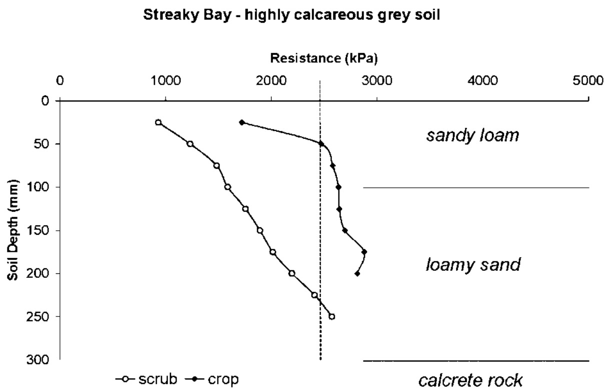

Figure 1: Penetrometer readings from Streaky Bay

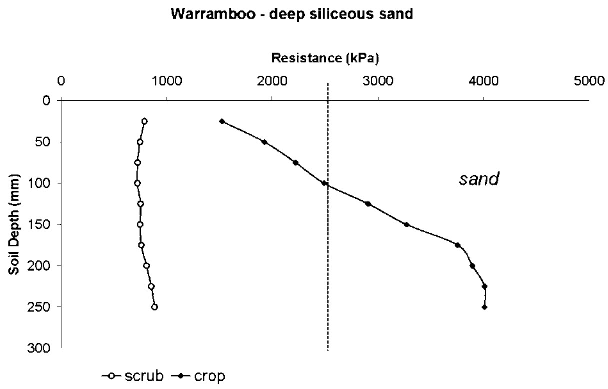

Figure 2: Penetrometer readings from Warramboo

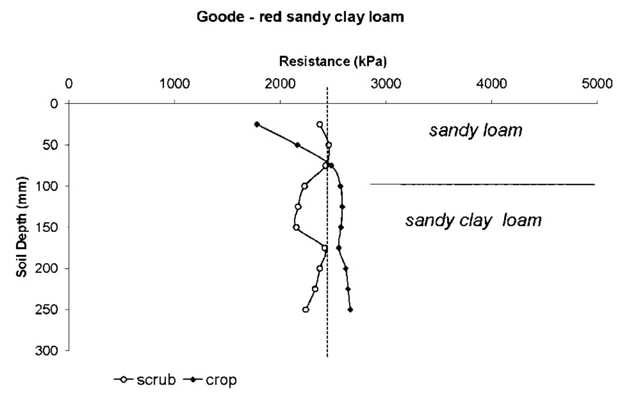

Figure 3: Penetrometer readings from Goode

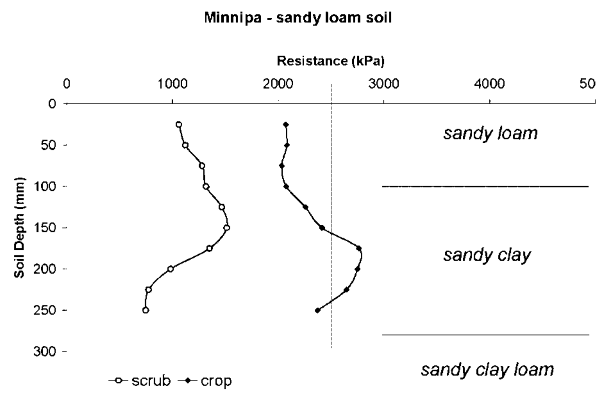

Figure 4: Penetrometer readings from Minnipa

soil was holding when we sampled, compared to the theoretical field capacity of that soil. The second graph produced from this work is a comparison of the penetrometer resistance of the soil in the scrub vs that cropped. *Figures 1 – 4* are examples of these.

Three of the graphs that I have chosen to put in this article *(figures 1 – 3)* all had soil moistures that were fairly close to field capacity, hence the actual figure of 2,500 kPa has particular relevance to root growth in those areas.

What happened?

Out of the 19 properties sampled across a range of soil types from Nundroo to Cowell, all of the cropped areas were more compacted than the adjacent uncropped comparisons apart from one at Tuckey.

Of the four properties presented in these results *(figs 1 – 4)*, three were at soil moisture levels that were close to field capacities for that soil *(Streaky – fig 1, Warramboo – fig 2 and Goode – fig 3)*, which means the theoretical resistance of 2,500 kPa has more relevance for these results. Of these three, all of them have a resistance of 2,500 kPa or above within the theoretical crop root zone – Streaky Bay @ 50 mm *(fig 1)*, Warramboo @ 100 mm *(fig 2)* and Goode at 75 mm *(fig 3)*.

What does this mean?

Finally we have some good survey data to estimate the current state of a range of UEP soils with regard to compaction, and the role of agriculture in developing this current state. The fact that 18 out of 19 of these properties have a more compacted soil under their cropping system than their adjacent uncropped land certainly justifies a renewed research effort in this area. This is particularly critical when the three samples that we managed to fluke at field capacity (after the 50 mm of rain) were all experiencing over 2,500 kPa of resistance in the crop root zone, a level theoretically high enough to cause problems for root growth. This means that these soils are so strong that even when the soil is as soft as it will ever get (ie at field capacity) it is still too hard for unrestricted root growth.

The results from this survey provide some good justification for further work in this area. We actually had this data analysed by early 2005 but didn't get the opportunity to write it up for last year's book. After we'd seen these results last year we put together an NLP funding submission for funds to continue our investigations. We heard just prior to Xmas last year that this submission was unsuccessful (too research oriented) so we have submitted a similar project to SAGIT. One way or another, we are going to find resources to address the following questions:

Question 1:

Are there any farming systems with uncompacted soils on EP – if so why?

Proposed Action

Conduct a more targeted compaction survey – target various farming systems on each soil type and within several rainfall zones, eg. conventional, min till, no till, no till + deep working, controlled traffic.

Potential Outcome

Farming system characteristics identified that will either cause, manage or improve soil compaction.

Questions 2:

- **What are the penalties and/or advantages of compaction?**
- **Is compaction of benefit in some soils, eg. buffer protecting roots from subsoil toxicities?**
- **Are there practical methods for managing or reducing compaction?**

Proposed Action

Trials to work out impact of compaction and management strategies to ameliorate compaction.

From the survey choose 2 investigation sites / soil type and set up medium term (3 years, longer if possible) trials to compare performance of potential compaction management techniques, eg conventional (control), deep rip, deep working points, controlled traffic, primer crops, etc.

Potential target soil types

Deep siliceous sand, siliceous sand over clay, calcareous grey sand, calcareous red loam, sand over buckshot, neutral to acid sandy loam

Potential Outcomes

Local relevant information generated for EP farmers regarding how compaction is financially and physically affecting their farming systems and options for managing it to improve profitability and sustainability of their systems.

Question 3:

How often does the combination of compaction and low soil moisture restrict root growth on EP soils?

Proposed Action

Establish soil moisture probes permanently at several sites to log and analyse how often lack of soil moisture restricts root growth throughout the season and across seasons.

Potential Outcome

This information added to that developed by the new EPFS project will provide the basis for estimating realistic yield potential based on soil and crop available water under Eyre Peninsula conditions.

Acknowledgements

Thanks to all of the families who participated in this survey, especially the ones who provided us with a wee nip of stout during the freezing cold and soaking wet period near the end!!

Thanks to GRDC for funding this field survey through the original EPFS project.

A special thanks to Ben Ward for providing most of the muscle behind the survey, often in adverse weather conditions and often as the sun was coming up and then going down again. Good job Ben, by the way, get a haircut!

Thanks to everyone who contributed technical advice during the set up and analysis of this survey (Bob, Nigel, Cliff Hignett and all those I've forgotten due to the time lag!).

Apologies to you all for taking so long to write this up!

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Searching for answers

Options for reducing the cost of soil compaction

Extension

Peter Walsh

PV&V Engineer, John Deere, Perth, WA

Note: *this article is an extract from the Eyre Peninsula Sowing Systems Field Day Manual (EPARF Field Day, 2004). Permission to reprint it was provided by Peter Walsh who was then an Agricultural Engineering Consultant based in Perth WA"*

Summary

Soil compaction costs Australian farmers about $1B per year but there are a number of practical options to contain the cost on the farm. This article explores some of the options and provides a framework to attack the problem on the farm as well as recommending how farmers might influence research and information providers to help.

The options covered in this article are:

- Confine and localise the area compacted using guidance and controlled traffic
- Methods to reduce the severity of compaction
  - Increased precision to overcome higher draft related to compaction (has many other benefits)
  - Reduce the damage by using lighter vehicles
  - Reduce the damage by using lower ground pressure
  - Manage operations to avoid traffic in weak soil conditions
- Encourage research funders and information providers to address machinery as well as their traditional areas of plants and chemicals.

Confine and localise compaction

It is widely understood that wheel traffic, particularly in moist conditions, produces a lasting strength increase in the soil, with adverse consequences for the soil and the resulting crop growth. Techniques such as controlled traffic and even improved guidance in random traffic reduce the percentage of the paddock that is compacted in any cropping cycle. In the case of controlled traffic, the compaction is localised to areas that may be treated with deep tillage or retained as permanent wheel tracks.

You may have seen graphical information and other estimates of the percentage of the paddock subject to compaction damage. *Figure 1* is an estimate of the percentage of the paddock covered by wheel tracks during the time taken to grow three crops in the Minnipa area of South Australia under a direct drill system. The result is produced by the Queensland DPI's Trackman program.

The program estimates that at least 80% of the paddock receives at least one wheel pass in any three year period. In the same period 72% of the paddock is rolled once or more by heavy axles such as tractor and air-seeder cart tyres.

The most important message from this analysis is that tyres (or tracks) capable of deep compaction cover almost the whole paddock even in a direct drill or no-till system in any three years of cropping and more than 50% each year. There is strong evidence that deep compaction persists for at least three years and the operations included in *Figure 1*, seeding and spraying, are almost all done in moist soil conditions.

This paper will go on to address ways of minimising soil compaction damage in conventional or random traffic farming. This should provide information to assist farmers to fine tune their existing setup, but if they consider that compaction is a serious issue, a long term strategy to move to a controlled traffic approach as machinery is replaced should be considered.

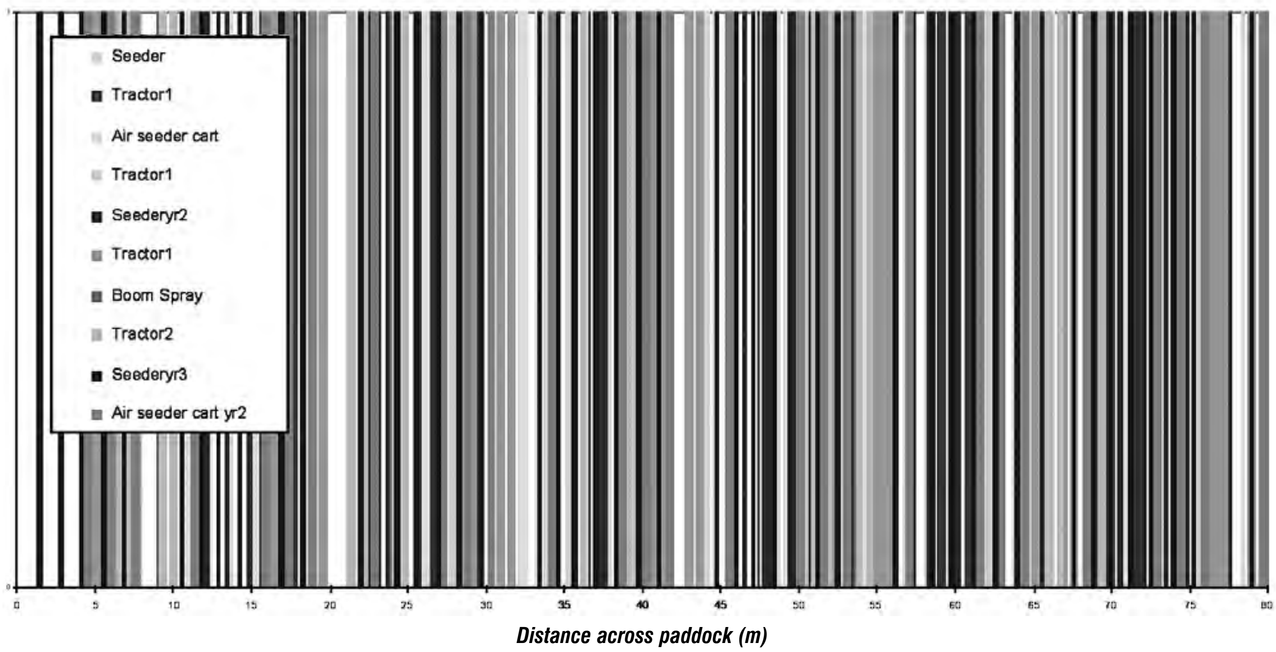

Figure 1. Wheel track coverage of a typical Minnipa (SA) paddock due to three years of winter cereal crops, the grain harvester and haul out equipment is assumed to operate in dry conditions and is not included.

Methods to reduce the severity of soil compaction

Ward Voorhees, a Soil Scientist from Minnesota, has published extensive research results on soil compaction and has provided an insight into the factors causing soil strength increase at various depths through the soil profile. He used differing axle weights while maintaining appropriate tyre configurations and pressures. His findings indicate that the depth of strength increase due to a tyre or track pass is related to the axle load. He suggested that axle loads above approximately 5 Tonne are more likely to cause lasting damage at depth below 150 mm. In general damage below 150 mm is of concern because it is not readily ploughed out during normal farming operations and moisture and temperature conditions are more stable giving less chance for natural repair.

Vorhees also looked at the persistence of the deeper compaction and the results must be of concern to Australian farmers employing random traffic farming methods. He was able to detect increased soil strength three seasons after a vehicle pass despite the area under test being subject to freeze-thaw during each winter between crops. Australian investigations have shown that in random traffic farming, almost the entire paddock is subject to at least one wheel over any three crops even in no-till or direct drill. Queensland researchers have also been able to measure the effect of imposed wheel traffic five years after the initial pass.

A review of research findings related to the surface soil (less than 150 mm below the surface) shows the consistent theme that higher tyre pressures lead to more damage in terms of strength increase or any other measure employed. For example infiltration rate is reduced, as are porosity and numbers of beneficial soil organisms.

Kondinin Group-Liebe Group joint trials in Western Australia have added weight to the argument that it is very difficult to ensure that there is not some lasting damage at depth when using any of the average sized equipment employed on Australian farms. *(See Farming Ahead December 2002)* Tractors ranging in size from a John Deere 8420 FWA to a Case IH Quadtrac STX450 were compared in both the tracked and tyred variants.

Substantial levels of soil strength increase at depth were recorded for all the vehicles tested. These had axle loads ranging from 6.5 T to 14 T for the wheeled vehicles and total weights of 12 T to 24 T for the tracked vehicles. Soil strength increase due to the vehicle pass exceeded 2000 kPa at depths around 300 mm below the surface in every case. Soil strength as measured by penetration resistance is sensitive to moisture content, but cereal crop roots do not generally access soil with strength exceeding 2000 -3000 kPa. In this trial a critical value of 2000 kPa was noted as likely to substantially reduce the number of roots entering the compacted soil. This value was chosen because the testing was done in good seeding moisture and much of the crop and root development was expected to occur in dryer and hence higher strength conditions.

These high levels of strength increase at depth were recorded with widely differing tyre pressures. Tyre pressures ranged from 6.5 PSI on the rear axle of the 8420 wheeled tractor, 8 PSI on the STX450 and 18 PSI on the grain harvester. Similarly the tracked tractors with calculated ground pressures of under 6 PSI also recorded high strength increase at depth.

Increase precision

The development of differential GPS guidance has made centimeter accurate guidance possible and affordable on farm. This precision allows farmers to consider row crop operations instead of broadcast.

Tillage to incorporate sprays may be replaced or supplemented with banded pre-emergent applications or precision guided hooded spray technology post-emergent.

Exploitation of precision can allow seed to be placed in a precise relationship to pre-applied fertilizer. Re use of crop rows in direct drill controlled traffic can reduce seeder draft requirements and exploit favourable soil conditions.

There are many other options that will be made possible as farmers and researchers (see research funding section below) learn to exploit the benefits of precise guidance. Some of the less obvious benefits of precision guidance will be in reducing the need for brute horse power for broadcast operations. Allowing farmers to scale back tractor and equipment sizes will result in lower weight tractors and smaller tyre sizes limiting depth of compaction and the area of the paddock compacted.

Encourage research funders and information providers to address machinery

Agricultural machinery represents around one third of the cost of crop production. Studies have shown that improvements related to better machinery and resulting farming systems have contributed about one third of long-term yield improvements. Yet machinery related projects receive less than one percent of the funds farmers contribute to funding research and extension. The study of the soil and how it is impacted by machinery is a good example of a topic of vital interest to farmers with little or no interest from research funders and departments of agriculture.

This paper has supported the view that research and information related to agricultural machinery has vast potential and if funded in any meaningful way, could produce results at least as significant as new varieties or novel rotations.

The funding for machinery related projects is actually declining and the numbers of staff employed in Departments of Agriculture with expertise related to machinery is on a steep decline. For example the Queensland Department of Primary Industries that produced the Trackman program and once boasted 18 agricultural engineers now has none working in crops. South Australia has shown an enlightened approach in this area, with the AMRDC and a few others. If the other states are any indication, farmers should not be complacent in South Australia if they are to retain or even build the state's machinery related expertise.

Please consider what is important for your farm and press those that control your research funds to use them to your best benefit rather than theirs. I do not contend that this is an easy task, as the only forums where such discussions take place exclude those with expertise in machinery research and have been known to exclude farmers as well.

Try this yourself now

Location
Buckleboo – Bill Lienert
BIG FIG

Rainfall
Av Annual: 325 mm
Av GSR: 250 mm
2005 Total: 298 mm
2005 GSR: 253 mm

Yield
Potential: 2.86 t/ha (wheat)
Actual: up to 1.75 t/ha (loam site), up to 1.50 t/ha (grey site)

Paddock History
Loam Site
2004: Mundah Barley
2003: Carnamah Wheat
2002: Medic Pasture
Grey Site
2004: Mundah Barley
2003: Carnamah Wheat

Location
Buckleboo – Tony Larwood
BIG FIG

Rainfall
Av Annual: 325 mm
Av GSR: 230 mm
2005 Total: 320 mm
2005 GSR: 290 mm

Yield
Potential: 2.86 t/ha (wheat)
Actual: up to 2.10 t/ha
Paddock History
2004: Mundah Barley
2004: Lupins
2002: Barley

Location
Buckleboo – Rowan Ramsey
BIG FIG

Rainfall
Av Annual: 300 mm
Av GSR: 210 mm
2005 Total: 219 mm
2005 GSR: 194 mm

Yield
Potential: 2.86 t/ha (wheat)
Actual: up to 1.24 t/ha
Paddock History
2004: Mundah Barley
2003: Yitpi Wheat
2002: Medic Pasture

Buckleboo "subsoil enhancer" demonstration (2nd year)

Demo

Buckleboo Farm Improvement Group (BIG FIG), Jon Hancock[1]
SARDI, Minnipa Agricultural Centre[1]

Key Messages

- **Gypsum application increased grain yield at the Sand site.**
- **Fluid fertiliser outperformed granular fertiliser at the Loam site.**

Why do the demonstrations?

These demonstrations, initiated by the Buckleboo Farm Improvement Group (BIG FIG) aim to see if ripping, nutrition and/or gypsum applications can increase the depth of soil profile accessible to crops to improve yield and reduce haying off in dry springs. They aim to answer the following questions over a number of years and soil types;

- Is there a response to deep ripping?
- Are fluid fertilisers more effective than granular fertilisers?
- Is deep placed fertiliser (40 cm) better than conventionally placed fertiliser (5 cm)?
- Are higher rates of deep placed fertiliser better than standard rates?
- Does the application of gypsum improve yield and/or access to subsoil moisture by improving soil structure?

Previous results were published in EPFS 2004 on pg 115-118.

How was it done?

The BIG FIG gained sponsorship to build a seeder equipped with primary sales hydraulic precision seeder tynes to deliver granular or fluid fertilisers to a depth of up to 40 cm. This machine was used to sow the demonstrations on four different soil types – sand, heavy red, grey and loam. Clearfield® Stiletto was sown dry at 70 kg/ha on the 1st of June. The two gypsum treatments, 2 t/ha bi-annually and a 5 t/ha once off application were applied in 2004. The nutrition treatments *(Table 1)* were applied perpendicularly during the sowing operation, either shallow (5 cm) or deep (40 cm). Ripping was done to 40 cm at all sites apart from the grey site, where rocks prevented any of the deep treatments being applied. The sites were sprayed with Midas® at 900 ml/ha on the 22nd of July for weed control. Plots were harvested at maturity and grain samples retained for protein analysis. Rain-out shelters were erected over areas of crop at anthesis to prevent any further rainfall from entering the crop's root zone and soil moisture samples were taken from these sites at maturity.

What happened?

In 2005, grain yield was increased by 8% following the application of 5 t/ha gypsum in the previous season at the sand site, however this also reduced grain protein levels *(Table 2)*. Gypsum application did not improve grain yield at any other site.

On the loam site, the shallow fluids and the deep fluid super brew lifted yields by up to 17% *(Table 3)*. At the other sites, district practice was as good or better than any other treatment. Protein was consistently higher in the deep fluid super brew treatment across all sites *(Table 4).*

The soil moisture samples taken from beneath the rain-out shelters at maturity revealed that quite substantial amounts of water was not accessed by plant roots and remained in the soil, particularly in the sub-soil *(Table 5)*.

Table 1: Nutrition & Placement Treatments for Buckleboo Demonstrations

Treatment Number	Name	Fertiliser rate & type		Fertiliser Placement
		Granular @ seeding	Fluid @ seeding	
1	District Practice	65 kg/ha 18:20 (12 N + 13 P)	-	Shallow
2	Rip Only	65 kg/ha 18:20 (12 N + 13 P)	-	Shallow
3	Shallow Fluids (brew 1)		11.7 N + 13P + 1Zn + 1Mn, + 0.5Cu	Shallow
4	Shallow Fluids (brew 2)		11.7 N + 13P + 1Zn + 1Mn, + 0.5Cu	Shallow
5	Deep Fluids	25 kg/ha 18:20 placed shallow	7.2N + 8P + 1Zn + 1Mn, + 0.5Cu	Fluid placed deep
6	Deep Fluids - super brew	25 kg/ha 18:20 placed shallow	20 N + 15P + 1Zn + 1Mn + 0.5Cu	Fluid placed deep

What does this mean?

The response to gypsum on the sand site is consistent with results from the previous season, however, at this stage it hasn't been determined whether this is due to a sulphur response or changes to the sodic subsoil. Apart from the loam site, fluids yielded similarly to the granular fertiliser treatment in 2005. Plants were not able to access quite large amounts of subsoil water. Much of this would have been due to soil texture (eg clays can hold a lot of unavailable water) but a component would also have been due to subsoil constraints preventing root access. Work is currently underway in the new farming systems project to determine the impact of subsoil constraints on soil water and quantify the amount of plant available water these soils can hold.

Table 2: Influence of gypsum application (applied in 2004) on grain yield and protein at the sand site.

Gypsum Rate (t/ha)	Grain Yield (t/ha)	Grain Protein (%)
Nil	1.85 b	9.9 a
2	1.88 b	9.6 b
5	2.00 a	9.5 b
LSD	0.09	0.27

Table 3: Influence of nutrition treatment on grain yield (t/ha) at each site.

Nutrition Treatment	Sand Site	Red	Grey	Loam
District Practice	1.96 ab	1.17 a	1.43 ab	1.50 c
Rip Only	1.80 c	1.02 c	-	1.46 c
Shallow Fluids (brew 1)	1.82 c	1.19 a	1.35 bc	1.63 b
Shallow Fluids (brew 2)	1.98 a	1.24 a	1.42 ab	1.75 a
Deep Fluids	1.85 bc	-	1.31 c	1.32 d
Deep Fluids - super brew	1.90 abc	0.95 b	1.50 a	1.63 b
LSD	0.12	0.11	0.10	0.12

Note: 'Deep Fluids' were applied shallow at the grey site due to rocky soil profile.

Table 4: Influence of nutrition treatment on grain protein (%) at each site

Nutrition Treatment	Sand	Red	Grey	Loam
District Practice	9.7 bc	14.6 c	9.5 b	7.6 c
Rip Only	9.8 b	15.5 ab	9.1 b	7.6 c
Shallow Fluids (brew 1)	9.4 c	14.4 c	9.5 b	7.9 ab
Shallow Fluids (brew 2)	9.9 b	14.9 bc	9.5 b	8.0 ab
Deep Fluids	9.7 bc	-	9.3 b	7.8 bc
Deep Fluids - super brew	10.3 a	15.8 a	10.2 a	8.1 a
LSD	0.36	0.82	0.55	0.24

Note: Deep Fluids were applied shallow at the grey site.

Acknowledgements

Thanks to the trial co-operators, Tony Larwood, Rowan Ramsey and Bill Lienert for the provision of trial sites.

BIG FIG sponsors:

Major Sponsors – AWB Ltd, Rabobank, Primary Sales, KEE.

Sponsors – Pringles Ag Plus, Hardie Australia, Fertisol, SARDI, Liquid Systems. Minor Sponsors – Mooses Metalworks, Landmark Kimba, Agsave, K&D Paul and Agrichem.

Special thanks to Fertisol and Agrichem for providing the fluid brews for 2005.

Thanks to Sam Doudle for getting these trials established in 2004 and staff of Minnipa Agricultural Centre for technical assistance.

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SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Table 5: Water (mm) present in soils that was not accessed by plants

Depth (cm)	Sand Site	Red Site	Loam Site
0-20	3	26	7
20-40	15	41	24
40-60	21	46	25
60-80	25	46	31
80-100	26	51	30
100-120	23	58	29
TOTAL 0-120	113	268	146

Residual benefits of subsoil amelioration at Darke Peak

Damien Adcock[1], Terry Blacker[2], Ian Richter[3] and Nigel Wilhelm[3]

University of Adelaide, Roseworthy[1], SARDI, Pt. Lincoln[2], SARDI, Minnipa Agricultural Centre[3]

Searching for answers

Location
Closest town: Darke Peak
Co-operator: Alan & Mark Edwards
Group: Darke Peak No-Till Group

Rainfall
Av. Annual total: 377 mm
Av. Growing season: 285 mm
Actual annual total: 334 mm
Actual growing season: 297 mm

Yield
Potential: 3.74 t/ha for wheat and 4.14 t/ha for barley.
Actual: 2.07-2.96 t/ha for wheat and 1.77-2.53 t/ha for barley.

Paddock History
2004: 1st year of subsoil amelioration trial (refer to EPFS summary pg. 113)
2003: Pasture
2002: Barley

Soil
Land System: Dune-Swale
Major soil type: Siliceous sand over sodic yellow clay.

Yield limiting factors
Water repellent sand and possibly Midas® residues for barley

Key Messages

- **Not all subsoil amelioration treatments conferred residual benefits in the subsequent year after application.**
- **In a season with above average rainfall in September and October additional dry matter production prior to anthesis resulted in greater grain yields and harvest indexes (unlike in 2004).**

Why do the trial?

The Darke Peak Subsoil experiment is part of a large GRDC funded project, 'Improving the profitability of cropping on hostile Subsoils', which aims to assist growers to identify, understand and manage subsoil constraints.

How was it done?

A replicated three-phase rotation of wheat, barley and lupins was established on a siliceous sand over sodic yellow clay subsoil with a series of subsoil amelioration treatments *(Table 1)*. These treatments were applied in 2004 only and are compared with the district 'best' practice in terms of dry matter production, grain yield and harvest index. In 2005 the extent of any residual benefits to crop performance from these subsoil amelioration treatments were assessed.

In 2005 all crops were direct drilled on the 13th June 2005:

Wheat - (Clearfield® Stiletto) @ 80 kg/ha. Roundup 450® + wetter @ 2.5 L/ha (pre-sowing).

Barley - (Sloop SA) @ 60 kg/ha. Roundup 450® + wetter @ 2.5 L/ha (pre-sowing).

Lupins - (Quilinock) @ 90 kg/ha. Simazine® @ 1.5 kg/ha (pre-sowing) and Roundup 450® + wetter @ 2.5 L/ha.

All crops received 50 kg/ha DAP + Zn (5%) banded below the seed, with a further 25 kg/ha as a starter with the seed. In addition the lupins received a foliar application of manganese mid season.

The barley plots were harvested on the 29th November. Wheat and lupins were harvested on the 13th December.

Table 1. 2004 subsoil amelioration treatment details

Treatment	Description
1	District practice as described in the paragraph above
2*	Deep ripping and injection of liquid nutrients to 0.4 m
3	Deep ripping and organic matter (2 t/ha lupin pellets) at 0.4 m
4	Deep ripping and Calcium (equivalent of 4 t/ha of gypsum) at 0.4 m
5	Surface application of approx. 20 t/ha of composted piggery bedding straw
6	'The Works' a combination of treatments 2-5.

***Liquid nutrients contained 60 kg N/ha, 20 kg P/ha, 2 kg Zn/ha, 4 kg Mn/ha and 2 kg Cu/ha.**

What happened?

Rainfall and yield potential

The amount of rainfall received from March to May in 2005 season was not dissimilar to the autumn of 2004, being very much below average (decile 2-5). However, the break of the season was very wet with 95 mm for the month of June (decile 10), but was followed by a dry period from July to August. Above average rainfall for September and October resulted in a total growing season rainfall of 297 mm, 17 mm more than the long-term average. Average annual rainfall at Darke Peak is 380 mm and average growing season rainfall (1st April – 31st October) is 286 mm *(Figure 1)*.

Using the French and Schultz method to determine yield potential for the 2005 growing season the expected yield of wheat was 3.47 t/ha and 4.14 t/ha for barley. However, grain yields were only 55-76% and 43-61% of yield potential for wheat and barley, respectively (see below).

Shoot dry matter production and grain yield

Dry matter production measured at early tillering was inconsistently affected by treatments, especially in the barley with irregular germination and poor vigour possibly due to residual Midas® from the Clearfield® wheat in 2004. Nonetheless, shoot dry matter production at anthesis for wheat, barley and lupins *(Table 2)* did not differ between treatments. The exception was the "Works" treatment for wheat, which produced more dry matter than the district practice *(Table 2)*.

Despite the lack of differences in shoot dry matter production at anthesis, some important differences in grain yield were measured between treatments for wheat, barley and lupins *(Table 2)*. The 'Works' treatments, for both wheat and barley, had the greatest grain yield. The highest wheat grain yield was achieved by the 'Works' treatment, which was greater than any of the other treatments. The deep ripping +

nutrients and deep ripping + lupin grain treatments also produced more wheat grain than the control, which emphasises the earlier work of Sam Doudle and Nigel Wilhelm with deep placed nutrients *(refer to previous Eyre Peninsula Farming Systems summaries)*.

What does this mean?

Residual benefits from the application of subsoil amelioration treatments in 2004 were recorded despite subsoil treatments having produced no grain yield benefits in 2004. Not all amelioration treatments produced yield benefits in 2005, however the increases in yield were still substantial, for example a yield increase of 0.6 t/ha (or 28%) and nearly 0.9 t/ha (or 43%) with wheat for the deep nutrient and 'Works' treatments respectively.

For the second year in a row, lupins appeared to be the least responsive to subsoil treatments of all the crops included, which suggests that if a farmer were to ameliorate the subsoil, then for the best early returns to recover the costs of the operation, they should avoid lupins in the rotation in the first years after the operation.

Although it was clearly demonstrated in 2004 that these treatments provide significant improvements in pre-anthesis growth and yield potential, the advent of sufficient spring rainfall during anthesis in 2005 has shown that residual benefits are possible from subsoil amelioration, in addition to the year of application. However, the economic viability of these subsoil treatments needs to be considered as well, and will be the focus of our research at Darke Peak next year.

Acknowledgements:

I would like to thank Alan and Mark Edwards for their support and hospitality, and all the staff at SARDI Pt. Lincoln and Minnipa Agricultural Centre who assisted with sampling.

This project is funded by GRDC as part of the Improving the profitability of cropping on hostile subsoils project (DAV00049) – a collaborative effort between SARDI, the University of Adelaide, DPI Victoria (Horsham) and the Birchip Cropping Group.

Table 2. Darke Peak crop growth and grain yield (2005)

Crop	Treatment	Dry Matter @ Flowering	Grain Yield
		(t/ha)	(t/ha)
Wheat	District practice	4.55	2.07
	Deep ripping and nutrients	5.64	2.66
	Deep ripping and organic matter	6.05	2.43
	Deep ripping and gypsum	4.65	2.08
	Surface composted piggery bedding straw	5.60	2.51
	'The Works'	6.47	2.96
	l.s.d p< 0.05	1.57	0.24
Barley	District practice	4.12	1.97
	Deep ripping and nutrients	5.37	2.34
	Deep ripping and organic matter	5.50	2.17
	Deep ripping and gypsum	4.03	1.97
	Surface composted piggery bedding straw	3.67	1.77
	'The Works'	6.38	2.53
	l.s.d p< 0.05	1.99	0.45
Lupins	District practice	3.50	1.10
	Deep ripping and nutrients	4.39	1.34
	Deep ripping and organic matter	4.74	1.23
	Deep ripping and gypsum	3.24	1.10
	Surface composted piggery bedding straw	2.50	0.99
	'The Works'	4.53	1.30
	l.s.d p< 0.05	2.28	0.19

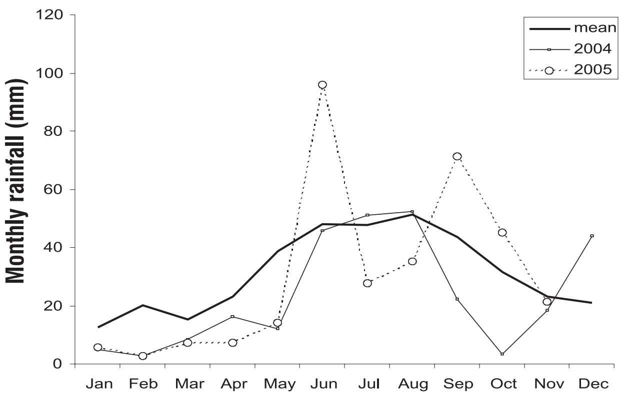

Figure 1. Monthly rainfall for 2004 and 2005 compared to monthly mean rainfall for Darke Peak.

Almost ready

Location
Sand over clays on the eastern EP and Stansbury on central Yorke Peninsula (400 mm annual rainfall)

Deep placement of nutrients – few excuses left not to recommend it

Nigel Wilhelm
SARDI, Minnipa Ag Centre

Key Messages

- **Deep placement of nutrients on sand over clays has almost always returned big yield increases in the year of application but now there is also firm evidence of useful yield increases in the year AFTER application.**
- **Can you think of reasons why you would not seriously consider a technique which can return 1.5 to 3 t/ha of wheat in the first two years and may only cost about $200/ha to implement ??**

Why do the work?

Subsoil constraints (SSCs) occur throughout large sections of the Australian grain belt, especially on the neutral and alkaline soils of south-eastern Australia. SSCs not only reduce on-farm profitability through their impact on grain yields and quality, they also reduce the ability of crops to use soil water, leading to groundwater recharge and the development of secondary salinity. The EP Farming Systems project has been investigating the impact of infertile subsoils in the sand over clay country of eastern EP for many years now and this work has now been taken up by a major GRDC-funded research project. This project has activities in both SA and Victoria. See articles on this work in all the previous EP Farming Systems Summaries (in the soils section).

Collectively, these efforts have identified a concept which offers yield improvements of a spectacular nature; the problem has always been to convert the concept into a broadacre practice. That prospect is getting much closer now because the economic rewards have improved markedly with recent results and the areas where it is applicable have also expanded greatly.

The EPFS project showed that placing a "shotgun'' mix of nutrients (N, P ,Zn, Cu, Mn) 40 cm into a sand over clay profile regularly doubled cereal yields in eastern EP environments. The GRDC-funded project (Hostile subsoils) has confirmed these results but has also shown that the same sort of response can not only be achieved in a medium rainfall environment (400 mm annual rainfall) but that canola is at least as responsive to the technique. Lupins do respond also, but to a much smaller degree.

The breakthrough which the team from the Hostile Subsoils Project, has just made is that placing nutrients deep into a sand over clay profile can have appreciable residual benefits. At Darke Peak, nutrients placed deep into the profile in 2004 increased cereal yields in 2005 by nearly 0.5 t/ha (see the article in this section, "Residual benefits of subsoil amelioration at Darke Peak" for more details). In a "kinder" central Yorke Peninsula environment, deep placed nutrients from 2004 increased wheat yields by nearly 1 t/ha and canola by nearly 0.3 t/ha *(see Figure 1)*. These residual benefits substantially increase the economic rewards from deep placed nutrients.

In the Hostile Subsoils Project, the deep placed nutrient technique which produced these yield benefits consisted of 60 N, 20 P, 2 Zn, 4 Mn and 2 Cu kg/ha applied as APP, UAN and chelated trace element fluid fertilisers into the ripping trench. At current retail prices, this technique would cost approximately $600/ha (including the cost of the deep ripping operation) but we believe we could get the same yield benefits with much cheaper fertiliser brews (eg nutrients applied as granular fertilisers or as cheaper fluid products) to bring the operation down to less than $200/ha.

In terms of converting the concept of deep placed nutrients into broad acre practice, our experience over the last decade with this concept provides us with the following information.

What sort of soil do you need ?

Deep sand profiles (at least 25 cm) have proven to be the most reliable at producing large yield improvements. Shallow sands can "hay off" in dry years, regardless of early benefits. A feature of the largest yield increases is that they have occurred on sands with very infertile A2 horizons. Profiles with rocks or hard layers within 40 cm are obviously a formidable challenge for the deep placement technique.

What rainfall zone do you need ?

We have not yet found a rainfall zone where it does not work – soil type seems to be more important.

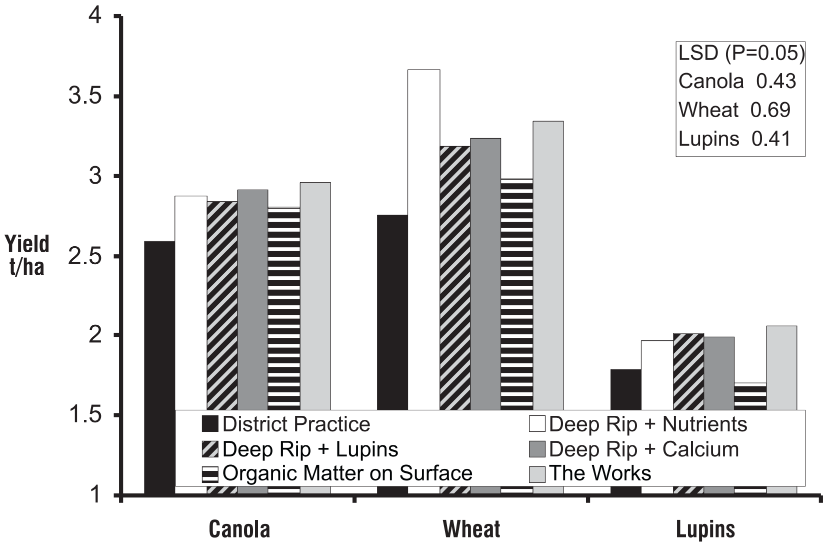

Figure 1. Grain yield of field crops in 2005 at Stansbury on Yorke Peninsula, one year after application of subsoil treatments.

What sort of deep ripper is best ?

At this stage, the only way we have been able to get nutrients deep into the soil profile is via a deep working steel tine. However, it does not seem to matter what sort of machine we use to get the nutrients in. We have used narrow profile high break out seeding tines, narrow profile straight legged rippers, bent legged deep rippers and even large discs and have achieved large yield increases with them all. Modern seeders can be used providing the tines can be kept in the ground to 30-40 cm, that they do not leave the surface lumpy and every second tine can be easily removed or locked out of the ground.

What tine spacing should be used for deep placement ?

It appears tine spacing makes little difference. We have used 25 to 75 cm spacings with similar benefits. We suspect though, that spacings greater than 50 cm may reduce the overall impact of the technique. We have had one trial result which achieved yields of double district practice with 50 cm spacings but crop rows between the rip lines did not perform very well. Tine spacing is always going to be a compromise between benefits of deep placement, horsepower required, "softness" of the paddock afterwards and susceptibility to erosion.

How deep do you need to go ?

We have used 40 cm as our "standard" depth for achieving large yield increases. When we have gone shallower (eg 20 cm) benefits have been less certain.

How are the nutrients applied deep into the soil profile ?

As yet, we have only used fluid delivery systems to apply nutrients deep but it does not appear to matter how they are applied into the deep ripping slot. We have applied them only to the bottom of the slot or "smeared" them throughout the slot and the benefits have been very similar.

Which nutrients do you need ?

This is one of the aspects which we are least confident about. However, we have no evidence that there is any value from applying nutrients which are deemed not to be in deficient supply according to conventional wisdom. For example, we conducted one experiment on a deep sand with very high reserves of phosphorus. Removing phosphorus from the shotgun mix had no impact on its benefits in this situation.

What rates of nutrients are best ?

From the few experiments we have conducted to test this aspect, it appears that nutrients should be applied at a rate to achieve the yield expected with the deep placement technique. For example, if yields are currently averaging 1.5 t/ha, deep placement of nutrients should increase yields to about 3 t/ha and nutrients should be applied to achieve 3 t/ha yields using current decision support tools.

Are there any downsides ?

Yes, in addition to the obvious hassle of undertaking the operation in the first place. Another downside is the susceptibility of the paddock to erosion after it has been deep ripped and the "softness" of the paddock for subsequent operations. Both are manageable but must be acknowledged. There is also the large "up front" investment in fertilisers and deep ripping on country which is normally very difficult to produce a profit from.

How much of the benefit from deep placement is due to the deep ripping ?

In our trials, deep ripping only has usually conferred some benefits but the bulk of the yield increases have usually come from the deep placement of the nutrients. This pattern has been so consistent that it is tempting to conclude that if a deep ripping operation is being planned for a sandy soil, then very serious consideration should be given to value adding to the operation by applying nutrients deep at the same time.

Given the reliability of deep placed nutrients at producing spectacular yield increases in cereals and canola on infertile sand over clays and the new evidence that these benefits will persist at least into the second year after application (and there is the untested prospect of benefits into the third year), I am running out of excuses not to recommend this technique. There is still a question mark over the financial benefits of the technique relative to the costs but given that I have every reason to believe that we could pare the costs down to less than $200/ha (with likely yield increases of 1-3 t/ha over the first two years), it still seems very attractive economically. What do you think ?

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Subsoil nutrition on clay spread soils

Demo

Kieran Wauchope
Rural Solutions SA, Cleve

Key Messages

- **Testing clays before spreading is essential.**
- **Clays high in free lime can reduce yield potential.**
- **Placing extra nutrition below incorporated clay layer reduces nutritional tie up issues.**
- **Deep ripped sands create seed placement issues.**
- **Gross margin analysis needed to determine best economical treatment.**

Why do the trial?

Previous research on Eyre Peninsula has identified that carbonate (free lime) found in clays used for clay spreading can result in nutrition deficiencies (particularly manganese) in subsequent crops. These demonstrations have been conducted to allow farmers to improve their understanding of issues involved and how to most effectively manage negative results.

How was it done?

Funding provided by the Eastern Eyre and Lower Eyre Soil Conservation Boards and the National Landcare Program was used to purchase a Yeoman's plough and conduct modifications to include a fertiliser hopper and ground driven rate controller.

Demonstration sites were established on nine different farms across Eastern Eyre Peninsula with particular focus given to those spread with clay high in free lime. Treatments were applied prior to sowing with the Yeomans working behind a 300 hp John Deere tractor. Farmers were advised that rolling post ripping would improve control of seed placement but this was not undertaken on all sites.

Sowing date varied but targeted the optimum sowing time allowed by the break of season.

Treatments were designed to determine the optimum depth to place nutrients. Treatments were:

- Deep (ranging from 35-45 cm), 77 kg/ha 18:20, 13 kg/ha $MnSO_4$, 5.7 kg/ha $ZnSO_4$ and 4 kg/ha Cu SO4
- Shallow (ranging from 15-25 cm), as well as a deep rip treatment.
- Ripping without additional nutrition
- Control

Measurements taken included:

- Plant counts
- Yield – (reapt using co-operators header and weighed in a weigh trailer)
- Protein and screenings

What happened?

Plant counts were significantly lower on ripped and deep fertiliser treatments that were not rolled. Despite this, all deep fertiliser treatments had higher yields compared to the control and at two sites doubled the yield *(refer Fig. 1)*. There was also a smaller response to shallow treatments and ripping but not on all sites.

Gross margin analysis *(Fig. 2)* identifies that ripping alone gave some benefit compared to the control at several sites,

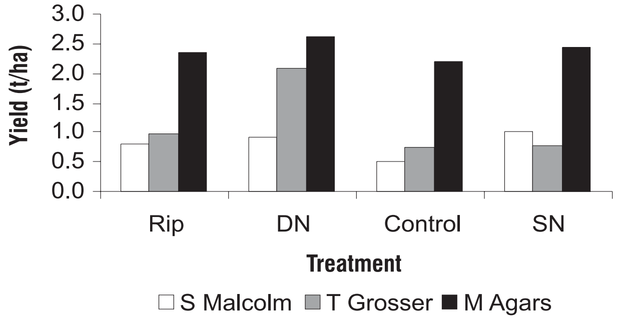

Fig.1 Yield comparison from three of the nine demo sites. (Note: DN - deep nutrition SN – shallow nutrition)

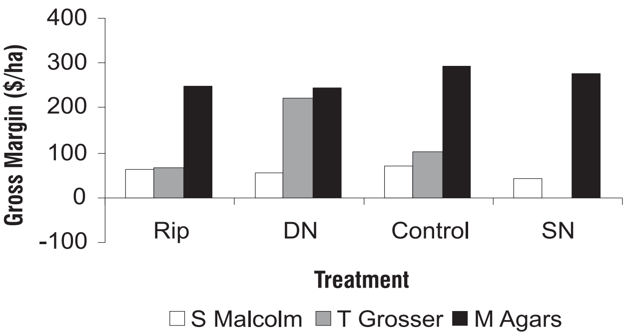

Fig.2 Treatment gross margin comparison from three of the nine demo sites (additional fertiliser costed @ $40.50/ha, ripping costed @ $65/ha)

and without the added cost of extra nutrition had some economic value. Shallow nutrition didn't always produce higher yields and hence had poor gross margins on some sites.

What does this mean?

Placement of nutrients below the incorporated clay layer appears to have reduced "tie-up" of nutrients from high levels of free-lime. This view is supported on some sites where the yield from shallow placement was similar to that of the control, suggesting the extra nutrition wasn't readily available to the plants. Also sites where the greatest increases in yield occurred corresponded with the highest 'free-lime' (>10%) levels.

Gross margin results show economical benefits from deep nutrition aren't a certainty for everyone. It is thought that if high levels of free-lime are present and nutrient tie-up is a definite problem, it is likely deep nutrients will produce significantly higher yields and hence improve gross margins. Ripping alone did produce some benefits but this also depended on the site. With such a good spring the deep ripping effects were masked slightly, but in drier finishes it may produce greater gross margin benefits.

Acknowledgements

Thanks to Pringles Ag Plus for the use of their John Deere 8520 and to all farmers who assisted with the demonstration sites. Thanks must also go to Corey Yates (Eastern Eyre Peninsula NRM Coordinator), David Davenport and Josh Telfer (Rural Solutions SA Land Management) for their help with site management and measurements.

Searching for answers

Surface and deep gypsum on hard-setting soils

Demo

Kieran Wauchope
Rural Solutions SA, Cleve

Key Messages

- **Deep ripped soils must be rolled for accurate seed placement**
- **Gypsum must be dry to flow freely**
- **Gypsum can be a waste of money if hard pans result from cultivation and not sodicity – dispersion tests should be undertaken before applying gypsum.**
- **Ripping addresses hard pans but may not deliver yield increases in all seasons.**

Why do the trial?

To determine the most effective and efficient way to apply gypsum to hard-setting soils.

Landholders on Eastern EP have received support from Natural Resource Management (NRM) groups and the National Landcare Program to encourage the use of gypsum to address poor soil structure . However, farmers have not always seen significant benefits and NRM groups are looking to increase the awareness of where gypsum is an option and the most economic method of application.

Demonstrations undertaken in 2005 have identified that simple testing can save time and money, as well as provide alternative options for improving hard-setting soils.

How was it done?

Funding provided by the Eastern Eyre and Lower Eyre Soil Conservation Boards and the National Landcare Program was used to purchase a Yeomans plough and conduct modifications to include a gypsum hopper.

Demonstration sites were established on eight different farms across Eastern Eyre Peninsula aiming to test gypsum responsiveness and application methods. Treatments were applied prior to sowing with the Yeomans working behind a 300 hp John Deere tractor. Farmers were advised that rolling post ripping would improve control of seed placement but this was not undertaken on all sites. Sowing date varied but targeted the optimum sowing time allowed by the break of season.

Treatments were:

- Ripping (ranging from 35-45cm) with gypsum at 5 t/ha dropped in furrow
- Surface gypsum
- Surface gypsum plus ripping
- Ripping without gypsum
- Control

Measurements taken included:

- Plant counts
- Yield – (reapt using co-operators header and weighed in a weigh trailer)
- Protein and screenings

What happened?

Plant counts were lower in all deep ripped and deep gypsum plots that were not rolled. In these plots seed placement varied from 1 to 15 cm, with emerged plants not as healthy or advanced as those in the non-ripped plots. Yield data from three of the sites *(refer fig 1)* demonstrates the importance of understanding soil characteristics prior to undertaking ripping and gypsum spreading.

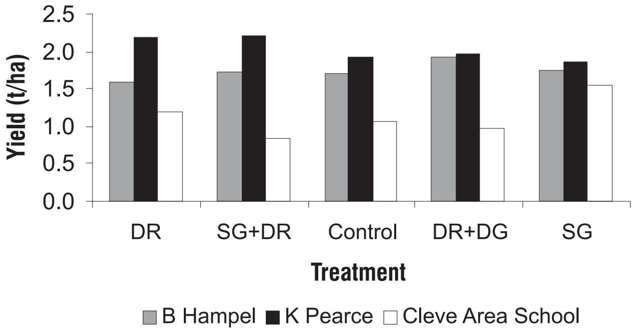

Figure 1 Yield comparisons from three of the eight different demos. (Note: DR – deep rip, SG+DR – surface gypsum plus deep rip, DR+DG – deep rip plus deep gypsum, SG – surface gypsum)

The Hampel site does not appear to have responded to ripping or surface gypsum. There may have been some response to ripping with gypsum placed behind the tines. This may be due to the sodic layer being deeper in the soil profile. If so, surface applied gypsum may also provide a benefit in several years time. This site will need to be monitored in following years to test for any positive effect from this demonstration.

The data on the Pearce site is inconclusive as deep ripping appears to have had an impact except on the deep rip + deep gypsum treatment. Soil analysis has identified that high salt levels (EC 1.60 dS/m) occur at 20-30 cm. This would reduce any impact of the treatments. Also applying gypsum may have initially increased EC levels potentially reducing yields. In time gypsum may improve soil structure allowing leaching of salt deeper into the soil profile reducing salt levels. This site also will be monitored.

The yield data from the Cleve Area School site demonstrates the necessity of rolling prior to sowing *(fig 1)*. Plants were slow to emerge and were weaker on ripped plots than the control and surface gypsum plots. There also appears to be a response to gypsum with the surface gypsum treatment yielding better than the control. Soil testing has identified that exchangeable sodium levels (ESP) were 15.7% at 10-30cms depth. Soils with ESP levels above 6 % are considered sodic and therefore a response on this site is not surprising.

What does this mean?

This work emphasises that some soil testing should be completed prior to undertaking ripping or gypsum application. Tests need to be taken from the different soil horizons down to 40 cm and should include dispersion, electrical conductivity and carbonate levels.

Deep ripping and deep gypsum can provide a positive yield response if managed correctly and rolling is seen as essential for the success of such work. Surface applied gypsum provides benefits where surface sealing is a problem and is the cheapest and easiest way to apply it to your soil. On sites with subsurface issues ripping the soil and getting the gypsum into the problem area should provide the most immediate yield response provided that other soil issues (such as salinity) are not present.

Acknowledgements

Thanks to Pringles Ag Plus for the use of their John Deere 8520 and to all farmers who assisted with the demonstration sites. Thanks must also go to Corey Yaetes (Eastern Eyre Peninsula NRM Coordinator), David Davenport and Josh Telfer (Rural Solutions SA Land Management) for their help with site management and measurements.

RURAL SOLUTIONS SA

EYRE PENINSULA NATURAL RESOURCE MANAGEMENT

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Section editor: Michael Bennet

SARDI/SANTFA, Minnipa Agricultural Centre

Tillage

Row direction, row spacing and stubble cover effects on evaporation and yield

Research

Jon Hancock

SARDI, Minnipa Agricultural Centre

Almost ready

Location
Minnipa Agricultural Centre

Rainfall
Av. Annual total: 325 mm
Av. Growing season: 242 mm
Actual annual total: 327 mm
Actual growing season: 267 mm

Yield
Potential: 3.14 t/ha
Actual: 1.29 t/ha

Paddock History
2004: Wheat
2003: Wheat
2002: Wheat

Soil
Red sandy loam

Key Message

- **Wheat yield was slightly higher when sown in the north-south direction but declined as row spacing widened.**

Why do the trial?

This trial aimed to determine how row direction, row spacing and stubble cover affect evaporation and grain yields. As farmers move from sowing paddocks around and around to sowing them up and back, the question arises as to whether crop yield can be improved by sowing in a particular direction.

How was it done?

A trial was established at Minnipa Agricultural Centre. Half of the plots were burnt to remove the previous years stubble. They were sown to Yitpi (at a target density of 180 plants/m^2) with 70 kg/ha of 18:20 on 7, 9 and 12" spacing in both north-south and east-west directions. Micro lysimeters (which are 15cm lengths of PVC tubing, capped on the bottom and filled with soil) were installed in the inter-row of each plot to compare evaporation rates between treatments at various stages throughout the growing season. Plots were harvested at maturity and grain samples were retained for quality analysis.

What happened?

Throughout most of the season, there were no treatment effects on evaporation, however in mid September, a difference in evaporation due to row direction and spacing was measured *(Table 1)*. Evaporation was similar across all row spacings when sown north-south, however, when sown east-west, evaporation was higher in wider row spacings.

Grain yield was 5% higher when the crop was sown in a north-south direction rather than east-west *(Table 2)*, however it declined as row spacing increased *(Table 3)*. Grain protein and screenings were unaffected by any treatment.

Table 1: Measured soil water evaporation rates (mm/day) as influenced by row direction and spacing. LSD = 0.42

Row Spacing	North-South	East-West
7"	3.94	3.71
9"	3.75	4.01
12"	3.62	4.48

Table 2: Effect of row direction on grain yield

Row Direction	Grain Yield (t/ha)
North-South	1.49
East-West	1.42
LSD (p<0.05)	0.07

Table 3: Effect of row spacing on grain yield

Row Spacing	Grain Yield (t/ha)
7"	1.52
9"	1.47
12"	1.38
LSD (p<0.05)	0.08

What does this mean?

Although there is some evidence of soil evaporation increasing with wide row spacings sown in a east-west direction, it must be remembered that for most of the season there were no treatment differences. At the time of this difference, the soil was quite wet and evaporation across all treatments was much higher than during the rest of the season (typically between 1 and 2 mm/day). The micro lysimeters used to compare evaporation rates between treatments did not have any plant roots present, so were wetter than the surrounding soil. Consequently, the measured rates would be higher than the actual evaporation.

The small increase in yield from sowing in a north-south direction is encouraging and suggests that sowing north-south may be preferable, however this also depends on paddock shape and orientation and other efficiencies like the length of runs and the area double sown also need to be considered.

Acknowledgements

Thanks to the staff of Minnipa Agricultural Centre for technical assistance.

Try this yourself now

Location
Minnipa Agricultural Centre

Rainfall
Av. total: 325 mm
Av. GSR: 242 mm
2005 total: 327 mm
2005 GSR: 267 mm

Yield
Potential: 3.14 t/ha (W)
Actual: 1.3 t/ha (W)

Paddock History
2004: Pasture
2003: Barley
2002: Wheat

Soil
Red sandy loam
Plot size
1.4 m x 24 m

Dry sowing wheat and canola

Michael Bennet

SARDI/SANTFA, Minnipa Agricultural Centre

Key Messages

- **Seeding system had no influence on final grain yield of wheat or canola.**
- **Minimum disturbance systems gave greatest crop emergence with canola.**

Why do the trial?

Determine the impact of seeding systems on dry sown wheat and canola, sown after a marginal rainfall event in mid May.

How was it done?

Trials were sown using a seven row plot seeder set on 23 cm (9") row spacing. Fertiliser was deep banded to avoid fertiliser toxicity issues in a dry seedbed. No pre-emergent herbicide was used with either trial. Midas® was applied on the wheat, and a Targa®/ Lontrel® mix was used for weed control on the canola. Insecticides were applied post sowing and after flowering on the canola.

	44C73 Canola	Clearfield®
Sowing Date	16 May	28 April
Seeding Rate	5 kg/ha	50 kg/ha
Fertiliser Rate (10:22:0:0)	60 kg/ha	50 kg/ha

What happened?

Many growers attempted to sow on the "opening" rains in 2005, with varying levels of success. While the level of rainfall at seeding was the greatest determinant of triumph, soil type also played an important role. Seven millimetres of rain fell at Minnipa on the long weekend in May, which made for a challenging situation to successfully establish a crop using no-till.

The experiment aimed to compare various tillage approaches including various combinations of sweeps, knife points, press wheels, prickle chains, rotary harrows and snake chains. Seeding depth was targeted at 20 to 30 mm to attempt to germinate the seed prior to the surface drying out. The disturbance of the sowing pass and warm weather post sowing dried the soil enough to prevent germination of the canola. A similar tillage trial was dry sown at Minnipa with Clearfield® wheat after Anzac day. The rainfall event on the 14th of May was sufficient to germinate the wheat, but emergence did not occur until the season break a month later.

What does this mean?

In these situations, seeding system had no impact on final grain yield for wheat or canola. Experimentation at MAC in regards to canola seeding rate *(EPFS Summary 2000, page 38)* indicates that canola is able to compensate for low plant establishment rates. It appears that a poor seeding system may be compensated for with higher seeding rates. Differences were observed between the different seeding systems with regards to crop emergence, however this did not translate in to additional yield.

The seeding rate of 5 kg/ha was chosen, as low establishment rates were anticipated due to a drying profile of moisture. The emergence observed however, was much greater than expected with excellent moisture conditions prevailing when the season eventually opened.

Snake chains contributed to greater emergence in both crops sown. The snake chains used were 20 cm long lengths of chain with less than 10 cm loops at the end of the chain. The main objective of snake chains is to drag some Trifluralin treated soil back into the crop row in order to reduce ryegrass germination in the crop furrow. A larger loop at the end of the chain is likely to result in damage to the emerging crop if high rates of soil applied herbicides are used.

Acknowledgements:

Agmaster for support with press wheels and rotary harrows used in trial. John Bennet for patient support for sowing trial while on holiday! Jon Hancock and Ben Ward for their support with the trials.

This research was funded by GRDC.

Table 1: Seeding system influence on emergence, soil moisture and grain yield in canola, Minnipa 2005.

Seeding System	Emergence (plants/m^2)	*Group	Soil Moisture (mm)	*Group	Yield (t/ha)
Knife point + press wheel + snake chain	88	a	2.176	a	1.31
Knife point + press wheel + aggressive snake chain	85	ab	2.042	ab	1.28
Knife point + press wheel	84	abc	2.022	ab	1.23
Knife point + rotary harrows	82	abc	1.975	abc	1.33
Knife point + press wheel + rotary harrows	69	bcd	1.471	c	1.29
Sweep + Prickle Chain	68	cd	1.646	bc	1.30
Knife point + Prickle chain	63	d	1.74	abc	1.32
LSD ($p<0.05$)	16.4		0.40		NS

Treatments followed by the same letters are not statistically different to each other.

Table 2: Seeding system influence on emergence, dry matter post anthesis and grain yield in wheat.

Tillage Treatment	Emergence (plants/m^2)	*Group	Dry Matter (t/ha)	*Group	Grain Yield (t/ha)
Knife point + press wheel + aggressive snake chain	147	a	2.67	bc	1.91
Knife point + press wheel + snake chain	134	ab	2.87	ab	1.89
Knife point + press wheel + non aggressive snake chain	130	b	3.00	ab	1.88
Knife point + Prickle chain	125	b	2.92	ab	1.78
Knife point + press wheel	124	b	3.17	a	1.87
Knife point + press wheel + rotary harrows	124	b	2.55	bc	1.89
Knife point + rotary harrows	124	b	2.33	c	1.78
LSD ($p<0.05$)	14.2		0.50		NS

Treatments followed by the same letters are not statistically different to each other.

GRDC Grains Research & Development Corporation
SANTFA
ABB
SARDI South Australian Research and Development Institute

Cowell seeding systems

Research

Michael Bennet
SARDI/SANTFA, Minnipa Agricultural Centre

Key Message

- **Yield differences between tillage systems were measured on a red soil but not on a sandy loam soil type at Cowell.**

Why do the trial?

The Franklin Harbour Ag Bureau raised interest for a sowing systems trial during the 2005 EP Farming Systems meetings. The trial was designed to investigate any potential differences between seeding treatments across two soil types at Cowell. Of particular interest was the investigation of the influence of press wheel furrows and the possibility of rotary harrows or snake chains reducing evaporation post sowing.

How was it done?

Seeding was achieved using a seven row plot seeder on 23 cm row spacing. The trial was sown on the 17th of June with 50 kg/ha Wyalkatchem and 60 kg/ha of 18:20 deep banded. Pre-sowing herbicides applied were 1 L/ha TriflurX® and 1 L/ha Sprayseed®. Emergence was measured three weeks after sowing and dry matter was measured post anthesis.

What happened?

Grain yield and dry matter were higher on the sandy loam soil compared to the red soil site. Greater emergence rates, however were measured on the red soil type.

A response to tillage treatment was measured in terms of emergence on the loam site, but not for anthesis dry matter or final grain yield. The treatments sown with sweeps produced the lowest emergence across the loam site. Whether or not the high emergence rates penalised some treatments is yet to be determined.

The low disturbance systems delivered the highest emergence rates on the red soil. No reduction in emergence was

Try this yourself now

Location
Franklin Harbour
Closest town: Cowell
Cooperator: Steve Edwards

Rainfall
Av. Annual total : 275 mm
Av. Growing season: 190 mm
Actual annual total: 291 mm
Actual growing season: 194 mm

Yield
Potential: 2.14 t/ha
Actual: 1.55 t/ha

Paddock History
2004: Canola
2003: Triticale
2002: Barley

Soil
Red Sandy Loam

Plot size
1.5 m x 15m x 4 reps

Table 1: Sowing systems - Loam site, Cowell 2005

Sowing System	Emergence (plants/m^2)	*	Dry Matter (t/ha)	Grain Yield (t/ha)
Knifepoint + press wheel + non aggressive snake chain	176	a	3.18	1.94
Knifepoint (no covering device)	175	a	3.58	2.00
Knifepoint + press wheel + aggressive snake chain	167	a	3.35	2.03
Knifepoint + press wheel + snake chain	160	a	2.94	2.04
Knifepoint + press wheel + rotary harrows	156	a	2.99	2.14
Knifepoint + rotary harrows	154	a	3.00	2.00
Knifepoint + press wheel	149	ab	3.36	1.94
Knifepoint + prickle chain	148	ab	3.04	1.99
Sweep + prickle chain	122	b	2.83	2.14
Sweep + rotary harrows	119	b	2.97	2.13
LSD ($p<0.05$)	30.5		NS	NS

Treatments followed by the same letters are not statistically different to each other.

Table 2: Sowing Systems -Red site, Cowell 2005

Sowing System	Emergence (plants/m^2)	*	Dry Matter (t/ha)	*	Grain Yield (t/ha)	*
Knifepoint + press wheel + rotary harrows	187	ab	2.19	a	1.55	a
Sweep + prickle chain	156	bc	1.81	ab	1.53	ab
Knifepoint + press wheel + aggressive snake chain	175	abc	2.16	a	1.48	abc
Knifepoint + press wheel	201	a	2.32	a	1.46	abc
Knifepoint + rotary harrows	158	bc	2.14	a	1.46	abc
Knifepoint (no covering device)	144	cd	2.01	a	1.44	bcd
Knifepoint + press wheel + snake chain	207	a	2.12	a	1.43	bcd
Sweep + rotary harrows	117	d	1.49	.b	1.42	cd
Knifepoint + press wheel + non aggressive snake chain	178	abc	2.32	a	1.42	cd
Knifepoint + prickle chain	191.1	ab	1.77	ab	1.36	d
LSD ($p<0.05$)	37.6		0.43		0.09	

**** Treatments followed by the same letters are not statistically different to each other.***

measured in the knifepoint + press wheel + snake chains in both trials. This indicates that the treatments did not suffer from excessive Trifluralin treated soil being dragged into the crop furrow. Aggressive designs of snake chains are more likely to result in Trifluralin damage than the ones used in the trial. It appears however that Trifluralin damage across the two trials was minimal with reasonable emergence recorded in the higher disturbance systems.

One interesting observation is the difference in emergence of the knifepoint with no covering device treatment, between the two sites. The emergence of this treatment was acceptable on the loam site, however poor on the red site. This indicates an increased requirement for seed/soil contact in this situation. There were no differences in protein or screenings between treatments.

No clear yield advantage was observed for the moisture harvesting of press wheel furrows in either trial. Results also indicated that there was also no yield benefit for reduced disturbance with the seeding pass. No yield or crop emergence penalty was measured for the use of rotary harrows behind the press wheels.

What does this mean?

In terms of emergence the low disturbance systems performed well, especially on the red soil type. Setting a target for crop emergence is one issue to be careful of when moving to a system that promotes greater emergence. A higher anticipated emergence percentage should be allowed for to prevent the possibility of the crop being sown heavier than desired.

Clear advantages for a low disturbance system are often found in a drying profile of moisture where reduced evaporation from the seeding pass plays a beneficial role. A season opening with small rainfall events will also favour the moisture harvesting of press wheel furrows. The seeding of 2005 will be remembered as one where growers were forced to stop seeding due to excessive moisture, which is highly uncommon to the lower rainfall districts of the Eyre Peninsula.

Acknowledgements

Agmaster for support with press wheels and rotary harrows used in trial. Steve Edwards for hosting the trial work. Jon Hancock, Ben Ward and Neil Cordon for assistance with taking measurements.

A practical perspective of inter-row sowing at Minnipa

Research

Brendan Frischke, Brett McEvoy & Kym McEvoy

SARDI, Minnipa Agricultural Centre

Almost ready

Location
Minnipa Agricultural Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2005 Total:327 mm
2005 GSR.:267 mm

Yield
Potential: 3.0 t/ha
Actual N12: 1.87 t/ha
Actual Airport: 1.47 t/ha

Paddock History
Airport
2004: Krichauff Wheat
2003: Krichauff Wheat
North 12
2004: Krichauff Wheat
2003: Krichauff Wheat
2002: Pugsley Wheat

Soil
Sandy Loam

Key Messages

- **The 2 cm guidance accuracy translated to a tine position accuracy of approximately 5 cm.**
- **Inter-row sowing cannot be achieved with guidance alone. Machine symmetry, tine positioning and satellite received position all require attention to detail.**
- **Inter-row sowing caused no yield differences in 2005.**

Why do the trial?

Adoption of equipment with automatic steering is increasing all the time. The most obvious benefits are reduced inputs (pesticide, fertiliser, fuel) and reduced driver fatigue. Some of these benefits can be achieved to some degree by using less expensive visual guidance. Work at Minnipa aims to identify other possible benefits of seeding with automated steering. Root disease research by the Crop Pathology-Plant Diagnostic Group based in Adelaide has shown that some diseases such as common root rot, crown rot and cereal cyst nematode are more highly concentrated close to the crop row. This trial addresses the following questions:

- How well does inter-row sowing using automated steering work in practice?
- Can disease impacts be reduced by inter-row sowing?

How was it done?

Two paddocks were selected where controlled traffic was used in 2004. Controlled traffic was again used to sow Krichauff wheat on a 23.3 cm row spacing. The Beeline Arrow guidance system with 2 cm nominal accuracy was used. This guidance system has a way line offset feature which allows corrections or adjustments to be made to the position of each way line. The correction value can be a centimetre or several meters and will shift every way line in the same direction. Using this feature, small adjustments were made on the first pass until tines were sowing on the previous years stubble rows. Every second pass was then sown in this way. When the far side of the paddock was reached, the way line offset was then adjusted by half a row spacing so that tines would then sow half way between stubble old rows. The remainder of the paddock was then sown resulting in alternating passes of row on row versus inter-row.

What happened?

Inspections following crop emergence revealed the success of achieving inter-row sowing was variable. Within passes that were intended for inter-row sown, many rows had successfully been sown between stubbles rows however several were immediately adjacent to a stubble row rather than centered between rows. A few rows were actually on the stubble rows. Similar observations were made on the row on row passes. In both cases the relative position of individual tines remained the same along the length of the pass. This indicated that the problem was not due to the seeder moving around.

Guidance Accuracy

To quantify seeding accuracy, an individual crop row that was successfully inter-row sown was monitored for its relative position between stubble rows over four separate seeding passes at 100 m intervals for the length of a paddock. Observations were on a scale of 0 to 10 where 0 is on the left hand side row and 10 is on the right hand side row. The results *(Figure 1)* show that the seeding tines remained very accurate for the length of the paddock and the maximum swing was less than a third of a row spacing. Statistical analysis revealed that the tines had a relative accuracy of 5.1 cm, i.e. within 5.1 cm of the intended position greater than 95% of the time. It should also be remembered that the relative accuracy is affected by inaccuracies of sowing from both years.

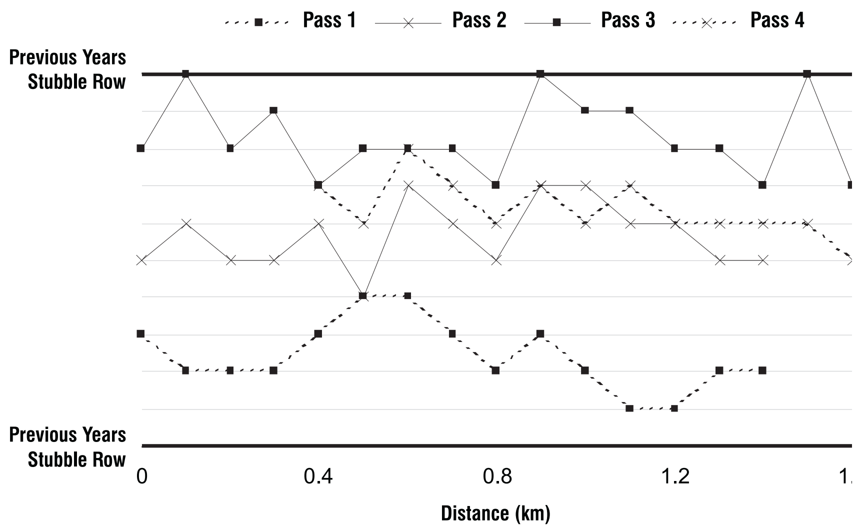

Figure 1: The position of crop rows are shown relative to the previous years stubble rows for four separate machine passes for the length of a paddock 1.7 km long.

Tine Positioning

Unequal tine spacing was investigated in an attempt to explain the variable success of inter-row sowing. The position of crop rows across the width of the machine were measured relative to the centre tine at four locations in the field. The direction of travel was noted to identify the left and right sides of the machine. The average measured position of each crop row was compared to the expected position according to row spacing (23.3 cm). Of 39 tines, 11 tines (38%) were found to have a position error greater than 5 cm. The largest error was 9 cm. Although its was visually obvious that a couple of rows were out of position, the extent of the problem was unknown until conducting this exercise.

Disease Impacts

It was intended to measure the yield impact of disease over a large area using the harvester's yield monitor. However, due to low incidence of disease (except for CCN in some parts) and the variable success of the inter row sowing this work was not completed. This aspect will be addressed in 2006.

Yield and Grain Quality

To ensure some yield data was collected, sites were identified where both inter-row and row-on-row sowing were successful on adjacent passes to allow paired comparisons. This was generally where the seeder had travelled the same direction both years. Strips 20 m long were harvested using a small plot harvester. Six sites were selected in one paddock (Minnipa Airport) and nine in another (Minnipa Ag Centre - N12) where soil type was more variable. No differences were measured for yield, protein or screenings in either paddock. Further analysis is required to determine if the results vary across soil types within the paddock with nine samples. Yield and protein for the paddocks are as follows: Airport (yield 1.47 t/ha, protein 9.4 %) and N12 (yield 1.87 t/ha, protein 10.0 %).

Stubble Handling

By visually inspecting inter-row sown passes versus row on row, it was quite obvious that stubble disturbance was minimal in the inter-row sown areas. Although the stubble load from 2004 was small, the difference observed was enough to suggest inter-row sowing would be a beneficial tool in handling larger stubble loads.

What does this mean?

In practice, more than accurate guidance is required to successfully inter-row sow. Attention to detail is required. Machine symmetry is very important if the operator plans to seed up and back and won't necessarily be travelling in the same direction as the previous year on any given sowing pass. Tines need to sow at exactly equal spacings and the tractor needs to be perfectly centered with respect to the bar. A good test is to turn back and sow on the previous pass and check the outside tines line up. Satellite receivers not exactly centred, sloppy drawbars and sloping ground can cause misalignment problems. A machine offset can be entered into the controller to correct this problem. Crop row spacing can be affected by bent shanks, loose knife points, bent seed tube systems, poorly aligned press wheels and tines seeding with excessive trash hanging on. Many of these small influences can be overcome by travelling in the same direction on every pass each year, if you can remember!

Acknowledgements

This trial work is made possible thanks to a renewed sponsorship agreement with Agline for three years to provide an auto steer guidance system. Agline are now the distributors of Beeline products. The Beeline Navigator system has been replaced with the newer more compact and user friendly Arrow system. Installation and essential back up support was provided by Ian Boothey of Agsist.

Almost ready

Research

Inter-row - the way to go?

Michael Bennet[1], Jack Desbiolles[2]

SARDI/SANTFA,Minnipa Agricultural Centre[1], University of South Australia, Mawson Lakes[2]

Key Message

- **No yield advantages measured for inter-row sowing found in a crown rot and stubble free situation.**

Why do the trial?

A trial was established at Kimba to follow on from a trial at Graham Machoss's property at Sandilands on the Yorke Peninsula where a 10% yield increase was observed from sowing wheat between the previous years wheat stubble rows.

Growers are anticipating several benefits from the concept of inter row sowing. From a stubble handling perceptive, the ability to inter-row sow allows a grower to harvest their crop higher. This therefore reduces the horsepower requirements of the harvester and increases capacity. Other benefits also include the reduced disease burden on the inter-row zone.

The yield increase on the Yorke Peninsula was attributed mostly to a reduction in crown rot severity when sowing on the inter row. Similar trials were also sown in 2005 at Karkoo, Hart, Waikerie and Yorke Peninsula under a SAGIT project "Agronomic benefits of inter-row sowing with 2 cm autosteer systems."

How was it done?

Jack Desbiolles of UniSA dry sowed the trial on the 6th of June. His equipment was fitted with a GPS Ag 2cm autosteer system. The seeder was equipped with Agmaster press wheels and Primary Sales points and boots. The trial was sown on 23 cm (9") spacing to fit the stubble rows in the paddock.

The treatments were in factorial design, and included sowing crops on 2004 stubble rows (in row) and between the previous seasons stubble (inter row). Other treatments included two crop varieties (Yitpi and Wyalkatchem) and two levels of nutrition (high (70 kg/ha DAP + Zn + 20 kg/ha urea) and moderate (50 kg/ha DAP + Zn).

What happened?

The stubble levels at sowing were minimal due to grazing and the poor yield of 300 kg/ha in 2004. A significant localised rainfall event post-sowing resulted in the majority of the remaining stubble being washed off the site. This factor virtually eliminated the anticipated yellow leaf spot and other leaf disease burdens on the sown crop.

Soil disease levels were low for all tested. The only noteworthy disease issue was a minor difference in the Rhizoctonia risk rating, which gave a higher reading within the crop row.

Positive yield responses were measured from increases in nutrition for both varieties and row orientations. In the 2006 season the carryover effect of the two rates of nutrition will be measured. Plant establishment was measured between 140 and 170 plants/m^2 with no differences between the various sowing treatments. No differences in protein, screenings or test weight were observed across the row orientation treatments.

Table1: Grain Yield

Row	Variety	Nutrition	Yield (t/ha)
Inter-row	Wyalkatchem	High	3.01
In-row	Wyalkatchem	High	3.11
Inter-row	Wyalkatchem	Moderate	2.82
In-row	Wyalkatchem	Moderate	2.85
Inter-row	Yitpi	High	2.78
In-row	Yitpi	High	2.72
Inter-row	Yitpi	Moderate	2.56
In-row	Yitpi	Moderate	2.60
LSD (p<0.05)			NS

What does this mean?

Although no yield benefits were measured for inter-row sowing in this situation, the benefits associated with increased harvester capacity and stubble handing offer significant merit across a whole farm operation. Other benefits coupled with 2 cm autosteer such as zero overlap and input savings are considerable. It is anticipated a site with higher levels of crown rot will reveal greater yield benefits for inter-row sowing than measured at Kimba in 2005.

The trial will continue in the 2006 season to measure effects with heavier stubble loads from the 2005 season.

Acknowledgements

SAGIT for providing funding to plant the trials across South Australia during 2005.

Jack Desbiolles and his team for travelling from Adelaide to sow the trial.

Almost ready

Location
Kimba
Cooperator: Trevor Cliff

Rainfall
Av. Annual total: 341 mm
Av. Growing season: 247 mm
Actual annual total: 341 mm
Actual growing season: 263 mm

Yield
Potential: 4.1 t/ha
Actual: 3.1 t/ha

Paddock History
2004: Westonia Wheat
2003: Oaten Hay
2002: Frame Wheat

Soil
Red sandy clay loam

Diseases
Stripe Rust

Plot size
1.3 m x 30 m x 4 reps

Almost ready

Long term impact of no-till on crop nitrogen availability

Research

Michael Bennet
SARDI/SANTFA,Minnipa Agricultural Centre

Key Message

- **Long term no-tillage contributes to higher grain yields requiring less nitrogen inputs than a system in the initial phase of no-till.**

Why do the trial?

A Canadian study discovered higher yields and protein with lower nitrogen requirements for crops grown under a history of long term no-tillage compared to a short term no-tillage history. Trials were established at Lock and at Hart in 2004 to investigate the impact of long term no-tillage on nitrogen supply and subsequent grain yield and protein. The results from the 2004 trials can be found in the *2004 EPFS page 129*.

How was it done?

Two contrasting trial sites were established at Lock and Hart in 2004. One paddock at each site meeting the criteria of long term no-tillage and stubble retention for fifteen years, with a site selected over the fence with a conventional cultivation history heading into its first year of no-till in 2004. The trials were sown to wheat in 2004 and again sown to wheat in 2005. Deep soil nitrates were tested from all sites to estimate N requirements and urea N application rates in the second year. Both sites had reduced urea rates applied in the second year.

The Lock experiment was sown on the 4th of July with Clearfield® Stiletto wheat using the MAC Nutrition Groups'

Tillage

Almost ready

Location
Lock
Co operators: Andrew Polkinghorne and David Bower

Rainfall
Av. Annual total: 340 mm
Av.GSR: 260 mm
2005 annual total: 321 mm
2005 GSR: 285 mm

Yield
Potential: 3.5 t/ha

Soil
Grey calcareous loam

Plot size
1.5 m x 20 m x 4 reps

Location
Hart
Closest town: Blyth
Co operators: David Maitland and Grant Crawford

Rainfall
Av. Annual total: 460mm
Av.GSR: 345mm
Actual annual total: 515 mm
Actual GSR: 367 mm

Yield
Potential: 5.6 t/ha

Soil
Red brown earth

Plot size
1.36 m x 20 m x 4 reps

DBS seeder on 23 cm row spacing. A phosphoric acid based fluid fertiliser with trace elements was used at Lock with urea deep banded for the additional nitrogen treatments. The fluid fertiliser consisted of 6 kg/ha phosphorus, 800 g/ha zinc, 800 g/ha manganese and 200 g/ha of copper per hectare applied at a total fluid output of 120 L/ha.

The trial at Hart was sown on the 16th of June to Wyalkatchem wheat with Rural Directions' 23cm row spacing no-till seeder. 106 kg/ha of 17:19 + 2.5% Zn was deep banded to all plots as a basal nutrition treatment at sowing. Urea was deep banded at sowing for the nitrogen treatments.

What happened?

Dry Matter

Dry matter was measured at anthesis at Hart and at head emergence at Lock *(Figure 1)*. The long term no-till (LT) site at Lock responded negatively to additional N until 22.5 units or greater were applied. The short term no-till (ST) site however responded positively to additional N. Large differences were observed in terms of dry matter production at Hart in 2004. These differences carried over in to 2005 with differences of at least one tonne/ha in most treatments. The cause of the bulge in the 43 kg/ha N treatments at Hart is yet to be determined.

Grain Yield

Differences in nitrogen response between tillage histories were measured in terms of grain yield at both sites *(Figure 2)*. The differences were most pronounced at Hart with the long term site yielding one tonne/ha above the short term site across all nitrogen treatments. A textbook nitrogen response curve was observed in the short term site with yield response levelling out at 55 kg/ha N. Most importantly is the difference in the slope of the response curve. The long term no-till plots had a relatively flat response curve, while the short term no-till plots had a steeper response curve.

At Lock the differences in grain yield were far less spectacular than Hart. The 0 kg/ha N treatment in the long term trial yielded similarly to the 22.5 and 30 kg/ha N in the short term trial. N rate response curves slopes were similar in both cases, although the long term plots yielded higher than the short term plots at the same rate of N. This combined with the higher grain protein *(Figure 3)* indicates an increased availability of mineralised N in the long term plots.

Grain Protein

The effects of nitrogen response on grain protein was significant with the long term no-tillage sites showing clear advantages. The Canadian study on the effects of long term no-tillage revealed that one of the major differences between the two systems was related to protein. With greater N inputs the short term no-till ground was able to produce a similar yield to the long term no-till ground. High levels of protein were not achievable in the short term no-till plots with differences of 1 to 2 percent across the different N application rates. The lower protein levels had a significant impact on the price received for wheat in Canada.

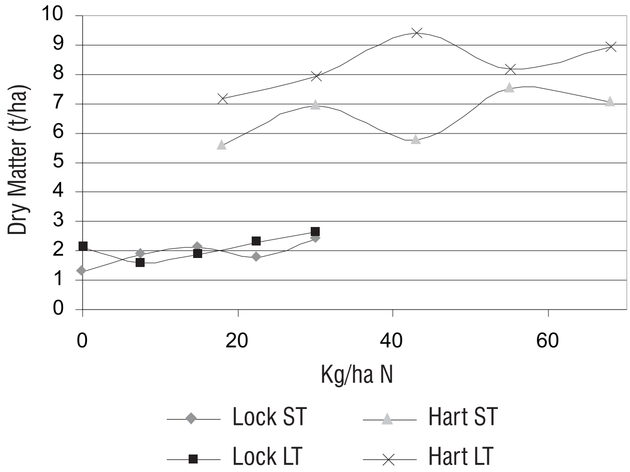

Figure 1: Dry Matter Production

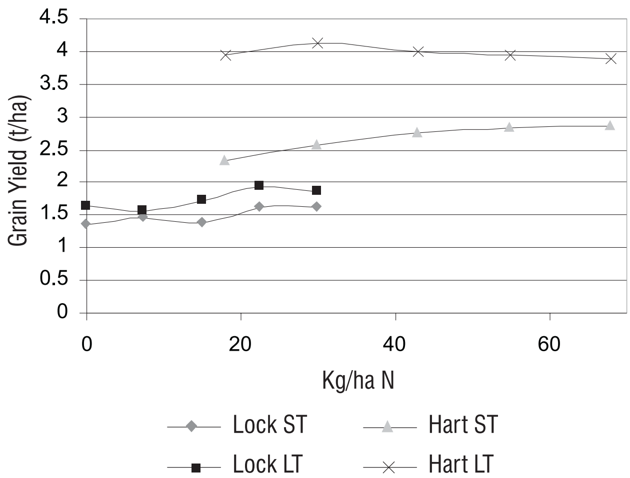

Figure 2: Grain Yield

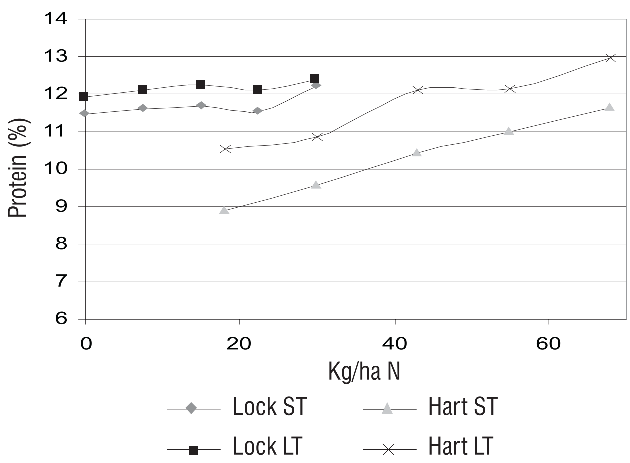

Figure 3: Grain Protein

At Lock and Hart, protein advantages were observed for the practice of long term no-tillage. At Hart the advantage of one percent across all N treatments give significant value with the Golden Rewards program.

What does this mean?

The research reflects grower experience with reduced requirements for N typically observed in the later years after no-till adoption. Growers will often experience a period of higher requirements for additional nitrogen fertiliser early in the no-till program. In a conventional cultivation system, nitrogen is rapidly mineralised with the tillage event. The no-till system needs to be advanced before the rate of nitrogen mineralisation increases, despite the reduced tillage disturbance. N rate response curves will tend to be flatter after many years of no-till.

Acknowledgements

GRDC, ABB Fertiliser & the University of Adelaide who jointly funded the project. Special thanks to Andrew Polkinghorne, David Bower, David Maitland and Grant Crawford for collaborating with this research

Cost effective no-till conversion and refining the inputs

Research

Greg Secomb[1] and Tiffany Ottens[2]

Rural Solutions SA, Port Lincoln[1], Streaky Bay[2]

Almost ready

Location
Elliston
Cooperator: Steve, Brad and Peter Agars

Rainfall
Av. Annual total: 400 mm
Actual annual total: 364 mm
Actual growing season: 311 mm

Yield
Potential: 4.02 t/ha
Paddock actual: 2.67 t/ha

Paddock History
2004: Lupins
2003: Barley

Soil
Red sandy clay loam over clay
Soil pH ($CaCl_2$): 5.8
Phosphorus : 20 mg/kg

Plot size
10m x 100 m x 2 reps

Key Messages

- **Moving into no-till does not have to be an expensive exercise.**
- **Post emergent nitrogen applications gave good responses in wheat at Elliston in 2005.**
- **Seeding rates did not have an impact on yield.**

Why do the trial?

The adoption of no-till around the Elliston region is comparatively low compared to other parts of the Eyre Peninsula. To help promote the adoption of no-till in this region we were keen to work closely with farmers to help them make the sometimes daunting shift from conventional into no-till farming methods.

The Agars family were already committed to make the shift into no-till for season 2005, but were keen to be part of a pilot project - *"EP Sustainable Agriculture"*, funded by the National Landcare Program. In making the shift to no-till, the Agars' were interested to find out more on refining their inputs to achieve the most productive and profitable cropping system.

This project was also about showcasing the no-till method of cropping to other growers in the region.

How was it done?

The first stage of this project was the initial conversion of the Agars' conventional Connor Shea bar on 15 cm row spacings to a machine capable of no-till seeding. The conversion included widening the rows out to 30 cm, adding knife points, boots with double shoot capability and press wheels. Total cost was about $10,000 plus a week and a half of labour.

The next stage was to investigate what the implication of the machinery modification would have on seeding and fertiliser rates, especially because of the wider row spacings.

An on farm demonstration trial was set up to compare different seeding and fertiliser rates compared with the Agars' standard practice. Treatments can be seen in *Table 1*.

The trial was sown on the May 29th after about 8 mm of rainfall, using the Agars' newly converted machine. Each plot was 100 metres long and 10 m wide (width of the airseeder).

On August 9th , half of each plot was top dressed with an additional 23 kg of N/ha (50 kg/ha urea) at the mid-late tillering stage. Plots were harvested on December 19th using the Agars' harvester and plot yields were measured using a grain weighing trailer.

What happened?

When harvesting the plots there was some large differences emerging between plot yields. On analysis of the results it soon became clear of what the underlying effect was - post emergence nitrogen! *(see Figure 1)*.

The other effects that we were trying to uncover with seeding rate and base fertiliser rate were not clearly apparent with only some small trends appearing.

Understanding the results:

There are three treatments with fertiliser rate and seeding rate tested. The pattern of the column indicates the fertiliser rate with seed as indicated on the axis (85, 100, 120 kg seed/ha).

Tillage

The treatments are then replicated. The left half had no post emergent nitrogen; the right side did have post emergent nitrogen.

Looking at the left hand side first " no post emergent N": The trend here indicates that fertiliser rate appeared to have more of an impact on the slight yield difference than the impact of sowing rate.

On the right hand side we see that all treatments are near to equal, and have yielded much better than all the treatments without post emergent nitrogen. For this site in 2005, it indicates that nitrogen is the limiting factor. The amount of base fertilizer and seeding rate has not had an impact when additional N has been applied.

The key points from the trial are:

- The effect of seeding rate has not had an impact on yield
- Base fertiliser rates have had a small effect, when no additional nitrogen was supplied
- The application of post emergent nitrogen has been significant ($P<0.001$).

What does it mean?

Overall it would suggest that the site was very responsive to nitrogen and that nitrogen has been the limiting factor in achieving yield. Deep soil nitrogen tests at the start of the season did indicate this.

Where no nitrogen has been top dressed there is a greater difference between treatments. The 180 kg of fertiliser (48.6 units of N) did appear to perform better than the standard of 120 kg of fertiliser (32.4 units of N).

Across all treatments the variation of seeding rate did not appear to have had an impact on yield.

Plots that had been top dressed with nitrogen all yielded fairly similar with no great difference in yields.

Acknowledgements

This trial was conducted with funding through National Landcare Program and managed by the EPNRM group.

Sincere thanks go to Steve, Brad and Peter Agars & families for all their support, co-operation and contribution to this project. The success of this project has been directly linked to your enthusiasm.

Thanks to Michael Bennet and Geoff Bammann, representing SANTFA, for the Field Day held on August 1, 2005.

Thanks also to Sophie Keen, EPNRM, for making everything work behind the scenes.

Table 1. Fertiliser and Seeding Rate Treatments

Treatment	Fertiliser Rate (27:12:0:0)	Seeding Rate (Trident wheat)
1. (Standard)	120 kg/ha	85 kg/ha
2	150 kg/ha	100 kg/ha
3	180 kg/ha	100 kg/ha
4	150 kg/ha	120 kg/ha
5	180 kg/ha	120 kg/ha
6	50 kg/ha	120 kg/ha
7	300 kg/ha	120 kg/ha

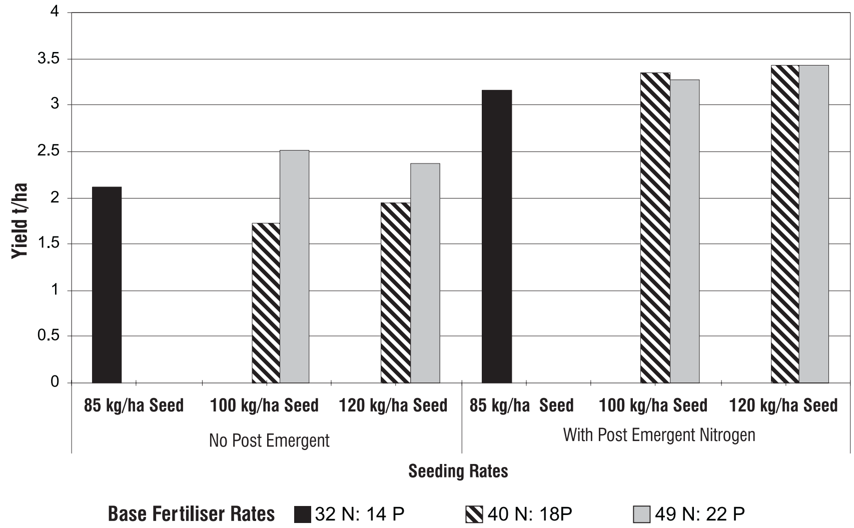

Figure 1. Input influence on final grain yield at Elliston

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Program

RURAL SOLUTIONS SA

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Sowing speed in no-till

Michael Bennet
SARDI/SANTFA,Minnipa Agricultural Centre

Searching for answers

Location
Minnipa Agricultural Centre
Closest town: Minnipa

Rainfall
Av. Annual total: 325 mm
Av. Growing season: 242 mm
Actual annual total: 327 mm
Actual growing season: 267 mm

Yield
Potential: 3.14 t/ha
Actual: 1.29 t/ha

Paddock History
2004: Wheat
2003: Wheat
2002: Wheat

Soil
Red sandy loam

Plot size
Dimensions: 1.5 m x 10 m x 4 reps

Key Messages

- **No adverse effects were measured from high speed no-till sowing with various herbicide mixes in 2005 at Minnipa.**

Why do the trial?

The trial was sown to help demonstrate the effects of herbicide damage from excessive soil throw from various row spacings and sowing speeds, and quantify the emergence and associated yield penalty.

How was it done?

Seeding equipment used in the trial was the Minnipa Ag. Centre Nutrition Groups DBS plot seeder on 18 cm (7”), 23 cm (9”) and 30 cm (12”) row spacings. The trial was sown with 50 kg/ha 10:22 deep banded and 50 kg/ha Wyalkatchem sown at a depth of 10 mm. Herbicide treatments were applied pre-sowing. The trial was sown on the 6th of July.

The herbicide treatments included:

1 L/ha TriflurX®
1 L/ha Diuron + 500 ml/ha Dual Gold®
1.2 L/ha TriflurX® + 180 g/ha Lexone®
Untreated

What happened?

No major differences were measured between the various sowing and herbicide treatments *(Table 1)*. This was a remarkable result, as great differences were anticipated particularly with the different herbicides which were applied to the trial. The conditions at sowing were moist, which would have given ample opportunity for the Diuron + Dual Gold® and TriflurX®+ Lexone® herbicide treatments to result in significant crop damage.

The seeder did not produce typical soil throw patterns when the trial was sown. Sowing speed with DBS tines typically needs to be kept at a moderate rate due to excessive soil throw. At the minimum manufacturer row spacing of 25 cm, an 8 km/h sowing speed is recommended to avoid problems with soil throw by the rear tines over the first and second rank of seeding rows. The soil was very moist at sowing which should have exacerbated soil throw problems. The trial was sown at 90 degrees to the 2004 sowing direction. The stubble was left standing and ungrazed which also meant the 2004 press wheel furrows were still intact.

Table 1: Row Spacing and Sowing Speed Influence on Crop Emergence and Yield *

Row Spacing (cm)	Sowing Speed (km/h)	Emergence (plants/m2)	Grain Yield (t/ha)
18	5	131	1.29
18	6	137	1.29
18	7	133	1.27
23	7	137	1.20
23	8	137	1.20
23	9	128	1.19
30	10	121	1.24
30	11	126	1.21
30	12	116	1.21
LSD ($p<0.05$)		NS	NS

***Summary of sowing speed results across all herbicide treatments**

What does this mean?

The observations from this trial are contradictory to grower experience where many exercise caution at seeding to avoid excessive soil throw and the resulting crop damage.

Some questions raised from this trial are; “What influence does sowing direction have on soil throw?” and “What influence does stubble management have on soil throw?” The lack of soil throw generated by the seeder when sowing the trial was remarkable, even at the higher sowing speeds. This is in direct contrast to the row spacing x seeding rate trials sown at Karcultaby in 2004. One trial was sown on grazed wheat stubble and another on medic pasture residues in very wet soil conditions. Soil throw was excessive in the stubble paddock, however on the medic pasture paddock soil throw was much less. There are several factors which may have influenced soil throw in this instance. The soil surface was more compacted on the pasture paddock and had much less residue than the stubble paddock. The residue in the stubble paddock was mostly knocked to the ground by the stock, which may also have contributed to the increased soil throw at seeding. Hopefully the questions raised above may be answered in the 2006 season.

Acknowledgements

Thanks to Jon Hancock, Ben Ward, Wade Shepperd, Kay Brace and Sue Budarick for technical support.

Minnipa Progress Association for use of land in the Minnipa Airport.

Grains Research & Development Corporation

Tillage

Types of Work in this Publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad scale nature, care should be taken when interpreting results from demonstrations.

Type of Work	Replication	Size	Work conducted by	How analysed
Demo	No	Normally large plots or paddock strips	Farmers and Agronomists	Not statistical. Trend comparisons
Research	Yes, usually 4	Generally small plot	Researchers	Statistics
Survey	Yes	Various	Various	Statistics or trend comparisons
Extension	n/a	n/a	Agronomists & Researchers	Usually summary of research results
Information	n/a	n/a	n/a	n/a

Section editor: Michael Bennet
SARDI/SANTFA Minnipa Agricultural Centre

Weeds

Managing brome grass; importance of crop rotations and herbicide choice

Research

Sam Kleemann and Dr Gurjeet Gill
University of Adelaide

Searching for answers

Location
Darke Peak - Allan & Mark Edwards
Rainfall
Av. total (2003-2005): 325mm
Av. GSR (2003-2005): 253mm
Paddock History
2002: Wheat
Soil
Deep siliceous sand over clay
Plot size
12.5 x 25 m x 3 reps
Other factors
History of brome grass (B. rigidus)

Location
Lock - Andrew & Jenny Polkinghorne
Rainfall
Av. total (2003-2005): 351mm
Av. GSR (2003-2005): 284mm
Paddock History
2002: Wheat
Soil
Deep siliceous sand over clay
Plot size
12.5 x 25 m x 3 reps
Other factors
History of brome grass (*B. rigidus*)

Key Messages

- **On non-wetting soils carry-over of the brome grass seed-bank from one season to the next was as high as 29%, and highlights the need for consecutive years of management for seed-bank depletion.**
- **Correct crop and herbicide choices are critical for lowering brome grass seed-banks and reducing the impact of this troublesome weed.**
- **Preliminary results indicate that strategic crop phases of legumes (lupins or vetch) or pasture with Clearfield® wheat can significantly reduce brome seed-banks.**
- **Use of Sulfonyl Urea herbicide Atlantis® or tank mixes of Trifluralin and Logran® in wheat resulted in poor control of brome grass and caused the seed-bank to rise substantially (up to 3 fold).**

Why do the trial?

Brome grass (*B. rigidus and B. diandrus*) has become an increasingly problematic weed for grain growers across Upper EP, following the adoption of no-till and continuous cropping practices. This well adapted weed has an aggressive rooting system that allows it to compete strongly with crops for nutrients and moisture, particularly on the sandy textured soils common to the region. In addition, brome grass has flourished in the dominant monoculture cereal phases of the region, where few effective herbicide options are used for control.

Recent introduction of imidazolinone cultivars of wheat (Clearfield®) tolerant to the herbicide Midas®, provide a new and effective means of controlling brome grass in the wheat phase. However, to realise the full potential of this innovation, robust crop rotations and herbicide strategies need to be developed that minimise replenishment of the brome grass seed-bank, without compromising on-farm sustainability and profitability. The aim of the trials reported here are to evaluate a range of alternate crop rotations and herbicide strategies for the control of brome grass.

How was it done?

In 2003, two trials were established to evaluate a range of alternate crop rotations and herbicide strategies for the control of brome grass (*B. rigidus*) at Lock and Darke Peak. Sites were selected where brome was historically a problem with cropping. Sites were established using on-farm machinery with three replications. Main plots (12.5m x 25m) were sown to the following rotations:

- W/W/B
- *W/W/W
- *W/Pa/ΔW
- L/*W/B or V/*W/B

W = Wheat
*W = Clearfield® Wheat
ΔW = Wheat (metribuzin tolerant)
B = Barley
L = Lupins (Darke Peak)
V = Vetch (Lock)
Pa = Pasture

Table 1: Crop rotation, variety, and herbicide regime used at Darke Peak & Lock sites in 2003.

Crop Rotation	Crop	Variety	Herbicide
W/W/B	Wheat	[1]Krichauff or [2]Wylkatchem	Trifluralin (1.2L) + Logran® (15g) or Atlantis® (330ml)
***W/W/W**	Cl® wheat	Cl® Janz	Midas® (900ml)
***W/Pa/W**	Cl® wheat	Cl® Janz	Midas® (900ml)
L/*W/B	Lupin	1Merrit	Simazine® (2 L) & Verdict® (300ml)
V/*W/B	Vetch	2Blanchefleur	Simazine® (800ml), Verdict® (300ml) & glyphosate (800ml)

[1]Darke Peak and [2]Lock, *W - Clearfield Wheat(Cl), Value in brackets () = rate of herbicide applied per ha Vetch plots were spray topped with glyphosate (0.8L/ha) in early spring

Table 2: Brome seed-bank carry-over (%) from one season the next at Darke Peak and Lock.

	2003 seeds/m²		Carry-over to 2004 (%)	2004 seeds/m²		Carry-over to 2005 (%)
	Mar	Sept		Mar	Sept	
Darke Peak	1344	224	17	1451	114	8
Lock	1857	440	24	1598	468	29

Table 3 : Effect of crop type on brome seed-bank (λ).

Crop type	Change in seed-bank (λ)	SE
Wheat	2.7	0.03
Clearfield® Wheat	0.2	0.57
Lupins	0.2	0.02
Vetch	0.1	0.02

λ value <1 = seed-bank decline versus λ value >1 = seed-bank increase

Table 4 : Effect of herbicide choice on brome seed-bank (λ).

Herbicide	Change in seed-bank (λ)	SE
Atlantis®	2.35	0.15
Trifluralin + Logran®	2.99	1.3
Midas®	0.21	0.03
Simazine® & Verdict®	0.12	0.09

λvalue <1 = seed-bank decline versus λ value >1 = seed-bank increase

Sub-plots had herbicide treatments applied at the recommended rates and weed stage of growth using a quad-bike equipped with a 5m boom delivering 100L/ha at 200kPA (*Table 1, only 2003 herbicide treatments shown*). Crops were sown using knife-points (no-till) and fertilised according to farmer recommendations and district practice. Sowing rates aimed for plant densities of 30, 60, 150 and 180 plants/m² for lupins, vetch, barley and wheat respectively. Pasture plots in 2004, comprised of regenerating cultivars Harbinger and Parabinga. Pre-sowing germinations of brome grass were controlled with applications of glyphosate at 0.8-1 L/ha.

Brome grass seed-banks were initially quantified at Darke Peak and Lock from 20 soil cores (7cm diameter, 10cm depth) sampled from each plot in March of 2003. Seed-bank sampling was repeated thereafter using the same procedure at the beginning of each season (2004 and 2005) and prior to new seed-set (September of each year) to determine the residual seed-bank. Seeds were also checked for viability. In addition, plots were monitored for brome grass behaviour, crop growth and yield (data not presented).

What happened?

Residual seed-bank

In September of 2003 and 2004, soil core samples were taken from plots at Darke Peak and Lock to determine the residual brome seed-bank, prior to new crop seed input (*Table 2*). In 2003, 17 and 24% of the viable seed-bank (germinable + dormant) remained to contribute to the 2004 season at Darke Peak and Lock. In 2004, a smaller proportion of residual seed was found at Darke Peak (8%), whereas 29% of the residual seed-bank remained at Lock to carry-over to 2005. This high level of seed-bank carry-over (29%) enables brome to persist even after seasons of excellent control (i.e. pasture phase). Furthermore, it highlights the need for consecutive years of management for successful seed-bank depletion of this persistent weed.

Changes in brome grass seed-bank

Changes in brome grass seed-bank were strongly dependent on crop type and herbicide management. Initial seed-bank data from Darke Peak and Lock (2003), showed strong directional changes in response to the type of crop grown and the herbicides used (*Tables 3 and 4*). Changes in seed-banks are often expressed as a lambda value (λ), where values of <1 indicate a decline versus values >1 show an increase in the seed-bank. Indicative of the poor herbicide options available for the control of brome in wheat, this crop type caused a 2.7 fold increase in the brome grass seed-bank. More specifically herbicides Trifluralin plus Logran® and Atlantis® used in the wheat phase, provided limited control of brome resulting in a 3 and 2.4 fold increase in the seed-bank respectively. Alternatively, the seed-bank declined after growing Clearfield® wheat (0.2), lupins (0.2), and vetch (0.1), reflecting the high levels of efficacy obtained when using herbicides Midas®, Simazine® and Verdict® to control brome.

Crop rotations & brome seed-banks

Strategic crop rotations using lupins or vetch followed by Clearfield® wheat (L/*W/B or V/*W/B) resulted in significant reductions in the size of the brome grass seed-bank at Darke Peak and Lock from 2003 to 2005. Rotations of lupins in year one (2003), followed by Clearfield® wheat in year two (2004) caused the seed-bank to drop from 1417 to 87 seeds/m² at Darke Peak (*Figure 1*). Similarly, vetch in year one (2003), followed by Clearfield® wheat in year two (2004) resulted in the brome seed-bank at Lock falling from 2925 to 30 seeds/m² (*Figure 2*). These rotations allow for high levels of brome control with the use of herbicides Simazine®, Verdict® or Targa® in year one, followed by use of Midas® herbicide in Clearfield® wheat in year two. Effectively the rotations provide consecutive years of brome grass management required to deplete the persistent seed-bank. On the other hand, cereal dominant rotations (W/W/B) that

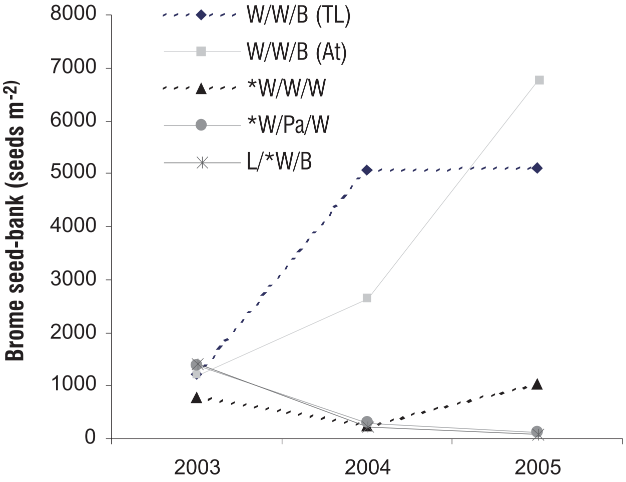

Figure 1: Effect of crop rotations on brome grass seed-bank at Darke Peak (2003-2005). - (TL) = Trifluralin + Logran® and (At) = Atlantis® application in 2003.

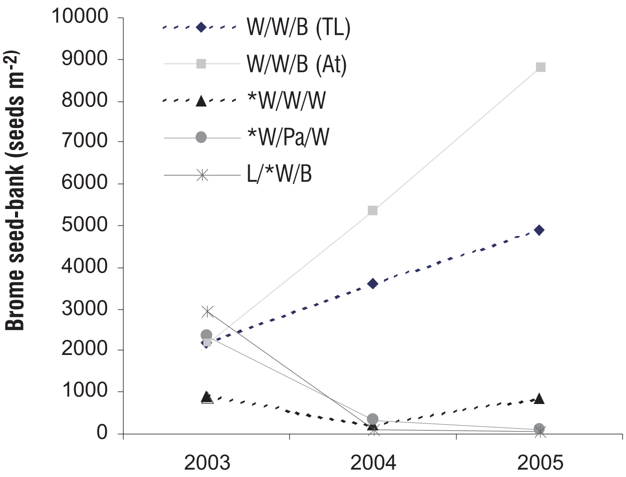

Figure 2 :Effect of crop rotations on brome grass seed-bank at Lock (2003-2005).- (TL) = Trifluralin + Logran® and (At) = Atlantis® application in 2003.

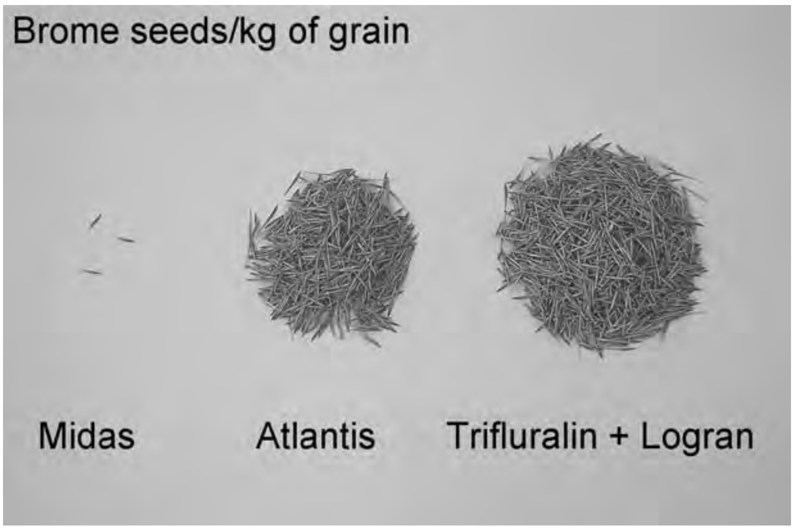

Figure 3: Brome seed contamination in grain samples taken from plots treated with herbicides, Midas®, Atlantis® and Trifluralin plus Logran® at Darke Peake in 2003.

have only poor herbicide strategies at their disposal (e.g. Trifluralin plus Logran® or Atlantis®) caused the brome seed-bank to rise substantially. In accordance to the poor brome grass control obtained with these herbicides was the amount of brome seed contaminating grain samples. Brome contamination following applications of Atlantis® and Trifluralin plus Logran® equated to 1225 and 2695 brome seeds/kg of grain for wheat samples taken from Darke Peak in 2003 (*Figure 3*).

What does this mean?

Considering the degree of brome seed-bank carry-over (29%) from one season to the next, crop rotations that provide consecutive years of management are required for seed-bank depletion. Rotations that utilise pasture or break-crops, followed by Clearfield® wheat provide the best means at present of achieving consecutive years of brome grass management and seed-bank depletion. Alternatively, monoculture rotations of cereals wheat and barley, where few effective herbicide options are available for controlling brome, can result in a rapid increase in the brome seed-bank.

Although growing Clearfield® wheat is an expensive option, consider only applying the herbicide to areas (i.e. sandy rises) where brome is of meaningful density. This will reduce the quantity of herbicide required and the overall cost across the farm. As Midas® herbicide provides reliable post-emergent control of grasses and broadleaf weeds, consider dry-sowing Clearfield® wheat. The benefits associated with this practice include cost savings of knockdown herbicides and spreading of the seeding workload, which allows for timelier sowing of crops. However, the downside to growing rotations utilising break-crops and Clearfield® wheat are the risks associated with crop failure (i.e. negative returns and high herbicide costs) and persistence of herbicides in the low rainfall environment of Upper EP. Unfortunately, the alternative herbicides provide limited control or at best suppression of brome, which can lead to a serious brome grass seed-bank that may require a longer more costly break (i.e. 3-4 years) to rectify and deplete.

Acknowledgements

Thanks to the Edwards and Polkinghorne families who allowed the trials to be conducted on their properties.

Technical assistance provided by Daniel Radulovic and Michael Burdett of the University of Adelaide.

The Grains Research and Development Corporation (GRDC) for project funding.

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GRDC Grains Research & Development Corporation

Searching for answers

Location
Lock
Andrew Polkinghorne

Rainfall
Av. Annual total 340 mm
Av. GSR: 260 mm
2005 Total: 321 mm
2005 GSR: 285 mm

Yield
Potential: 3.5t/ha

Soil
Grey calcareous loam

Location
Tuckey - Jason Burton
Tuckey Ag. Bureau

Rainfall
Av Annual: 324 mm
Av GSR: 241 mm
2005 Total: 313 mm
2005 GSR: 281 mm

Yield
Potential: 3.42 t/ha
Actual: up to 2.14 t/ha

Paddock History
2004: Wheat
2003: Canola
2002: Wheat

Soil Type
Sandy Loam / Red Clay Loam

Herbicides for the control of brome grass in wheat and barley

Sam Kleemann & Gurjeet Gill
University of Adelaide

Research

Key Messages

- **For two consecutive seasons in 2004 and 2005 tank-mixes of Lexone® at 180 g/ha with either Trifluralin or Stomp® incorporated by sowing (IBS) offered a safe and effective option for the control of brome grass in barley.**
- **Be aware that use of high rates of Lexone® (>180 g/ha) in barley can result in significant crop damage, particularly when applied to soils low in clay content and/or organic matter (i.e. sandy soils).**
- **Potential exists for the use of Lexone® in metribuzin tolerant wheat cultivars, which could provide a more cost effective alternate to growing "Clearfield®" wheats for the control of brome.**
- **Imidazolinone herbicides (Midas®, Clearsol® and Eurolightning®) provide an excellent option for controlling brome grass in "Clearfield®" wheat, and offer the greatest opportunity to deplete the seed-bank in the cereal phase.**

Why do the trial?

Brome grass species, *B. diandrus* and *B. rigidus*, have proliferated as weeds in cereal crops of Upper Eyre Peninsula, resulting in significant reductions in crop yield and penalties associated with delivery of contaminated grain. The increasing prevalence of brome grass can be related to increased frequency of cropping, early seeding with adoption of conservation tillage and lack of effective herbicides required for control in the cereal phase.

The aim of these trials was to evaluate the herbicide options currently available for the control of brome grass in wheat and barley.

How was it done?

Trials were established at Rudall and Lock to assess herbicide treatments for the control of brome grass in wheat and barley. Two trials assessing Imidazolinone herbicides were dry-sown to Clearfield® Stilletto in early June, and the third was sown on the 23rd of June to barley cultivar, Barque.

In barley all treatments were applied by Incorporation By Sowing (IBS) method and comprised of:

Lexone® (750 g/ha metribuzin) at rates of 180, 270 and 360 g/ha

Lexone® @ 180 g/ha + Trifluralin 1.5 L/ha

Lexone® @ 270 g/ha + Trifluralin 1.5 L/ha

Lexone® @ 180 g/ha + Stomp® 1.8 L/ha

Lexone® @ 270 g/ha + Stomp® 1.8 L/ha

In wheat, post-emergent applications were applied on 27th and 28th July at Rudall and Lock, and included:

Atlantis® (30g/L mesosulfuron-methyl) @ 330 ml/ha

Midas® (288.5 g/L MCPA + 22 g/L imazapic + 7.3 g/L imazapyr) @ 900 ml/ha

Clearsol® (a different formulation to Midas®) @ 85 ml/ha

Eurolightning® (a different formulation to Midas® and Clearsol®) at rates of 300 and 600 ml/ha

Additional experiments were established at Rudall and Wudinna on the 22nd June to evaluate brome grass control and tolerance of wheat cultivars to Lexone®. Lexone® was applied IBS at rates of 180, 270, 360 and 540 g/ha to wheat cultivars, EGA Eagle Rock, Blade (tolerant), Westonia and Spear (sensitive) and barley cultivar Sloop SA.

What happened?

Brome control in Barley (Rudall):

The highest rate of Lexone® at 360 g/ha was more active on brome grass than lower rates of 180 and 270 g/ha and resulted in the highest grain yield (2.7 t/ha). However, this rate (360 g/ha) also caused crop phototoxicity reducing the plant density of barley by 11% compared to the weedy control (*Table 1*). For a second season, IBS tank-mixes of Lexone® at 180 and 270 g/ha with either Trifluralin or Stomp® were safe on the crop and provided significant brome control (>76%) and increased grain yield.

Brome control in Clearfield® Stilletto wheat (Rudall and Lock):

Post-emergent applications of imidazolinone herbicides Clearfield Midas®, Clearsol® and Eurlightning® provided excellent control of brome grass at both Rudall (>98%) and Lock (>85%). Post-emergent herbicide Atlantis® caused low levels of seedling mortality of brome at Rudall (11%) and Lock (27%), resulting in suppression rather than plant kill. Good suppression of brome with Atlantis® herbicide was recorded at Rudall where seed production was significantly retarded. However, seed production was still higher when compared to the of Clearfield® herbicides at both sites. The "Clearfield" herbicides were so effective that no viable brome seed was produced. However, to be fair to Atlantis® herbicide, the brome grass densities presented at both sites exceeded the maximum density of 150 plants/m² to which this herbicide should effectively be used (*see label*).

Table 1: Effect of herbicide treatments on plant density, grain yield of barley, density and panicle number of B. rigidus and net returns over the untreated weedy control.

Treatment	Chemical cost ($/ha)	Barley (plants/m²)	Brome (plants/m²) *HE - (%)	Brome panicles/m² (seed/m²)	Grain Yield (t/ha)	Net return over control ($/ha)
Trifluralin @ 1.5 l/ha	12	117	20 (59)	42 (1001)	2.29	-3.6
Stomp®@ 1.8 l/ha	14.4	116	26 (47)	56 (1331)	2.32	-2.4
Lexone®@ 180 g/ha	9.9	120	32 (35)	64 (959)	2.48	21.3
Lexone®@ 270 g/ha	14.85	114	21 (57)	43 (805)	2.4	6.75
Lexone®@ 360 g/ha	19.8	106	4 (92)	7 (113)	2.74	42.6
Trifluralin @ 1.5 l/ha + Lexone®@ 180 g/ha	21.9	122	7 (86)	18 (340)	2.62	26.1
Trifluralin @ 1.5 l/ha + Lexone®@ 270 g/ha	26.85	116	3 (94)	6 (140)	2.49	5.55
Stomp®@ 1.8 l/ha + Lexone®@ 180 g/ha	24.3	129	11 (76)	24 (560)	2.4	-2.7
Stomp®@ 1.8 l/ha + Lexone®@ 270 g/ha	29.25	126	1 (98)	2 (33)	2.5	4.35
Weedy control	0	119	49	112 (2239)	2.22	0
LSD (P=0.05)		NS	25	55	NS	

****HE - (%) - Herbicide efficacy in brackets as a percent of the weedy control, Net returns over the untreated weedy control; barley price (feed) = $120/t, Herbicide prices used are recommended retail prices for the 2005 growing season (GST Inc).***

Table 2: Effect of herbicide treatments in Clearfield® wheat on B. rigidus plant and panicle density (seeds/m²) at Rudall and Lock in 2005.

Treatment	Chemical cost ($/ha)	Brome Plants/m², HE (%)		Brome Seeds/m²	
		Rudall	Lock	Rudall	Lock
Atlantis® @ 330 ml/ha	25.7	186 (11)	151 (27)	2888	3989
Midas® @ 900 ml/ha	35.90	3 (98)	11(95)	0	0
Clearsol® @ 85 ml/ha	-	0 (100)	1 (99)	0	0
EuroLightning® @ 300 ml/ha	∇T.B.C	3 (98)	31 (85)	0	0
EuroLightning® @ 600 ml/ha	∇T.B.C	0 (100)	0 (100)	0	0
Weedy control	0	209	208	9298	3269
LSD (P=0.05)		29	46	2962	1408

****HE - (%) - Herbicide efficacy in brackets as a percent of the weedy control, - ∇Retail price of Eurolightning® T.B.C, - Herbicide prices used are recommended retail prices for the 2005 growing season (GST Inc).***

Brome grass control and tolerance of wheat to metribuzin (Rudall and Wudinna):

The high rates of IBS Lexone® (270, 360 and 540 g/ha) all gave excellent brome control at Rudall in comparison to the low rate of 180 g/ha and the weedy control, however the wheat cultivars tested differed markedly in their response. For a second season, EGA Eagle Rock and parent cultivar Blade, were more tolerant to high rates of Lexone® than sensitive cultivars Spear or Westonia, which had reduced plant density, anthesis dry-matter and ear number. Regardless of the site all cultivars showed some symptoms of metribuzin toxicity (leaf chlorosis, necrosis and plant death) especially the cultivars Spear and Westonia.

What does this mean?

These trials have shown for a second year that brome grass can be effectively controlled using selective herbicides in wheat and barley. Tank-mixes of Lexone® at 180 g/ha with either Trifluralin (1.5 L/ha) or Stomp® (1.8 L/ha) offered safe and effective options for the control of brome in barley, although, the highest rate of Lexone® (360 g/ha) resulted in a minor reduction in barley density at Rudall. Crop phototoxicity can occur, particularly on moist soils with low clay or organic matter content. Be aware of the risks associated with the movement of this herbicide with rainfall, particularly into press wheel furrows where it can cause severe crop damage.

Although, the responses to IBS Lexone® were of smaller magnitude between the tested wheat cultivars this season, consistent results from the Rudall and Wudinna sites showed that this herbicide (metribuzin) could be used safely in tolerant wheat cultivars EGA Eagle Rock and Blade. However, further research is required to determine the optimum rates of Lexone® for maximising brome control and minimising crop damage. Safe and effective use of metribuzin in tolerant wheat cultivars could provide an alternate to growing "Clearfield®" wheats and using fragile group B herbicides. Nevertheless, Clearfield® wheats provide the best opportunity to control brome grass in wheat, which was evident at Rudall and Lock sites, where post-emergent herbicides Midas®, Clearsol® and the new formulation Eurolightning® resulted in excellent levels of brome grass control. However, be aware of the residual activity associated with the use of these herbicides, particularly on soils of high pH and following seasons of low rainfall (consult label).

Acknowledgements

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Technical assistance provided by Daniel Radulovic, Michael Burdett, Kay Brace and the Minnipa Ag. Centre team.

The Grains Research and Development Corporation (GRDC) for project funding.

Eurolightning® is an experimental herbicide currently being evaluated prior to commercial release.

GRDC Grains Research & Development Corporation

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Location
Penong - Craig Trowbridge
Charra Ag Bureau

Rainfall
Av Annual: 318mm
Av GSR: 215mm
2005 Total: 287mm
2005 GSR: 221mm

Soil Type
Light sandy clay loam.

Plot size
2 m x 20 m x 3 reps

Iceplant control in pasture

Neil Cordon

SARDI, Minnipa Agricultural Centre

Key Messages

- **Iceplant control was achieved with an off label herbicide mix in medic based pasture for less than $10/ha.**
- **Herbicides are available to control iceplant with minimal effects on medic growth.**
- **There appears to be a synergistic effect when low rates of Broadstrike® and Diuron are mixed.**

Why do the trial?

Iceplant (*Mesembryanthemum crystallinum*) is an autumn/winter annual or occasionally biennial prostrate plant with large glistening papillae giving a frosted appearance. It was a garden escape originating from South Africa, and is now a well established problem weed throughout Eyre Peninsula, especially the lighter soil regions from Cowell to Nundroo.

This trial was designed to evaluate a range of herbicides to control iceplant in a medic based pasture at an economic cost level, and to monitor the impact of the herbicides on medic production.

Research by M.J.Catt identified iceplant had the presence of a water-soluble allelopathic agent, which severely interfered with wheat seed germination. He found that after ten days wheat germination had been reduced by 80% and the length of radicale reduced by 95% when planted into dense iceplant residue.

Control in the cropping phase is relatively simple and cost effective however control in the pasture phase can cost up to $20/ha and needs chemical rates which severely affect pasture production. Sheep tend to nibble young plants, however it makes sheep scour. Thick residues of iceplant can create problems during crop preparation the following year.

Demonstration strips in 2003 and 2004 provided some initial data indicating the herbicide Broadstrike® had a positive effect on controlling iceplant but a cost of $17/ha limited its appeal to farmers. It was questioned whether herbicides applied at low rates in combination with Diuron would have synergistic effects and hence improved iceplant control.

How was it done?

Combinations of herbicides were sprayed at the post emergent stage in replicated small plots in a regenerating pasture that was dominated with iceplant.

Plots were sprayed on the 27th July in ideal conditions with active growing weeds at a water rate of 90L/ha.

Medic was 2 to 8 leaves, whilst the iceplant was 2 to 4 leaf.

Wetting agent BS 1000 was applied with the Raptor® at 2ml/L and Broadstrike® at 1ml/L.

Measurements taken were visual appraisal of effect on weed and medic using the European Weed Research scale.

What happened?

All treatments had a positive effect in controlling the iceplant (*Table 1*) with light to very light medic damage. Raptor® controlled the odd barley grass however was visually weaker on the iceplant, especially a narrow leaf succulent plant.

What does this mean?

Satisfactory control of iceplant in pasture was observed when using a low cost option of Broadstrike® at 8 gm/ha and Diuron at 70 to 140 gm/ha.

This “brew” appears to have a synergistic effect similarly to the Diuron/MCPA amine mix for broad-leaved weeds in cereals.

Broadstrike® is not recommended for iceplant control, whilst Diuron at 500 gm/ha is recommended to control iceplant in pasture but medic damage may occur.

This research will be repeated in 2006 where some more “brews” will be evaluated however these initial findings provide encouragement that iceplant can be economically controlled in pasture.

It must be highlighted that Raptor® is not recommended for iceplant control, and that Raptor® and Broadstrike® are

Table 1: Treatment cost, and visual rating of effect on weed and medic for ice plant at Penong, 2005.

Treatment (per hectare)	Cost ($/ha)	Visual effect on Iceplant (1-9)	Visual effect on Medic (1-9)
No Spray	-	9	1
25 gm Broadstrike® + 140 gm Diuron	18.65	1	3
12.5 gm Broadstrike® + 70 gm Diuron	9.54	2	1
12.5 gm Broadstrike® + 140 gm Diuron	10.90	2	3
8 gm Broadstrike® + 70 gm Diuron	6.57	2	1
8 gm Broadstrike® + 140 gm Diuron	7.43	2	3
25 gm Raptor® + 140 gm Diuron	18.58	6	2
12 gm Raptor® + 140 gm Diuron	10.26	6	2

Note: The lowest figures indicate positive weed control and the highest poor weed control.

Group B herbicides so management for herbicide resistance should always be considered.

Previous work and farmer experience has shown that rolling with a ribbed roller to squash the papillae will reduce iceplant growth and improve the effectiveness of herbicide entering the plant.

Acknowledgements

Thanks to Ken Webber (Nufarm) for his guidance and assistance with trial design and monitoring. Thanks also to Ben Ward for trial management and to Craig Trowbridge for providing the trial site.

- Broadstrike®; registered product of Dow Agro Sciences
  Raptor®; registered product of BASF

Targeting small ryegrass

Research

Michael Bennet

SARDI/SANTFA Minnipa Agricultural Centre

Searching for answers

Location
Minnipa Agricultural Centre

Rainfall
Av. Annual total: 325 mm
Av. GSR: 242 mm
2005 Total: 327 mm
Actual GSR: 267 mm

Soil
Sandy Loam

Plot size
3m x 24m.

Key Message

- **Further trials are needed to determine whether it is possible to successfully target small grass weeds without producing excessive spray drift.**

Why do the trial?

Nozzles were evaluated in several different spraying application situations this season on Eyre Peninsula. Working closely with Graham Betts of ASK GB, the nozzle trials were formulated to provide a decision making tool for growers looking for an answer to drift and nozzle selection questions.

How was it done?

The trials were sprayed using a manual boom spray towed behind a 4WD. The spraying treatments were six nozzles (3m) wide. The boom was plumbed to handle pressures up to 10 bar which is in excess of the pressures used within the trials. For accurate results to be obtained, a consistent speed was required from the towing vehicle, which was no small challenge.

One critical lesson learnt from the spray trials this season was related to the actual output of each nozzle. Each nozzle is rated by an international standard according to the volume of water output at given pressures. For example, a yellow 02 nozzle is rated for an output of 790 ml/min at 3 bar output pressure. Unfortunately it was measured that the actual water output varied by as much as seven percent from the specified output for certain nozzles. These variations are taken in to account with a flow meter and rate controller in most commercial boom sprays. In early trials, chemical was applied at constant speed and pressure, which did not take in to consideration the nozzle variation from original specifications.

A trial was established to rate the performance of various nozzles on a small target (in this case, emerging ryegrass) with a contact herbicide. Guard ryegrass was sown in a pasture paddock at Minnipa using a small plot seeder in late September. The sown ryegrass suffered from a staggered germination with dry conditions post sowing, which reflected in the results. The trial was sprayed on the 21st of October with 1L/ha of Gramoxone®. Half of the ryegrass had its first true leaf showing, while the other half only had the coleoptile visible above the ground.

The trial was sprayed in a delta T of 5.5 (19°C and 55% relative humidity) with a cross wind of 11 km/h. Spraying speed was a constant 20 km/h across all treatments.

What happened?

The trial was originally sown as a four replicate trial, however the fourth replicate germinated later than the others, so it was removed from the data analysis. The high LSD (least significant difference) indicates the large variation found within the remaining three replicates. Statistically, there was

Weeds

no difference between the Turbodrop Airmix® (4.4 plants/m²) and the Turbodrop XL® (18.7 plants/m²). This gives an indication of the variation within the trial. Great variation can often be measured within herbicide trials (with this one certainly no exception!) and it indicates how necessary it is to have many replicates to obtain quality data.

No additional control was observed for increasing water rate from 50 to 100 L/ha with a fine or medium droplet spectrum nozzles. However a higher water rate appeared to increase the performance of coarse and very coarse droplet nozzles.

Table 1: Ryegrass control with various nozzle types and water rates

Nozzle	Spray Quality	Size	Pressure (bar)	Water Rate (l/ha)	Ryegrass Plants/m²	Group *
Extended Range (XR)	Fine	02	3.5	50	3.3	a
Hardi Injet®	Very Coarse	03	6	100	4.1	a
Turbodrop® Airmix	Medium	02	3.5	50	4.4	a
Turbo Teejet®	Medium	02	3.5	50	5.5	a
Hardi Minidrift	Coarse	04	3.5	100	6.6	a
Turbodrop® TDCFFC	Medium	03	6	100	8.7	a
Lechler Anti Drift	Medium	02	3.5	50	12	a
Lechler ID	Very Coarse	02	3.5	50	12	a
Extended Range (XR)	Fine	04	3.5	100	12	a
Lechler IDK	Coarse	02	3.5	50	14.2	a
Turbodrop® TDCFFC	Medium	015	6	50	15.8	a
Lechler ID	Coarse	025	9	100	17.5	a
Turbodrop® XL	Medium	015	6	50	18.7	ab
HP Teejet® AI 110	Coarse	015	6	50	37.6	b
	Untreated				62.4	c
LSD (<0.05)					21.3	

**** Treatments followed by the same letters are not statistically different to each other.***

What does this mean?

The trial indicates that there is potential for medium and perhaps even coarse droplets to give similar performance to the standard extended range (XR) nozzles with contact herbicides. Consideration may need to be given to higher water rates when applying a contact herbicide to a small target weed, especially with greater than medium droplet sizes. It is important for the trial to be repeated in 2006 to obtain more reliable data in order for growers to make an accurate choice when choosing nozzles.

Unfortunately the jury is still out to find a suitable nozzle that will not produce drift for the contact herbicide applications such as applying Paraquat to small ryegrass. The trial did indicate potential for non conventional nozzles to perform in a contact herbicide situation, however it is crucial to conduct additional replicated experiments to justify a move to alternative nozzles in this particular application.

What about other herbicides?

During 2005 Nufarm changed the label recommendations on their Group I herbicides such as Estercide 800®, LV Estercide®, Baton®, Amicide 625® and Surpass 300® which will affect the way in which growers can apply their herbicides. It is now required by law for growers to apply these herbicides through nozzles producing no less than a coarse to very coarse droplet size according to ASAE S572. Restrictions to only spray between 3km/h and 15 km/h wind speeds have also been applied to the label. Nufarm will continue research in 2006 to make droplet recommendations for the MCPA group of herbicides.

2006 plans

It is anticipated to repeat the experiment in 2006 with equipment from the SANTFA Premier sponsor Case IH and Commercial Research Partners Nufarm-Croplands and KEE Technologies. Using commercial equipment will enable greater control over speed and spray application across the various treatments and will allow for consistent results to be obtained for growers in the 2006 season.

Acknowledgements

Graham Betts of ASK GB and Len Horne of Mr Nozzle for help with nozzle selection and boom plumbing.

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Grains Research & Development Corporation

Section 11

Section editor: Amanda Cook

SARDI, Minnipa Agricultural Centre

Risk Management

Overview of climate change - what does it mean to grain growers on EP?

Searching for answers

Information

Peter Hayman and Melissa Rebbeck,

SARDI Climate Risk Management Unit, Waite Campus

Key Messages

- **South Australia's winter cropping season is getting warmer, but single records are not as important as the underlying trends.**
- **There is more confidence in the projections for temperature than rainfall projections.**
- **Grain farming is an annual crop and in the past many growers have adapted to changes.**

Changing questions on climate change

In the space of about five years many grain growers and their advisers have moved from asking “What is climate change?” or “Is it real?” to “How do we manage for climate change?” and “What will the impact be on the grains industry?” It is hard to miss stories on climate change in the media. However, local events have also got people talking. Hot spells in February 2004 and October 2004 and the very hot and dry start to the 2005 cropping season, and the hot January of 2006 have all highlighted the vulnerability to climate and increased concern about possible changes.

As seen in *Figure1* below, South Australia's winter cropping season is getting warmer. More detailed analysis is needed for sites on Eyre Peninsula, but there is an overall picture of each decade since the 50's in Australia being warmer. 2005 was the warmest year on record, but single records are not as important as the underlying trends.

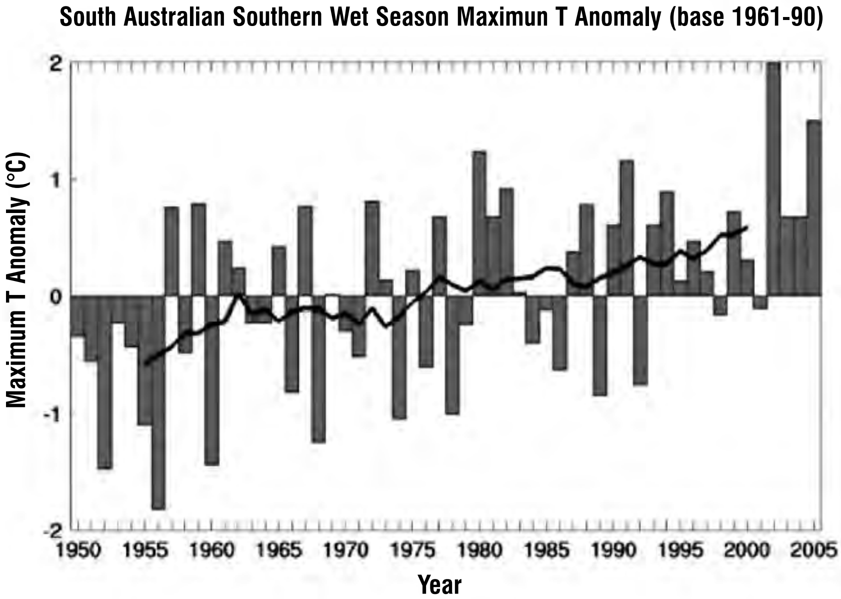


Figure 1a - Temperature anomalies (difference from 1961-1990 average) for April to October for South Australia from www.BoM.gov.au

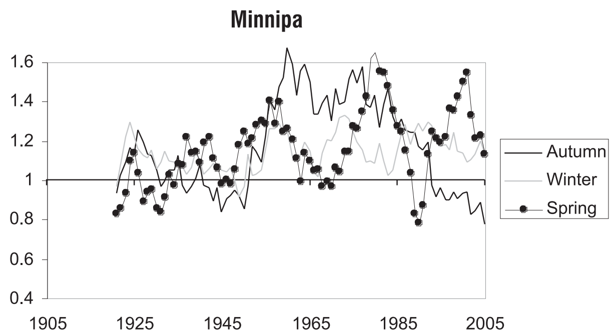


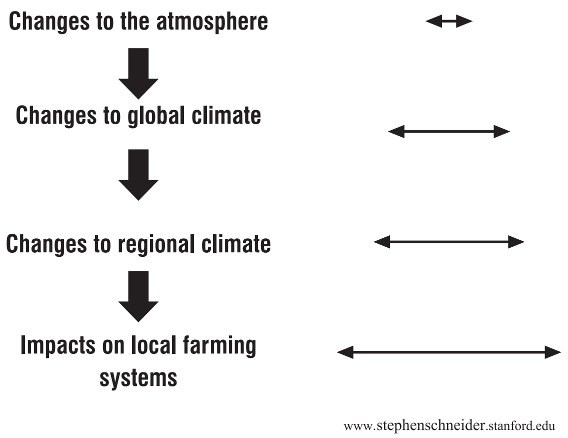
Figure 2 - Ten year moving averages of autumn (Mar-May), winter (Jun-Aug) and spring (Sept - Nov) rainfall for Minnipa. The Y-axis is the ratio of that 10 year period to the long term average. Autumn rainfall for the period 1995 to 2005 was 20% less than the long-term average.

Rainfall for Minnipa is highly variable and it is hard to pick strong trends. *Figure 2* shows that the drying trend in autumn has been compensated by wetter winters and springs.

The CSIRO projections for South Australia can be found at; www.environment.sa.gov.au/sustainability/pdfs/csiro_report.pdf . Across much of the agricultural regions temperatures are projected to increase by 0.2 to 1.4°C by 2030 and 0.6 to 4.4°C by 2070. Annual rainfall is projected to decline by 0 to 18% in 2030 and 0 to 40% by 2070. The rainfall outlook from the models is the most worrying, but also the most uncertain aspect of the projected changes.

From global climate change to local impact - varying levels of confidence

Figure 3 below can be used as a framework to think about the uncertainty. The evidence for the vertical arrows is getting stronger. However the exact impact on regional climates and then local farming systems is best represented as cascading uncertainty.



Cascading uncertainty

Figure 3: Cascading uncertainty of climate change.

There is more confidence in the projections for temperature (including more heatwaves and fewer frosts), sea level rise and increase in cyclonic wind intensity. There is lower confidence in rainfall, run-off and non-cyclonic severe weather events.

We need to keep working on a top down approach whereby we access the latest climate modelling from CSIRO. However there is likely to always be a mismatch between the resolution desired by decision makers and what can be delivered by climate science. A complementary approach is a "bottom up" approach whereby we characterise the vulnerability of different industries to changes in temperature, rainfall and extreme events. By definition this is a task that is best done locally and to be effective needs to include decision makers.

Most adaptations to a warmer and drier environment such as conserving more water, improving water use efficiency, timely sowing and careful management of weeds, disease and nutrition are sensible practices for the grains industry in the absence of climate change. In other words they are no-regret adaptations. Unlike fixed horticulture (eg a vineyard with a 30 year planning horizon) or irrigation systems, grain farming is an annual crop and in the past many growers have adapted to changes in the market and seasonal conditions.

SAGIT has funded SARDI to run workshops on climate change in the grains industry- for more details contact Rebbeck.Melissa@saugov.sa.gov.au.

or SA Greenhouse strategy
http://www.climatechange.sa.gov.au/default.htm

Try this yourself now

Research

Reducing frost risk

Melissa Rebbeck, Chris Lynch, Peter Hayman and Victor Sadras

SARDI Climate Risk Management Unit, Waite Campus

Key Messages

- **Clay delving stands out as the most consistent and effective treatment to reduce frost risk on sandy soil.**
- **Rolling soils is effective on both sandy and clay soils, but results are more variable.**
- **Manipulating the soil heat bank is more important in reducing frost risk than manipulating canopy density.**

Why do the trial?

The aim of this project is to quantify and understand the impact agronomic management practices have on frost risk in broadacre cropping. Although frost damage is difficult to assess it has been estimated that frost causes an annual average damage of $33m to the grains industry of Victoria and South Australia via direct and indirect losses. Frost damage has seemingly been getting worse in the last 10 years, despite the warming trend of minimum temperatures over the last 50 years.

We believe that farmers are using more efficient machinery accelerating the time it takes to sow, putting more crop into a frost risky window. Thicker lusher crops can also be a cause of increased frost. Modelling studies have indicated that, in some locations, sowing to flowering time in wheat has decreased by up 2.5 to 3 days per decade, which is equivalent to 1.5 weeks earlier in 2000 than the 1960s (Sadras and Monzon, 2006). This is an expected response to warmer temperature, which may accelerate flowering and potentially shift frost-sensitive crop stages to earlier times of the year. Therefore, the expectation that the projected increase in temperature may reduce frost risk and current agronomic practices need to be considered carefully.

More detailed background can be found in previous EPFS publications or contact the author for details.

How was it done?

This report is mainly about the 2004 results with comments relating to 2005 data analysed to date. In both years the following soil treatments were applied: rolling the soil, clay delving and various stubble treatments (slashed vs standing vs removed). We were particularly interested if there would be an interaction between claying and rolling. We were also curious if the effect of crop row spacing on frost risk is dependant on the soil texture. The other crop canopy manipulation treatments studied included: variety blends, low and high nitrogen rates and seeding rates.

Each trial was located in a frost prone area of a farming property and was selected so that there was minimal variation due to soil type or slope across the site. Wheat was sown on all major sites because of its economic importance as well as being one of the more frost susceptible cereals. Farmer machinery was used in 2004 to reduce the edge effects that small plots create. In 2005 small plot machinery was used on main trials to gain more treatments and farmer machinery on farmer demonstration sites. There were no walkways to ensure that cold air would not drain off the plots.

Experiments in 2004 included;

- Delving clay x row spacing x wheat variety on sand over clay at Keith in the South East.
- Seeding rate x N rate x variety selection on black cracking self-mulching clay at Mintaro in the Mid North.
- Rolling x seeding rate x N rate on a loamy sand grading into a light clay at Parilla in the Southern Mallee.
- A rolling sub trial on sand over clay near Lameroo in the Southern Mallee.
- Stubble sub trial on sand over clay near Karoonda in the Northern Mallee.

In 2005, we combined field and frost-chamber experiments to further clarify unanswered questions highlighted in 2004. This includes the significance of wide rows, row spacing, variety and N rates. We also wanted to substantiate our significant findings with delving clay and other soil treatments. In 2005, we maintained similar sites to 2004, with the addition of 4 sites around Buckleboo on the Eyre Peninsula. Here trials researched the impact of many types of rollers and press wheels, and further investigated the impact of stubble. We used the frost chamber at the Waite campus to examine in detail the effect of variety and growth stage on frost. Much of the 2005 data still needs to be analysed.

Measurements taken at the frost trials

A Hobo® weather station was set up at each of the three core sites and recorded ambient temperature, wind speed, gust speed, rainfall, solar radiation, relative humidity and dew point. The temperature was recorded at 1.5m above the ground (Stevenson screen height).

Temperature data loggers (Starlogger® and Hobo®) were used to monitor soil and canopy temperatures of each plot. These loggers were programmed to log the temperature every 15 minutes. A soil probe was placed onto the soil surface firmly to give good soil contact and remain exposed to the sky. Directly above the soil probe was another temperature probe mounted on a wooden arm on an iron dropper to monitor temperature at crop head height. These wooden arms were raised with crop growth and the probe was always level with the top of the canopy and later at the average height of the wheat heads.

A frost score was made and cross validated with yield and temperature records. Grain quality measurements included grain protein %, screenings % (fraction < 2mm), grain plumpness (fraction > 2.5mm) and 1000 grain weight. The AWB scale for frost distorted grain was used to classify grain as distorted or not (AWB 2005).

Further methodology with photos and diagrams explaining frost principles and reason behind treatments being trialed can be found in our 2003 Frost Report (Lynch and Truscott, 2003).

What happened?

Our research has shown it is possible to use agronomic management to reduce frost damage. We have manipulated the soil heat bank to release heat at night making it warmer at crop head height. It is possible for broadacre growers to gain greater control over frost risk via agronomic management. The magnitude that each management practice influences frost risk is better understood.

We have found that the soil heat bank has a much greater influence on increasing temperature at crop head height than alterations to crop canopy density or structure. The most effective soil treatment so far has been delving clay in a frost prone sandy soil. This treatment has reduced frost losses by up to 68%; we have measured up to 1.5°C warmer at canopy height and have increased grain yields by up to 1t/ha in 2 years of trials. This yield benefit likely results from a combination of effects including overcoming non-wetting problems, improved water and nutrient availability in topsoil, reduced soil mechanical impedance and reduced frost damage. Our analysis indicated that reduced frost damage is one of the main factors underlying the improved yield in delved soil. Delving of clay is a once off treatment where the benefits can recover the costs in a single year.

Rolling a sandy soil has generally resulted in less frost risk, as measured by warmer temperatures at crop head height, up to 20% less frost damage and higher yields. The benefits of rolling are less substantial than claying, and possibly more variable with soil and seasonal conditions. However, the 2004 research at Keith indicated that rolling the clayed sand helped to reduce frost losses over and above adding clay alone. This is most encouraging as it indicates potential additive effects which can further help to reduce frost losses on sandy or clay soils.

Agronomic treatments that aim to reduce crop canopy density to allow better interception and storage of heat into and out of the soil have shown small frost protection. There were differences between varieties but the traits involved remain confounded, wheat variety Buckley (awnless) has been up to 20% less frost damaged than Tameroi Durum (awned). It may be that Buckley simply flowered outside the frost risky window; therefore we have conducted further trials in the frost chamber (yet to be analysed). Lowering seeding, wider row spacing and nitrogen rates have not yet been seen to have much influence on frost damage.

Manipulating the soil heat bank has proven to have the largest impact on reducing frost losses, especially delving clay in a sandy soil. From a 'Susceptibility to Water Repellency' report by Soil and Land Information report (DWLBC), we estimate that about 70% of the frost prone country in SA is sandy, and of this, 70% is suitable for spreading or delving clay. So overall claying may be a suitable option for 50% of the frost area in SA.

The canopy treatments are still important and are being further investigated. If such practices have a small effect, the sum of these may become useful since Marcellos and Single (1984) demonstrated that even a small increase in temperatures at the critical freezing levels can make a large difference in the amount of frost damage.

Future plans

During 2006 we will examine all of the results from the frost trials conducted since 2002 including data from similar research in WA. Collaboration with the WA project and a Victorian project on frost will be coordinated to jointly develop and deliver a generic frost risk decision rule package for southern Australia. This will include a decision aid, and a book on the principles of frost management. Please keep a watch out for workshops in your area to demonstrate and receive these products and services. For more information contact us at the SARDI Climate Risk Management Unit on 08 83039639.

Acknowledgements

We gratefully acknowledge the following contributions and support for the 2004/5 frost field trials:

Mick Faulkner from Agrilink Consulting, Garren Knell from ConsultAg, Narrogin WA, Bronya Alexander and Frankie Charman- Green and Jim Egan from SARDI. Thanks to the many farmers who have provided land and machinery to sow the trials and a special thanks to the McKillop and Buckelboo farmer groups. Thanks to members of the frost steering committee, SARDI Field Crop Evaluation team and Rural Directions for harvesting the trials. Michelle Lorrimer of Biometrics SA performed the statistical analyses.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Section editor: Amanda Cook
SARDI, Minnipa Agricultural Centre

Sharing Information

Low Rainfall Collaboration Group

Information

Geoff Thomas
LRCG Project Manager

The Low Rainfall Collaboration Group, funded by GRDC, comprises the farm systems groups on EP and Upper North in SA, Mallee in SA, Victoria and NSW, Birchip in Victoria and Central West and Western Wheat in NSW. All are in the less that 350 mm rainfall belt.

The purpose of the group is to share information and activities between groups and avoid duplication. Whilst the soils and environments might differ between areas, many of the same principles apply and farmers have benefited greatly from observing and discussing different approaches to similar issues.

This has been achieved in a number of ways including farmer/staff visits to each other's areas, regular newsletters, workshops and field days.

In addition, a lot of work has been done to assist groups in building memberships and sponsorships and in evaluation of their work in terms of its value to farmers.

The various groups have also benefited from seeing how others run their field days and workshops.

The project finishes in early 2006, but a new one is planned which builds on the solid foundation achieved so far.

While the work on improving communication between groups will continue, the main emphasis will be on fitting the various technologies together into a true farm systems approach and sharing the findings of the various groups on this basis. This will include such things as climate variability, better use of plant available water, nutrition, root diseases and different crops in rotation, and assessing the role of livestock in the system.

It will not just be technical but will include detailed financial and risk analysis to assess the value of the various technologies to farmers, both on their own and together. This responds to the call we frequently get from farmers to look at all of these things in a systems way, just as they have to. It will also place greater emphasis on cost control and risk management, rather than just concentrate on maximizing production and profit.

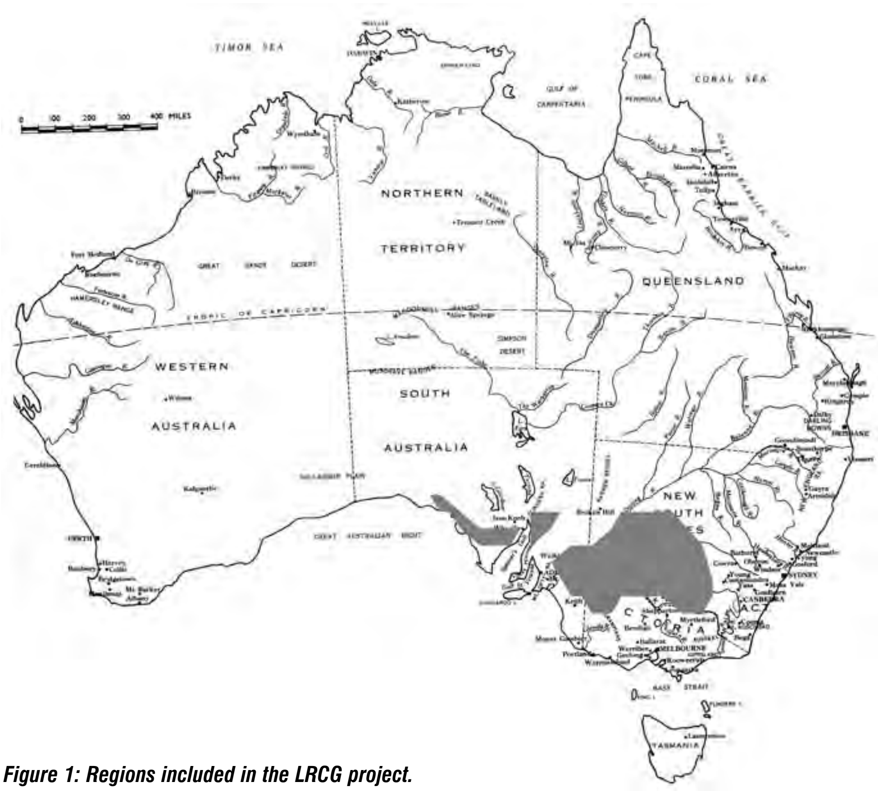


Figure 1: Regions included in the LRCG project.

Grains Research & Development Corporation

Introducing LEADA - A new farmers' group for Lower EP

Information

Greg Secomb

Rural Solutions SA, Port Lincoln

Key Messages

- **A new growers group formed with the aim of attracting Research & Development investment and to encourage the adoption of sustainable and best management agricultural practices to the LEP region.**
- **Successful with a National Landcare Program bid - project to commence in 2006.**
- **Farmers on Lower EP are encouraged to become members.**

The *Lower Eyre Agricultural Development Association* (LEADA) was formed in May 2005 after a series of meetings with a range of farmers, agribusiness and government agency representatives. Michael Richards of the Ag Excellence Alliance initiated the meetings to help foster the development of a regional growers group to represent the interests of Lower Eyre Peninsula.

Regionally based grower groups have driven recent trends in agricultural Research and Development and this has been a preferred model for funding agencies. With the absence of such a formal body on the LEP it was perceived that the region was disadvantaged in gaining local and relevant research information.

Early meetings were used to identify a range of issues that affect growers in the region and to form a foundation committee to further develop the group into the future. Our name, LEADA, was chosen to reflect our aims of promoting the Development of Agriculture on the Lower Eyre Peninsula.

An early commitment was gained from the Department of Water, Land & Biodiversity Conservation to invest in a Coordinator for the group for two days per week. This has been a critical step to get the momentum of the group up and running.

During the course of the year some representatives of LEADA met with the GRDC Southern Panel on their regional tour. The GRDC took a great interest in the formation of this new group and it was an important opportunity to begin forging relationships with this organization.

A key message from GRDC is that they look to have a maximum coverage of growers when looking to invest in projects. For this reason we are keen for farmers on the Lower EP to become members of LEADA so that we can demonstrate that we are directly accessing a wide range of farmers. Of course, there will be a range of other benefits of becoming a member of LEADA.

In December 2005 we were welcomed with the fantastic news that our bid with the National Landcare Program Community Grants round was successful. The project "*Improving the water use efficiency of Lower Eyre Peninsula cropping systems*" will commence in 2006 with an investment of $55,000.

This is an incredible boost for LEADA and helps us put our first runs on the board - but more importantly it represents an investment and benefit for all LEP farmers.

Further information on LEADA can be obtained from:

- Kingsley MacDonald, Farmer at Koppio, Chairman; Phone: 8684 4257
- Greg Secomb, Consultant at Rural Solutions SA, LEADA Group Coordinator; Phone 8688 3409

Acknowledgements

Thanks go to Michael Richards and the Ag Excellence Alliance group for providing the initial momentum in establishing the group.

Thanks also to Peter Butler, DWLBC, for providing the initial investment in to the group. Without it, we wouldn't be anywhere near reaching the potential that this group has.

Special thanks and congratulations to Kingsley MacDonald, our founding chairman, for believing and committing to the group when you already had more than enough on your plate.

Ag Excellence Alliance

RURAL SOLUTIONS SA

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Government of South Australia
Department of Water, Land and Biodiversity Conservation

Eyre Peninsula NRM

Sophie Keen, Naomi Scholz, Susan Stovell

EPNRM, Wudinna

Information

Key Messages

- **EP natural resources are critical to the economic and social survival of the region.**
- **The results are in - EPNRM in partnership with the community are making a difference.**
- **Technical and financial assistance is available for landholders who want to better manage their natural resources.**

Why do we manage Natural Resources?

The European settlement of Eyre Peninsula was founded upon a strong primary industry base, a trend that continues to this day. Industry and economic activity on Eyre Peninsula is based almost entirely upon its natural resources, either directly or indirectly as a secondary or support operation. Sustainable development and utilisation of the regions natural resources is therefore critical to the economic and social survival of the region.

Throughout Eyre Peninsula it is evident that where Natural Resource Management is successful it is community driven. Considerable capacity for, and commitment to, managing natural resources has been developed within the region. Community Groups and committees have made significant achievements in managing natural resources with the assistance of dedicated project officers and with varying technical and policy support from regional organisations and government agencies.

How do we manage Natural Resources?

The Eyre Peninsula community is a major stakeholder in NRM, with the single largest investor being landholders themselves. The region also has approximately 100 local and regional community and school groups that assist natural resource management in the region through funded or volunteer activities, which include crucial monitoring programs.

The EPNRM is a regional body representative of the community that receives funding through the Australian and State Governments to implement a Regional Natural Resource Management Plan. Linked to the NRM Plan are annual Investment Strategies that identify projects within Eyre Peninsula that address natural resource management issues such as salinity, erosion, soil condition, biodiversity and impacts on our coast and marine environments.

The Investment Strategy each year is divided into the following theme areas:

- ***Community support and capacity*** - This section funds "enabling" projects, Capacity Building activities and a component of Monitoring and Evaluation.
- ***Water*** - This section funds activities that promote sustainable use and management of precious water resources, such as wetlands management and catchment based activities to protect creeklines to ensure that water quality is maintained or improved.
- ***Flora and fauna*** - Generally the larger component of the Investment Strategy, this section incorporates projects that assist landholders and communities in protecting, restoring or enhancing their native vegetation and in implementing important management practices such as pest and weed management, threatened species management and key native vegetation monitoring.
- ***Coast and marine*** - Activities in this area are undertaken in close collaboration with Local Government and include on-ground activities to reduce the impacts on our precious coastline through formalizing access tracks and parking areas for beaches, putting in boardwalks and protecting coastal vegetation.
- ***Soils and minerals*** - Activities in this area focus on sustainable agriculture, and in assisting landholders to address issues such as wind erosion and salinity. With the diversity of inland conditions throughout Eyre Peninsula many of these activities are catchment based, whilst others are delivered on a regional scale throughout the whole Eyre Peninsula.

Projects and their Delivery -

With three years investment being received by the EPNRM there are currently over 100 specific projects or activities being delivered throughout the region. The following are examples of activities that are delivering results and assisting landholders:

Integrated Pest Management - This is a community based program which coordinates pest control activities on a landscape scale. Through the program, landholders are provided with free fox baits and associated materials as well as access to rabbit control equipment. The program benefits biodiversity as well as improving agricultural productivity through reduced predation on stock and increased soil stability and pasture production. Animal Plant Control and Department for Environment & Heritage officers are the key deliverers of this project.

Regional Strategic Vegetation Protection and Revegetation - Eyre Peninsula boasts approximately 2,187,560 ha (43% of the region) of its original vegetation. Although this level is relatively high compared with many other regions in the state, the loss of native vegetation cover has still contributed to the loss of native species, and to soil and land management issues including erosion and salinity. This project provides funding incentives and technical support for landholders to protect existing vegetation (fencing) and revegetation of areas susceptible to erosion & salinity.

Sustainable Agriculture - The development of improved management systems for the agricultural districts of Eyre Peninsula is a high priority throughout the region, specifically in the areas relating to management of dryland salinity (recharge), soil health decline, and soil erosion management. Whilst there are a range of 'best practice' management systems available, they aren't necessarily achievable for all landholders. This program utilises agricultural knowledge and expertise from around the region and compliments it by providing funding incentives to assist landholders with sustainable on-farm change.

Sheoak Grassy Woodland Project - Once the second most dominant vegetation type on EP, Sheoak Grassy Woodlands have now been reduced to less than 1% of their original distribution.

This project works closely with landholders to assist them in researching the vital role that Sheoaks and native grasses play in providing ground cover, drought persistence, soil protection and erosion control. Trials are currently being undertaken to gauge the value of these areas for landholders as alternative grazing land for livestock during drought periods. Results of these trials from the past four years will be something to look out for in the next EP Farming Systems book.

Project Collaboration

Partnerships, networking and collaborative initiatives have been one of the Eyre Peninsula's strengths. The Investment Strategies include a range of activities that are evidence of this, with partners including PIRSA, DEH, EPCWMB and other regional bodies, as well as educational institutions. This approach is also evident at the ground level with staff from all organisations in the region working closely together to ensure natural resource management issues are addressed efficiently and effectively.

What has been done?

With so many activities being delivered on-ground throughout the region, the impact on our natural resources is substantial and some of the key deliveries for the past year include:

- The protection of 1,518 ha of remnant vegetation.
- The revegetation of 288 ha of native vegetation, most of which was achieved using direct seeding techniques.
- Over 4,850 native seedlings planted.
- 821.5 ha of clay spreading to reduce erosion and improve water use efficiency.
- 62 ha of saltbush established for grazing in areas of low production.
- 215 ha of gypsum spread to address sodicity.
- 130 ha of lime application to improve acidic soils.
- 70 ha of puccinellia established for grazing in saline areas.
- The West Coast Integrated Pest Management program has some pretty impressive statistics, with 430 registered participants in the program undertaking fox and rabbit control well over an area of one million hectares. Around 30,000 fox baits were distributed in 2005, and trends of fox sightings have generally been decreasing.

Future directions

The EPNRM Board is currently in the process of completing the next version of the Investment Strategy for the 2006-2008 periods.

While this package represents investment through National Heritage Trust funds and is in effect a significant foundation for continuing on ground activities, a challenge for the Board in upcoming years will be in accessing investment from other sources to continue to add value to past, current and future project activities.

Landholders and indeed anyone in Eyre Peninsula are encouraged to contact the EPNRM today to find out how they can get involved in restoring and protecting our natural resources. Assistance can be provided to landholders in accessing technical support and incentives to undertake on-ground activities on their properties. Community members are always welcome to join in with some of the volunteer initiatives undertaken in the region, whether it's monitoring Mallee fowl breeding sites, rejuvenating some of precious coastal areas or simply planting trees - all support is appreciated and vital to the management of our region's natural resources.

For further information visit the EPNRM website at http://www.epnrm.com or ring us direct on 08 8680 2653.

EYRE PENINSULA
NATURAL RESOURCE MANAGEMENT

Explaining the variable benefit of stubble retention in storage of soil water during fallow

Research

Searching for answers

Juan P. Monzon[A], Víctor O. Sadras[B], Fernando H. Andrade[A]

University of Mar del Plata[A], South Australian Research and Development Institute[B], University of Adelaide, Waite Precinct[A]

Key Messages

- **The effect of stubble mulch on soil water storage during fallow is highly variable.**
- **In environments with low rainfall and coarse-textured soil (e.g. Mallee), contribution of stubble to gains in water storage and yield is often smaller than in wetter environments with heavier soil (e.g. Wimmera).**
- **While this pattern is recognised, the effect of rainfall, evaporative demand and soil remains confounded.**
- **Our modelling analysis suggests that rainfall pattern is the main driver of stubble effect in the storage of soil water during fallow.**

What we did?

We used the model CropSyst with long-term climate records to calculate soil evaporation and storage of water during fallow. We targeted two contrasting locations: Walpeup in

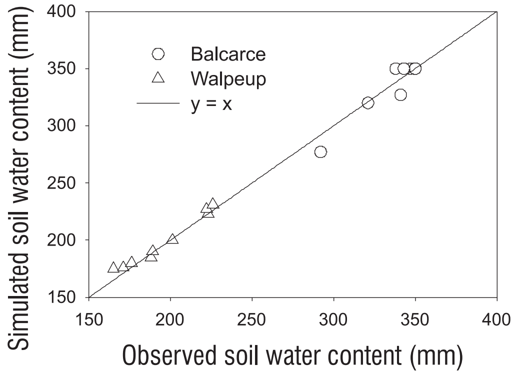


Figure 1 inset

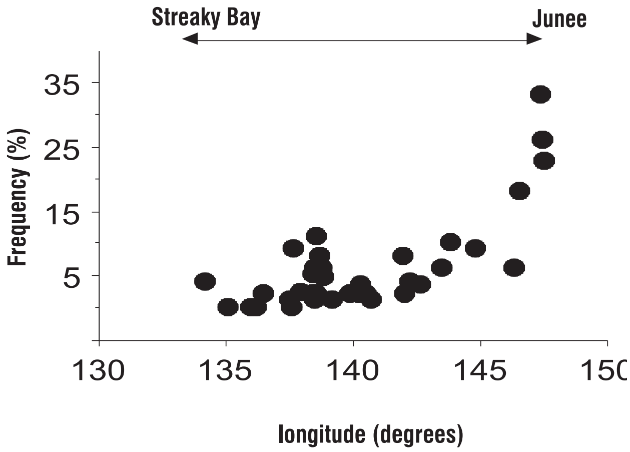


Figure 2: Modelled frequency of optimum or above optimum benefit of stubble (2 t/ha) in terms of soil water storage during fallow (1 January - 30 May) in a transect in south-eastern Australia. The transect includes 39 locations in a 3° latitude band. Calculations based on rainfall records between 1957 and 2000. These estimates assume sandy-loam to loam soils with plant available water between 132 and 171mm, and climate conditions summarised in Table 1.

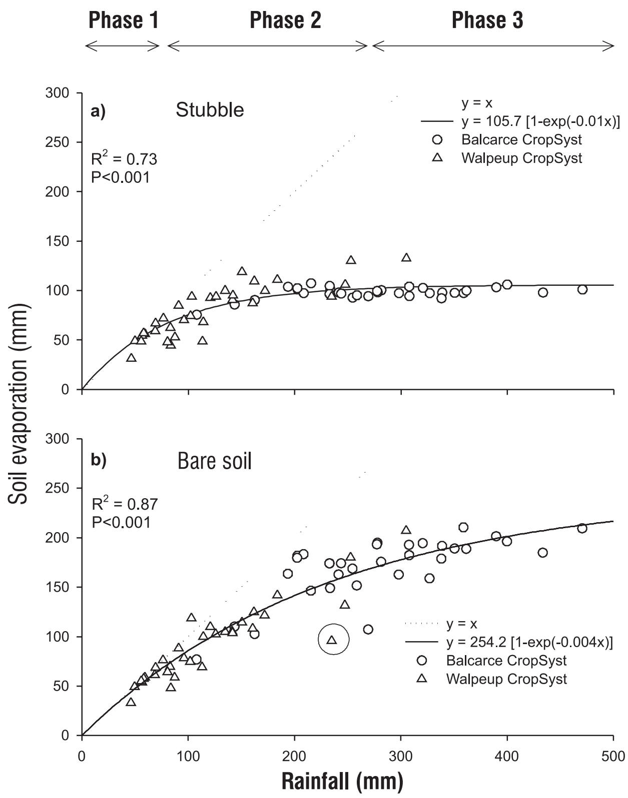


Figure 1: Simulated soil evaporation as a function of rainfall for summer fallow at Walpeup, and winter fallow at Balcarce. (a) Shows soil with stubble and (b) bare soil. Simulations with Cropsyst using climatic data from 1971 to 2003. The dotted y=x line is a hypothetical maximum whereby all rainfall is loss through soil evaporation. Inset compares soil water content simulated with CropSyst and measured soil water content at the end of fallow periods for soils with stubble at Balcarce and Walpeup.

the semi-arid Victorian Mallee, and Balcarce in the subhumid Pampas of Argentina; this allowed for contrasting climate and soils (*Table 1*). Comparison of modelled and measured storage of soil water indicated a good performance of the model (*Figure 1*).

What did we find?

Soil evaporation in bare soil and in soil with stubble comprised three phases (*Figure 1*). In the first phase, all the rainfall was evaporated irrespective of soil cover. Graphically, phase 1 corresponds to the section of the curves in *Figure 1* which are close to the dotted y = x line. Therefore, during this phase there was no benefit of stubble towards storage of soil water. In the second phase, stubble reduced soil evaporation with respect to bare soil, with a subsequent gain in soil water. In the third phase, rainfall started to be sufficient to meet evaporative and storage demands irrespective of soil cover.

While *Figure 1* highlights the strong association between soil evaporation and total amount of rainfall, there are other important factors to be considered, including the size of rainfall events. For instance, the curve in *Figure 1b* shows the average trend in soil evaporation for a given amount of rainfall. In a season with fallow rainfall around 230 mm, average soil evaporation is around 150 mm. A substantial deviation from this trend is illustrated with the encircled triangle in *Figure 2b*. This corresponds to Walpeup in 2000, when 83% of fallow rainfall (234 mm) was accounted by large events (average 39 mm) concentrated in 5 days, leading to estimated soil evaporation of less than 100 mm.

Intuitively, we can expect that stubble retention will result in no benefit in terms of storage of soil water in extremely dry

Table 1: Soil and climate (1971-2003) features at Walpeup (35° S, 142° E) and Balcarce (38° S, 58° W)

Feature	Walpeup	Balcarce
Soil	sandy loam	loam
Maximum plant available water in soil profile (mm)	132	171
Simulated fallow period	1 January to 30 May (summer-early autumn)	15 May to 15 October (winter-early spring)
Rainfall range during fallow (mm)	46 to 305	108 to 471
Reference evapotranspiration* range during fallow (mm)	595 to 686	185 to 240

**Reference evapotranspiration is a measure of atmospheric demand for water; it depends on radiation, temperature, wind, and air humidity.*

situations, when most of the fallow rainfall will be lost through soil evaporation. Likewise, if the season or site is too wet, water storage will be close to the maximum soil storage capacity, and again stubble wont make much difference. It is only in some intermediate rainfall range that stubble will improve soil water storage. For the conditions in our simulation study, we found no benefit of stubble (fixed at 2 t/ha) if rainfall during fallow was below 65 mm or above 440 mm. The maximum benefit was achieved when fallow rainfall was around 250 mm. These thresholds are of course not fixed. For instance, optimum and maximum rainfalls will be higher in soils with greater storage capacity, and lower in soils with less capacity to store water.

Figure 2 shows the estimated probability of achieving maximum or above maximum benefit from stubble in a transect from Streaky Bay to Junee. The probability increases eastwards, in parallel to the increase in summer rainfall.

What does it mean?

It is just logical to expect that stubble will improve soil water storage within a certain range of rainfall - if it is to dry or too wet, stubble will make little difference. Here we used a model to estimate the minimum, optimum and maximum rainfall for stubble benefit, and to calculate the probability of achieving optimum or above optimum benefit in a range of locations in south-eastern Australia.

There are two important issues to be considered when assessing the reliability of modelled data. The first relates to the ability of the model to reproduce the real world, and the second relates to the assumptions underlying the calculations. The model used in this study accounts for the well-established physical principles of soil evaporation, and provided sound estimates of water storage. All estimates assumed soil and climate conditions within certain ranges, and care should be used in extrapolating results beyond these conditions. Within these limits, the expectation is that stubble benefit in storage of water requires rainfall between 65 and 440 mm, with an optimum around 250 mm. The role of stubble in soil conservation is particularly important in extremely dry and extremely wet conditions, where as its impact on soil water storage is less likely.

Further reading

A detailed account of this research can be found in *Fallow soil evaporation and water storage as affected by stubble in sub-humid (Argentina) and semi-arid (Australia) environments. Field Crops Research 2006, in press.*

Fungicides for control of wheat stripe rust in Central-West NSW

Try this yourself now

Research

Ken Motley[1], Karen Roberts[1], Nathan Border[1], Tim McNee[1], Jan Edwards[1], Rob Griffith[2], Andrew Rice[3].

NSW Dept of Primary Industries[1], BayerCropScience[2], Ivey ATP (Agricultural Consultants and Charter Accountants)[3]

Key Messages

- **Stripe Rust (SR) caused yield losses in all but the highly resistant variety Sunstate at most sites.**
- **Fungicides helped to protect yield potentials in susceptible varieties, except when SR pressure was either very low or very high.**
- **Timely early and late protection appeared more important than fungicide choice @ Z39 (flag leaf just visible on Zadoks score)**
- **The genetic resistance in Sunstate was clearly the most outstanding form of SR control when disease pressure was very high, exceeding any fungicide strategy used on susceptible varieties.**
- **Until growers have available a range of highly SR resistant wheat varieties with desired agronomic traits, fungicide protection of SR on susceptible varieties is a practical and profitable option.**

Trial details

The aims of these trials were to:

- Assess the potential for yield and quality responses from controlling Stripe Rust (SR) in several wheat varieties with differing levels of SR resistance in central-west (CW) NSW.
- Assess the level of stripe rust control achieved by using different fungicide products including seed dressings, fertiliser dressings and foliars.

Trials were sown at six sites in central west NSW including, Cowra, Alectown, Wirrinya, Gunning Gap, Condobolin and Nyngan. Four wheat varieties were sown including H45, Chara, Janz and Sunstate. Fungicide treatments listed in Table 1 were applied to H45 at various stages including @ sowing, @ Z32 (second node detected) and @ Z39 (flag leaf just visible). Best bet fungicide treatments were applied on Chara, Janz and Sunstate to observe the benefit of SR control on varieties with increasing level of SR resistance.

What happened

A comprehensive set of results has been produced from these trials including SR control measurements, grain yield and quality effects and economic analysis. Complete statistical analysis of the results was not available at the time of writing this article and thus no data has been included. However, a summary of the results is provided below. Please contact the author for completed results.

What does it mean?

H45 proved very susceptible to SR at all sites in this trial series. Large grain yield and screenings responses to SR control in H45 were recorded at all sites except at Nyngan where SR pressure was low. Grain yield responses to SR control were recorded in Chara and Janz at all sites except Nyngan and Alectown, but to lesser degrees than in H45. No screenings responses to SR control in Chara or Janz were found at any site. The highly SR resistant variety Sunstate showed little sign of SR damage at any site. Under low SR pressure such as a Condobolin and Nyngan, Chara, Janz and Sunstate were not significantly different in terms of the amount of SR infection they harboured. However, under higher SR pressure the different varieties genetic resistance rankings to SR became apparent.

These trials demonstrated that a combination of pre Z39 and Z39 SR protection is needed on susceptible varieties to protect yield potentials when SR pressure is moderate to high. The choice of pre Z39 fungicide use will depend on the situation. Seed and fertiliser fungicide dressings appear to have a role in situations where management restrictions prevent timely pre Z39 foliar fungicide applications as and when required. Pre Z39 foliar fungicides require a higher degree of management than seed dressings to ensure that the application timing occurs at the critical stage of the SR's development. Z32 will not always be an appropriate time for pre Z39 foliar fungicide timing. It is suggested that pre Z39 foliar fungicides need to be applied in regard to SR development rather than crop growth stage.

In terms of evaluating seed dressing and fertilising dressing products, Jockey® appeared to have the edge over Baytan® for SR protection. However, Baytan® provided a useful level of early SR protection at some sites when followed up with a late (Z39) foliar fungicide. The low rate (300 ml/100 kg) of Jockey® was not much different from the standard rate for SR protection (450 ml/100 kg) and will help to make Jockey® a more economically viable option for many farmers. It must be remembered that the low rate of Jockey® is unlikely to control Take All. Within the fertiliser dressings, Impact® (IF) appeared to have the edge over Bayleton® (IF). Fertiliser striping limited comparisons between the IF fertiliser treatments and seed treatments to the Condobolin and Nyngan sites, where no fertiliser flow problems were encountered. The IF treatments gave better control of SR than the seed treatments at Condobolin, but no such differences were found at Nyngan.

There was generally little difference between the fungicide products used at Z39. They all appeared to work satisfactorily. Bayleton® appeared weaker than Folicur® at Z32 and weaker than most other products at Z39, but still gave a useful level of control even at the low rate (500 ml/ha). The reported benefit of Opus® providing a longer period of retained green leaf over other products was not seen in these trials. Timely early and late protection appeared more important than fungicide choice at Z39.

Despite extensive testing of fungicide products and strategies in these trials, genetic resistance was clearly the most outstanding form of SR control. The genetic resistance in Sunstate stood up to very high SR pressure at Cowra, where the fungicide strategies used in this trial series failed to protect yield potentials in susceptible varieties. While grain yield was largely a function of SR resistance at Cowra, other agronomic traits such drought hardiness and high water limited yield potential were just as important or more important at the other sites. These trials show that until growers have available a range of highly SR resistant wheat varieties with desired agronomic traits, fungicide protection of SR on susceptible varieties is a practical and profitable option.

Acknowledgements

These trials were conducted as part of the CWFS Regional Site program. Greg Gibson (NSW DPI), Sharon Taylor and Daryl Reardon (CWFS) provided invaluable technical assistance. The data was analysed by Helen Nicol (NSW DPI). Special thanks to the cooperating farmers who hosted the trials.

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GRDC Grains Research & Development Corporation | CWFS Central West Farming Systems | NSW DEPARTMENT OF PRIMARY INDUSTRIES

Table 1: Fungicide products, rates and indicative costs.

Application method	Product used	Active ingredient	Available as other products	Rate			Adjuvant	Product cost	
	Abbreviation	Chemical		Abbreviation	Quantity			$/L	$/haD
Seed Dressing	Raxil T®A	Tebuconazole 25g/L+ Cypermethirn 4g/L		Standard	100	ml/100 kgB	n/a	$33	$1.63
	Baytan T®	Triadimenol 150g/L + Triflumuron 4g/L		Standard	150	ml/100 kgB	n/a	$51	$3.83
	Jockey®	Fluquinconazole 167g/L	Jockey® Only	Low	300	ml/100 kgB	n/a	$75	$11.25
	Jockey®	Fluquinconazole 167g/L	Jockey® Only	Standard	450	ml/100 kgB	n/a	$75	$16.88
Fertiliser dressing	Impact® (IF)	Flutriafol 250g/L	Jubilee®	Standard	400	ml/ha	n/a	$44	$17.42
	Bayleton® (IF)	Triadimefon 125g/L	See note belowC	Standard	800	ml/ha	n/a	$6	$4.74
Foliar Fungicide	Bayleton®	Triadimefon 125g/L	Turret®, Triad®	Low	500	ml/ha	Nil	$6	$2.96
	Bayleton®	Triadimefon 125g/L	Turret®, Triad®	Standard	1000	ml/ha	Nil	$6	$5.92
	Folicur®	Tebuconazole 430g/L	Stingray®, Orius®	Standard	145	ml/ha	+ 1% oil	$66	$11.11
	Tilt®	Propiconazole 250g/L	Bumper®, Aurora®	Standard	250	ml/ha	Nil	$31	$7.78
	Tilt Xtra®	Propiconazole 250g/L + Cyproconoazole 80g/L	Tilt Xtra® Only	Standard	250	ml/ha	Nil	$67	$16.79
	Opus® E	Epoxiconazole 125g/L	Opus® only	Standard	250	ml/haE	Nil	$60	$15.01

[A]Raxil T® provides no control of stripe rust and is effectively a Nil treatment. All seed other than that treated with Baytan® or Jockey® was also treated with Raxil T®. [B]Rate per 100 kg seed. [C]Bayleton 125 EC® is not registered for use as a fertiliser dressing fungicide in NSW. Baytan 125 EC® was used at a rate to provide 100g ai/ha, in line with the registration for triadimefon powder in WA. Powdered product was not used in this trial because of OHS issues. [D]Cost includes adjuvant for Folicur®. Costs are indicative values only for the products and do not include application costs. [E]Opus® is registered for control of stripe rust at 500ml/ha. A half rate of 250ml/ha was used for trial purposes.

Angel proves to be a godsend

Research

Ali Cooper
Rural Solutions SA, Jamestown

Try this yourself now

Location
Closest town: Morchard
Co-operator: Morchard farming community
Group: Upper North Farming Systems

Rainfall
Av. Annual total: 330 mm
Av. GSR: 233 mm
2005 Total: 233 mm
2005GSR: 251mm

Yield
Potential yield of pasture: 8019 kg/ha

Paddock History
2004: Wheat (1.5 t/ha)
2003: Grass Pasture
2002: Grass Pasture

Soil
Alkaline, red clay loam.

Land value
$650/ha

Plot size
2m x 4m

Other factors
None

Key Messages

- **Angel will tolerate residual levels of SU herbicides**
- **Angel can be controlled to the same degree as Herald using an MCPA and Lontrel® mix.**

Why do the trial?

Annual pastures are a major feed source for most livestock in the cereal-livestock zone. One major issue that faces many annual legume pastures in this zone is the widespread use of sulfonylurea (SU) herbicides, particularly on alkaline soils where high soil residue levels persist for one or more years after application. Where a residual effect has occurred, severe stunting, reduced dry matter production, reduced seed yields, poor regeneration and persistence, and decreased nitrogen fixation can occur.

This trial is aimed at demonstrating to Upper North growers the impact that sulfonylurea (SU) residues and other broadleaf herbicides have on two medic pastures, Herald and the new strand medic Angel.

How was it done?

The two cultivars were sown at 10 kg/ha on the 29th June 2005 in a split plot design with 75 kg/ha of DAP (18:20) pre-drilled. Pre-emergent herbicide treatments were applied on the 7th May, and the post-emergent herbicides were applied on the 7th September, see *Table 1* for treatments. Visual scores and estimates of dry matter production were made using photographic guides, including 'Pasture Pic' and 'A photographic guide to annual pastures for low-rainfall sheep production'.

What Happened?

Establishment was reasonably even for both medics. Once Herald encountered the Logran® residues, it became stunted and purple in colour, while Angel continued to grow at a reduced level compared to the control.

Application of Ally® to both medics resulted in reduced herbage production of Angel and the elimination of Herald. Whilst the application of the MCPA and Lontrel® mix, resulted in severe stunting of both medics.

What does this mean?

The results have confirmed that Angel will tolerate residual levels of SU herbicides but can be suppressed by particular post-emergent broadleaf herbicides enabling it to be controlled in crop. SARDI Pastures Group research results published in the *EPFS 2004 Summary, page 61*, have also shown that Angel can be effectively controlled to an acceptable level in-crop by a range of commonly used chemicals. Therefore, Upper North growers can be confident in sowing Angel medic pastures as a valuable feed source that is able to tolerate SU herbicide residues, and be confident about control in a later cereal crops.

Acknowledgements

I would like to thank Gilmour Catford for his dedicated cooperation in applying the treatments. Thankyou also to David Cooper for his help in seeding the trial.

The Grains Research and Development Corporation (GRDC) for funding this research by the Upper North Farming Systems project.

GRDC Grains Research & Development Corporation

RURAL SOLUTIONS SA

Table 1: Herbicide treatments and their visual scores (taken on the 9th Sept) and estimated dry matter production for the herbicide tolerance trial at Morchard trial, 2005.

Treatment	Application Rate	Application Date	Herald Visual Score (1-10)	Estimated dry matter production (t/ha)	Angel Visual Score (1-10)	Estimated dry matter production (t/ha)
Nil			10	2.0	10	2.0
Logran® 750 WG	5 g/ha	7th May	0	0	7	1.3
Logran® 750 WG	10 g/ha	7th May	0	0	7	1.3
Amicide® 625	1.4 L/ha	7th Sept	10	2.0	10	2.0
MCPA 500® + Lontrel 750 SG®	1.4 L/ha 0.25 L/ha	7th Sept	2	0.1	2	0.1
Ally®	5 g/ha	7th Sept	0	0	5	0.9

Grazing cereals
Mallee Grain & Graze trials

Research

Chris McDonough
Rural Solutions SA, Loxton

Location
Closest town: Loxton
Cooperator: Steve May

Group
Loxton Mallee Sustainable Farming Groups

Rainfall
Av. Annual total: 273 mm
Av. GSR: 180 mm
2005 Total: 334 mm
2005 GSR: 234 mm

Soil
Reasonably flat paddock, sandy clay loam soil texture in surface

Other factors
Major yield limiting factors - very little Autumn rainfall and stored soil moisture, late break to the season.

Location
Closest town: Karoonda
Cooperator: Bruce Kerr

Group
Karoonda Mallee Sustainable Farming Groups

Rainfall
Av. Annual total: 339 mm
Av. GSR: 233 mm
2005 Total: 431 mm
2005 GSR: 298 mm

Soil
Generally light sandy loam paddock with sandy rises.

Other factors
Major yield limiting factors - very little Autumn rainfall and stored soil moisture, late break to the season.

Key Messages

- **Mallee trials show benefits of high density, well fertilised cereals for pasture.**
- **Significant increases in early dry matter production were obtained.**
- **Well managed cereal pastures can help reduce the feed gap while achieving grass control for future cropping.**

Why do the trial?

The Mallee Grain & Graze program is aiming to demonstrate ways of increasing stock carrying capacity, while complimenting cropping. One of the key issues is overcoming the feed gap from late Autumn until pastures are ready to graze, particularly in a late breaking season.

Many Mallee pastures have become fairly poor, particularly as cropping intensity has increased. This has often been due to the removal of grasses, the use of sulfonylurea (SU) herbicides or extended cropping phases reducing medics, and the dominance of less preferable pasture weeds such as capeweed.

These trials aimed to test the productive potential of sown cereal pasture and high input sown cereal pasture against volunteer pasture growth, particularly for early feed. This should help provide more feed and reduce the feed gap, and also allow for deferred grazing on good medic pastures.

It is also felt that by sowing and fertilising cereals for grazing, that the increased dry matter production may help to achieve many of the soil and microbial benefits that have been evident in the continuous cropping plots at the Waikerie MSF coresite. Flexible management could be used to decide whether these paddocks are shut up after grazing to reap, or sprayed out to prevent grass seed set in September, depending on the paddock, season and rotation.

How was it done?

One monitor farm was at Loxton (Mays) using cattle, while the second was a sheep farm at Karoonda (Kerrs).

At Loxton a paddock that had three years of cropping including sulphonylureas was divided into three areas: normal sown cereal pasture, double sown cereal pasture and volunteer pasture. The cereal areas were sown on 14th June with Chebec barley at a seeding rate of 60 kg/ha and a fertiliser rate of 45 kg/ha of 24:16. The double sown area was cross sown with the same machine at the same rate, resulting in a seeding rate of 120 kg/ha and 90 kg/ha of 24:16. The farmer used a twelve inch row spacing no-till bar that provided excellent water harvesting, but even after cross sowing left large squares with no plants, which was not ideal. The volunteer pasture showed very poor emergence and early plant growth, due to the previous years of chemical control. Dry matter production was estimated using quadrat cuts and dry stock equivalent (DSE) grazing days. Plant and weed densities were also measured.

At Karoonda, two adjoining paddocks were chosen to be monitored, both with similar paddock history. One paddock contained the volunteer pasture. The other was sown with both normal and double seeding and fertiliser rates. Because the two areas were not fenced, dry matter cuts from pasture cages were used to define growth rates on the various areas. Grazing days were also recorded, and there has been some measurement of soil biological activity, which is yet to be reported on.

What happened?

The double sown area of barley for pasture at Mays property, Loxton SA, has produced approximately 40% more dry matter volume up until the 20th Sept, compared to the district practice rate single sown cereal. The production from the volunteer pasture, which has shown very poor regeneration after three years of cropping, produced less

Table 1: Loxton Grazing Trial, plant densities and dry matter production

Treatment	1st Aug 2005			20th Sept 2005		
	Crop Density (Pl/m^2)	Ryegrass density (Pl/m^2)	Medic Density (Pl/m^2)	DM (kg/ha)	Estimated DM Eaten (kg/ha)	Tot DM (kg/ha)
Volunteer	9	13	56	322	50	372
Single sown	125	52	13	264	500	764
Double sown	243	15	1	348	720	1068

Sharing Info

Table 2: Karoonda Grazing Trial, early dry matter production, plus September growth rates.

Treatment	Dry Matter (DM) kg/ha				
	Up to Sept 6th			Sept Growth Rates	
	DM measured	DM grazed estimated	Total DM	Measured 21-Sep	DM Gain
Volunteer pasture	1034	263	1297	1963	929
Single sown cereal	1404	554	1958	2356	952
Double sown cereal	2223	900	3123	3546	1323

than half the dry matter of the district practice sown cereal and only approximately 35% of the production from the double sown cereal. Another benefit of the double sown area was the significantly lower ryegrass populations measured, compared to single sown.

Table 2 clearly shows the benefit of early feed production of sown cereal pastures over volunteer pastures. The Kerrs placed 600 wether lambs for thirty days on this 30 ha paddock, preparing them for sale. Clearly, if a higher proportion of the paddock had been double sown, then more sheep could have been placed for a longer time. The volunteer pasture (40 ha) had 300 ewes and lambs for fourteen days. On September 6th it was estimated that the single sown cereal area had 1.5 times the dry matter production of the volunteer pasture, while the double sown had 2.4 times the dry matter production.

The continuing growth rate from September 6th to September 21st from the three areas showed the benefit of the higher plant density and increased fertiliser. The single sown area took about another fifteen days to reach the dry matter production level of the double sown area. The volunteer area (after much lower grazing pressure) started to produce close to the same rate as the single sown area. The total dry matter for the double sown was still 1.8 times higher than the volunteer pasture, and 1.5 times higher than the single sown, despite the higher grazing pressure.

What does this mean?

Even though both of these trials could have been managed better for even higher production, (with higher nutrition and earlier grazing) the benefits of well fertilised higher density sown cereals for grazing are clearly evident, showing significantly higher dry matter production than both volunteer and district practice sown cereals.

The trials have demonstrated the value of higher production pastures providing more quality feed earlier. It may mean that fewer paddocks may be required to produce more feed, with a decreased risk of wind erosion, while still maintaining grass control for an extended cropping phase.

These techniques may be used in conjunction with strategic feedlotting, and good grass controlled medic paddocks (that become more productive later toward Spring), to better match feed availability to livestock needs, while minimising compromises to following crops.

Tim Prance, Pasture Advisor with Rural Solutions SA suggests that cereal pastures should be sown as early as possible (April/May), or dry, use of high seeding rates - double normal grain rates. Use adequate P at seeding, along with high rates of N - at least as much as you would if sowing wheat in a continuous cropping regime. Start grazing early - as soon as plants are anchored, and secondary roots have developed. Aim to start grazing at about 800-1000 kg/ha dry matter, but don't crash graze. If applying extra N at three leaf stage, make sure you allow twenty days before grazing, to avoid stock poisoning.

Early continuous grazing will help to delay stem elongation. Crops can be grazed quite low - to the “white” line - as long as the growing points are not removed. A dense, well fertilised crop should maintain enough leaf area to carry 20-30 DSE/ha - but you will need to reduce stocking density if livestock are grazing the crop to below 800 kg/ha dry matter.

Acknowledgements

Mallee Grain and Graze.

RURAL SOLUTIONS SA

Grain&Graze
Profit through knowledge

Yield responses of dual purpose wheat to grazing management in southern NSW in 2005

Research

Guy McMullen[1,4], Jim Virgona[1,3], John Angus[2] and Craig Muir[1,3]

E.H. Graham Centre for Agricultural Innovation, Wagga Wagga[1], CSIRO Plant Industry (Canberra)[2], School of Agricultural And Veterinary Sciences, CSU[3], NSW DPI, Wagga Wagga[4]

Key Messages

- **Grazing delays flowering in winter wheat - this has implications for time of sowing and the risks of frost and moisture stress.**
- **In extreme grazing situations, yield has been depressed by 1-2 t/ha. Simple economic analyses show that losses associated with this decrease in grain yield can be outweighed by the income generated from grazing.**
- **In drier environments/ seasons it is possible that grazing could defer water use to later in the season compared to ungrazed crops.**

Why do the trial?

Traditional advice regarding the grazing management of winter wheat in NSW has been conservative, advocating late commencement of grazing with brief periods of grazing leaving comparatively high residual biomass to protect the developing ear. Up until recently there has been little data available on the yield response of winter wheat to grazing. However, experimental results from the past two seasons have shown that winter wheat (cultivar EGA Wedgetail, in particular) can be grazed aggressively, providing valuable feed during July and August, and still return acceptable grain yield.

The relationship between yield and the length and intensity of grazing was investigated in a series of experiments at sites in southern NSW carried out over 2004 and 2005. The key question being addressed was: 'what, if any, is the trade-off between grain production and grazing intensity in dual purpose wheat?' To impose different grazing management systems both the length of grazing and the stocking rates were varied. This paper reports the results from the 2005 experiments.

How was it done?

Two experiments carried out in 2005 on the Wedgetail cultivar were identical in design and but located at different sites (Cookardinia - Holbrook and Wallendbeen). The site details including time of sowing, fertiliser use, etc. can be found in *Table 1*.

The experiment consisted of five grazing treatments each replicated four times. The grazing treatments were a combination of either high (~17 dse/ha) or low (~30 dse/ha) grazing intensity and early (3-4 weeks) or late (~ 6 weeks) grazing duration with an ungrazed control. The grazing treatments and relevant data are presented in *Table 2*.

What happened?

Grazing delayed flowering considerably in both experiments (*Table 2*). Flowering was delayed by 13 and 16 days at Cookardinia and Wallendbeen, respectively in the high/late grazing treatment. Further analysis showed a negative (linear) relationship between delay in flowering and grazing intensity. At the Cookardinia site, yield declined with longer grazing (more so at high intensity) but was unaffected by the shorter grazing period. At Wallendbeen yields were disappointingly low due to the prevalence of diseases such as take-all and wheat streak mosaic virus. Nonetheless, yields were highest when the crop was grazed for a brief period and declined markedly when grazed late at either high or low intensity (*Table 2*).

Further analysis from the Cookardinia site has also shown that there was no significant effect of grazing treatment on grain size, as in 2004. Hence, the component most closely related to yield was grain number (per m^2). This indicated that the decrease in leaf area was translated into lower yield via either fewer grains per ear and/or fewer ears per m^2. At the time of writing this data was unavailable for the Wallendbeen site.

Table 1: Site and sowing details for Cookardinia and Wallendbeen. The experiments were carried out in paddocks that had been sown by farmers under normal commercial conditions.

	Cookardinia	Wallendbeen
Sowing date	April 25	March 17
Sowing Rate (kg/ha)	80	80
Fertiliser (kg/ha)	125 (MAP)	100 (MAP + Impact)
Other sowing info.	30 cm row spacing, direct drill	22 cm row spacing, direct drill
Stock used	Wethers (~ 45 kg)	Weaners (~40 kg)
Rainfall Jan. to sowing (mm)	163	138
In-crop rainfall (mm)	452	529
Soil Type	Red Sodosol	Red Kandosol

Table 2: Details of the grazing experiments and Cookardinia (CK) and Wallendbeen (WB) and key results. Note that grazing commenced on 12 July at Cookardinia and 11 July at Wallendbeen.

Site	Treatment	Grazing Duration (days)	Stocking Rate (DSE/ha)	DSE.days	DM at end of grazing (kg/ha)	Delay in Flowering (days)	Yield (t/ha)
CK	ungrazed	0	0	0	-	-	5.8a
	low/early	21	17	365	1600	2	5.8a
	high/early	21	29	599	697	4	5.8a
	low/late	41	17	713	1226	6	5.4b
	high/late	41	29	1169	202	13	5.0c
WB	ungrazed	0	0	0	-	-	3.2b
	low/early	28	17	465	2520	7	3.8a
	high/early	28	31	855	945	9	3.9a
	low/late	43	18	757	2034	9	3.1b
	high/late	43	33	1412	725	16	2.3c

What does this mean?

- Grazing delays flowering in winter wheat. This has significant implications for the recommended time of sowing of dual purpose wheat varieties and the associated risks of frost and moisture stress. This also has important implications for breeders and the conditions under which new cultivars are developed.
- Grazing crops earlier, at higher than recommended stocking rates can increase fodder utilisation and reduce residual biomass. In extreme grazing situations, yield has been depressed by 1-2 t/ha. Simple economic analyses show that losses associated with this decrease in grain yield can be outweighed by the income generated from grazing.
- In drier environments/seasons it is possible that grazing could defer water use to later in the season compared to ungrazed crops and this could give rise to variation in grain size.

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Grains Research & Development Corporatio

Rotational grazing lifts native pasture productivity

Research

Kylie Nicholls

Clare, Mid North Grasslands Working Group

Key Messages

- **Native perennial pastures are vital for the long term sustainability of grazing enterprises in SA.**
- **Farmers could significantly increase native perennial pasture productivity and profitability by using rotational grazing.**
- **Results from a Mid North grazing trial show a 79% increase in stocking rate through rotational grazing according to plant growth rates.**
- **The project also demonstrates that rotational grazing of native grasses can increase perennial plant health, reduce bare ground and improve water infiltration rates.**

Why do the trial?

Run by the Mid North Grasslands Working Group, the project is evaluating the effects of rotational grazing on native pasture biodiversity and health, sheep and wool productivity and farm financial returns.

More than 400,000 hectares of native grasslands in the Mid North is grazed. The rainfall in this region varies from 250 mm up to 600mm. Traditionally, native pastures in the hill areas of the Mid North have been continuously grazed from the autumn break in May until harvest in December to fit in with the cropping program.

Over time, this common grazing practice has reduced the population of native perennial grasses and produced pastures dominated by annual grasses such as wild oats and barley grass. From a pasture management point of view, a strong dominance of these annual plants is not desirable. They compete strongly for nutrients and moisture but produce palatable leaf material for only a few months of the year.

Native grasses are perennial, and will persist for many years if grazed correctly. They are resistant to drought, frost tolerant and many are highly palatable and vigorous growers. Perennial plants can use water that falls at any time of the year, not just through winter. A pasture with a mix of perennial and annual grasses in conjunction with herbs and clovers is considered most desirable.

How was it done?

A 32 ha experimental site was established at Ryves and Tom Hawker's property, Anama, near Clare, to determine the effects of six different grazing management strategies on animal and native grass productivity. The treatments included summer rest from grazing with continuous grazing at all other times (district practice) and rotational grazing according to plant growth rates which can be applied throughout the year. Seasonal grazing treatments are also being trialled which include autumn and summer rest from grazing and spring and summer rest from grazing. These treatments are designed to see if the recruitment of young perennial plants can be influenced by grazing and resting at different times of the year.

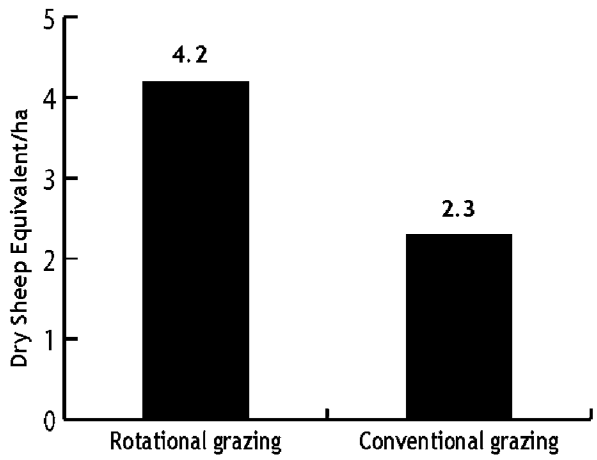

Figure 1: Stocking rates for rotational and conventional grazing systems.

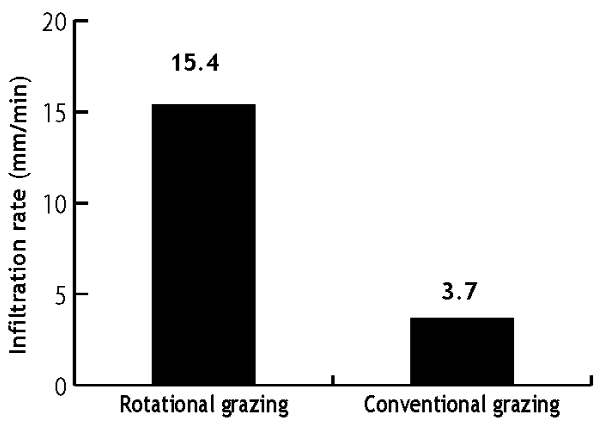

Figure 2: Infiltration rates for rotational and conventional grazing systems.

Stocking rates for the seasonal grazing treatments have been set to 2.5 DSE/ha (1 DSE/acre), which is considered to reflect the long-term carrying capacity of the Mid North. Sheep numbers in each treatment are adjusted for a varying number of graze days so that the planned annual stocking rate for each grazing treatment is the same.

The grazing times and stocking rates in the rotational grazing treatment are determined by plant growth and are generally different from the 2.5 DSE/ha used in the other treatments. Typical graze periods are between 2-4 days while the recovery periods vary from between 60-180 days.

Seven farms located from Robertstown in the Lower North up to Carrieton in the Upper North are also taking part in the grazing project. The farmers received assistance through the Natural Heritage Trust to subdivide large paddocks producing a minimum of five and a maximum of thirty paddocks among the properties. The resulting paddock sizes varied from 4-80 ha.

On these areas, small mobs of sheep were combined into one mob and farmers rotationally grazed the sheep through each paddock, according to pasture growth, with emphasis on providing sufficient recovery periods to allow the perennial plants to regrow leaf area following each grazing event.

Across the different farms the grazing periods (excluding lambing) vary from 2-30 days and rest periods from 30-150 days.

Periods of rest from grazing are shortest during the peak pasture growth season and longest over summer when pasture growth is slow.

Four of the seven properties have maintained a control paddock where traditional grazing practices have been continued to compare the effects of the changed management.

A range of plant and soil measurements are being taken throughout the project by Agricultural Information and Monitoring Services, Armidale, New South Wales. The measurements include stocking rate, pasture growth rate, change in native and annual pasture species, species diversity, ground cover, herbage mass, mob size and animal class, grazing period, sheep live weight and water-use efficiency.

What happened?

Recent results from the trial indicate that rotational grazing according to plant growth rates can have a range of benefits. This includes increased stocking rates, healthier perennial plants, reduced bare ground and improved water infiltration.

One of the most significant results at Anama is the 79% increase in stocking rate achieved in the rotational grazing treatment (*see Figure 1*). This grazing practice has resulted in an average stocking rate of 4.2 DSE/ha compared with an average stocking rate of 2.3 DSE/ha in the regional grazing practice and additional rest treatments.

Bare ground has increased from 2.3% up to 26% under the regional set stocked grazing practice while bare ground in the rotational grazing treatment has remained at about 5%. The contribution of perennial grasses to total pasture dry weight has also increased over time, with the largest increase of 96% occurring in the rotationally grazed paddock, compared with an increase of 19% under the regional set stocked grazing practice.

Other results also indicate that rotational grazing results in higher water infiltration rates and soil porosity when compared with the set stocked treatment. Adelaide-based business Soil Water Solutions carried out initial measurements in 2001 when both the district practice and rotational grazing treatments recorded an infiltration rate of 0.6 mm per minute. By 2005, the district practice treatment was measuring an average water infiltration rate of 3.7 mm/min while the rotational grazing treatment had increased to a high of 15.4mm/min (*Figure 2*).

The results also show that the seasonal grazing treatments have not produced any consistent positive advantages in grassland composition, basal cover, bare ground and stocking rates.

The most significant changes recorded on the demonstration farm sites were increase in average pasture growth rates and water use efficiency which has resulted in an increase in stocking rates.

The subdivided paddocks which are being rotationally grazed have achieved an average 14% increase in pasture growth rates and an average 6% improvement in water use efficiency compared with the set stocked control paddocks.

Recent results show the average pasture growth rate of the rotationally grazed paddocks is 13.5 kg of dry matter per hectare per day compared with 10.8 kg DM/ha/day in the control paddocks.

Water use efficiency is measured in terms of the amount of pasture produced in kilograms of dry matter per hectare per millimetre of rainfall recorded. Across all sites water use efficiency in the rotationally grazed paddocks is averaging 9 kg DM/ha/mm while the control paddocks are recording an average of 8.5kg DM/ha/mm.

These combined effects of rotational grazing have also resulted in an increase in stocking rate on the demonstration farms. The average stocking rate of the rotationally grazed paddocks is 30% higher than the set stocked control paddocks. The average stocking rate of rotationally grazed paddocks during the trial is 3.0 DSE/ha but varied among different paddocks and farms from 0.2 -7.7 DSE/ha. In the control paddocks the average stocking rate is 2.3 DSE/ha with a range from 0.5 -5.4 DSE/ha.

What does this mean?

The results of this project challenge the traditional view that increased stocking rate is linked to native grassland degradation. Changing the way grazing animals are managed - by increasing mob size and reducing the area of pasture available to livestock while most of the area is allowed to recover from grazing - has significant potential to improve native pasture health and productivity and increase animal production.

But it is important to remember several factors when making a change to rotational grazing. This includes:

1 Always match stocking rate to the carrying capacity of the property. Grazing management will not compensate for over stocking. As the carrying capacity of the property will change seasonally and very likely from year to year review pasture growth rates and productivity regularly throughout each year.

2 Manage for the desirable pasture plants by allowing adequate periods of recovery following each grazing event, this is achieved by reducing paddock size and increasing the number of paddocks. Overgrazing occurs as a result of plants being exposed to animals for too long a time period or animals coming back onto paddocks too quickly, not from too many animals.

3 Manage to increase animal production by reducing graze periods. By increasing the number of paddocks and increasing rest periods, graze periods are reduced and animals are frequently moving onto fresh pastures with higher nutritional value.

4 Manage for the health of the paddock by increasing stock density. Reducing the available grazing area at any time and increasing the number of stock in the mob results in more even utilisation of the pasture and greater distribution of nutrients through dung and urine in each paddock.

5 Most importantly monitor paddocks regularly for any sign that the current management is not achieving the desired outcomes in terms of pasture condition and health. If monitoring reveals any movement away from the desired result review the current grazing plan and take action.

Acknowledgements

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