



Eyre Peninsula Farming Systems

2003 Summary

This publication is proudly sponsored by

United Grower Holdings

UGH

Uniting Active Growers

GRDC Grains Research & Development Corporation

Foreword

Dear Readers

UGH is pleased to once again, provide a significant contribution to the valuable work being undertaken by the Minnipa Research Foundation and Agricultural Centre.

As most southern Australian grain growers would be aware, UGH is the grower-owned holding company for AusBulk Ltd. Our primary function is to maintain an effective controlling interest in AusBulk Ltd for the benefit of our grain grower shareholders. In an effort to provide further support to growers, UGH is also committed to using our resources to develop and improve the grain industry in a number of other areas, including developing the skills and education of growers, and researching and promoting grain industry issues.

Our sponsorship of the Minnipa Research Foundation and Agricultural Centres' communication program has been one of the premier sponsorship relationships that the Company has entered into since it was created almost four years ago. The attraction of this sponsorship is that their publications are very widely distributed across the Australian grain grower community, thereby offering an extensive number of growers the opportunity to learn and benefit from new production techniques and philosophies explained in the latter pages of this book.

UGH has also been pleased to assist the personal development of grain growers through the share education workshop series, conducted in 2002 and the grain industry education and marketing options workshop series, run in 2003. The success of both series was made possible through the invaluable assistance from members of the South Australian Partners in Grain network. Given the overwhelming positive grower response to these events, UGH will continue to explore other initiatives that may enhance the knowledge and professionalism of all partners in a farm unit.

UGH's mission is to lead our stakeholders through this evolutionary phase of the grains industry. We have sought to do this through various initiatives. In a practical sense though, one of the primary functions that we have achieved is to assist growers to benefit from the developments that farm systems groups such as the Minnipa Research Foundation and Agricultural Centre, uncover through their dedicated work. With this in mind UGH is proud to support the publication of this book and the Minnipa Research Foundation and Agricultural Centre.

Ken Schaefer
Chairman
United Grower Holdings Ltd

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Eyre Peninsula Farming Systems 2003 Summary

All article submissions are reviewed by the Editorial Team prior to publication for scientific merit and to improve readability, if necessary, for a farmer audience.

This manual was compiled by

Michael Kemp & Taryn Coad of WOOF Design & Print

93 Washington Street, Port Lincoln SA 5606

March 2004

Front Cover:

From bottom to top: Dr Annie McNeill, University of Adelaide (EP Farming Systems Project) at the 2003 Minnipa Ag. Centre Field Day. Subsoil nutrition experiment at Balumbah, district practices vs supermix. Ken Wetherby, Soil Survey Specialists at the 2003 Buckleboo soil pit training day. Low Rainfall Farming Systems Collaboration project – first meeting of groups at Minnipa in 2003 – Central West NSW, Mallee Sustainable Farming (NSW, Vic, SA), Western Wheat Group (NSW), Upper North (SA), Eyre Peninsula Farming Systems. Barley at Streaky Bay, 2003.

Back Cover:

From top to bottom: Brendan Frischke demonstrating the Root Zone Injector at the 2003 Minnipa Ag Centre Field Day. Penny Day (University of Adelaide) and Matt Dunn (Tuckey) at the long-term rotation research site on the Dunn property at Tuckey. Fish Cordon in a barley crop on the 2003 Minnipa District Farmers Sticky Beak Day. Jon Hancock, Ben Ward and Willie Shoobridge (EP Farming Systems Project, MAC), applying late nitrogen with a plot straddler at Wharminda, 2003.

Inside Back Cover:

Photos from various Eyre Peninsula agricultural events in 2003.

Cover design:

Michael Kemp, WOOF Design & Print.

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Do you need this book to continue?

Do you need the Eyre Peninsula Farming Systems Project to continue?

Whether your answers are "yes" or "no" to the above questions, we need to know about them.

The Eyre Peninsula Farming Systems project is due to finish in mid 2005. We need your opinions urgently on whether it should continue and if so in what form? Not filling in this form and sending it back immediately will be taken as a sign that the project is not necessary in the future. Your honest responses to the questions below would be appreciated ASAP.

Send the completed pages to Minnipa Ag Centre by fax (08 86805020), or post (Box 31, Minnipa 5654)

Your Details

Postcode____________________

How many people in your business does this survey represent? ____________________________________

Are you a Farmer / Adviser / Researcher / Other ____

QUESTIONS ABOUT THE EYRE PENINSULA FARMING SYSTEMS PROJECT

Have you been involved in the EP Farming Systems project? YES NO

***If yes, how so?** (tick each thing you have been involved with)*

- ☐ Read this book
- ☐ Read the newsletters
- ☐ Read about it in the papers, heard about it on the radio
- ☐ Go to the group meetings in March
- ☐ Had research on my place
- ☐ Have done my own farmer demonstration
- ☐ Been on the Farmer Reference Groups
- ☐ Saw the work at Sticky Beak Days
- ☐ Done workshops organised by EP Farming Systems (disease, chemicals, snails, herbicide resistance)
- ☐ Done some of the research
- ☐ Been to issue specific Field Days organised by EP Farming Systems (clay spreading, subsoils, disease
- ☐ Minnipa Research Foundation Field Days (2002 Herbicide, 2003 Nutrition)
- ☐ Minnipa Ag Centre Field Day
- ☐ Listened to the researchers at conferences
- ☐ Have gotten information from other farmers who have been actively involved in the project
- ☐ Other

What does the EP Farming Systems Project really mean to you? ***(tick as many as applicable)***

☐ You get to read this book

☐ The project has been researching your farming questions…

Which of your questions have already been answered? ____________________________________

____

Which of your questions are currently being addressed?___________________________________

____

Which of your questions still need to be answered?______________________________________

____

____

☐ The project has been making things happen in your local area…tell us what has happened in your area

____

____

☐ The project has changed the way you do something on your farm….tell us what you have changed

____

____

☐ The project has given me confidence that the way I am currently doing things is about as good as I can get at the moment……what farming practices has the project reinforced for you? ____________________

____

____

☐ Nothing, I've never participated in any of the things mentioned in this survey….*if you ticked this one could you please let us know why haven't wanted to be involved*? ____________________

____

____

Do you want your GRDC grain levies invested in another EP Farming Systems Project? YES NO

If "NO", how would you like your levies invested instead?____________________

____

____

If "YES", how could we improve the next project for you? ____________________

____

____

Any other comments about the EP Farming Systems project? ____________________

____

____

ABOUT THESE BOOKS

Do you keep and refer to copies of these books from previous years?	YES	NO
Have you ever chased up further information after reading an article in these books?	YES	NO
Have you ever tried anything new after reading an article in these books?	YES	NO

Tell us about it! ____________________

____

____

What has been the most useful thing about these books for you? ____________________

____

____

If you have appreciated receiving this book then why not take a moment to personally thank UGH Ltd, your sponsors for the last three years.

THANKS FOR TAKING THE TIME TO FILL THIS OUT AND SEND IT BACK

A couple of dates for your diaries: Minnipa Research Foundation Field Days 4th & 5th August (Tillage theme), Minnipa Ag Centre Field Day 23rd September.

Well folks, thanks for the amazing support for the Eyre Peninsula Farming Systems Project and this publication over the last six years. We have certainly learnt lots and had a great time doing it!

With our best wishes for the future

The EP Farming Systems Management Group - *Peter Kuhlmann, Bruce Heddle, Ed Hunt, Sam Doudle, Annie McNeill, Nigel Wilhelm, Fish Cordon*

The EP Farming Systems Research & Extension Team - *Sam Doudle, Ali Frischke, Nigel Wilhelm, Fish Cordon, Jon Hancock, Wade Shepperd, Willie Shoobridge, Ben Ward, Annie McNeill, Damien Adcock, Penny Day, David Coventry, Linden Masters and Mark Habner*

Contents

Minnipa Research Foundation

What is it?

The Minnipa Research Foundation is the fund-raising arm of the Minnipa Agricultural Centre. The Foundation members are Paul Kaden of Cowell, John Masters of Wharminda, Rowan Ramsey of Buckleboo, Peter Kuhlmann of Mudamuckla and Samantha Doudle and Ros Fromm of Minnipa Ag. Centre. The Foundations aim is to work with MAC staff to target corporate bodies, charitable institutions and the community, to provide an extra untargeted source of funds with which to initiate new areas of activities, plug the gap in ever decreasing government funds, and to use as leverage with the major funding bodies. These funds are in turn used to support the Minnipa Agricultural Centre and the huge research and extension program it undertakes across the upper and eastern Eyre Peninsula.

2003 ACHIEVEMENTS

Sponsorship Deals

Gold Sponsors

- United Grower Holdings Ltd –sponsorship of this publication and the EP Farming Systems Newsletter.
- Croplands – renegotiated an upgrade of the Minnipa Ag Centre broad-acre boom-spray to a PINTO MT3405
- Outback Guidance – provided a steering guidance system in conjunction with the Croplands deal.
- AWB Ltd – sponsors of the Minnipa Ag Centre Farming Systems Competition.
- Beeline Technologies - use of a Beeline Navigation System for the controlled traffic demonstrations on Minnipa Ag Centre.
- Burando Hill - use of 2 Haukaas Marker Arms for controlled traffic comparisons on Minnipa Ag Centre.

Silver Sponsors

- Joint sponsors of the Nutrition Field Days

Bank SA	Hi-Fert Pty Ltd	Liquid Systems
Fertiliser Solutions	Incitec Pivot	Agrichem Manufacturing

Field Day

The 2003 Eyre Peninsula Nutrition Field Day was our second 'specialised' annual event organised for Foundation members. The two day event was open to everyone on the first day (@ $100/head, and 'Foundation members only' (including dinner that evening) on the second day, with the same program run on both days.

The Foundation is planning a Tillage focus for our 2004 special field day. The tentative date is set for Wednesday 4th August 2004, subject to change with seasonal conditions. Once again the day will be a mix of trials, demonstrations, guest speakers and machinery displays, all relating to tillage and trash handling systems. Numbers will again be limited to ensure those attending get the most out of the day. If you want to ensure you get an invite to this event make sure your Foundation membership is up to date – or if you haven't joined yet, do it soon!

Newsletter

All members receive a Foundation newsletter twice a year, letting them know what's happening with their membership fees. Another newsletter is due out shortly after this book is finished!

HOW TO JOIN

Memberships are available to individuals ($100) OR an individual plus their spouse ($120). There is also a discounted student rate (aged 16 and under) now available ($50).

Memberships to the Minnipa Research Foundation are due annually in October and are payable at the Minnipa Agricultural Centre Field Day or via post to Minnipa Agricultural Centre, PO Box 31, Minnipa SA 5654. Contact Ros Fromm at Minnipa Agricultural Centre on (08) 86 806202 for a membership form today.

THANK YOU FOR SUPPORTING DRYLAND AGRICULTURAL RESEARCH

Members of the Minnipa Research Foundation

Baldock	Graeme & Heather	Kimba
Bammann	Geoff	Cleve
Bammann	Paul	Cleve
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Bates	Andrew	Wudinna
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Nield	Roger	Cleve
Nielsen	Peter & Pauline	Penong
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Oswald	John	Yaninee
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Trezona	Neville	Streaky Bay
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Wilkins	Gregor & Linda	Yaninee
Williams	David & Jenny	Port Neill
Williams	Ken & Heather	Streaky Bay
Williams	Kim	Streaky Bay
Williams	Roger & Gwenda	Kimba
Wohling	Carl	Kimba
Woolford	Graham & Barb	Kimba
Woolford	Michael	Cleve
Woolford	Peter	Kimba
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Minnipa Research Foundation

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2003 - What Happened on Eyre?

Linden Masters, Mark Habner and Jeff Braun

Rural Solutions SA, Cleve, Streaky Bay & Port Lincoln

Eastern Eyre Peninsula

- Weather patterns on Eastern Eyre Peninsula provided the greatest influence and variation to crop production this season.
- February rains provided good sub soil moisture and some areas experienced further thunderstorm activities in April. Farmers were faced with a choice to continue spraying melons and summer weeds, rip up or even sow early.
- Excellent rains across the region on May 21st & 23rd allowed most farmers to start seeding.
- From this good start, a dry windy July impacted on the early sown crops and some yield potential was lost. July provided a month with some of the most frequent and highest wind velocity events recorded at Cleve, resulting in up to 20% of cropping land drifting. So severe were these wind events that even early sown crops at mid-tillering were being cut off.
- Low residue levels from the poor season of 2002, meant that farms that had kept reasonable stock numbers experienced many bare areas. Fortunately the changes of farming practices in stubble retention, min-till and n-till, reduced what could have been a very devastating year. Many re-sown crops were reapt giving average yields.

- The turning point of the season came with a change in the winter weather pattern with good rains falling mid-August.
- September was a relatively dry period. A frost on the 29th of September combined with a drying soil profile, impacted on crops differently, depending on the crop growth stage.
- An unusually mild spring resulted in crops reaching their potential, with improved grain quality and minimum screenings. Canola achieved high oil content 48%, however cereal protein percentages were greatly reduced.
- Rhizoctonia was prevalent particularly in barley crops. Septoria tritici blotch in wheat and several leaf rust diseases become obvious.
- Harvest conditions were cool and a few days were lost through poor weather. Above average wheat and many record-breaking barley yields were recorded. Peas were again a mixed bag with frost damage being reported however many had exceptional yields and low disease levels.
- Pasture growth was excellent with many cutting hay. Record September "off shears sales". Young ewes sold $100 - $138, 5yr $58-$87,wethers $80.
- An increased interest in sowing lucerne has seen several hundred hectares sown in 2003. Excellent conditions for establishing lucerne. Success was dependant on providing protection from soil erosion and insect damage.

Lower Eyre Peninsula

2003 was a good year for farmers on the Lower EP. Above average rainfall for most areas and a relatively cool finish provided mostly ideal conditions for one of the best seasons on record.

- Early thunderstorm activity at the end of February, produced widespread falls, but did not significantly alter subsoil moisture in most areas, particularly those with heavier soil types.
- Seeding for some farmers began in early May, allowing some of the large canola crop and a few lupins to be sown under ideal conditions. The rainfall in early May was patchy, but most had started seeding by the middle of May. Wind events following seeding had little effect due to the moist topsoil and the widespread adoption of stubble retention and no-till.
- Cool conditions and adequate rainfall going into spring saw most farmers applying additional nitrogen aiming for greater yields. Foliar nitrogen saw fairly widespread use in later applications. With the warming spring weather came foliar diseases, which flourished in such mild conditions. This saw a great deal of foliar fungicide flown out onto wheat, barley and beans. Reports of canola crops (Surpass and Hyola 43 & Hyola 60) being severely affected with blackleg became common, as crops lodged and some plants died as a result of the disease.
- Spring was mild except for a couple of hot, windy days in September and October dried out crops considerably and caused more damage than people expected at the time.
- Harvest began in November, with record barley yields in most areas. Quality was also good with many crops gaining Shochu grade. Record canola oil percentages were also recorded at silos, with some loads going 50%. Yields were variable due to blackleg, but generally were above average in most areas. Farmers looked toward harvesting wheat with great hopes of high yields as seen with the barley. Yields however were disappointing compared to barley and can probably be attributed to the hot and windy days drying out crops in spring. Proteins were also low in many crops, despite increased applications of nitrogen. Grain legumes were also of mixed quality with many lentils being rejected due to more stringent receival standards. Lupins were also scrutinised due to small grain, yet another result of drying days in spring.
- Overall harvest was well above average, with generally good grain quality.

Western Eyre Peninsula

2003 was a mixed year for farmers on Western EP. A patchy start with hefty winds in June and July made for an apprehensive start but a mild spring meant that most finished up with at least close to average yields, up to the best on record.

- Early thunderstorm activity at the end of February produced widespread falls and should have added to the subsoil moisture profile. Weather conditions after this rain played a part in much of this moisture being lost to evaporation.
- Most districts were able to sow close to the optimum sowing date with the exception of Ceduna and Penong, which held off until rains in late June
- Winds in late June and July caused significant drying of the soil and wind erosion severely impacted many crops. Crops that were sown after mid-June were the hardest hit, with some areas being re-sown.
- Rainfall until August was very patchy and wide variations between districts were seen.
- Rhizoctonia was prevalent, particularly in the Wirrulla district.
- Conditions from August into October improved the season outlook considerably with mostly mild weather and some rainfall recorded.
- Overall most districts yielded well, particularly in the southern districts where some received their highest yields ever. Some patches missed out on rain at critical times and had reduced yields, particularly north of Streaky Bay. Protein levels in wheat tended to be less than expected mainly due to the mild weather experienced during spring.
- During harvest, weather conditions were fairly mild with significant rain coming on the 18th of November and for a few days in mid-December.

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 … 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 be 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 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	n/a	Usually summary of research results

Some Useful Conversions

Area

1 ha (hectare) = 10,000 m^2 (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

10 psi (pounds per sq inch) = 0.69 bar = 69 kPa (kiloPascals)
25 psi = 1.7 bar = 172 kPa

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 Australian
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

It is my pleasure to welcome you to the 2003 edition of the Eyre Peninsula Farming Systems (EPFS) Summary. Since it began in 1999 this booklet has set the standard for timely and effective presentation of information that other groups can only follow.

Throughout 2003, the EPFS has continued to undertake farming systems trials in consultation with growers on the Eyre Peninsula. Amongst the summaries in the booklet are the results of pasture trials, including work on SU tolerant medics and alternative legumes, as well as a summary of a recently completed PhD on nitrogen and water cycling.

The new survey technique employed by the EPFS to gather information from growers on issues ranging from the extent of herbicide resistance to clay spreading has proved to be a useful tool in formulating a profile of the Eyre Peninsula and in planning trial work. The results of these surveys are also included in this booklet.

I am pleased that the advent of the low rainfall coordination project has made it possible to provide an additional chapter in the summary booklet. Chapter 12 includes summary results from other low rainfall farming systems projects, including results from the Central West Farming Systems Group (NSW), the Mallee Sustainable Farming Systems Group (SA, Vic, NSW), and the Upper North Farming Systems Group (SA). The inclusion of this information illustrates the increased emphasis on information and technology sharing and collaboration between low rainfall farming systems groups.

The Eyre Peninsula Farming Systems Group is one of the first eight groups throughout Australia to have been approached and will be participating in the Grain and Graze Program. Grain and Graze is a collaborative program of the GRDC, Meat and Livestock Australia and Land and Water Australia. The aim of the Grain and Graze Program is to increase the profitability of mixed farming enterprises whilst maintaining or enhancing biodiversity and water quality. With the Eyre region dominated by mixed farming enterprises, it is most appropriate for the Group to be involved in this program.

The Eyre Peninsula Farming Systems Group is recognised as having strong grower input into its annual systems trials. The enthusiasm and motivation of both the EPFS staff and the growers involved with the Group are commendable.

Martin Blumenthal

Program Manager Sustainable Farming Systems

Ed Note: The EPFS project appreciate the constant support and wise advice received from Jane Lilley, Program Coordinator, Sustainable Farming Systems, GRDC – thanks Doc!

Section 1

Section editors: Michael Bennet & Neil Cordon
SARDI, Minnipa Agricultural Centre

UNITED GROWER HOLDINGS

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Cereals

2003 demonstrated the wide climatic variation that can be experienced on the EP within the one season. The total amount of wheat grown on the EP for 2003 was approximately 1,455,000 tonnes, 609,000 tonnes of barley, 40,600 tonnes of oats and 24,800 tonnes of triticale.

For the first time the cereal section includes the SAFCEP summary tables on the yield performance of wheat, barley and triticale over all of EP. Oat data was not available at the time of printing. (NB: varieties should be selected on more factors than just yield in one single season).

Cereal Variety Performance, 2003

SAFCEP Wheat Variety Yield Performance

(2003 and long term, 1997-2003, expressed as a % of Frame's yield)#

	UPPER, EASTERN AND WESTERN EYRE PENINSULA																LOWER EYRE PENINSULA					
	2003								7 year average (97 – 03)								2003			7 year average (97 – 03)		
Variety	Kalanbi	Kimba	Minnipa	Mitchelville	Nunjikompita	Penong	Streaky Bay	Warramboo	Kalanbi	Kimba	Mitcheville	Minnipa	Nunjikompita	Penong	Streaky Bay	Warramboo	Cummins	Lock	Ungarra	Cummins	Lock	Ungarra
Annuello	87	72	117	102	93	188	81	86	105	102	103	104	100	106	99	101	123	105	128	102	98	103
Babbler	107	90	129	115	92	177	78	92	95	94	97	97	91	96	91	94	117	111	123	98	96	99
Camm	108	124	121	113	89	157	101	152	110	108	110	108	106	107	105	107	115	114	124	103	104	105
Chara	102	53	86	85	83	126	93	75	98	91	92	96	95	98	95	93	124	92	121	100	94	99
Drysdale	101	98	116	122	94	211	101	142									126	93	123			
Excalibur	135	145	150	130	110	231	108	173	105	108	106	108	107	112	107	109	126	113	120	103	105	104
Frame	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
H45	109	121	139	127	92	214	79	164	105	107	107	108	100	107	99	107	141	119	125	104	103	103
Janz	101	88	130	111	94	187	78	99	97	97	99	99	93	98	92	96	112	102	120	98	95	101
Krichauff	134	95	133	128	92	172	107	136	113	108	110	111	106	110	106	109	117	107	116	103	105	105
Kukri	97	110	127	122	97	156	87	121	88	96	95	98	90	95	92	94	109	93	116	97	96	98
Machete	71	109	140	119	93	171	95	152	87	94	92	96	88	93	91	96	119	111	120	97	96	98
Pugsley	102	105	105	119	96	130	106	125	115	109	113	110	111	112	109	110	105	108	112	104	106	105
Sapphire	127	105	138	112	97	193	84	120									116	101	128			
Silverstar									92	101	103	103	94	100	94	104				100	99	101
Spear									100	101	104	102	97	102	97	103				101	101	101
Wyalkatchem	74	131	141	123	97	222	99	160	118	115	114	114	113	116	110	115	149	125	132	109	109	107
Yitpi	119	106	111	121	102	149	115	123	104	106	109	106	105	105	105	106	114	104	112	103	103	103
*Durums**																						
Arrivato		65	70									77					105	64	74	89	81	86
Bellaroi		34	73									73					108	78	76	87	79	84
Gundaroi		63	93									82					105	82	80	91	87	89
Kalka (99006)		33	60									83					104	77	86	93	87	90
Tamaroi		65	120									85					107	80	76	92	88	90
Frame's yield t/ha	**0.10**	**0.75**	**0.70**	**0.88**	**1.05**	**0.67**	**1.38**	**0.80**	**0.81**	**1.67**	**1.28**	**1.58**	**1.04**	**1.31**	**1.40**	**1.66**	**3.65**	**2.30**	**3.31**	**3.65**	**2.30**	**3.31**
Date Sown	19/6	10/6	10/6	8/6	17/6	19/6	12/6	10/6									10/6	12/6	11/6			
Soil Type	SCL/SL	SCL/liC	L/SCL	LS/SCL	LS/SCL	LS/S	S	SCL/liC									LS/liC	SL/SCL	SCL/SC			
A-O rain (03)	146	230	200	218	151	217	270	266									332	273	399			
PH_w	7.5	8.5	8.5	8.6	8.9	9.0	9.0	8.3									5.7	8.3	7.5			
Stress Factors	de,dl,lb	b,cr,de,dl	b,de,dl,p,r	b,de,dl	de,dl	De,dl,b,cr	C,r,ys	b,de,dl,p									ys	dl,r,ys	l,r,ys			

*Durum varieties trialed separately and not completely valid to compare against bread wheats.

SAFCEP Barley Variety Yield Performance

(2003 and long term, 1997-2003, expressed as a % of Schooner's yield)#

	Lower Eyre Peninsula				Upper Eyre Peninsula									
	2003		Long term (1997–2003)		2003					Long term (1997–2003)				
Variety	Cum mins	Wan-illa	Cum-mins	Wan-illa	Elliston	Mang-alo	Minnipa	Streaky Bay	Whar-minda	Elliston	Mang-alo	Minnipa	Streaky Bay	Whar-minda
Barque	105	107	105	105	113	109	107	106	100	109	112	108	112	109
Baudin	82	96	103	103	104	94	101	100	94	105	106	107	108	102
Chebec			102	102						104	101	101	105	106
Dhow	83	93	98	96	97	103	102	91	80	100	102	101	102	92
Franklin			94	94						96	92	78	93	83
Gairdner	89	101	102	102	105	104	76	95	98	112	111	104	112	97
Galleon			102	101						103	104	104	106	100
Keel	101	100	108	106	107	97	142	101	103	112	113	118	110	110
Mundah			103	105						108	115	103	106	98
Schooner	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Sloop	90	101	100	100	98	83	87	99	97	101	104	101	101	97
SloopSA	97	100	101	100	101	95	101	98	103	102	105	104	104	98
SloopVic	96	103	99	99	103	82	74	101	98	101	103	97	102	98
Torrens	95	98	94	90	98	77	97	87	85	92	88	87	89	85
WI3297	101	110	107	108	101	111	89	99	102	109	117	110	112	110
WI3385	105	105	109	109	120	92	96	105	102	114	115	115	120	110
Schooner's yield	**4.81**	**5.01**	**3.62**	**3.06**	**3.86**	**1.24**	**1.10**	**3.12**	**3.22**	**2.22**	**1.90**	**1.87**	**1.78**	**1.94**
Date Sown	10/6	7/6			11/6	9/6	10/6	16/6	7/6					
Soil Type	SCL/MC	S/MC			S/LS	S/CS	L/SCL	S/LS	S/SC					
A-O Rain (2003))mm	332	345			354	310	200	235	266					
PH_w	7.9	6.8			8.2	7.3	8.5	9.0	6.8					
Site Stress factors	c,lr, ns,wl	lr,ns			lr,ns,p	de,g,n	b,de, dl,r	ns,r	lr,ns,r, s					

SAFCEP Triticale Variety Yield Performance

(2003 and long term, 1998-2003, expressed as a percentage of Tohora's Yield)#

	2003				Long term (1998-2003)			
Variety	Piednippie	Minnipa	Wharminda	Greenpatch	Piednippie	Minnipa	Wharminda	Greenpatch
Credit	85	89	86	98	91	95	92	96
Everest	92	103	101	93	96	101	98	98
Kosciuszko (ISR497-14)	98	107	99	115	105	105	107	104
Muir	96	106	103	102	95	96	97	96
Prime322	85	94	103	93	94	93	100	95
Speedee	92	120	104	129	97	103	101	103
Tahara	100	100	100	100	100	100	100	100
Tickit	96	108	108	106	103	101	106	101
Treat	103	107	98	105	97	99	102	99
Bevy Rye	76	64	110	85	72	72	91	85
Frame Wheat	93	98	97	86	85	97	85	85
Krichauff Wheat	81	120	101	123	92	105	94	92
WI3385 Barley	81	134	150	141	111	122	127	120
Tahara's yield (t/ha)	**1.57**	**0.85**	**2.41**	**2.97**	**1.61**	**1.66**	**1.59**	**3.20**
Date sown	June 12	June 11	June 7	June 9				
Soil type	S	L / SCL / CL	S / SC	LS / CS				
pH (water)	8.5	8.3	6.8	5.7				
Apr-Oct rain (mm)	270	200	266	475				
Site stress factors	w, rh	de, dl						

#Data source: SAFCEP (long term data based on weighted analysis of sites, Biometrics SA). Compiled by Rob Wheeler and Jim Egan.

Abbreviations

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: b=boron, c=cereal eelworm, cr=crown rot, de=moisture stress pre flowering, f= frost, h=grass herbicide damage, lr=leaf rust, lb=late break, p=pratylenchus, s=sandblasted, r=rhizoctonia, ns/n=net blotch(spot/net), wl=waterlogged, g=grazed

Farmer Wheat Trials

Demo

Neil Cordon

SARDI, Minnipa Agricultural Centre

Key Messages

- **Wyalkatchem has attributes which make it an attractive APW variety for wheat on wheat situations.**
- **Results from the cereal evaluation program should be considered when selecting varieties for your farming system.**

Why do the trial?

These trials were set up at the request of the local Ag Bureaus to compare current cereal varieties with some that aren't commonly grown in the district. It also enables varieties to be compared in a different environment to S4 cereal evaluation sites on E.P.

MT COOPER DISTRICT CEREAL TRIAL

How was it done?

- Treatments - varieties included 5 wheat lines and 3 barley cultivars.
- Sowing date - 24th June
- Seeding rate - 75 kg/ha (wheat) and 70 kg/ha (barley)
- Fertiliser - 18:20:0 @ 80 kg/ha
- Measurements - grain yield and quality attributes

What happened?

Table 1: Results from Mt Cooper Ag Bureau cereal trial, 2003

Variety	Grade	Protein %	Screenings %	Test Weight kg/hL	Yield t/ha	Gross Income * $/ha
Wyalkatchem	APW	9.5	1.0	82.8	2.17	403
Yitpi	AH	8.7	1.5	80.6	2.12	367
Frame	APW	9.6	1.1	80.8	1.92	359
H45	APW	9.7	1.5	82.6	1.89	354
Pugsley **	APW	9.2	1.6	80.6	1.82	326
Sloop S.A.	Malt	9.3	1.8	67.4	2.58	481
Sloop Vic	Feed	8.8	1.0	67.4	2.58	409
Keel	Feed	9.9	2.0	69.4	2.51	398

* *Gross Income is yield x price (with quality adjustments) delivered to Port Lincoln as at 1st December 2003.*

*** Grain unpickled and weevil damaged.*

What does this mean?

Wyalkatchem and Yitpi yielded higher than the other wheat varieties. Sloop S.A. and Sloop Vic yielded the same however Sloop Vic was downgraded to feed because of low protein. Yields of wheat and barley were 55% and 63% of potential due to low rainfall in October and late sowing. Low protein levels also indicate that the site suffered from nitrogen deficiency.

Acknowledgements

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

FRANKLIN HARBOUR WHEAT VARIETIES

How was it done?

- Treatments - Twelve commercially available wheat lines were sown in demonstration strips.
- Measurements - grain yield and quality.
- Sowing Date - 10/6/03
- Sowing Rate - 60 kg/ha
- Fertiliser - 18:20:00 @ 70 kg/ha

What Happened?

Above average rainfall at this site produced good growing conditions and yields. However a week of hot windy weather late in September caused tipping and a severe frost early in October may have affected those varieties flowering at the time, especially Frame. Varieties yielded up to 71% of the potential with delayed sowing, grass weeds and weather events (mentioned previously) limiting yields.

It appeared visually that Janz and H45 were most affected by the weed competition whilst Worrakatta tipped badly.

The quick maturing Silverstar yielded well and had the best gross return with the new variety Wyalkatchem a close second.

What does this mean?

Wyalkatchem should be considered as a replacement APW variety especially as its moderate resistance for Yellow Leaf Spot is attractive for wheat on wheat situations. Yitpi, a hard variety has continued to yield well in this district and could be

Try yourself

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

Rainfall
Av. Rainfall: 350mm
Av. G.S.R: 270mm
2003 Total: 374mm
2003 G.S.R: 294mm

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

Paddock History
2002: Grassy Pasture
2001: Barley
2000: Wheat

Soil Type
Reddish brown loam

Plot Size
20m x 1.5m x 3 reps

Other Factors
Late sowing, dry October, nitrogen deficiency

Location
Cowell - Roger Story
Group – Franklin Harbour Ag Bureau

Rainfall
Av. Rainfall: 390mm
Av. G.S.R: 277mm
2003 Total: 450mm
2003 G.S.R: 334mm

Yield
Potential (W): 4.5t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Wheat

Soil Type
Red sandy loam

Other Factors
Late sowing, hot winds, frost, sowing time

a replacement for Janz and Silverstar.

The performance of the varieties in this demonstration should be evaluated in conjunction with the replicated cereal program at Cowell and Upper Eyre Peninsula. Further testing of the Pioneer varieties, Combat and Sapphire is required before they can be recommended to grow.

Acknowledgements

Darren Peach from Elders Cleve.

Members of Franklin Harbour Ag Bureau.

Roger Story for his time, machinery and dedication to the trial.

Table 2: Yield, grain quality and gross income of wheat at Franklin Harbour Ag Bureau site 2003.

Variety	Grade	Protein (%)	Screenings (%)	Test Weight (kg/Hl)	Yield (t/ha)	Gross Income * ($/ha)
Silverstar	AH	10.8	0.5	82	3.19	652
Wyalkatchem	APW	11.6	0.1	83	3.20	648
Yitpi	AH	10.7	0.3	82	2.83	577
Carnamah	APW	11.2	0.1	83	2.90	581
Sapphire	APW	11.4	0.1	83	2.81	566
Pugsley **	APW	11.5	0.3	83	2.76	556
Worrakatta	ASW	10.4	0.4	81	3.02	554
Camm	APW	11.9	0.3	84	2.68	545
H 45	APW	11.2	0.4	83	2.61	521
Janz	AH	11.3	0.2	83	2.42	501
Frame	APW	11.4	0.2	83	2.46	495
Combat	APW	11.8	0.2	82	2.42	493

*** Grain unpickled and weevil damaged.*

** Gross income is yield x price (with quality adjustments) delivered to Port Lincoln as at 1st December 2003.*

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Cereals for difficult soils and environments

Research

Jim Egan[1], Brian Purdie[1], Leigh Davis[2] and Michael Bennet[2]

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

Searching for answers

Location
Penong
Cooperator: Bill & Trevor Oats
Charra Agricultural Bureau

Rainfall
Av. Annual: 318mm
Av. GSR: 215mm
2003 total: 307mm
2003 GSR: 217mm

Yield Potential (W&T) 2.14 t/ha, (B) 2.54 t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Pasture

Soil Type
Loamy sand over clay sand, surface pH 8.5.

Plot size
10 m x 1.5 m x 3 reps

Other factors
Late sown (June 19), due to late break. Dry spring.
Visual boron toxicity

Key Messages

- **Drought tolerant wheat lines out-yielded current varieties at Penong but not Cowell in 2003 trials.**
- **A barley line selected for adaptation to low rainfall conditions was slightly ahead of Keel at Penong.**
- **Tickit and Tahara triticale also yielded well at Penong, of the order of 10-15% better than Excalibur.**
- **Head tipping symptoms had no bearing on final grain yield in wheat.**

Why do the trial?

To identify cereal varieties or breeding lines better adapted to districts where soil constraints (e.g. high boron soils) and climatic limitations (low rainfall/short growing season) limit yields from current varieties.

There has been major emphasis within wheat and barley breeding programs in recent years to target specific stress factors in an effort to understand how they limit plant growth and production, and develop varieties with improved tolerance to these stresses. Particular projects underway on Upper Eyre Peninsula, which are reported on elsewhere in this Research Summary, are for drought tolerance in wheat and boron tolerance and low rainfall adaptation in barley. In response to the needs of farmers in the Cowell and Penong districts, as identified in the EP Farming Systems Reference Group meetings, we have taken some of the most promising lines identified in these breeding projects for testing in each of these districts, alongside our S4 (Secondary) wheat trials. Several triticale varieties were also included at Penong, since triticale has a reputation of performing better than wheat on some problem soil types, and because of increased interest in growing triticale in the Far West district. Similar trials have been conducted at Penong for the past 2 years (*see EP Farming Systems 2002 Summary, pages 23-25*), while 2003 was the first year of such testing at Cowell.

How was it done?

Thirteen lines from the drought tolerant wheat program were provided by Dr Neil Howes, on the basis of their yields in Upper EP trials in previous years. Check varieties of Krichauff, Frame and Excalibur were also included. All wheat lines were sown at a constant 200 seeds/m^2, which gave an average seeding rate of 75 kg/ha.

Dr Jason Eglinton provided eight barley lines from the boron tolerance and low rainfall adaptation breeding programs, again on the basis of yields in recent Upper EP trials. Check varieties of Schooner, Sloop SA, Barque and Keel were also included. All barley lines were sown at 175 seeds/m^2, which gave an average seeding rate of 79 kg/ha.

The triticale comparison included three varieties with relevant adaptation to the Upper EP, namely Tahara, Tickit and Speedee, at a rate of 225 seeds/m^2, giving an average seeding rate of 90 kg/ha.

The wheat trials were sown at both Penong and Cowell, and the barley and triticale trials at Penong only.

Penong trials were all sown on June 19, with 17:19:0 Zn 2.5% at 70 kg/ha drilled with the seed. The trial site received a pre-sowing herbicide spray mix of Sprayseed® @ 1 L/ha and Triflur X® @ 1.2 L/ha, and an in-crop herbicide treatment mix of Bromicide MA® @ 750 mL/ha plus Lontrel® @ 200 mL/ha on July 29.

Severe head tipping developed in the wheat lines at Penong late in the season, and strong boron toxicity symptoms in the barley. These were scored in late October. Trial plots were harvested on November 25, and plot weights recorded.

The Cowell trial was sown on June 8, with 18:20:0 @ 80 kg/ha drilled with the seed. The trial area was sprayed by the farmer with a herbicide mix of Roundup Max®, Triflur 480® and Logran® prior to sowing the surrounding paddock. As this was 2-3 weeks before the trial was sown (due to quarantine restrictions on moving trial seed out of Waite, following detection of wheat streak mosaic virus there), the trial area received another spray application of Roundup Max® @ 1 L/ha, Triflur 480® @ 1 L/ha and Striker® @ 100 mL/ha immediately pre-sowing on June 8. Not surprisingly, no in-crop herbicide sprays were required after this intensive pre-sowing treatment!

No gross differences between lines in the Cowell trial were observed during the growing season, and plot weights were recorded at harvest on December 3.

What happened?

It will probably come as no surprise to Far West farmers that Excalibur was the top yielder of current wheat varieties at Penong, achieving nearly 1.3 t/ha compared with Krichauff's 1.0 t/ha. Frame yielded very poorly, at less than 0.7 t/ha (*Table 1*). But Excalibur was itself beaten by one of the drought tolerant selections, CO5693*AO36, which achieved 1.44 t/ha. A number of the other drought tolerant lines produced similar yields to Excalibur. Despite the wide range of head tipping symptoms in the lines at Penong, from nil in some of the drought tolerant lines to very high in Krichauff, this had no bearing on final grain yield.

Grain yields were much more even at Cowell, although still depressed by the short growing season. Krichauff and Excalibur both yielded close to 1.0 t/ha, and none of the lines produced higher yields, although some, including Frame, were significantly lower (*Table 1*).

The barleys at Penong yielded slightly better than the wheats, with a mean yield across the trial of near 1.4 t/ha, and a top yield of 1.6 t/ha (*Table 2*). This yield was produced by WI3806, a low rainfall selection derived from a Mundah/Keel/Barque cross, which is being fast-tracked for potential release in 2005. In the meantime, however, Keel provides a high yielding feed barley option for the Upper EP. As reported previously from studies at Minnipa, grain yields showed no relationship to the severity of boron toxicity symptoms observed on barley lines in late spring.

Triticale yields at Penong were similar to barley. Both Tahara and Tickit produced around 1.45 t/ha, while the new early maturing variety Speedee was lower yielding, at 1.25 t/ha. No obvious plant stress symptoms were observed.

What does this mean?

Improved wheat yields through selection for drought tolerance were demonstrated at Penong but not Cowell in

Table 1: Grain yields of drought tolerant wheat lines at Penong and Cowell, 2003

VARIETY/LINE	PENONG			COWELL	
	Head tipping score (21/10)	Grain yield (t/ha)	Yield as % Krichauff	Grain yield (t/ha)	Yield as % Krichauff
Krichauff	4	1.02	100	0.98	100
Excalibur	1	1.28	126	0.97	98
Frame	3	0.66	64	0.79	80
CO5235*B55	1	1.37	134	1.01	103
CO5364*A36 #	4	0.97	95		
CO5642*AC09 #	1	0.96	94	0.88	89
CO5642*AT01 #	3	0.56	55	0.95	97
CO5642*BG01 #	1	0.81	79	0.83	84
CO5642*BG10 #	1	1.19	116	0.94	96
CO5693*AO25 #		1.32	129	0.90	91
CO5693*AO31 #	0	1.16	114	0.94	95
CO5693*AO36 #	0	1.44	141	0.99	100
CO5693*BO43 #	1	1.12	109	0.99	101
DC875-1 #	0	1.30	127	0.96	98
EO27 #	0	1.03	100	0.91	93
EO78	0	1.19	117	0.94	96
Site Mean		1.09		0.93	
LSD (P=0.05)		0.13		0.08	

**Head tipping score: 0=nil, 1=light, 2=moderate, 3=high (>50% heads affected), 4=very high (all heads affected).*

 # Lines culled from the drought tolerant program due to quality/yield and rust issues.

Location
Cowell
Cooperator: Jack & Paul Kaden
Franklin Harbour Agricultural Bureau

Rainfall
Av. Annual: 300mm
Av. GSR: 210mm
2003 Total: 324mm
2003 GSR: 218mm

Yield
Potential: (W) 2.16 t/ha

Paddock History
2002: Pasture
2001: Potoroo oats
2000: Excalibur wheat

Soil Type
Loamy sand over sandy clay, surface pH 8.6

Plot size
10 m x 1.5 m x 3 reps

Other factors
Late sown (June 8), due to seed restrictions. Dry spring.

Table 2: Grain yields of boron tolerant and low rainfall barley lines at Penong, 2003

VARIETY/LINE	Boron toxicity score	Grain yield (t/ha)	Yield as % Schooner	Comments
Barque	3	1.31	125	Top feed variety on sands
Keel	1	1.55	147	Top feed variety on Upper EP
Schooner	2	1.06	100	
SloopSA	3	1.39	131	Top malting variety on Upper EP
WI3586/1747	1	1.44	136	
WI3788	1	1.23	117	B tolerance, later maturity
WI3794	1	1.35	128	B tolerance
WI3795	1	1.21	115	B tolerance
WI3797	2	1.48	140	B tolerance (?)
WI3804	1	1.47	139	Good yields at low rainfall sites
WI3806	2	1.60	152	Good yields at low rainfall sites
WI3816	1	1.24	117	
Site Mean		1.36		
LSD (P=0.05)		0.14		

**Boron toxicity score (degree of leaf spotting): 0=nil, 1=light, 2=moderate, 3=high (>50% leaf area affected).*

2003. The best of the drought tolerant selections, CO5693*AO36, was also top in the 2002 drought tolerance screening trials. However, this line has now been culled from the drought tolerance program for 2004, due to high susceptibility to leaf rust. CO5235*B55 also yielded well at both sites, and at other primary drought trial sites. The head tipping reaction to a dry finish, as observed in a number of lines including Krichauff at Penong in 2003, showed no relationship with final grain yield.

Similarly, boron toxicity symptoms in barley showed no connection with final yield at Penong in 2003. In this trial, the low rainfall selection WI3806 outyielded all others. This line has previously been identified within the barley breeding program for fast-tracking towards potential commercial release. Keel was not far behind it for yield, however.

Triticale varieties Tickit and Tahara performed very well at Penong, with yields around 14% above Excalibur (although not directly comparable, since they were not all within the same trial).

Acknowledgements

Our thanks to our farmer cooperators, Bill and Trevor Oats at Penong and Jack and Paul Kaden at Lucky Bay (that's near Cowell) for use of their land, and to Dr Neil Howes, formerly of SARDI, and Dr Jason Eglinton of the SA Barley Improvement Program for supply of seed of breeding lines for testing.

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Wheat Variety Evaluation on Sand

Tim Richardson, Brian Purdie and Ashley Flint

SARDI, Port Lincoln

Research

Key Messages

- **Wyalkatchem and Westonia were the highest yielding wheat varieties in trials on sandy soils in 2003.**
- **A new WA wheat variety, EGA Bonnie Rock, showed potential in its first year of testing.**

Why do the trials?

In response to interest from local bureau groups wheat trials were established adjacent to existing Field Crop Evaluation S4 trial sites in the traditional barley growing districts of Elliston and Wharminda. A third trial was established in 2003 at Wanilla to meet grower demand. The aim of these trials was to allow farmers to observe the relative performance of new lines and cereal varieties within their area. The entries included breeder's lines, new releases and varieties grown in the area.

How was it done?

Elliston District Wheat on Sand Trial

Treatments - varieties included 7 commercial wheats, WI3385 barley, and Tickit triticale.

Table 1: Elliston District Wheat Variety Trial, 2003

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre wt (kg/hL)
EGA Bonnie Rock	3.53	9.0	3.9	79.5
Frame	3.17	8.7	3.4	79.3
Krichauff	3.24	9.3	3.7	79.1
Pugsley (WI99069)	3.47	8.5	4.0	77.7
Worrakatta	3.44	8.5	4.3	76.1
Wyalkatchem	3.94	9.1	2.7	81.3
Yitpi	3.53	8.1	7.2	79.2
WI3385 barley	4.49	8.8	2.5	62.9
Tickit Triticale	3.08	8.8	1.6	64.9
Site mean	3.54	8.8	3.7	75.6
CV (%)	4.5	1.4	31.5	1.0
LSD (P<0.05)	0.32	0.2	2.0	1.4

Table 2: Wharminda District Wheat on Sand Variety Trial, 2003

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre wt (kg/hL)
Blade	2.51	11.7	0.4	78.1
Clearfield Stiletto	2.72	10.7	0.3	81.6
EGA Bonnie Rock	2.96	11.1	0.8	80.7
Excalibur	2.99	11.0	0.6	78.1
Frame	2.32	11.0	0.3	82.1
H45	2.40	11.3	1.3	81.1
Krichauff	2.53	11.6	0.5	79.1
Kukri	2.63	11.9	0.4	81.2
Pugsley (WI99069)	2.77	10.7	0.4	81.3
Tickit Triticale	2.51	11.1	0.9	68.6
Trident	2.81	11.5	0.3	81.4
Westonia	3.32	10.7	0.8	78.5
Worrakatta	2.59	10.2	0.6	77.1
Wyalkatchem	3.19	11.2	0.2	81.7
Yitpi	2.80	10.5	0.4	80.1
Site mean	2.74	11.1	0.6	79.4
CV (%)	5.2	3.5	27.2	1.2
LSD (P<0.05)	0.24	0.6	0.3	1.6

Table 3: Wanilla District Wheat on Sand Variety Trial, 2003

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre wt (kg/hL)
Annuello	4.06	13.4	3.5	78.2
EGA Bonnie Rock	4.18	13.5	4.2	79.1
Excalibur	4.06	13.8	2.7	75.2
Frame	3.20	14.4	0.9	78.4
Krichauff	3.66	14.3	2.6	75.9
Kukri	3.40	14.5	2.6	77.3
Pugsley (WI99069)	3.61	14.0	1.5	77.8
Tickit Triticale	3.43	13.8	1.6	66.2
Westonia	4.58	13.3	3.2	77.1
Worrakatta	3.85	13.0	4.1	73.7
Wyalkatchem	5.02	13.1	1.0	79.2
Yitpi	3.75	14.1	1.4	77.3
Site mean	3.90	13.8	2.4	76.3
CV (%)	3.1	5.5	28.3	2.0
LSD (P<0.05)	0.22	1.3	1.2	2.5

Sowing date - June 11, 2003.

Fertiliser - All varieties received 100 kg/ha of 22:15:0, drilled with the seed.

Trace elements - Mangasol @ 1.5 l/ha.

Herbicides - Touchdown® @ 1 L/ha, Triflur480® 1 L/ha, RoundupMax® 1L/ha, Striker® 0.1 L/ha, LVE MCPA® 0.7 L/ha and Ovation500® 0.75 L/ha and Meta snail bait.

Measurements - grain yield and quality attributes.

Wanilla District Wheat on Sand Trial

Treatments - varieties included 11 commercially available wheat lines and Tickit triticale.

Sowing date - June 7, 2003.

Fertiliser - All varieties received 100 kg/ha of 18:20:0, plus 160kg/ha Urea.

Trace elements - Mn 400 g/ha, Zn 200 g/ha and Cu 60 g/ha (active element).

Herbicides - RoundupMax® 1 L/ha, Striker® 0.1 L/ha, RoundupMax® 1 L/ha, Triflur480® 800 L/ha, Diuron 1 L/ha, Dimethoate 0.4 L/ha, Fastac® 0.2 L/ha, Bumper® 0.25 & 0.5 L/ha.

Measurements - grain yield and quality attributes.

Wharminda District Wheat on Sand Trial

Treatments - varieties included 14 commercially available wheat lines and Tickit triticale.

Sowing date - June 7, 2003.

Fertiliser - All varieties received 80 kg/ha of 18:20:0, plus 50kg/ha Urea.

Trace elements - Mn 400 g/ha, Zn 200 g/ha and Cu 60 g/ha (active element).

Herbicides - RoundupMax® 0.8 L/ha, Striker® 0.1 L/ha, RoundupMax® 1 L/ha, Triflur480® 1.0 L/ha, LVE MCPA® @ 0.7 L/ha.

Measurements - grain yield and quality attributes.

What happened?

See Table 1.

What does this mean?

All three sites experienced good opening rains and moisture levels were satisfactory throughout the growing season, and the relatively mild finish assisted in grain

Location
Elliston: Nigel and Debbie May

Rainfall
Av. Annual total: 400mm
2003 Total: 443mm
2003GSR: 354mm

Yield Potential: 4.9 t/ha

Paddock History
2002: Pasture
2001: Euro oats
2000: Pasture

Soil Type
Highly calcareous loamy sand

Plot size
1.5m x 10m x 4 replicates

Location
Wharminda: Peter Forrest

Rainfall
Av. Annual total: 320mm
2003 Total: 341mm
2003 GSR: 266mm

Yield Potential: 3.1 t/ha

Paddock History
2002: Pasture
2001: Wheat
2000: Pasture

Soil Type
Sand over sodic clay

Plot size
1.5m x 10m x 4 replicates

Location
Wanilla:
Graham & David Giddings

Rainfall
Av. Annual total: 450mm
2003 Total: 449mm
2003 GSR: 345mm

Yield Potential: 4.7 t/ha

Paddock History
2002: Canola
2001: Pasture
2000: Pasture

Soil Type
Non wetting sand over medium clay

Plot size
1.5m x 10m x 4 replicates

Table 4: Wheat variety performance in Individual years and Long-term averages at Wharminda and Elliston, between 2001 to 2003, expressed as a % of Frame's Yield.

Variety	WHARMINDA				ELLISTON			
	2001	2002	2003	AVE	2001	2002	2003	Ave
Barque Barley	143	126		134				
Bevy Rye	98	134		116				
Blade	107		107	107				
Camm	109	107	146	120	101	95		98
Excalibur	110	104	129	114				
Frame	100	100	100	100	100	100	100	100
H45	96	113	104	104	79	112		95
Krichauff	109	107	109	108	93	116	102	104
Schooner Barley	108	154		131				
Tahara Triticale	102	124		113		109		109
Trident	112	119	121	117				
Westonia	125	111	141	126	87	126		106
Pugsley	118	106	121	115		93	109	101
Worrakatta	102		112	107				
Wyalkatchem		105	140	122		130	124	127
Yitpi	96	105	122	107	107	103	111	107
Frame's Yield (t/ha)	**1.34**	**0.83**	**2.22**	**1.46**	**1.50**	**0.96**	**3.17**	**1.88**

* *Averages are calculated on the individual percentages of Frame in each year.*

filling. There were no major problems with diseases or pests that would have limited yields.

Barley's dominance in yield over wheat on these particular sandy soil types, was highlighted with the performance of the new breeders' line WI3385 at Elliston. Across the three sites in 2003, Wyalkatchem and Westonia were the highest yielding varieties, which is consistent with their performance in other stage 4 trials across Eyre Peninsula. EGA Bonnie Rock which was released from WA in 2002 as a high protein achieving variety, has been classified as APW in SA and performed well at all locations, but further evaluation is required to determine its adaptability to EP.

From the 2003 data and the long term table, no wheat variety was observed to show any specific improved adaptation to sandy soils, with variety performance consistent with what we could expect on more traditional wheat growing soils.

Acknowledgements

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Research

Almost ready

Fast Tracking Drought Tolerant Wheat

Michael Bennet[1], Phil Davies[2], Stephen Jefferies[3] and Neil Howes[4]

SARDI, Minnipa Agricultural Centre[1], SARDI, Waite Precinct[2],

Australian Grain Technologies Pty Ltd[3] and formerly SARDI, Waite Precinct[4]

Key Messages

- **New drought tolerant varieties yield 20% greater than Frame across all Eyre Peninsula sites in 2003.**
- **Summer increase of some lines allowing extensive field testing in 2004 with potential commercial release in 2007.**

Why do the trials?

The "Fast Tracking Drought Tolerant Wheat" project was initiated to identify the reasons why particular varieties such as Excalibur continue to perform well in low rainfall growing seasons. The aim of the project is to identify the characteristics that define a "drought tolerant" wheat variety. Identification of these traits will enable wheat varieties suitable for low rainfall farming regions to be recognised early in the Australian Grain Technologies (AGT) breeding program and hasten their commercial release.

How was it done?

Two wheat varieties, Excalibur and Krichauff and one breeder's line (RAC875) have consistently performed better than other varieties in low rainfall seasons on Upper Eyre Peninsula. (UEP)

Excalibur has, since its release in the early 1990's, consistently performed well in low rainfall seasons. It has moderate resistance to root lesion nematode and appears that it may be able to restrict the number and flowering time of tillers produced under different conditions. Regrettably Excalibur sits alongside Krichauff in the ASW grade and is very susceptible to leaf rust.

Krichauff is also a variety that has performed relatively well over a number of years on UEP. Krichauff is early maturing and moderately tolerant to boron toxicity and may have a slightly superior level of salt tolerance. Krichauff is also moderately resistant to root lesion nematode and is susceptible to leaf rust and now also stripe rust. Krichauff also has the ability to curl its leaves during the warmer parts of the day, which may benefit it in hot conditions.

RAC875 is a breeders line identified in the AGT breeding program that has performed exceptionally well in low rainfall seasons. This line produces high levels of wax on its leaves when it encounters warm dry conditions and this reaction may be of benefit under these conditions. RAC875 also has the ability to maintain large grain size under drought stress. The line however is very susceptible to leaf rust and late maturity alpha amylase (a form of sprouting susceptibility) but has good quality characteristics.

The aim of the breeding strategy was to intercross Excalibur, Krichauff and RAC875 so as to potentially combine the traits, which may contribute to the superior performance in low rainfall areas and improve the rust resistance and quality of the progeny by including Kukri as a parent in the intercrossing. The breeding strategy involved intercrossing the parents, selecting superior progeny and then intercrossing the progeny. The drought tolerance experiments consist of more than 100 progeny from this final cross. Based on pedigree, we would expect the progeny to be made up of, on average (across all progeny), 43.75% RAC875, 18.75% Excalibur, 18.75% Krichauff and 18.75% Kukri.

The progeny was grown at three sites on the Eye Peninsula during 2003. The Kimba, Minnipa and Streaky Bay trials were sown on the 10th, 11th and 12th of June respectively. A late planting at Minnipa was sown on the 3rd of July. The Streaky Bay and Minnipa sites were sown with 70 kg/ha of 17:19:0 + 2.5% Zn. The Kimba site was sown with 80kg/ha of 18:20. All trials were sown on 18 cm row spacing, except the Streaky Bay site which was sown on 18.5 cm. The trials all received a knockdown and trifluralin pre-seeding.

Two additional drought tolerance selection trials were included in the AGT seeding program for 2003. The aim of these experiments was to determine the potential of the varieties in different yield potential environments. Roseworthy in the lower North enjoyed an exceptional season. A trial was also sown at Woomelang, 25km South West of Sea Lake in Victoria.

What happened?

The 2003 season provided a wide range of conditions for the various sites across the Eyre Peninsula. Streaky Bay enjoyed a healthy growing season with above average yields. The Kimba site took advantage of excellent early conditions, however suffered later in the season with severe tipping of varieties such as Krichauff. The season at Minnipa started poorly and continued with below average rainfall through to harvest. Of particular interest is the sound performance of the lines at Roseworthy, which indicates that their suitability may not be limited to just low rainfall districts or seasons (*Table 1*).

The 2003 season saw new developments in the battle with leaf rust with more than a third of varieties included in the drought trials affected to some extent. Regrettably, some of these varieties have shown promise for the UEP.

The lines were expected to differ for a range of characteristics that may be associated with drought tolerance, including boron tolerance, waxy leaves, leaf rolling, large grain size, pratylenchus resistance, tolerance to high soil pH and early vigour. Measurements taken during and after the growing season enabled differentiation of each individual lines ability to cope with drought conditions.

Almost ready

Location
Minnipa
Co-operator: MAC

Rainfall
2003 total: 263mm
2003 G.S.R: 204mm

Yield Potential: 1.9 t/ha

Location
Kimba
Co-operator: Alex Sampson

Rainfall
2003 total: 323mm
2003 GSR: 230mm

Yield Potential: 2.7 t/ha

Location
Streaky Bay
Co-operator: Simon Patterson

Rainfall
2003 total: 340mm
2003 GSR: 270mm

Yield Potential: 3.2 t/ha

Location
Roseworthy
Co-operator: University of Adelaide

Rainfall
2003 total: 440mm
2003 GSR: 330mm

Yield Potential: 4.8 t/ha

Location
Woomelang
Co-operator: Rex Barbery

Rainfall
2003 total: 372mm
2003 GSR: 230mm

Yield Potential: 2.9 t/ha

Table 1: Grain yield of wheat lines and varieties in 2003; t/ha (% of Frame)

Site	Frame	Excalibur	Co5693*F036	Co5235*B55	Co5693*E002	Co5693*D046	Co5693*E023
Kimba	0.85 (100)	1.03 (121)	1.41 (166)	1.14 (134)	1.05 (123)	1.11 (130)	0.93 (109)
Minnipa 1	0.55 (100)	0.74 (140)	0.68 (127)	0.73 (137)	0.65 (122)	0.77 (145)	0.81 (153)
Minnipa 2	0.61 (100)	0.73 (130)	0.87 (155)	0.74 (133)	0.84 (150)	0.72 (128)	0.76 (135)
Streaky Bay	1.17 (100)	1.71 (147)	1.52 (131)	1.65 (142)	1.40 (120)	1.56 (134)	1.51 (130)
Woomelang	1.77 (100)	2.03 (114)	1.93 (109)	2.04 (115)	2.21 (124)	1.55 (87)	1.98 (111)
Roseworthy	3.69 (100)	3.66 (99)	3.58 (97)	4.05 (109)	4.16 (112)	3.96 (107)	3.94 (106)

2004 Plans

Pre-seeding 2004 will see flour and dough quality testing completed to determine the grade and end use of the perspective varieties. This analysis is imperative to clarify which varieties will make the leading choice as cultivars for sowing through the low rainfall belt. The drought tolerant lines also need to be subjected to both stripe stem rust resistance screening to determine their relative resistance status. The parental varieties have varying degrees of resistance to stem and stripe rust, however testing will ascertain which are the most suitable lines for release.

The breeding lines have been culled back to a list of 20 that will make up the prospective "drought tolerant" varieties for release. This list will be culled further once the flour and dough analysis is complete. Three of the perspective lines, Co5693*E002, Co5693*D046 and Co5693*E023 were included in the AGT summer increase, and were planted under a centre pivot near Roseworthy. This will increase the availability of seed for further testing.

This year's experimentation will include some new breeding material from the AGT program, which may be suitable for low rainfall environments. The core drought trials at Minnipa will remain fairly similar to the 2003 program, to allow the drought tolerant characteristics to be assessed further. However the size of experiments at other sites will be condensed considerably (only the retained lines) which may allow for extra sites to be planted within the resources available.

Acknowledgements

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Appreciation also goes to Brian Purdie and Jim Egan for managing the Kimba site, Colin Warner for managing the Roseworthy site and Russell Eastwood for managing the Woomelang site. Thanks to the numerous MAC staff who generously assisted during the course of the season.

SAGIT | SARDI South Australian Research and Development Institute | Government of South Australia | AGT Australian Grain Technologies

Searching for answers

Location
1: Minnipa Agricultural Centre
2: Pt Wakefield

Cooperators
1: MAC
2: Andrew Wilson

Rainfall
2003 Total
1. 263mm
2. 325mm
2003 GSR
1. 204mm
2. 238mm

Sowing Date
1: 25th June
2: 20th June

Fertiliser
1: 17:19:0+2.5%Zn @ 70kg/ha
2: 22:14 :0 @ 115kg/ha

Plot size
1: 5.0 m x 1.6 m
2: 3.2 m x 1.2 m

Potential Yield
1: 2.3 t/ha
2: 4.8 t/ha

Barley Breeding for Low Rainfall Environments

Stewart Coventry[1], Jason Eglinton[1], Leigh Davis[2], Michael Bennet[2] and Brian Purdie[3]

School of Agriculture and Wine, University of Adelaide[1], SARDI, Minnipa Agricultural Centre[2], SARDI, Port Lincoln[3]

Research

Key Messages

- **ICARDA lines yielding equivalent to the best Australian feed varieties in low rainfall trials were identified.**
- **Some lines have high relative yield across drought stressed and favourable environments.**
- **These ICARDA lines represent genetically different sources of adaptation for Australian breeding programs.**

Why do the trial?

The University of Adelaide is collaborating with ICARDA (International Centre for Agricultural Research in the Dry Areas) in Syria to produce barley that is better adapted to the low rainfall areas of Australia. Collaborative barley breeding means there is an interchange of barley lines and evaluation of their performance in the respective countries, which promotes mutual benefit and reciprocity between Australia and Syria. ICARDA have utilised wild barley and primitive landraces to breed for improved drought tolerance and adaptation to soils of low fertility. ICARDA barley has historically led to major advances in the adaptation of Australian barley, with lines from North Africa and the Middle East used in the development of Clipper and Keel.

ICARDA barley has been evaluated in Australian low rainfall environments since 1999, as previously reported in the EP Farming Systems Summary (*FS1999 pg 15, FS2000 pg 15-16, FS2001 pg29-30, FS2002 pg28-29*). ICARDA barley was evaluated at five low rainfall environments across Australia in 2003, with the primary environments being Pt. Wakefield and at the Minnipa Agricultural Centre (MAC). The performance of new ICARDA barley is evaluated against cultivars and elite breeding lines from Australian breeding programs, and ICARDA lines previously selected for superior performance since 1999. The best ICARDA lines are being incorporated into current Australian barley to improve the productivity of barley in the cereal growing areas of Australia.

How was it done?

Field trials in 2003 included ICARDA barley lines having comparable yields to current Australian varieties evaluated previously under a range of environmental conditions from 1999-2002, new introductions from ICARDA, and elite breeding lines and cultivars. In South Australia, replicated field trials were conducted at Pt. Wakefield and MAC, with 144 barley lines evaluated at each site. The drought of 2002 meant there was only enough seed to evaluate all the new ICARDA introductions (30 lines) at Pt. Wakefield, and approximately 50% of these at the MAC, with the difference made up with selections from a Barque*wild barley cross which performed well in 2002. Field trials were also conducted on ICARDA barley lines excluding those new introductions for 2003 at Ouyen (Victoria), Condobolin (NSW), and Salmon Gums (WA). Assessment was made for yield and physical grain characteristics, plant height and maturity at all sites, and biotic or abiotic stresses where they occurred. Boron toxicity symptoms were observed at both the MAC and Pt. Wakefield, with foliar disease additionally at the latter site.

What happened?

At Pt. Wakefield there was good early growth and moderate temperatures, with only mild soil moisture deficit briefly during stem elongation, followed by favourable conditions until maturity. The growing season at MAC was characterised by high temperatures during stem elongation and subsequently severe drought stress, returning to cooler, yet dry conditions during grain filling. Grain yields were between 0.6-1.4 t/ha (avg. 1 t/ha) at MAC, and between 2.6-3.2 t/ha (avg. 2.9 t/ha) at Pt. Wakefield. Average yields for the other sites were 1.3 t/ha at Ouyen, 2.4 t/ha at Condobolin, and 3.3 t/ha at Salmon Gums.

The trial at MAC was the lowest yielding, and gave the best test for adaptation to low rainfall environments. Ouyen was also low yielding, but this was due to the influence of frost and sandy soils, giving rankings of lines opposite all other sites. Keel was the highest yielding barley in all environments, except Ouyen, and Salmon Gums where it ranked third, showing its good general adaptation, within the low rainfall type barley lines. Keel sets the benchmark for other varieties to out yield, and the yields for a subset of the top ICARDA lines under different environments are expressed relative to Keel in Table 1. The breeding line WI3806, derived from a Mundah/Keel/Barque cross, shows great promise for the low rainfall areas, where it yields equivalent to Keel. Also evaluated in 2003 was the Victorian breeding line VB0216, which yielded equivalent to WI3806 at MAC, but higher in the more favourable environments also. In the low rainfall MAC environment, ICARDA lines with equivalent grain yield to Keel were identified, as shown in Table 1. The highest yielding ICARDA line was ISBYT-LRA(C)-4, which also performed well in the 2002 low rainfall environments. None of the new ICARDA introductions performed well in this environment. Grain physical characters (screenings percentage, thousand grain weight, and test weight) are being currently assessed.

*Table 1: The performance of several ICARDA barley lines in comparison to four current varieties evaluated over 5 seasons (1999-2003) x 2 sites (Minnipa Agricultural Centre =MAC, Port Wakefield =PTW), representing drought stressed (indicated by *) and favourable environments. Values are grain yield expressed as a percentage of Keel (yield greater than Keel indicated in bold) at individual locations, with adjusted mean yield (t/ha) in parenthesis for Australian varieties.*

	1999		2000		2001		2002		2003	
Genotype	**MAC***	**PTW***	**MAC***	**PTW**	**MAC**	**PTW**	**MAC***	**PTW***	**MAC***	**PTW**
ICARDA#12	-	-	94	**107**	97	93	91	83	88	97
ICARDA#23	-	-	88	98	98	80	**102**	**100**	88	96
ICARDA#25	-	-	87	88	94	75	95	86	78	93
ICARDA#26	-	-	97	97	87	80	86	86	82	94
ICARDA#39	-	-	78	87	84	88	95	94	82	96
PARENT#19	-	-	77	97	88	73	**111**	**107**	87	98
ISBON--LRA-M-52	83	81	90	98	94	83	90	92	88	96
ISBON--LRA-M-81	95	84	85	92	83	75	86	89	88	95
ISBON--LRA-M-107	95	68	84	88	81	73	97	**101**	70	93
ISBYT-LRA(C)-4	86	81	92	99	97	86	**100**	85	92	98
ISBYT-LRA(C)-15	80	89	88	94	77	77	**100**	**100**	78	94
ISBYT-LRA(C)-19	83	**103**	95	**102**	94	89	85	77	77	93
ISBYT-LRA(M)-19	98	78	93	97	91	83	90	90	79	94
ISBYT-LRA(M)-22	75	74	82	93	94	78	96	94	81	94
ISBYT-LRA(C)-19/24							99	94	79	96
WI3806							**107**	**102**	92	98
Keel	(0.80)	(0.74)	(2.05)	(3.37)	(3.88)	(3.13)	(2.01)	(0.94)	(1.4)	(3.15)
Barque	86 (0.69)	**105** (0.78)	**100** (2.06)	**102** (3.45)	81 (3.16)	82 (2.57)	83 (1.70)	68 (0.63)	69(0.97)	93(2.93)
Mundah	**105** (0.84)	70 (0.52)	90 (1.84)	96 (3.24)	**102** (3.97)	84 (2.63)	96 (1.97)	94 (0.88)	87(1.21)	97(3.06)
Schooner	85 (0.68)	**100** (0.74)	99 (2.03)	84 (2.83)	91 (3.53)	76 (2.38)	85 (1.75)	82 (0.78)	78(1.09)	95(2.98)
Site Mean (t/ha)	0.56	0.53	1.71	2.99	3.49	2.43	1.54	0.69	1.08	2.94
%CV	18.5	18.5	9.1	12.8	7.7	13.9	16.0	20.6	12.7	3.2

What does this mean?

The low rainfall trial at MAC in 2003 has provided further useful information for identifying ICARDA lines with good adaptation to these environments. Combined with the other trial data, it can be seen that a number of ICARDA lines have high yields in both stressful and favourable environments, indicating yield stability. Although none of the ICARDA lines have out yielded Keel in all environments, having comparable yield is an achievement for straight introductions with different genetic background to the current Australian breeding material. A number of these ICARDA lines are being used as parents in development of the next generation of low rainfall Australian barley varieties. Breeding lines developed from ICARDA barley will be evaluated at the SABIP mainstream sites, and promising material will be included in trials at the 6 low rainfall sites as part of the program to develop improved barley varieties for low rainfall regions across southern Australia. In 2004 there will be further field evaluation at six sites of new and well performing ICARDA lines, tested against new Australian breeding lines and cultivars.

Acknowledgements

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THE UNIVERSITY OF ADELAIDE AUSTRALIA

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Types of Work in this Publication

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	n/a	Usually summary of research results

Section 2

Section editor: Amanda Cook

SARDI, Minnipa Agricultural Centre

Break Crops

The following varieties are consistent performers over a range of trial sites on E.P. during 2003, however varieties should be selected on more factors than just yield in one season.

- Field Peas - Parafield, Kaspa
- Lupins - Quilinock, Jindalee
- Faba Beans - Fiesta, Farah
- Lentils - Matilda, Nugget, CIPAL 203
- Chick Peas - Tyson, Howzat
- Canola – *Conventional:* Ag Outback, Ag Spectrum, Ag Emblem, Rivette
  Clearfield: 46C04, 44C11
  T.T. - ATR Beacon, ATR Stubbie, Surpass 501TT
  Hybrid -Hyola 43

A question that arose from the group meetings in March 2003 was "How much nitrogen does canola stubble contain?" In answer to that query there is 12 kg nitrogen, 1.2 kg phosphorus and 4 kg sulphur per tonne of canola stubble.

Break Crop Variety Evaluation 2003

SAFCEP Field Pea Variety Performance

Long term (1997-2003) yields expressed as a percentage of Parafield's yield

Variety	Lock	Minnipa	Yeelanna
Alma	86	85	90
Dundale	89	89	93
Dunwa	89	89	93
Excell	94	92	94
Glenroy	79	80	86
Helena	94	92	94
Kaspa	106	106	104
Kiley	89	85	93
Morgan	89	89	91
Mukta	92	94	100
Parafield	100	100	100
Paravic	94	92	97
Santi	92	91	97
Snowpeak	90	88	91
Soupa	93	94	99
Parafield's Yield (t/ha)	**2.17**	**1.62**	**3.19**

SAFCEP Lentil Variety Performance

2003 and long term (1997-2003) yields expressed as a percentage of Nugget's yield.

Variety	2003		1997-2003	
	Cocka-leechie	Yee-lanna	Cocka-leechie	Yee-lanna
Aldinga	99	103	100	99
Cassab	91	98	101	94
Digger	90	99	100	101
Matilda	92	112	96	97
Northfield	80	101	93	94
Nugget	100	100	100	100
CIPAL203	101	115	101*	103*
Nugget's yield (t/ha)	**2.00**	**2.17**	**2.18**	**2.34**
Date sown	11-Jun	19-Jun		
Soil type	CL/SC	SCL/LC		
A-O rainfall (mm)	323	318		
pH (H_2O)	8	7.8		
Site Stress Factors	vg,bo,w	bo,dl,wl		

SAFCEP Canola Variety Performance

2003 and long term (1997-2003) yields expressed as a percentage of Oscar and Pinnacle's yield

	2003					1997-2003				
Variety	**Minnipa**	**Yeelanna**	**Tooligie**	**Ungarra**	**Mt Hope**	**Minnipa**	**Yeelanna**	**Tooligie**	**Ungarra**	**Mt Hope**
44C11	139	123			114	133	116			115
44C73	129	91			101	111	101			104
45C05	94	117			106	114	109			108
45C75	100	85			105	95	96			100
46C04	116	128			104	119	110			110
46C76	88	101			111	101	101			103
Ag-Castle	81	116			111	95	100			103
Ag-Outback	137	111			109	113	108			107
Ag-Spectrum	115	136			115	126	110			110
AV-Sapphire	83	126			111	121	112			110
Emblem	130	100			98	109	107			109
Hyola 43	136	98			109	122	108			109
Hyola 60	125	69			101	119	111			112
Hyola 61	98	113			103	107	104			105
Lantern	110	111			111	112	107			108
Mystic	112	88			96	100	99			99
Oscar	100	100			100	100	100			100
Rainbow	79	104			108	105	105			105
Rivette	147	118			116	130	112			111
Surpass 404CL	137	79			79	85	90			92
Surpass 603CL	98	63			86	104	102			104
Oscar's yield (kg/ha)	**491**	**2704**			**2774**	**698**	**1832**			**1947**
ATR-Beacon	115		111	102		98		103	108	
ATR-Eyre	98		99	106		77		93	92	
ATR-Grace	89		97	86		93		97	102	
ATR-Hyden	88		105	95		90		100	105	
ATR-Stubby	137		115	101		104		102	105	
Pinnacle	100		100	100		100		100	100	
Surpass 501TT	110		116	91		93		103	101	
Tranby	106		103	109		90		96	104	
Tornado 555TT	113		110	113		93		101	107	
Pinnacle's yield (kg/ha)	**289**		**1743**	**2064**		**692**		**1342**	**1348**	
Date sown	7/6	22/5	20/5	26/5	23/5					
Soil type	SL/SL	LiSCL/LC	S/LC	S/SC	LS/LC					
A-O rain	200	317	285	324	388					
pH	8.4	7.8	7.0	6.9	5.1					
Stress factors	de, dl	bl,sn								

SAFCEP Desi & Kabuli Chickpea Variety Performance

2003 & long term (1997 & 2003) yields expressed as a percentage of Howzat's yield

Variety/Line	2003			1997-2003		
	Cockaleechie	**Lock**	**Minnipa**	**Cockaleechie**	**Lock**	**Minnipa**
Howzat	100	100	DROUGHTED	100	100	100
Tyson	98	109		98	98	97
FLIP94-508C	110	85		93	86	82*
ICCV96836	93	101		100	100	100*
Kaniva#	73	-		86	-	-
Howzat's yield (t/ha)	**1.57**	**1.38**		**1.67**	**1.02**	**0.65**
Date sown	11-Jun	21-May	08-Jun			
Soil type	CL/SC	SL/SC	SL/SCL			
A-O rainfall (mm)	323	300	200			
pH (H_2O)	8	7.9	8.3			
Site Stress Factors	dl	sc,w,dl	ls,de/l,w			

SAFCEP Faba Bean Variety Performance

(2003 and long term (1997-2003) yields expressed as a percentage of Fiesta's yield

Variety	Sowing Density (seeds/sq.m)	2003				1997-2003			
		Minnipa	Lock	Cockaleechie	All SA sites mean	Minnipa	Lock	Cockaleechie	All SA sites mean
Ascot	24		110	102	80	64	85	89	84
Barkool	24	57	98	110	86	80	88	93	88
Cairo (SP95054)	24	96	103	88	95	80	89	91	89
Farah (483/3)	24	83	100	102	103	101	101	103	102
Fiesta.hi	24	100	100	100	100	100	100	100	100
Fiesta.med	18	65	98	108	91	85	92	96	92
Fiord	24	63	117	109	97	83	92	96	93
Icarus*Ascot/7/3	24	80	112	115	99	107	102	105	101
Icarus*Ascot/56/1P	24	90	107	102	99	92	97	97	95
Fiesta.hi yield (t/ha)		**0.29**	**2.47**	**4.07**	**2.43**	**0.98**	**1.85**	**3.26**	**2.41**
Date sown		June 8	May 21	May 16					
Soil type		SL / SCL	SL / SC	CL / SC					
pH (water)		8.3	7.9	8.0					
Apr-Oct rain (mm)		200	300	323					
Site stress factors		de, dl, w	w	cs					

SAFCEP Lupin Variety Performance

2003 & long term (1997-2003) yields expressed as a percentage of Merrit's yield

Variety	2003			All SA sites mean	1997-2003			All SA sites mean
	Tooligie Hill	Ungarra	Wanilla		Tooligie Hill	Ungarra	Wanilla	
Belara	84	96	108	98	101	100	101	103
Jindalee	96	110	96	105	102	104	102	103
Kalya	104	102	89	104	100	98	98	101
Merrit	100	100	100	100	100	100	100	100
Moonah	82	96	98	99	98	100	100	102
Quilinock	90	92	94	110	107	103	104	105
Tanjil	88	98	91	98	98	99	98	101
Wonga	94	106	91	99	100	100	98	101
Walan2118	96	99	102	106	103	102	100	103
Walan2128	90	95	90	99	104	103	101	104
Walan2141	85	105	105	106	107	103	104	106
Merrit's yield (t/ha)	**2.55**	**2.41**	**2.79**	**1.93**	**1.53**	**2.42**	**2.73**	**2.24**
Date Sown	20-May	26-May	23-May					
Soil Type	S/SC	S/SC	S/MC					
A-O Rain 2003 (mm)	285	324	345					
pH (H_20)	6.7	6.9	5.0					
Site Stress Factors	e,dl	-	-					

Data source: SAFCEP (long term data based on weighted analysis of sites, Biometrics SA)

Compiled by Trent Potter, Larn McMurray and Tim Richardson.

Abbreviations

Soil type S=sand, C=clay, L= loam, H= heavy, M= medium, Li= light, F= fine, K= coarse, / 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, wl = waterlogging, vg = excessive vegetative growth / juvenile lodging, bo = botrytis grey mould, sc = sclerotinia, ls = late sown, ap= aphids, hd= herbicide damage, bl= blackleg, wind= wind loss, ls=late sown, sn= snails

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Try yourself

Location
Minnipa Agricultural Centre
Paddock – North 3

Rainfall
Av. annual : 326mm
Av. G.S.R.: 241mm
2003 total : 263mm
2003 G.S.R.: 204mm

Paddock History
2003: Canola trials
2002: Barley
2001: Wheat
2000: Pasture

Soil Type
Sandy loam, pH 8.9

Canola and Mustard in a Dry Environment

Trent Potter[1] and Amanda Cook[2]

SARDI, Struan[1], SARDI, Minnipa[2]

Research

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. Each type has advantages and disadvantages that we will discuss here.

Trials conducted at Minnipa and other low rainfall sites between 2001 and 2003 tested a range of early maturing canola cultivars. When looking at these results *(Table 1)*, be aware that oil contents in 2001 were high compared to poorer years and oil contents for 2002 are low due to late sowing and a dry finish. The season of 2003 was even worse than 2002 with an even later break and then little rain at the end. In future it may be that we need to achieve over 42% oil to avoid a dockage in price.

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. A new conventional cultivar that has been released is 44C11 from Pioneer. This is an early-mid season cultivar that may fit into the low rainfall area but has had little testing so far.

The highest yielding early maturing Clearfield®, cultivar in trials in 2001 and 2002 was 44C73 that produced similar yields to the best conventional cultivars. However in the poor season of 2003 the earlier maturity of Surpass 402CL produced higher grain yields than 44C73. Oil content of 44C73 was relatively low compared to the highest cultivars. Surpass 404CL has been released by Pacific Seeds and at Minnipa was very early flowering, similar to Surpass 402CL.

When triazine tolerance (TT) 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.

Two new TT cultivars have been released for 2004. These are ATR-Stubby, a short, early-mid season cultivar that has yielded well in low rainfall areas over the last several years. The other cultivar is Tornado 555 TT from Pacific Seeds, which has not been tested widely. However in two trials at Minnipa in 2003 it yielded similarly to ATR-Stubby.

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. The best Clearfield®, cultivars nearly match the conventional cultivars for yield and oil but are more expensive (seed plus herbicide package is about $80 per hectare). Also 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 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.

The last two years have shown that sowing date

Table 1: Grain yield (relative to Ag-Outback) and oil content (%) of conventional and Clearfield® canola cultivars at Minnipa, 2001, 2002 and 2003.

Cultivar	Grain yield 2001 (% of Ag- Outback)	Oil content 2001 (%)	Grain yield 2002	Oil content 2002 (%)	Grain yield 2003
Conventional					
Monty	94	39.1	-		
Ag-Outback	100	38.8	100	34.9	100
Rivette	103	42.1	91	35.9	108
Clearfield®					
44C73	102	39.7	80	34.4	94
Surpass 402CL	79	43.1	70	36.8	100

Table 2: Grain yield (t/ha) & oil content (%) of triazine tolerant canola cultivars at Minnipa, 2001, 2002 & 2003.

Cultivar	Grain yield 2001	Oil content 2001 (%)	Grain yield 2002	Oil content 2002 (%)	Grain yield 2003
Karoo	1.32	38.3	0.61	35.2	
ATR-Eyre	1.17	40.5	0.33	33.2	0.28
Surpass501TT	1.22	41.8	0.58	36.1	0.32
ATR-Beacon	1.37	39.3	0.59	35.0	0.33
ATR-Stubby			0.72	36.5	0.40

and conditions during the growing season 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. In order to produce high yields it is necessary that canola be sown as early as possible, given good weed control, and sowing as late as was the case in the last two years is not recommended. 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 allowed canola to be sown in April is the best option for farmers to grow canola in the rotation in low rainfall areas. Use it as 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 frequently than canola is now.

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, 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 are currently being crossed with higher oleic acid sources from Canada. Canola quality cultivars are expected to be available for commercial production by 2005. Initially it is likely that these cultivars will be conventional but additional herbicide resistant types will also be released as has been the case with canola.

As can be seen from *Table 3*, in years where canola yields above about 1 t/ha, the mustard lines under test produce lower yields than commercial canola cultivars. However, in years where lower yields are attained such as in 2002, the mustard lines often perform better than canola, although yields were similar at Minnipa in 2003. At Miltaburra, a selection of canola and mustard were sown on a lighter sandier soil and mustard lines clearly outperformed canola (*Table 4*).

At present, it seems that mustards that are more likely to produce canola quality grain, produce lower yields than

Table 3: Grain yield (t/ha) and oil content (%) of mustard lines and canola cultivars at Minnipa, 2001, 2002 and 2003

Cultivar/line	Grain yield 2001	Grain yield 2002	Grain yield 2003
Canola			
Ag-Outback	1.47	0.47	0.62
Rainbow	1.49	0.29	0.45
Mustard			
Non-canola quality	1.34	0.50	0.62
Canola quality	1.15	0.46	0.63
Arid (Canadian)		0.35	0.41

Table 4: Grain yield (t/ha) of canola and mustard selections at Miltaburra in 2003

Cultivar/line	Canola	Mustard
Average	0.43	0.54
Best lines	0.57 (Ag Outback)	0.77 (887-1-6-1)
	0.56 (44C73)	0.62 (JP056)

Table 5: Grain yield (t/ha) of canola selections at Minnipa in 2003

Cultivar/line	Conventional	Triazine tolerant
Best control	0.53 (Ag-Outback)	0.40 (ATR-Beacon)
Highest yielding line	0.72 (BLN2017*SL008-SL101)	0.56 (TO094*SP009)

mustards that have lower levels of Oleic acid (the fatty acid that makes canola oil monounsaturated and therefore more healthy to eat). However much of this yield difference is caused by the later flowering caused by crossing Australian adapted mustards to later flowering but better quality Canadian lines. An example of this is the cultivar Arid that was released in Canada in 2002. This is late flowering and low yielding under our conditions. When earlier, high quality mustard lines are selected it is hoped that higher yields will be achieved.

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. Those 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. As can be seen from Table 5, increased yields have been achieved in both triazine tolerant and conventional canola lines and oil content has also been increased (data not shown). We hope to release an early flowering triazine tolerant cultivar in the next two years that will give more consistent yields and higher oil content than the currently available commercial cultivars. While there may also be a place for an early flowering conventional cultivar, it is more likely that these lines will be crossed to develop even better triazine tolerant cultivars in future.

Acknowledgements

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SAGIT

Searching for answers

Location
Closest town: Poochera
Cooperator: Peter and Kevin Carey

Rainfall
Actual annual total: 297mm
Actual growing season: 244mm

Yield
Potential: 2.01 t/ha
Actual: 1.1 t/ha

Paddock History
2002: Wheat
2001: Pasture

Soil
shallow grey calcareous loam over sandy clay loam over sheet limestone (26 cm)

Plot size
20 m x 1.5 m

Other factors
Shallow soil over limestone meant that plots finished off under moisture stress despite good growing season conditions

Biodiesel: a new opportunity for Upper Eyre Peninsula?

Nigel Wilhelm
SARDI, Minnipa Ag Centre

Research

Key Messages

- **Oilseeds for biodiesel may be a new marketing opportunity for upper EP farmers.**
- **Mustards for biodiesel have shown promise in 2003.**

Why do the trial?

Biodiesel is a generic name for fuels obtained by esterification of any vegetable oil or animal fat. It can be blended with conventional diesel or used in 100% concentrations. The end product is a fuel with very similar properties to pure diesel, but with potential improvements in emissions performance. Engines running on biodiesel emit 40% less particulates, 60% less total unburnt hydrocarbons, 100% less sulphate and 44% less carbon monoxide. Biodiesel can be used in modern diesel engines generally without modification (minor modification required in older engines). Biodiesel is an emerging industry in Australia which has the potential to cause large reductions in urban air pollution and make major contributions towards greenhouse gas targets.

The biodiesel industry will be initially based on waste cooking oils and tallows but further expansion will rely on crop-sourced oils as feed stock. I believe mustard represents 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 is too expensive in the current fuel pricing environment). 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.

A trial was conducted at Chandada on a shallow grey calcareous loam to test the performance of a range of mustard lines under upper EP conditions. These lines had been shelved from current breeding programmes because their oil quality is not suitable for human consumption. A similar trial was also conducted at Cambrai in the Murray Plains.

How was it done?

- Nine mustard lines from the Horsham oilseed breeding programme (NRE) were grown and compared against 3 canola lines. In addition, nine agronomic treatments were included to assess their impact on oilseed productivity at the site. Canola was grown in these treatments, only because of a shortage of mustard seed.
- See table 1 for treatment descriptions.
- Measurements – establishment, earliness scores, grain and oil yield (oil analyses not yet completed).

What happened?

Early seeding plots were seeded on 15 May under very marginal moisture conditions, the rest of the trial was seeded 12 days later on 27 May.

The season at Chandada was above average for the early and middle parts of the season and growth of most lines was very good. There was a wide range of maturities across the mustard lines and the canolas appeared to be intermediate within this range. The early seeding plots had higher broad leaved weed burdens than the rest of the trial so plots were hand weeded to give an indication of the value of an extra 12 days growing season. However, early seeding did not produce extra grain yield in this trial, perhaps because lower plant numbers which established in these plots limited yield *(Table 1)*.

Generally, grain yields were promising in this trial with all lines, excepting two, yielding approximately 1,000 kg/ha on a site with low yield potential due to shallow soil *(Table 1)*. Mustard C and the two canolas, 45C05 and 45C75, had the highest grain yields at the site (better than 1,100 kg/ha in the case of C and 45C05). Normally we would expect the earlier maturing lines to have an advantage in low rainfall districts but in this trial there was no clear relationship between earliness and grain yield, except the very late mustard H performed poorly.

Reducing seeding rate and not using Zn fertiliser both decreased grain yield. Other agronomic treatments had little impact on yield which suggests that the factors we tried did not improve canola's ability to make use of the growing conditions, over and above the STANDARD package. Granular fertiliser at seeding was less effective than fluids in this trial because similar canola yields were achieved with fluid fertiliser at one half of the rate of phosphorus.

Trent Potter (SARDI) made selections of the best performing plants in each mustard line from this trial for future development.

Mustards and canola also produced similar grain yields at Minnipa in 2003, which is another heavier soil type situation

Table 1: Performance of mustard & canola lines with different agronomic treatments at Chandada in 2003.

Crop Type	Treatment	Maturity Score[j]	Grain Yield (kg/ha)
Mustard A	Standard[a]	6	994
B	Standard	4	959
C	Standard	3.5	1111
D	Standard	6.5	978
E	Standard	6	1065
F	Standard	4.5	1030
G	Standard	8	1050
H	Standard	1	633
I	Standard	8	823
Canola NS4397	Standard	2.5	974
45C05	Standard	5	1171
45C05	Early seeding[b]	7	997
45C75	Standard	3	1071
45C75	Early seeding	5	972
45C75	Extra N[c]	2	987
45C75	Granular NP fertiliser[d]	2	989
45C75	Gaucho® seed[e]	3	986
45C75	Jockey® seed dressing[f]	3	1065
45C75	Half seeding rate[g]	3	941
45C75	No RLEM control[h]	2.5	1035
45C75	No Zn[i]	3	962
	LSD (P=0.05)	*ns*	*124*

a *Seeded on 27 May at 3 kg/ha with banded fluid NP & Zn fertiliser at 10, 5 and 0.5 kg/ha, respectively with 1 L endosulfan/ha applied to the soil surface pre-seeding for red legged earth mite control.*

b *Treated in the same way as STANDARD except seeded on 15 May.*

c *Treated in the same way as STANDARD except with an extra 10 N/ha at seeding.*

d *Treated in the same way as STANDARD except granular fertiliser (P rate double the STANDARD) was used at seeding instead of fluids.*

e *Treated in the same way as STANDARD except an insecticidal seed dressing was used.*

f *Treated in the same way as STANDARD except a broad spectrum fungicidal seed dressing was used.*

g *Treated in the same way as STANDARD except seeded at 1.5 kg/ha.*

h *Treated in the same way as STANDARD except no treatments were applied for red legged earth mite control.*

i *Treated in the same way as STANDARD except with no zinc at seeding.*

j *Maturity rating in early November 2003 (1=very green – 8=very ripe).*

for the upper EP (at yield levels of about 500 kg/ha) and at Cambrai in the Murray Plains (yield levels of about 400 kg/ha). The Cambrai site was on a redder and deeper soil type than Chandada. On a sandier site at Miltaburra, some mustard lines clearly outperformed canola last year, which is more typical of the general and historical performance of mustard (relative to canola) under low rainfall conditions. For more details of the Miltaburra and Minnipa trials see the article, "Canola and mustard in a dry environment" in the Break Crops section of this book.

What does this mean?

Biodiesel represents an exciting prospect for the introduction of a true break crop into upper EP farming systems because it will (hopefully) create a market for a crop which will be viable (hopefully!) in our cropping environments.

One of the major hurdles this exciting prospect has to jump before it becomes a viable option for upper EP farmers is that the price received for the mustard grain must be sufficient to make it financially attractive as a rotation option. By the time this book goes to press next year, a biodiesel plant should be in production in SA and some realistic prices should be available.

Another threat to this concept is highlighted in the Chandada trial and that is the good performance of canola lines relative to mustard. If mustard does not prove to be an appreciably better crop than canola for farmers (ie more reliable, better returns, and/or easier to grow) and canola continues to become better adapted to low rainfall environments, then farmers will grow canola instead of mustard and the biodiesel industry may be priced out of the market.

In the mean time we hope to do further work in 2004 to further assess the viability of mustard as a cropping option for low rainfall districts of SA.

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Government of South Australia

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Best practice

Canola Economic Summary 1995-2003

Extension

Michael Bennet and Amanda Cook

SARDI, Minnipa Agricultural Centre

Key Messages

- **Conventional canola is considerably more profitable than herbicide tolerant varieties (provided broadleaf weeds are under control).**
- **Canola can be more than an opportunity crop with gross margins >$100/ha in six out of the last eight seasons.**
- **Varietal improvement has almost doubled yields in less than ten years.**

How was it done?

The gross margins were calculated by using current input prices, historical canola prices and actual yields from trials at Minnipa. The gross margin only includes pure input costs and does **not** reflect machinery and labour costs as these vary from enterprise to enterprise. The gross margin includes the associated costs with each production system (ie Simazine for triazine tolerant (TT) and OnDuty®, for Imidazolinone tolerant (IT)). The standard fertilizer mix for canola at Minnipa is 70 kg/ha DAP, 25 kg/ha urea and 25 kg/ha sulphate of ammonia. An application of Targa®, is included for the conventional and TT canola, but not the IT. The gross margin also includes an application of Endosulfan and Cypermethrin for insect control. The calculated input costs for Conventional, TT and IT are $96.8/ha, $108.4/ha and $129.9/ha respectively. A costing of $45/ha for a full 40 g/ha rate of OnDuty®, was used in the input costs calculation.

Risks associated with canola

The 1994 canola trials were not sown until late June, and with a growing season rainfall of 128mm they suffered badly. However, the canola did survive and continue on to yield 150 kg/ha which demonstrates a degree of drought tolerance. In the 1997 season the oilseed trials at Minnipa were severely damaged by false wireworm. This demonstrates the fragile nature of canola, and the attention to detail required for insect monitoring and control. The trials in 2000 were affected by wind damage which caused extensive shattering. The mustard trials in that season were harvested prior to the damage. Of the two canola varieties included in the trial, Monty yielded 1.15 t/ha, whereas in the later harvested trials it only achieved 0.69 t/ha due to wind damage.

What does this mean?

The different variety type options for canola allow greater flexibility today than growers have had in the past. TT and IT technologies have enabled growers to grow canola in a paddock that isn't free of brassica weeds. IT varieties tolerate sulfonylurea (SU) residues, vastly expanding rotation options for paddocks with a history of SU usage. Gross margins will differ from property to property with varying needs for weed and insect control. Weed and insect burdens cannot be fully anticipated, however budgets need to consider the possibilities. Machinery costs associated with canola will also vary wildly for different growers. Most operators have different systems for calculating their machinery costs. A grower with a draper front harvester will find the costs associated with owning or hiring a windrower eliminated. To maximise profit within our farming systems canola should be considered as an option in seasons with an early break (sown before the third week in May), and hopefully in the future we will have higher yielding varieties for lower rainfall environments. Refer to the SAFCEP canola assessments in this section for variety selection.

Acknowledgements

Thanks to SAGIT for funding the breakcrops program since 1994. Many thanks to Stephen Marcroft, Ingrid Kennerley and Brendan Frischke for the past data used in the article and to Trent Potter for his input into the oilseeds program.

Table 1: Summary of Canola Yields and Gross Margins at Minnipa.

	Variety Type	1995	1996	1998	1999	2000	2001	2002	2003
$/t Price		$360/t	$340/t	$395/t	$290/t	$320/t	$350/t	$490/t	$380/t
Yield*	Conventional	1.09	0.89	0.92	0.46	0.69	1.76	0.57	0.69
	Triazine Tolerant			0.87	0.23	0.55	1.42	0.72	0.39
	Imidazolinone Tol.					0.73	1.64	0.75	0.77
Gross Margin	Conventional	$281	$196	$257	$31	$117	$498	$179	$160
	Triazine Tolerant			$220	$52	$62	$372	$237	$37
	Imidazolinone Tol.					$95	$425	$232	$155

** Yield is equivalent to the average of the top performing named variety in each year.*

Pulse Evaluation and Agronomy on Upper Eyre Peninsula in 2003

Research

Larn McMurray[1] and Amanda Cook[2]

SARDI, Waite Precinct[1]; SARDI, Minnipa Agricultural Centre[2]

Try yourself

Location
Minnipa Agricultural Centre
Paddock – South 3S

Rainfall
Av. annual : 326mm
Av. G.S.R.: 241mm
2003 total : 263mm
2003 G.S.R.: 204mm

Paddock History
2003: Pulse trials
2002: Chemical fallow
2001: Yitpi wheat
2000: Pasture

Soil Type
Sandy loam, pH 8.9

Key Messages

- **Peas are the most robust pulse option in low rainfall environments, but erosion risks must be well managed.**
- **Early sowing is essential for maximising pulse yields.**
- **Kaspa is an option for low rainfall regions, but has generally performed best in the more favourable years.**
- **No significant yield difference occurred in Kaspa by increasing plant density from 45 to 55 plants/m² in 2003.**
- **Beans and chickpeas are opportunity crops only in low rainfall environments and suited to better years and more favourable conditions.**

Why do the trial?

Pulses are a valuable break crop option in rotations in many low rainfall areas, although they do not currently fit all areas, situations and seasonal conditions. Breeding lines of pulse crops are evaluated at Minnipa alongside current varieties, with the aim of producing varieties better adapted to low rainfall environments.

Agronomic testing of lines with potential in low rainfall areas (to verify that recommendations for maximum production in other pulse growing regions of SA are applicable under low rainfall conditions) is limited. Kaspa generally outyields Parafield in most areas of SA. It flowers about a week later than Parafield and has a condensed pod filling/flowering window making it a slightly riskier option in low rainfall areas. Seeding rate trials in the Mid North and Yorke Peninsula indicate Kaspa is more responsive to higher seeding rates (50-55 plants/m²) than Parafield (40-45 plants/m²). A trial was run at Minnipa in 2003 to verify this recommendation in a low rainfall situation.

What Happened?

Seasonal conditions at Minnipa in 2003 were not favourable for pulse production. The late and fragmented break to the season resulted in pulse trials being sown 10-14 days later than ideal. In years where growing season rainfall is average or below, the delay in sowing results in significant reduction in yields. Early plant growth was slow due to the late start, especially in vetch and chickpeas. Vegetative growth was low at the onset of flowering and continued dry conditions through spring led to low final levels of vegetative production. High temperatures (33°C) on September 20-21 abruptly finished flowering and caused high levels of flower and pod abortion in all pulses. Rain in late September allowed some yield compensation in later varieties but generally yields of all pulses were poor due to the combination of low levels of vegetative growth and dry conditions. Weeds were also at high levels in most trials as the dry conditions made timely and effective herbicide control difficult.

The capacity of peas to tolerate low rainfall conditions better than all other pulses was again evident in 2003. Pea yields averaged 0.9 t/ha in the seeding rate trial compared with grain yields of 0.3-0.4 t/ha in the bean variety trials and less than 0.2 t/ha in the vetch and chickpea variety trials. Peas continue to be the most reliable pulse option in low rainfall areas, providing erosion risks are managed well.

Peas

A replicated trial of the varieties Parafield and Kaspa at a range of seeding rates from 20 to 120 plants/m² was sown on June 8, with 70 kg/ha of 18:20:0 fertiliser. The trial was harvested on November 10. Similar trials were also sown in other regions of the State.

Parafield was 9% higher yielding than Kaspa at standard seeding rates in 2003. This is similar to previous results at Minnipa in below average growing season rainfall years (<240 mm), when Parafield has outyielded Kaspa (*Table 1*). In years of above average growing season rainfall, Kaspa has yielded similarly or slightly above Parafield. This result supports previous findings that although Kaspa is still an option for low rainfall areas of South Australia it is more suited to medium to high rainfall areas with milder finishes.

Over the last five years high grain yields in peas at Minnipa have occurred in years when growing season rainfall has been well above the average (2000 and 2001), even when sown later than the accepted cut-off date of May 20. In years of below average rainfall it is critical to sow early to maximise yield, as shown in *Table 1*.

Table 1: Parafield and Kaspa pea trial yields compared with rainfall and sowing date at Minnipa, 1999-2003.

	1999		2000		2001		2002		2003	
	Parafield	Kaspa	Parafield	Kaspa	Parafield	Kaspa	Parafield	Kaspa	Parafield	Kaspa
Yield (t/ha)	0.90	0.81	2.20	2.24	2.46	2.56	1.40	1.40	0.87	0.79
GSR (mm)	210		299		267		219		204	
Annual Rainfall	268		389		354		277		263	
Seeding Date	May 31		June 2		May 29		May 27		June 8	

Results from the seeding rate trial indicate that grain yield of both Parafield and Kaspa increases with targeted plant density (*Table 2*). However, only the very low (20 plants/m^2) and the very high (120 plants/m^2) seeding rates produced grain yields significantly different from the recommended seeding rates (45 plants/m^2 for Parafield and 55 for Kaspa). Plant establishment was variable due to the dry start and plant emergence counts showed no significant difference in establishment between the targeted rates of 45, 55 and 65 plants/m^2 (*Table 2*), although visual differences were observed. This lack of measurable difference in plant establishment is most probably responsible for the lack of grain yield differences between treatments.

This result supports findings from elsewhere in SA where a minimum plant population of 40-45 plants/m2 is required to maximise yields. The higher targeted plant density of 55 plants/m^2 in Kaspa did not increase yields significantly in 2003. The significantly higher yield achieved with the very high seeding rate at Minnipa is not an uncommon finding in dry years and also occurred in Parafield at Willamulka (a medium to low rainfall sandy clay loam site on Yorke Peninsula) (*Table 3*). Such high rates however are unlikely to be economic and definitely not logistically possible. They are also unlikely to hold true in years of above average rainfall or where early vegetative growth is more prolific.

General pea performance in 2003

Kaspa continues to perform well in SA and is broadly adapted. Its best performances in variety trials have been in medium to high rainfall areas where finishing conditions are generally more favourable. Kaspa's maturity timing is well suited to crop topping of rye grass, although effective herbicide-weed contact may often be difficult to achieve due to its bulky, erect growth habit. Windrowing of Kaspa may be an option to achieve more effective control of rye grass.

Table 2: Effect of plant density on grain yield of Kaspa and Parafield peas at Minnipa, 2003.

Targeted Plants/ m^2	Grain yield (t/ha)		As % of Parafield @ 45 plants/m^2		Plants/m^2 established	
	Kaspa	Parafield	Kaspa	Parafield	Kaspa	Parafield
20	0.46	0.61	53	70	18	19
45	0.74	0.87	85	100	54	65
55	0.79	1.02	91	118	37	67
65	0.87	0.99	100	114	66	65
75	0.90	0.98	103	113	85	82
120	0.97	1.13	111	131	118	142
Site Mean	0.86				67	
LSD (0.05)	0.18				35	
CV %	9.7				25.2	

Table 3: Effect of plant density on grain yield (t/ha) of Kaspa and Parafield peas at Minnipa, Willamulka and a predicted mean across 7 sites in SA in 2003.

Targeted Plants/m^2	Minnipa		Willamulka		State Mean (7 sites)	
	Kaspa	Parafield	Kaspa	Parafield	Kaspa	Parafield
20	0.46	0.61	1.92	1.72	2.82	2.50
45	0.74	0.87	2.27	2.15	3.40	2.92
55	0.79	1.02	2.32	2.48	3.33	2.98
65	0.87	0.99	2.42	2.32	3.30	2.95
75	0.90	0.98	2.30	2.33	3.26	2.79
120	0.97	1.13	2.30	2.52	3.20	2.95
Site Mean	0.86		2.26		3.03	
LSD (0.05)	0.18		0.26			
CV %	9.7		4.9			

Frost was a major yield limiting factor in many areas in 2003. While peas are tolerant to frosts in the vegetative stage, flowers and developing seeds can be very sensitive. There is no difference in frost tolerance at the reproductive stage between current pea varieties. Frost avoidance due to differences in variety flowering/podding time or perhaps due to differences in canopy architecture are the likely reasons for observed differences in yield losses between varieties.

Kaspa's susceptibility to blackspot is similar to Parafield's and growers are urged to implement blackspot management strategies to minimise yield loss. Bacterial blight was not a widespread problem in SA pea crops in 2003, as it was in NSW and Victoria, but growers are reminded of the importance of obtaining clean disease free seed (especially if sourcing seed from NSW or Victoria) and implementing farm hygiene protocols to reduce the risks of the disease becoming a problem.

Performance of other pulses at Minnipa in 2003

Other pulse crops evaluated at Minnipa in 2003 were disappointing. Yields were very low (less than 0.4 t/ha) and variability in the trials was high making discrimination between varieties on grain yield difficult. The poor performance was a direct result of the dry seasonal conditions but also highlighted the importance of early sowing for these crops in low rainfall environments.

Beans

Visually, beans handled the dry conditions and weed competition better than chickpeas and vetch in 2003, and yields were slightly better. Height to the bottom pods was very low due to reduced levels of vegetative growth making harvest difficult and yield losses comparatively high. Fiesta was the highest yielding variety (*see the SAFCEP Bean Variety Evaluation Results*) although yield differences were not significant. Fiesta sets its pods further off the ground than other varieties which often makes harvest easier and grain losses less.

Beans yielded exceptionally well at Lock in 2003, with very favourable conditions for growth (300 mm GSR) and earlier seeding allowing good crop establishment. Fiord was the highest yielding variety (2.9 t/ha), with Farah and Fiesta performing similarly (2.5 t/ha). Fiord set a prolific amount of early pods which enabled it to yield higher than Fiesta at numerous sites across the State. Bean yields at Lock in 2003 show that they can be a profitable crop in medium to low rainfall areas in better seasons, particularly when sown early.

The major interest for faba bean growers in SA is the release of the new variety Farah, as a replacement for Fiesta VF. Seed should be available through PlantTech for commercial sowings in 2004. Farah is a direct selection from Fiesta VF. It is identical to Fiesta VF in most attributes, but with the advantage of reduced susceptibility to ascochyta. Growers can therefore expect ascochyta seed staining to be less of a problem with Farah than with Fiesta VF, and it may also allow fewer fungicide sprays for adequate ascochyta control. Farah is unlikely to expand bean production in low rainfall areas but will provide a lower disease risk option for areas currently successfully producing beans.

Chickpeas and Vetch

Chickpea and vetch results from Minnipa in 2003 are not presented as yields were less than 0.2 t/ha and had very high variability due to the dry seasonal conditions and weed competition.

The anticipated release of the desi chickpea line FLIP94-508C with improved resistance to ascochyta will provide some growers with a low disease risk option in 2004. Due to its lower yields than Howzat, poor adaptation to dry conditions and inherently small dark seed (making it less preferred by marketers than Howzat) it will not be suited to low or medium to low rainfall areas.

No new vetch varieties have been released for 2004. Several promising advanced lines are continuing to be widely evaluated, including lines derived from complex crosses between Morava and Cummins and Morava and Languedoc, with the aim of producing early maturing, rust resistant grain and forage types with beige coloured cotyledons.

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Survey of Alternative Crops in the Calca/Mt Cooper District

Survey

Neil Cordon

SARDI, Minnipa Agricultural Centre

Almost ready

Location
Mt Cooper / Calca
Mt Cooper Agricultural Bureau

Rainfall
Mt Cooper
Av. annual : 425mm
Av. G.S.R.: 334mm
Calca
Av. annual : 365mm
Av. G.S.R.: 298mm

Soil Type
Alkaline grey calcareous sands to neutral reddish brown loams.

Key Messages

- **Alternative crops are economically and environmentally sustainable in the Mt Cooper/Calca district.**
- **Field peas are the proven long-term performer and the major alternative crop for the district with excellent contribution to farm profit.**
- **Alternative crops are profitable 90% of the time.**
- **The main threats to future production are disease and herbicide resistant weeds.**
- **Farmers are well aware of the sustainability risks with alternative crop production.**
- **Targeted surveys are an excellent technique for trapping information, trends and issues of a farming system without the need to conduct long-term research projects.**

Why do the survey?

To evaluate the performance of alternative or break crops in the area in relation to their economic and agronomic sustainability. The members of the Mt Cooper Agricultural bureau in 2003 participated in a priority-setting meeting for research identified the need to look at the sustainability of alternative crops and agreered that a survey technique could be used to address the issue.

How was it done?

The survey targeted farmers in the district who have consistently been growing alternative crops, which equated to 12 businesses or 90% participation rate. Lynch Farm Monitoring staff conducted the survey which involved sending out a generic form followed up by face-to-face interviews. All information was confidential and raw data has since been destroyed. Records were not available to objectively measure the stated benefits so comments were based on observations and perceptions although yield and gross margin data are from good records. At the completion of the survey all participating farmers received an expanded copy of survey discussion and findings.

What did we find?

The three major alternative crops were peas, canola and faba beans with lentils, vetch and lupins not grown consistently.

Peas have been grown the longest. When first introduced, peas increased wheat yields on all soil types when compared with wheat grown after medic pasture. Field peas are the proven long-term performer and are the major pulse for the district with excellent contribution to profit. Through improvements in pasture management only 10% of participants now believed alternative crops have a positive yield effect on subsequent crops on the more fertile soils however on the grey less fertile soils their impact is often better than pastures (All the survey participants wish to still be growing peas in five years time due to their consistent economic yield and ease of management.)

Canola has been grown by 83% of survey participants in the past, but only 41% sowed it in 2003. Within five years, 83% of farmers expect to be growing it again with the area sown dependant on early price signals. Canola however it is considered to be more risky than field peas.

Beans are grown by a small percentage of farmers but nearly half of the survey participants are interested in trying them in the future due to their harvestability, to introduce different weed control options and initial yield data. There is interest in their evaluation over a range of soil types and seasons.

Farmers identified disease management and grass weed control as the key management factors for growing alternative crops. The main factors to determine the type of alternative crop to grow are ease of management, profitability, experience, rotation and timing of harvest in relation to other crops and soil type. Lupin production is limited by soil type whilst harvest difficulties and distance to markets have prevented widespread adoption of lentils.

Farmers are well aware of sustainability risks with alternative crops by engaging in such practises as applying nutrients to match or exceed crop removal rates, careful grazing of residues (all have livestock in the system) and adopting direct sowing technology (67%). Livestock played an important role in minimising volunteer pulse emergence in following crops plus add value to any remanent pulse grain. There was a perception from 30% of participants that there was an increased risk of erosion following an alternative crop however 50% thought that they present no problems to following crops.

The three biggest threats to alternative crop production were disease (black spot, black leg), time required to manage and harvest and the risk of poor yields/returns. Herbicide resistance was not weighted highly as a general threat to the farming system that includes alternative crops and although 33% of participants "crop top" for aiding harvest and weed control, little benefit is placed on the practise as a means of controlling resistant grass weeds.

Economic Information

The alternative crops are profitable as "stand alone" crops in the region when adequately managed. Farmers commented that alternative crops generally cost more to grow than a cereal crop. However 91% of participants said break crops are profitable 90% of the time (with dry seasons like 1999 the exception) and they contributed up to 10% of total farm income annually. The profit margin was less on the lower fertile grey soil.

Beans have provided the best gross margin of the three alternative crops studied *(Table 1)*, however they have only been grown over recent favourable years by a small number of farmers on the better type soils so valid comparisons with canola or peas is difficult. Canola was a relatively poor contributor to farm profit.

Table 1: Average yield and gross margin of alternative crops at Mt Cooper/Calca.

Crop	Years Grown	Av. Yields (t/ha)	Av. Gross Margin ($/ha)	Potential Yield t/ha*
Field Pea	22	1.4	123	2.8
Faba Bean	2	1.9	243	2.8
Canola	10	0.9	106	3.1

** Calculated using an average growing season rainfall of 316 mm.*

What does this mean?

The choice of alternative crop has largely been driven by grower comfort with the crop management and exposure to price and yield risks. Farmers in the Mt Cooper/ Calca district are comfortable with peas as their major alternative crop. They have been successfully grown for 22 years, produced excellent long-term returns and are considered a profitable easily managed rotation alternative to cereals and pasture. Farmers would like to be growing alternative crops well into the future, but realise they may have to reduce their reliance on peas to do this as they have identified blackspot disease as a major threat to pea production sustainability. Strategies such as DNA soil tests and seed pickling should be future considerations.

Herbicide resistance was not perceived as an issue, however it's not a matter of "if" but "when" resistant weeds will appear. Whole farm strategies such as good record keeping, monitoring of weed populations and chemical rotations need to be actively pursued.

The short-term performance of beans warrants further investigation on a variety of soil types over a number of seasons to see if they offer long-term profit advantages over peas.

The survey has been timely as participants are questioning the role of other crops in their systems (to compliment peas) and are interested in the experiences of neighbouring farmers. Good messages are provided for those currently growing alternative crops or for those who are not fully confident of having a go in their farming system. By trapping the information via a survey we are able to speed up the process rather than a white peg trial program which is expensive, labour intensive and would take several years before meaningful results emerge. Let's face it the biggest long-term trial is actually happening on-farm already.

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LYNCH FARM MONITORING

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SAGIT

Natural Heritage Trust
Helping Communities Helping Australia

Disease Risk Index for Blackspot of Peas

Jenny Davidson

SARDI, Waite

Survey

Why do the project?

United Grower Holdings is sponsoring the development a computer program by SARDI that enables growers and industry to determine the risk of blackspot in pea crops prior to planting the crop. The disease risk index in the computer program is being validated in three different regions of South Australian pea growing areas. It is anticipated that future research will develop similar indices for other diseases and crops that will also use the program.

How was it done?

The blackspot complex, also commonly known as ascochyta blight, is a common disease of field peas in Australian growing conditions, and is found in most pea crops to varying degrees. It has been estimated that this disease reduces the Australian pea crop by an average of 15% annually, worth ~$12.71 million based on 2001/02 figures. Worldwide research has found that there is no major gene resistance to this disease, and in Australia fungicides for blackspot control are generally uneconomic. Disease control is reliant upon management practices such as delayed sowing to reduce seedling infection, wider rotations to reduce spore carryover in the soils, and placement of pea crops away from the previous years pea stubbles. These strategies may have an impact on final yields especially delayed sowing, so that crop management and final yield is a compromise between longer growing seasons and disease minimisation. *Figure 1* demonstrates the various influences on an epidemic that determine the actual disease levels in crops and the effect on yields.

A prototype blackspot disease risk index has been produced using data from ten years of trials conducted by SARDI and University of Adelaide. The index predicts blackspot disease development and pea yields from sowing date, rainfall before and after sowing, and degree-days in the growing season. Used in combination with long range weather forecasting and historical climatic conditions this index will assist growers to make management decisions that will maximise pea yields and minimise disease. This index was initially produced by Dr. Alexandra Schoeny, pea pathologist from INRA France, who is visiting SARDI Field Crops Pathology Unit for ten months (October 2001-July 2002). Data used for developing the index has come from collaborating scientists on pea projects funded by SAGIT and GRDC. It is being further developed and validated by Jenny Davidson, Pulse Pathologist at SARDI. The index requires input in the form of time of sowing, pea rotation interval, blackspot levels in soil (from DNA test), pea cultivar, rainfall, likely growing season and further management information. This information generates an output that indicates whether the risk of blackspot is low, medium or high. Management strategies can be altered until the anticipated risk from blackspot is low and yields are maximised.

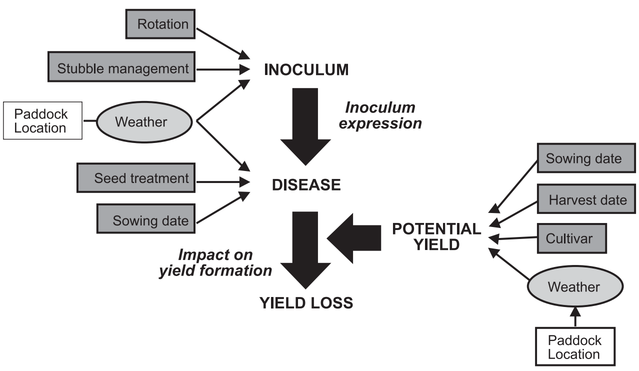

Figure 1: Environment and management of a crop determine final disease level and effect of the disease on yield.

The index was tested in pea crops on Eyre Peninsula in the Wudinna region, on Yorke Peninsula, and Riverton in the 2003 growing season. These regions are representative of low, medium and high rainfall areas. Predicted blackspot levels and yield were confirmed by disease assessment in the field and final yield measurements, and the predicted and actual data is currently being compared.

Inputs and Outputs of the Model

Inputs

- Location (nearest town) (to determine average rainfall and temperature data for last 50 years)
- Rotation (years since last pea crop in paddock)
- Adjacent pea stubble (yes or no)
- Cultivar (Alma, Dundale, Earlydun, Glenroy, Laura, Mukta, Parafield, Santi, Soupa)
- Sowing Date
- Harvest Date
- Seed treatment (Apron at full or half rate, P-Pickel T, or Apron plus P-Pickel-T)

Outputs (Deciles 1 and 9)

- Predicted Blackspot levels
- Predicted Yield loss
- Potential Yield in absence of blackspot
- Predicted Yield in presence of blackspot

Later sowing shows a fall in blackspot at both sites. This is associated with the release of blackspot spot spores from the previous years stubble that occurs at the break of the season. Any crops emerging at that time or the next couple of weeks will be severely infected with blackspot. If crops are sown 2-3 weeks after this break there will be fewer spores in the air to cause the initial infection.

An adjacent pea stubble increases the severity of blackspot infection and higher yield losses.

P-Pickel T indicates a slight drop in infection and an associated yield gain.

What does this mean?

The disease risk index is able to demonstrate the parameters that cause blackspot in field peas, and what environment and management strategies that increase or decrease the disease levels. Currently the disease index has approximately 60% reliability but it will continue to be fine tuned as more research data becomes available. The yield prediction component is already very predictive of actual yields demonstrating that this is highly dependent on climatic data. The disease risk index has been put into a computer format that is easily managed by growers and consultants. It is anticipated that the program will be made available to users either through a website, CD, or through a semi-automated faxback system. It is anticipated that consultants, agronomists and farmers will be trained in the use of the disease risk index after the testing has been completed. The index will be further promoted at updates, field days and in the rural media. This is a prototype for disease risk indices and it is anticipated that further data from other research will be treated in a similar manner, and risk indices will be produced for more diseases.

Table 1: Examples of predicted blackspot and yield loss from the model.

Inputs (Parafield)	Median Blackspot severity (0-5)		Median Yield loss from Blackspot	
	Riverton	Yeelanna	Riverton	Yeelanna
Standard practice*	2.4	2.8	8%	11%
Standard practice and an adjacent pea stubble	2.8	2.9	11%	12%
Late sowing	1.8	2.5	0.5%	8.5%
Early sowing	2.6	2.9	10.5%	11.5%
Early sowing + P-Pickel T	2.1	2.3	6%	7.5%

Standard practice = sown 5th June, no adjacent pea stubble, no seed treatment, within a three year rotation.

Acknowledgements

The following people assisted with validation of the disease risk index in pea crops in 2003.

Neil Cordon, Senior Extension Agronomist, SARDI, Minnipa Agriculture Centrel. Michael Richards, SYP Alkaline Group, Minlaton. Andrew Parkinson, Wesfarmers Riverton. Local farm co-operators who made their crops available for monitoring and us gave access to paddock records.

United Grower Holdings

Herbicide Effects on Nitrogen Fixation in Legumes

Research

Elizabeth Drew[1], Amanda Cook[2], Michael Bennet[2], VVSR Gupta[1] & David Roget[1]

CSIRO Land & Water, Waite Campus[1], SARDI, Minnipa Agricultural Centre[2]

Searching for answers

Location
Minnipa Agricultural Centre
Paddock South 3S

Rainfall
Av. annual: 326mm
Av. G.S.R.: 241mm
2003 total: 263mm
2003 G.S.R.: 204mm

Paddock History
2003: Pulse trials & Medic Pasture
2002: Pasture
2001: Yitpi wheat
2000: Pasture

Soil Type
Sandy loam, pH 8.9

Plot size
10m x 1.44m x 4 Reps.

Key Messages

- **Growers should be aware that herbicides which cause yellowing in pulses and medics are highly likely to be reducing the number of effective nodules of the plant roots and nitrogen fixation.**
- **In-crop applications of some broadleaf and grass herbicides reduced nodulation of peas.**
- **Some herbicides decreased dry matter production and yield for peas and medic at Minnipa in 2003.**
- **Timing of herbicide application and seasonal conditions play an important role in influencing herbicide-legume interactions.**

Why do the trial?

Herbicides are a vital component within current farming systems and are commonly used in medic pastures and legume crops to control weeds. In the low rainfall region of the Murray Mallee a number of herbicides recommended for use in legumes (vetch and peas) have been found to reduce nodulation of plants and N_2 fixation. Since one of the major benefits from legumes is the N input to the system it is important to determine if broadleaf or grass selective herbicide applications reduce N_2 fixation. This years trials were conducted at Minnipa and Waikerie to investigate the effect of commonly used herbicides on nodulation and N_2 fixation in medic and peas.

How was it done?

Replicated plots of Herald strand medic and Parafield peas (fertilised with 0:20:0 @ 70 kg/ha) were sown on 12th June 2003. Due to dry seasonal conditions sown medic establishment was poor, so a regenerated medic pasture was also included in the trial. Diuron treatments were applied post sowing on 13th June, the Imazethypr and Metribuzin were applied on 24th of July, and all other chemical treatments on

Table 1: Herbicide treatments applied to Medic and Peas at Minnipa in 2003.

Crop	Herbicide (Chemical name)	Rates	Additive
Parafield Peas	Control (no application)		
	Clethodim	250 ml/ha	0.5% Hasten
	Haloxyfop 520	375 ml/ha	0.5% Uptake
	Flumetsulam	25 g/ha	0.5% Uptake
	Imazethpyr 720	70 g/ha	0.2% BS1000
	Metribuzin	180 g/ha	
	Diflufenican	200 ml/ha	
	Diuron 500g/L	1L/ha	
Herald Medic Sown and Regenerated	Control (no application)		
	Haloxyfop 520	375 ml/ha	0.5% Uptake
	Flumetsulam	25 g/ha	0.5% Uptake
	Quizalfop-P	250 ml/ha	0.5% Hasten
	Sethoxydim	750 ml/ha	1% DC Trate
	MCPA Amine 500 g/L	700 ml/ha	
	2,4,D Ester 800 g/L	700 ml/ha	
	MCPA 250g/L + Diflufenican 25 g/L	100 ml/ha	

the 27th August. Herbicides were applied using a 2 m shrouded boom with TeeJet® 11002 nozzles at a pressure of 32 psi. Water volume was 100L/ha.

Shoot dry matter was sampled and the pea plants roots were assessed for number and appearance of nodules on 10th September. The modified Corbin scoring system was used for nodules and ranged from zero, which indicated poor nodulation, to a maximum of five corresponding to excellent nodulation. A second pre harvest dry matter was taken on 31st of October. The pea treatments were harvested on 10th November, and the medic treatments on 2nd December. The medic seed was cleaned and threshed to give a seed weight.

What Happened?

Peas

Crop yellowing and/or stunted growth were observed in all herbicide treatments 10 days after spraying. Observation of pea roots 3 months after sowing *(Table 2)* showed unsprayed control plants had significantly more nodules than sprayed plants, with Metribuzin causing the greatest reduction in nodulation.

Applications of Metribuzin and Imazethypr reduced early growth in peas. However, the crop appeared to have recovered from these herbicides by the end of anthesis. Despite only small variations in dry matter production between treatments, yields varied significantly. Both Flumetsulam and Imazethypr (broadleaf herbicides) caused significant yield reductions of over 50%. Metribuzin and Clethodim caused reductions of around 20%.

The results in 2003 are more severe than 2002 (at Minnipa), where Diuron+MCPA Amine (sprayed late) was the only herbicide to significantly reduce yields. In the 2002 study most herbicides were applied either post emergent or at the 5 node stage in comparison to 2003 where the majority of herbicides were applied at the 12 node stage, including Flumetsulam and Clethodim. Late spraying of some herbicides, due to dry seasonal conditions, probably delayed flowering and when followed by a rapid end to the season resulted in poor grain filling and yields. Although Metribuzin and Imazethpyr were sprayed early in 2003 crop growth was delayed enough to result in lower grain yields, which was possibly exacerbated by the drought stress to the crop.

*Table 2: Effect of herbicides on nodulation, dry matter production and yield of peas at Minnipa in 2003. *indicates values significantly lower than control treatments.*

Herbicide	Nodule Score(/5)	Dry matter (t/ha)		Yield (t/ha)
		Pre-anthesis	Anthesis	
Control	3.9	1.64	2.25	0.46
Flumetsulam	2.9*	1.53	1.92	0.17*
Diflufenican	3.2*	1.71	2.43	0.44
Diuron	3.4*	1.62	2.60	0.42
Metribuzin	2.3*	1.10*	2.60	0.37
Clethodim	2.8*	1.52	2.67	0.38
Imazethpyr	2.9*	1.26*	2.22	0.19*
Haloxyfop	3.1*	1.63	2.54	0.38

Medic

Crop yellowing and/or stunted growth was observed in sown and regenerated medic 10 days after spraying with MCPA Amine, 2,4,D Ester, MCPA+ Diflufenican and Flumetsulam. 2,4,D Ester caused yield reductions of more than 50% in sown and regenerated medic *(Table 3)*. Flumetsulam or MCPA Amine caused yield reductions of 30% in regenerated medic.

This result is similar to that found in a previous trial at Minnipa (2002). In both years 2,4, D Ester, MCPA Amine and MCPA + Diflufenican reduced dry matter production and/or grain yields. Flumetsulam only reduced grain yields in 2003. Similarly to peas, late spraying and consequently delayed flowering may be the primary cause of this yield reduction.

How does this compare to other farming districts in SA ?

Similar field trials were conducted at Waikerie (SA) in 2003, where we looked at the impacts of a single herbicide application (4-6 node stage of the crop) on several parameters including nitrogen fixation and crop yield of peas. Herbicide effects could be seen 2-3 weeks after spraying by the yellowing of crop leaves. This was measured using a 'SPAD 520 chlorophyll meter'. With the exception of Butroxydim + Fluzaifop-P all herbicides tested caused significant yellowing of the crop *(Figure 1)*. There was a significant association between leaf yellowing and the number of effective nodules found on plant roots. The more yellow the leaf (more herbicide damage), the less effective nodules were present on the plant roots. Several of the broadleaf and grass herbicides caused a significant reduction in the nodulation of peas *(Figure 1)*. Flumetsulam was the only herbicide which caused a significant yield reduction (50%) at Waikerie. Analysis of grain and dry matter samples for nitrogen fixation is in progress.

What does this mean?

Post-emergent applications of Flumetsulam in peas resulted in early crop yellowing, stunted growth and reduced yields at both Minnipa and Waikerie in 2003. Single applications of Imazethypr, Metribuzin, and Clethodim also caused yield reductions at Minnipa. Some broadleaf and grass herbicides significantly reduced nodule number in peas at both sites. This would likely translate to a reduction in nitrogen fixation by the legume and therefore less carry over benefit to the following wheat crop. Further investigations continue with this work.

The effects of herbicides on medic have been consistent over the 2002-2003 period. 2,4,D Ester, MCPA Amine and MCPA + Diflufenican can all cause losses in dry matter production or yield. Late spraying of Flumetsulam is also risky and in 2003 resulted in significant yield losses.

Herbicides are essential in intensive faming systems, particularly with the move towards reduced till systems. In 2002 weeds were the main factor affecting crop yields, therefore weed management should not be compromised. Our work aims to identify which herbicides may put a legume or pasture crop at risk, hence allowing farmers to make more informed herbicide choices. Further work will continue to investigate parameters such as spray time, carry over benefits to cereal crops and the effects of herbicides on nitrogen fixation.

Growers should be aware that herbicides which cause yellowing in pulses and medics are highly likely to be reducing the number of effective nodules of the plant roots and nitrogen fixation.

Acknowledgements

Thanks to Ken Webber (Nufarm) and Natasha O'Brien (Bayer Crop Science) for providing chemical and assistance of Lisa Bennie, MAC.

This work was funded by GRDC, SARDI and SAGIT.

*Table 3: Effect of herbicides on dry matter production and seed yield of sown and regenerated medic at Minnipa in 2003. * indicates values significantly lower than control treatments.*

Herbicide	Sown		Regenerated
	Dry matter anthesis (t/ha)	Yield (t/ha)	Yield (t/ha)
Control	0.66	0.19	0.37
2,4,D ester	0.44*	0.01*	0.17*
Flumetsulam	0.69	0.25	0.27*
MCPA Amine	0.56	0.26	0.26*
Sethoxydim	0.55	0.21	0.40
Quizalfop-P	0.59	0.20	0.33
MCPA + Diflufenican	0.51	0.25	0.34
Haloxyfop 520	0.63	0.21	0.32

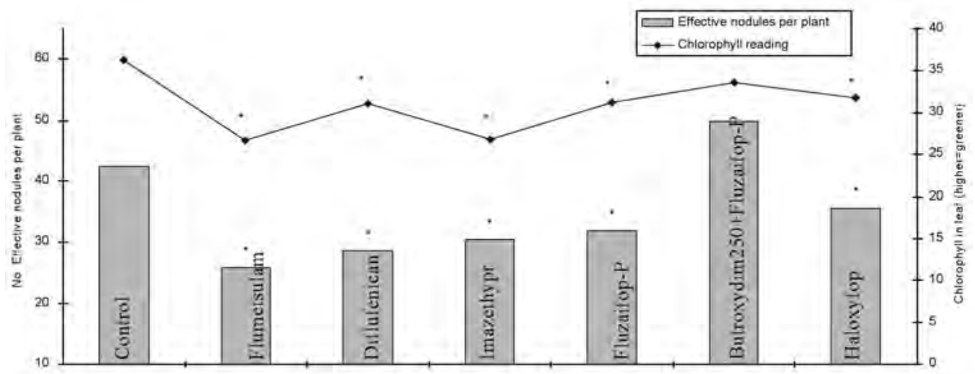

*Figure 1: Effect of a single herbicide application (at 4 node stage) on the chlorophyll content and nodulation of Parafield peas 3 weeks after the application at Waikerie 2003. Chlorophyll was measured using a SPAD 520 meter. Bars with * are significantly lower than control treatments.*

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Summer Crops for Southern Australia- what have we learnt?

Research

Brenton Growden and Nigel Wilheml

SARDI, Sustainable Farming Systems

Break Crops

Key Messages

- **Paddock selection for summer crop production is critical. (choose lighter soils for best results).**
- **Sow as soon as soil temperatures reach the prescribed minimum for the crop.**
- **Forage sorghum is a good choice of crop type because:**
  - **useful yields are already being achieved**
  - **there are several end uses**
  - **investment in dedicated machinery is not necessary**

Why do the trial?

To assess the potential of summer crops as new rotation options for the farming systems of temperate Australia.

How was it done?

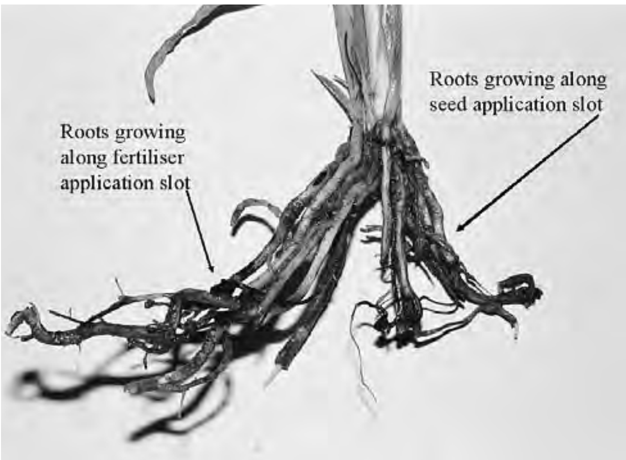
Trials have been carried out in a diverse range of SA's agricultural areas, from lower rainfall areas such as the Mallee to the higher rainfall environment of Kangaroo Island. The program has been ongoing since 2000.

Aspects examined include:

- Relative performance of various crops
- Row spacing/seeding rate
- Adaptability to soil type, annual rainfall, climatic conditions
- Seeding techniques/machinery requirements
- Grazing potential

A common perception is that summer crops are mainly useful for replacing a failed cereal crop. While this is certainly an option, the chances are high that the drought conditions that caused the failure of the cereal crop will still be in force as the summer crop is sown.

Plate 1: A sorghum plant from the Edillilie site showing root development largely restricted to the confines of the adjacent slots cut by the seeding and fertiliser placement coulters of the precision planter.



We see bigger potential benefits in incorporating the summer crop into the farming system. A rule of thumb is that a minimum of 100 mm of combined soil moisture and growing season rainfall is considered necessary to have any chance of a return from summer crops.

What happened?

Our trial results to date suggest that soil type is at least as important as adequate moisture for the successful production of summer crops. The best results have been achieved on duplex soils with about 40 cm of sandy topsoil. In situations where the topsoil is loamy, restrictions to root development have occurred *(Plate 1)*. This problem can be overcome by ripping but soil moisture conservation may be compromised.

A wide range of crop types and cultivars have been put through their paces with varying degrees of success.

Experience over four years suggests that grain sorghum, forage sorghum, sunflowers and corn are the four crops holding the most promise for inclusion into our farming systems. Of these, forage sorghum seems to perform most consistently and affords the best versatility in end use.

Forage Sorghum

Forage sorghum has stood out in the trial program as being the most promising, performance-wise and as one of the more versatile as far as end use goes. Forage sorghum lends itself to grazing and silage production and has been used to produce high quality, high value hay suitable for export. At Parndana on Kangaroo Island and Tooligie Hill this summer the first cut of Bettagraze forage sorghum yielded 4.5 t/ha and 1.8 t/ha dry weight of forage per hectare respectively (we would normally expect two cuts for the season). Although it has the same soil temperature constraints as grain sorghum, unlike many of the other summer crops, it can be sown successfully with conventional seeding machinery with 7" row spacing. Narrow row spacing, combined with a higher seeding rate of around 15 kg/ha promotes plants with more slender stems. (A requirement of forage sorghum destined for export hay to Japan is stem diameters similar to that of a pencil). Forage sorghum can be toxic to stock in some circumstances but this problem can easily be avoided with the correct management practices. We have not received any reports of stock losses due to this problem. Limited grazing assessments suggest that standing forage compares favourably with good quality lupin stubble for finishing prime lambs.

So, on the strength of our trial program so far, what are our recommendations?

- Trial experience to date suggests that the best choice of summer crop is either corn, sunflowers, grain sorghum, or forage sorghum, with the forage sorghum offering some advantages such as more versatility of end use and establishment methods.

- Choose a paddock with lighter textured soil for best results.
- Minimise soil disturbance at sowing and sow into moisture.
- Sow as early as possible but be aware of minimum soil temperature constraints.
- The intrinsic longer term benefits of incorporating a summer crop into your farming system, such as resistant weed and summer weed control, mean that you may only need to break even on the proceeds of the summer crop to be well in front. Anything you make on the crop itself should be considered a bonus.

Grain Sorghum

Grain sorghum has usually performed quite well in our trials. It is one of the most drought-tolerant of all grain crops, has a degree of salt tolerance but is not adapted to acidic soils. The grain fetches a price similar to that of feed barley but would command better returns if large tonnages were consistently available.

A major management consideration with grain sorghum production is that (as with forage sorghum) there is a minimum soil temperature requirement for successful seedling establishment. Sowing should not occur until the soil temperature reaches and is maintained above 16oC. For the SA environment, this can mean delays in seeding until late October when the chances of sowing into a moist seed bed (and thereby maximising establishment) are reduced. Another issue with grain sorghum is staggered grain maturity. It will normally be necessary to desiccate the crop when the later heads are immature. Grain sorghum performs well when sown in wider row spacing configuration. Row spacing of 1.0 metre and 1.0 metre single skip have been used with success in lower rainfall areas.

Corn

Corn has also proved to be an interesting option for summer planting in dry land situation. Provided it is sown into a seedbed where moisture is available, seedling development is spectacularly rapid. Although not as drought tolerant as sorghum, corn's lower minimum soil temperature requirement of 10oC allows for earlier sowing, therefore enhancing the chances of good crop establishment. A consistent planting interval and sowing depth is required for maximum corn yield so that sowing with a precision seeder is considered mandatory. At Edillilie in 2003 corn planted with a conventional tined seeder established extremely poorly, due, in part at least, to moisture loss from the seedbed as a result of soil disturbance. The marketing situation for corn is similar to that of sorghum in southern Australia in that with sufficient tonnages this grain would find a ready market in the stock feed arena. Grain yields of 3 t/ha have been achieved in our trials but yields of 0-0.5 t/ha have been more common.

Sunflowers

Sunflowers are extremely drought tolerant and can survive with little or no rainfall over summer. They have a similar soil temperature requirement to that of corn so that they can normally be sown between mid and late August. However, the sunflower plant is susceptible to frost damage after the sixth leaf stage so that sowing earlier than 5-6 weeks prior to the last frost of the season is inadvisable. Sunflowers also should be sown with a precision planter. They may be harvested with minor adjustments with a normal open front header. At a site near Minnipa during the 2001/2 season the best of the sunflower plots yielded about 1.2 t/ha. Sunflowers are grown either for the confectionary/birdseed or oilseed markets in northern Australia, but our opportunities with oilseed are currently restricted due to a lack of nearby crushing facilities. The market for birdseed is also finite (a SE producer currently supplies half the Adelaide's requirements in his own right).

Safflower

Safflower is a winter-spring growing oil/birdseed crop. It is an erect woody-stemmed plant with a strong taproot. It has the advantage of a low (100°C) minimum soil temperature requirement and can be sown and harvested with normal cereal growing equipment.

It is, however, relatively susceptible to weather damage if rain occurs during harvest. Our trials suggest that it is also less drought tolerant than some of the other crops tested.

Safflower seed can fetch around $600/tonne but prices are very volatile.

Other Crops

Other summer crops trialled included Lablab (forage legume), mung beans, soybeans, sunn hemp, chicory and cotton with little success.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SU Tolerant Medic - Minnipa 2003

Jake Howie[1] and Ben Ward[2]
[1]SARDI Pastures Group, Waite Campus and [2]Minnipa Agricultural Centre

Key messages
- Low rates of triasulfuron residues decreased Herald establishment, dry matter production and seed yield by over 50% (cf. FEH-1) in the year after application.
- The new medic, "FEH-1", continues to show good tolerance to sulfonylurea herbicide residues.

Why do the trial?
To further validate the tolerance of a new mutant strand medic line (FEH-1) to sulfonylurea (SU) herbicide residues.

FEH-1 was bred from Herald strand medic using mutation breeding (John Heap, SARDI and Chris Preston, CRC for Weed Management Systems). Annual medics are normally extremely susceptible to even very low residues of SU herbicides (eg < 1 part per billion!) resulting in severe stunting, reduced dry matter production, seed yields, persistence, and N fixation. Interactions under stressful conditions are also highly likely to result in increased susceptibility to root diseases and nutrient and moisture stresses. However in single plant studies at Minnipa and Walpeup (EPFS 2002, p52), FEH-1 has shown good tolerance to triasulfuron and chlorsulfuron residues with respect to dry matter production when compared to its susceptible parent, Herald.

How was it done?
In 2003 metsulfuron methyl was included to the herbicides tested and the range of rates increased. Plots were also sown as swards for the first time and allowed to mature to enable assessment of seed yields and the potential for trial regeneration (nb. previous experiments have all been destructively harvested before maturity). Metsulfuron methyl, chlorsulfuron and triasulfuron (eg Ally®, Glean® and Logran®) were applied at 0, 1.75, 3.5, 7, 14 & 28 g/ha; 0, 5, 10, 20, 40 & 80 g/ha and 0, 7.5, 15, 30, 60 & 120 g/ha respectively (i.e. 0, 25, 50, 100, 200 & 400% of full label rates) to plots in July 2002. These residue plots were then kept weed free prior to sowing with Herald and FEH-1 @ 10kg/ha in late May 2003. Measurements taken during 2003 included plant establishment, dry matter production and pod and seed yields.

What Happened?
The results were unfortunately confounded by the presence of pre-existing triasulfuron residues which had been applied @ 10 g/ha in March 2002. Thus the results need to be seen in the context of the control (0%) treatments being equivalent to a low rate of triasulfuron (say 30%) and that every other treatment is in fact a function of the interaction between it and this background triasulfuron. However, the effects have been so great in some instances that it is still possible to make some generalisations.

Plant Establishment
There were big differences between cultivars with Herald establishment only 55% that of FEH-1 on average. Herald seedling numbers declined with increasing herbicide rates of triasulfuron and particularly chlorsulfuron. FEH-1 showed little response to either herbicides or rates (Fig. 1) confirming its tolerance at the seedling stage.

Dry Matter
Dry matter production was also greatly effected by the presence of residues with FEH-1 producing on average three times the biomass of Herald across all treatments. Herald was sensitive to triasulfuron and particularly chlorsulfuron (all rates) (Fig. 2).

Pod and seed yield
FEH-1 showed good tolerance to all three herbicides at all rates (except chlorsulfuron @ 400%). With triasulfuron there is a small upward trend of seed yield with increasing rates of herbicide application. Herald, on the other hand, was tolerant of metsulfuron methyl but its yields were reduced by >50% at levels of herbicide greater than triasulfuron 50% and chlorsulfuron 25% (Fig. 3).

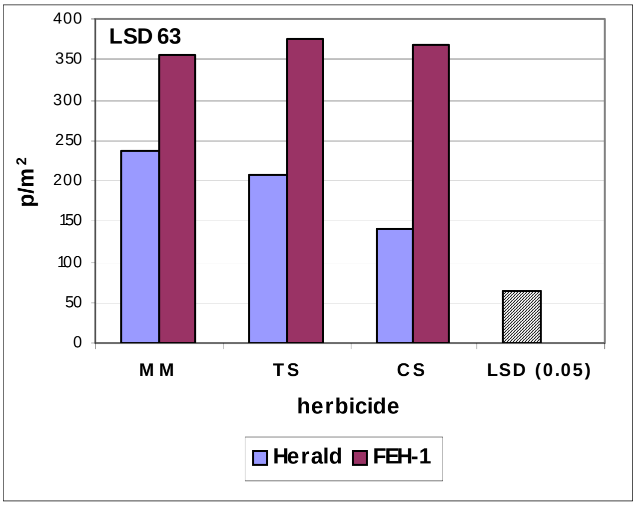


Figure 1. Plant establishment (p/m^2) of Herald and FEH-1 in soil applied with metsulfuron methyl (MM), triasulfuron (TS) and chlorsulfuron (CS).

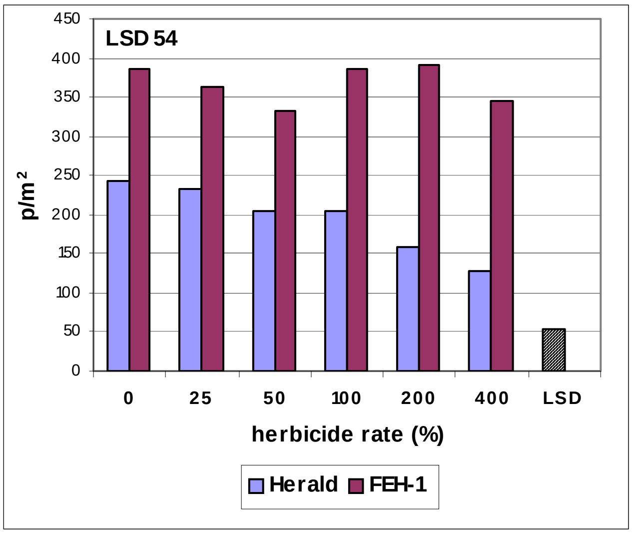


Figure 2. Plant establishment (p/m^2) of Herald and FEH-1 in soil applied with sulfonylurea herbicides @ 0, 25, 50, 100, 200 & 400% of full label rate.

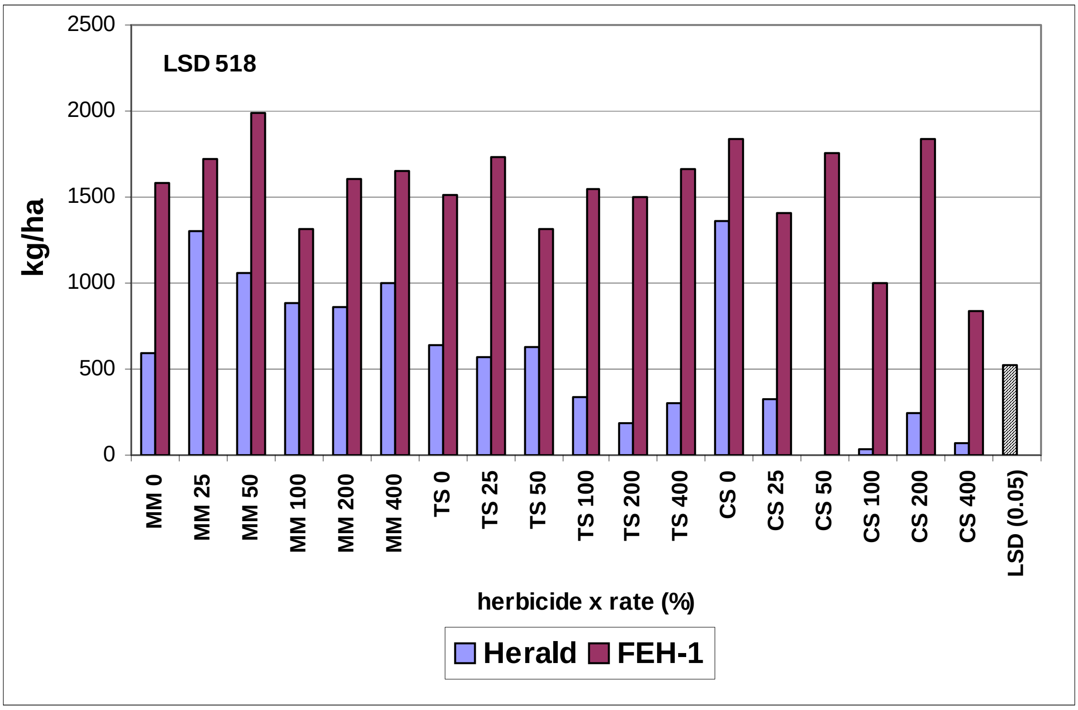


Figure 3. Dry matter production (kg/ha) of Herald and FEH-1 in soil applied with metsulfuron methyl (MM), triasulfuron (TS) and chlorsulfuron (CS) @ 0, 25, 50, 100, 200 & 400% of full label rate.

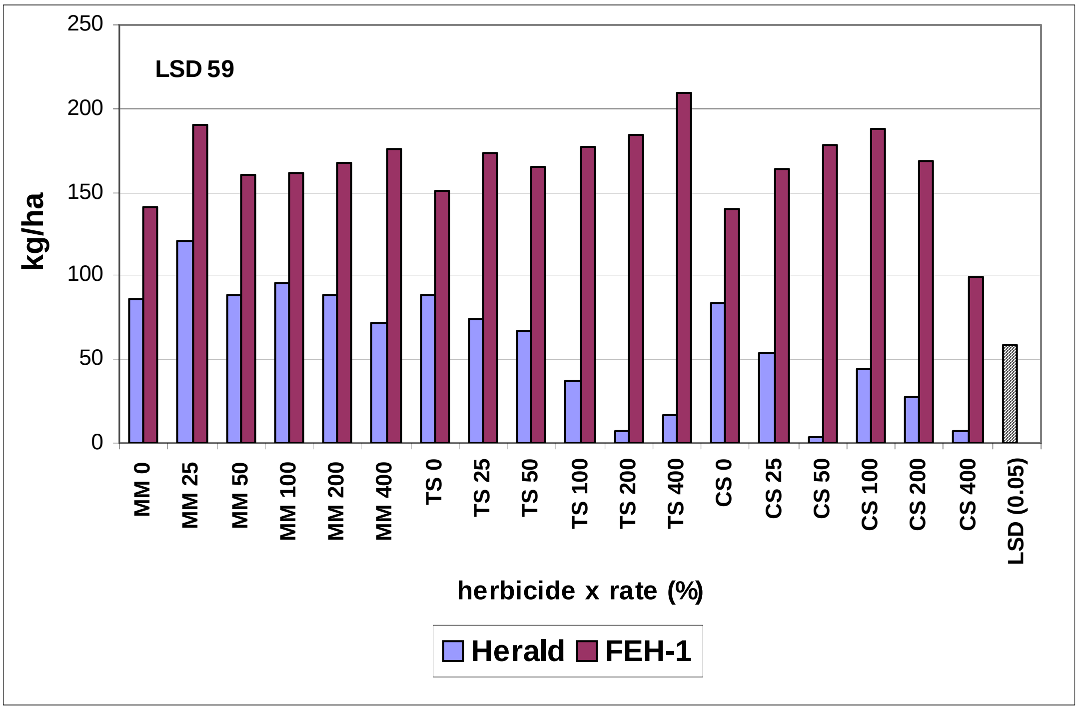


Figure 4. Seed yield (kg/ha) of Herald and FEH-1 in soil applied with metsulfuron methyl (MM), triasulfuron (TS) and chlorsulfuron (CS) @ 0, 25, 50, 100, 200 & 400% of full label rate.

The data is difficult to interpret precisely because of the background presence of triasulfuron residues on-site which needs to be considered when comparing Herald with FEH-1 particularly in the controls. If we could assume that the performance of Herald and FEH-1 in the absence of SU residues is equivalent, then this might suggest that even this low level of background triasulfuron residue (approximately equivalent to a triasulfuron 30% treatment), is having a large effect on medic production in the year after application. The low rainfall in 2002 may also have contributed to a slower breakdown of residues. In EPFS 2002 we did report an unexplained difference between Herald and FEH-1 in their controls, which I suggested could have been either a result of an old application of SU's on-site or that there were other differences between Herald and FEH-1 than we are as yet unaware of – the jury is still out!

2003 was the first year these dose response trials have been sown as swards (cf. single spaced plants) and it was interesting to observe the effect of herbicide residues on plant establishment. This is a significant finding because of the implications this has for early and total dry matter production and competitiveness with weeds of the sward as a whole. The negative effect of SU residues on dry matter production is significant not only with respect to the availability of stockfeed but because of its effect in reducing nitrogen fixation. 2003 was also the first time these trials have gone to seed and the large reduction in seed yield of Herald in the presence of increasing levels of chlorsulfuron and triasulfuron residues is a significant finding. Seed banks drive the persistence and ultimately the productivity of medic pastures and factors that negatively impact upon them weaken the system making it more vulnerable to seasonal variations.

What does this mean?
The results confirm the findings from Minnipa and Walpeup 2002, and the robust performance of FEH-1 in the presence of most of the herbicide residue treatments was very encouraging, particularly its ability to maintain seed yield. Herald proved to be very sensitive to residues of triasulfuron and particularly chlorsulfuron for all parameters measured. However we are still left with the question of actually how persistent are the effects of SU residues and whether they may be longer lasting in some cases and more significant than initially thought?

What now?
Information is still being processed from other SU residue dose response sites to further add to the story.
We will also be evaluating the regeneration of FEH-1 and Herald in 2004 at some of these sites in order to better ascertain the hardseed breakdown pattern of FEH-1. Seed multiplication is underway and if results continue to be supportive, FEH-1 could be released as a cultivar within a couple of years.

Acknowledgements
The funding of this work by GRDC is gratefully acknowledged, as is the valuable assistance provided by Peter Schutz, SARDI.

Category
Searching for Answers

Location
Minnipa Agricultural Centre
Rainfall
Av. Annual: 326 mm
Av. G.S.R: 241 mm
2003 total: 263 mm
2003 GSR: 204
SoilType
Red sandy loam
pH 8.5

Further Information
Jake Howie, Waite Campus
Phone (08) 8303 9407

Alternative Pastures: Year 2

Neil Cordon and Ben Ward, SARDI, Minnipa Agricultural Centre

Key Messages

- Annual medics are still the proven performers on neutral to alkaline soils with excellent adaption to a wide range of environmental conditions.
- Management of pastures as a crop is vital to maintain highly productive and regenerative stands.
- Vetch is still the best forage pasture species but "watch this space".

Why do the trial?

In the low rainfall zones of Eyre Peninsula the risks associated with pulse and canola crops within the rotation are considered too high for many growers. In many cases the only viable 'break" option is a legume based pasture which has traditionally been medic, however there has been an explosion of new pasture species which need to be evaluated on Eyre Peninsula, especially on the slightly acidic soil types.

How was it done?

In June 2002 a range of pasture species was sown at various seeding rates, depending on the species.

Assessment of pod set and dry matter production was carried out in October 2002 and results are published in E.P.F.S. summary book 2002, page 54. The site was grazed as part of the larger paddock over the summer with regeneration monitored during 2003 as the balance of the paddock was sown to wheat. Management of the site included control of insects, grass and broad-leaved weeds.
Measurements: Visual observations for vegetative growth and pod yield.

What happened?

Four cultivars stood out for both pod yield and vegetative growth (Table 1) *ie* Paraggio, Mogul, Herald and Scimitar, which were all medic species. Toreador medic had good growth but was low in pod yield.

Table 1: Pasture legume performance at Mangalo; 2003.

Variety	Pod Yield gm/m^2	Vegetative Growth
Caliph Barrel Medic *	128	34
Parabinga Barrel Medic *	177	73
Paraggio Barrel Medic *	380	85
Cavalier Burr Medic *	100	35
Jester Barrel Medic *	179	73
Trigonella balansae *	-	4
Mogul Barrel Medic *	216	87
Frontier Balansa Clover	-	21
Casbah Bisserula	-	6
Prima Gland Clover	-	55
Dalkeith Sub Clover	-	59
Orion Sphere Medic	122	40
Cadiz Serradella	-	11
Charano Serradella	-	30
Herald Strand Medic	189	86
Toreador Disc/strand Medic	90	91
Scimitar Burr Medic	195	78
Rose Clover	-	25
Morava Vetch	-	24
Septre Lucerne	-	16
Super 10 Lucerne	-	19

* Not inoculated
N.B. Vegetative growth ratings (out of 100) conducted on the 22nd August 2003.

Some pasture species may have been disadvantaged, eg lucerne, vetch and serradella by management practices that were used over the site. However, the regeneration during 2003 is a good indication of those adaptable varieties.

What does this mean?

This supports previous work throughout S.A. that the annual medic still appears to be the best legume pasture option for the low rainfall, neutral/alkaline soils with the best adapted varieties being Paraggio, Mogul, Herald and Scimitar. Scimitar's soft seeded attributes have seen it regenerate densely in the second year. Vetch is not suited to trials like this as it needs to be sown every year. It is planned to sow this to crop in 2004 and then monitor regeneration in the next season.

Acknowledgements
This work was funded by GRDC, SARDI and SAGIT and would have not been possible without the assistance of Wade Shepperd, MAC. Thanks to Rob and Sue for their cooperation during the year.

Category: "Searching for answers"
Location:
Mangalo
Rob and Sue Norris
Franklin Harbour Ag Bureau

Rainfall:
Av Annual: 350 mm
Av G.S.R.: 250 mm
2003 total: 349 mm
2003 G.S.R.: 273 mm

Paddock History:
2001: Wheat
2000: Pasture
1999: Wheat

Soil Type:
Shallow acidic red mica schist loam

Plot Size:
10m x 2m x 3 reps

Looking at Phosphorus in a wheat / pasture system

Neil Cordon, SARDI, Minnipa Agricultural Centre

Key Messages

- Different forms of phosphorus had little effect on root disease levels.
- Fluid P and granular P had no residual value for subsequent wheat and medic production.
- In a wheat / pasture system the degree of response to fluid P depends on soil type.
- Reducing the influence of root diseases in a farming system is bettered achieved by careful rotational and agronomic strategies rather than altering sources of phosphorous fertiliser.

Why do the trial?

To investigate the effect of forms of P fertiliser on wheat yields, medic production and *Pratylenchus neglectus* levels in a wheat/pasture system.

Numerous studies have identified production limitations of medic and wheat on Upper Eyre Peninsula, called 'medic decline' and 'sick wheat' syndromes. This trial is focusing on a wheat/medic rotation for three years to see if fluid P can positively influence both phases of the rotation.

This is a follow on from a trial set up at Wirrulla in 2001 with 2002 results reported in EPFS research summary 2002, page 100.

How was it done?

Trial Details – A phase of grass free medic was established in 2001 over the trial site with no fertiliser applied during that year. An initial soil test for nutrients and root disease was conducted in May 2001.

In 2002 medic and wheat were sown with granular P, fluid P or no fertiliser. The wheat variety was Yitpi, sown on 22nd May at 65 kg/ha under excellent soil moisture and seeding conditions.

- Treatments: Fertiliser applications consisted of 8 kg P/ha either as triple super or phosphoric acid compared to nil fertiliser.

Water rate for the fluid application was 120 L/ha and both fertilisers were applied in the seeding operation.

Grain yield, grain quality and *P neglectus* levels were measured in December 2002.

In 2003 medic and wheat was sown with no fertiliser on 19th June. Seeding rate for Yitpi wheat and Herald medic was 65 and 5 kg/ha respectively.

Measurements: Grain yield, grain quality, *P neglectus* and Colwell Phosphorus in December 2003.

Table 1: Treatment and rotation details at Wirrulla 2001 to 2003.

Year 1 2001	Fertiliser Treatment	Year 2 2002	Fertiliser Treatment	Year 3 2003	Fertiliser Treatment
Medic	Nil	Medic	Nil	Wheat	Nil
Medic	Nil	Medic	Granular	Wheat	Nil
Medic	Nil	Medic	Fluid	Wheat	Nil
Medic	Nil	Wheat	Nil	Medic	Nil
Medic	Nil	Wheat	Granular	Medic	Nil
Medic	Nil	Wheat	Fluid	Medic	Nil
Medic	Nil	Wheat	Nil	Wheat	Nil
Medic	Nil	Wheat	Granular	Wheat	Nil
Medic	Nil	Wheat	Fluid	Wheat	Nil

What happened?

Grain yield and quality – In 2003, there were no yield or grain quality differences between the nutrition treatments (nutrients applied in 2002) on either wheat or medic, (Table 2). This indicates that there was no residual benefit from either forms of applied phosphorus and that fluid P did not out perform granular P.

Table 2: Grain yield and quality of wheat at Wirrulla in 2002 and 2003 by nutrition treatments.

Treatment	2002 Yield (t/ha)	2003 Yield (t/ha)	2003 Protein (%)	2003 Screening (%)	2003 Test Weight (kg/h L)
Granular P	0.75	0.41	14.8	0.4	80.2
Fluid P	0.78	0.41	14.8	0.5	80.7
Nil	0.63	0.39	14.5	0.4	80.2
LSD (P≤0.05)	0.04	N.S.			

The medic, wheat, wheat, rotation was higher yielding than the others in 2003 (Table 3).

Table 3: Grain yield and quality of wheat and medic yield at Wirrulla in 2003 by rotation.

Rotation	Yield t/ha	Protein %	Screening %	Test Weight Kg/h L
Medic/Medic/Wheat	0.32	15.0	0.6	79.9
Medic/Wheat/Medic	0.31*	-	-	-
Medic/Wheat/Wheat	0.48	14.4	0.3	80.9
LSD (P≤0.05)	0.05			

*Yield is pod, not medic seed.

Root disease and soil phosphorus - The initial soil test of extractable P level was 32 mg/kg however after three years the levels had dropped down to 25 mg/kg for the fluid treatment, 23 mg/kg for the granular treatment and 22 mg/kg for the nil treatment.

Root disease monitoring showed no influence on cereal eelworm, takeall, *Pratylenchus thornei* and crown rot, with low levels or below detectable levels throughout the trial.

The influence of nutrition on *Pratylenchus neglectus* and Rhizoctonia appear to be minimal, however the lower levels of common root rot using granular P warrant further investigation (Table 4).

Table 4: Levels of P neglectus (Pn), Rhizoctonia and Common Root Rot at Wirrulla 2001 to 2003.

Treatment	**Initial Levels 2001**		**December 2002**	**December 2003**		
	Pn	**Rhizoctonia**	**Pn**	**Pn**	**Rhizoctonia**	**Common Root Rot**
Nil	101	51	27	35	67	229
Fluid	101	51	29	25	87	234
Granular	101	51	28	21	68	64
Medic/Medic/Wheat	101	51	14	22	78	215
Medic/Wheat/Medic	101	51	35	11	20	64
Medic/Wheat/Wheat	101	51	35	44	125	248

What does this mean?

The data suggests that there is no difference in residual phosphorus from either granular or fluid P, either in a following medic or wheat crop. There has been no yield advantage on wheat or medic from fluid phosphorus when compared to granular phosphorus. At a cost of $43/ha for fluid P compared to $18/ha for granular P there is an economic disadvantage from using fluid P on this soil type and farming system.

The phosphorus was applied as phosphoric acid (fluid) and triple super (granular). In this environment products containing nitrogen are more effective than those containing phosphorus alone, eg ammonium poly phosphate or 18:20:0.

Higher levels of soil fertility enable crops to grow away from root diseases and other work on Eyre Peninsula has suggested that fluid P could be reducing *P. neglectus* multiplication rates. However in this trial there was no influence by phosphorus form on *P. neglectus* and Rhizoctonia levels. The influence of nutrient form on common root rot is interesting as granular P had lower levels than either the nil or fluid P treatments.
Rotation has had the largest influence on grain yields and root disease levels with the medic / wheat / medic rotation having the highest levels of *P. neglectus*, Rhizoctonia and Common Root Rot at the end of the phase.

The data over the three years highlights the importance of rotation in reducing root disease and that a quick fix solution is not achievable by altering sources of phosphorus.

Acknowledgments
This project was funded by the GRDC. Thanks to Wade Shepperd and Ben Ward for their technical assistance.

Category “Searching for answers”
Location
Wirrulla
Craig & Jeanette Rule
Nunjikompita Ag Bureau
Rainfall
Av. Annual: 300 mm
Av. GSR: 208 mm
2003 Total: 282 mm
2003 GSR: 151 mm
Yield
Potential (w): 1.2 t/ha
Soil
Red calcareous sandy loam
Plot Size
13m x 1.6m x 4 reps
Other Factors
Delayed sowing, dry windy conditions throughout the year.

Section editor: Jonathon Hancock

SARDI, Minnipa Ag Centre

Research Officer, Farming Systems

United Grower Holdings

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Rotations

The Far West Farming Systems Competition (sponsored by ABB Grain) didn't get sown in 2003 due to the very late start. The entire area (remembering we have changed sites from 2002) has been EM mapped and soil sampled and an independent draw conducted to allocate each team their 100 ha area. The Charra Bureau and Research Birds team would like to remind the Eccentric Scientists' camp (Tony Rathjen et al) that a fishing trip is still owed them as a result of Rathjen coming last in 2002!

The Effect of Previous Crop on Nitrogen & Water Use of Wheat

Research

Damien Adcock and Ann McNeill

University of Adelaide, Roseworthy

Searching for answers

Location
Closest town: Rudall
Cooperator: Matt & Mignon Dunn

Rainfall
Av. Annual total: 344mm
Av. Growing season: 254mm
Actual annual total: 301mm
Actual growing season: 199mm

Yield
Potential: 1.78 t/ha
Actual (average all treatments): 1.05 t/ha

Soil
Land System: Dune-Swale
Major soil type description: Shallow grey sandy-loam over calcrete rubble

Plot size
45m x 19m

Key Messages

- **Soil water content at sowing was not affected by previous crop or differences in pre-sowing rainfall.**
- **The total water use of wheat during the growing season was not affected by previous crop.**
- **A strong relationship exists between the amount of soil mineral N (nitrate and ammonium) present at sowing and the final grain yield of wheat.**
- **The inclusion of a legume in the crop sequence requires careful management to avoid 'haying off' in the subsequent wheat crop.**

Why do the trial?

The rotation trial at Tuckey, near Rudall, was established to develop an understanding of plant-soil nitrogen and water dynamics in relation to different crop sequences in a semi-arid climate. Ultimately, the main objective of the trial was to determine if continuous cropping could be sustained without decreasing soil productivity.

How was it done?

Refer to previous Eyre Peninsula research summaries (2000, 2001 & 2002) for a description of experimental design. Briefly, water use efficiency and nitrogen dynamics were determined for wheat, sown in 2000 and 2002, after a series of alternate crops in 1999 and 2001, namely barley, canola, medic pasture, vetch (manured) and wheat.

What happened?

The results presented here are a brief summary of the four years of the Tuckey trial.

Available Soil Water

During the trial the amount of soil water present at sowing was remarkably constant, despite differences in rainfall amount and distribution in summer and autumn, emphasising the limited soil water storage capacity at the site (*Figure 1*). The total soil water content to a depth of 0.8 m ranged from 158-177 mm at sowing and at harvest, the amount of water still present in the soil ranged from 129-145 mm.

So the amount of water provided from soil water storage was approximately 29-32 mm, enough to grow an extra 580-640 kg/ha of wheat, assuming it was all transpired by the crop and converted to grain at a rate of 20 kg/ha per millimetre.

The pattern of water use (change in soil water content) reflects the importance of regular rainfall and the inability of the soil to provide an effective buffer against prolonged periods with little or no rainfall (*eg. between 63-112 DAS in 2002, Figure 1*).

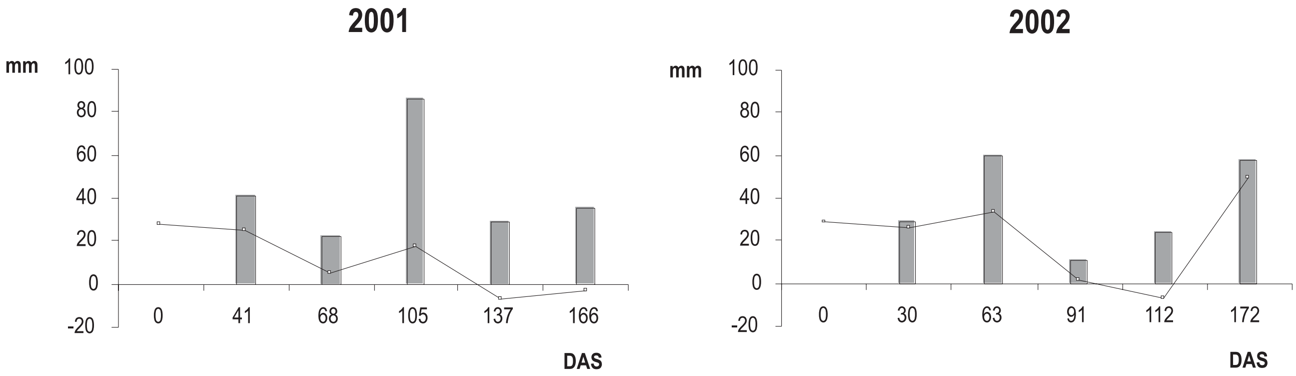


Figure 1: Mean available soil water content [A] (mm) and rainfall [B] in 2001 and 2002 at Tuckey.
[A.] Available soil water content (□) determined by the subtracting wilting point (-1.5MPa) water content from measured water content.
[B.] Rainfall (columns) is equal to the amount received from the previous measurement period.

Water use efficiency

In 2001, the combination of above average rainfall and stored soil water at anthesis (105 DAS) resulted in wheat grain yields (e2.9 t/ha) exceeding the theoretical maximum (2.1 t/ha), determined using the French and Shultz equation and actual growing season rainfall (sowing to harvest). The onset of drought conditions in 2002, below average August-October rainfall and no available stored soil water coincided with anthesis (91 DAS) and grain filling (112 DAS). Nonetheless, wheat grain yields in 2002 achieved between 45-94% of the yield potential. These results compare favourably to the proportion of yield potential achieved in 2000 (above average rainfall), which ranged from 58-67%.

Crop water use (transpiration) efficiencies varied considerably within and between years, despite all crop sequences using the same amount of water in any one year (*Table 1*).

The TE values for 2000, an above average year (GSR = 301mm) are not significantly different suggesting that water was not limiting, and maximum TE (i.e. 20 kg/ha/mm) was restricted by N or some other factor. The TE values in 2002 indicate that wheat after barley and wheat after canola (>20 kg/ha/mm) were water limited, while wheat after vetch was limited by something else. In the case of wheat after vetch, and to a lesser degree wheat after medic pasture, excessive amounts of soil-nitrate at sowing pre-disposed the crop to 'haying off'. Wheat after both medic and vetch transpired more water, 70 and 73mm respectively, during the pre-anthesis period compared to wheat after barley, wheat after wheat and wheat after canola, which transpired 44, 40 and 57mm for the same period.

This additional transpiration was due to the increased leaf area, which was a function of N supply.

Soil mineral N at sowing

The wide variation in crop water use (transpiration) efficiency values in 2002 demonstrates the effect of N supply in below average years. Crop water use efficiency decreased with increasing soil-nitrate (0-0.8 m) at sowing (*Figure 2*). Similarly, the relationship between soil-nitrate content at sowing and grain yield was negative, but not as strong in 2000.

Table 1: Wheat yields and efficiencies in 2000 and 2002.

CROP SEQUENCE		YIELD		EFFICIENCY	
1999	**2000**	**Potential[1] t/ha**	**Actual t/ha**	**WUE_G[2] kg/ha/mm**	**TE_G[3] kg/ha/mm**
Canola	Wheat	3.82	2.52	8.2	11.7
Vetch	Wheat	3.82	2.15	6.8	10.1
Medic	Wheat	3.82	2.23	7.5	11.4
Barley	Wheat	3.82	2.56	8.2	11.7
Wheat	Wheat	3.82	2.39	7.4	10.8
	l.s.d.	-	*0.12*	*0.8*	*2.0*
2001	**2002**	**Potential[1] t/ha**	**Actual t/ha**	**WUE_G[2] kg/ha/mm**	**TE_G[3] kg/ha/mm**
Barley	Wheat	1.42	1.33	9.6	22.9
Canola	Wheat	1.42	1.18	8.6	21.4
Medic	Wheat	1.42	1.03	7.2	17.5
Vetch	Wheat	1.42	0.64	4.9	9.7
Wheat	Wheat	1.42	1.17	8.7	16.0
	l.s.d.	-	*0.16*	*1.1*	*6.3*

[1.] *Potential yield calculated using French and Shultz equation with 110mm soil evaporation and sowing-harvest growing season rainfall.*
[2.] *WUE (water use efficiency) = Y_{actual} / ET.*
[3.] *TE (Crop transpiration efficiency) = Y_{actual} / T.*

What does it mean?

The water use of wheat was not affected by preceding crop type and despite differences in pre-sowing rainfall, the amount of water stored in the soil at sowing was relatively constant (ca. 30 mm). The greater the amount of stored soil water, the greater the buffering capacity against periods of little or no rainfall. So if the evaporative demand were 5 mm/d during grain fill then the crop would have 6 days before attaining wilting point.

What is apparent from this trial is that the amount of soil mineral N at sowing determines the rate of water use during the growing season, particularly in the pre-anthesis period. After a legume (medic or vetch) the soil supplied considerable amounts of N, most likely mineralised during autumn. However, the limited soil water capacity limits the continuity of water supply and moisture stress results, usually at anthesis or during grain filling as seen in 2002.

Maintaining the continuity of water supply in such a soil is difficult, so what strategies exist to avoid

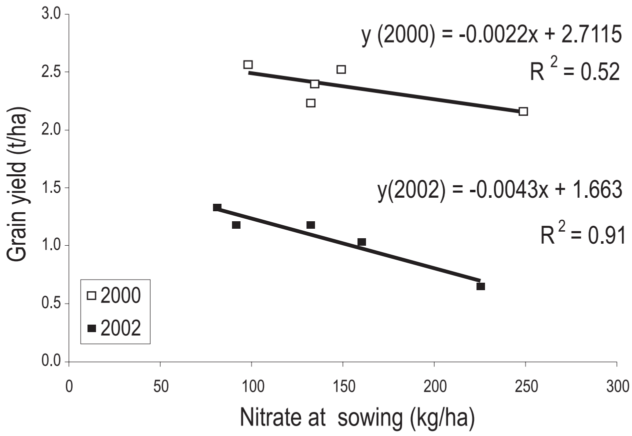


Figure 2: Relationship between soil-nitrate content at sowing & grain yield of wheat.

exhausting water supply before the critical post-anthesis period? One method that may be possible, is limiting N supply early in the season and strategically apply N at tillering or as required (refer to Jonathan Hancock's work). The downside to this approach is that yield potential may be decreased. What about the benefits from reduced soil evaporation with rapid canopy development? This approach works best for heavier clay loam soils that are frequently wet in spring and summer and offers little benefit in sandy soils where soil evaporation is generally water limited. Mulching is another alternative that reduces the amount of energy reaching the soil surface and conserves water, however the challenge is to produce enough stubble to begin with. Finally, mixed residues in the legume phase of the crop sequence (i.e. vetch and oats/cereal rye or medic pastures with canola or mustard perhaps) may offer a means of slowing N mineralisation in autumn and improve the timeliness of N supply during the growing season. All of these are suggestions that may warrant some investigation in the future.

During the course of this trial crop sequences without a legume component have outperformed those sequences with one or more legume phases (refer previous summaries). Phases of continuous cropping (3-5 years) appear to be feasible and do not result in reduced water use efficiencies. The critical aspect is grain quality, soil N availability and weed pressure, all of which should be used to indicate when to spell a paddock and restore fertility with a legume pasture or similar.

In conclusion, a word of caution, this trial was conducted on a paddock with a 30-year history of medic pasture ley-wheat and provided a strong foundation for a successful period of continuous cropping (six years). Other paddocks may not support a similar period of continuous cropping without extra inputs.

Acknowledgements

I would like to thank Matt, Mignon and Peter Dunn for their continued support and hospitality, and all the staff at the Minnipa Agricultural Centre who assisted with sampling.

Thanks to Penny Day at the University of Adelaide for soil and plant analysis and Annie McNeill for her supervision and advice during the course of this project.

This project was funded by GRDC as part of the Eyre Peninsula Farming Systems Project.

GRDC Grains Research & Development Corporation

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Rotations

The effects of residues & wet-dry cycles on plant available Nitrogen

Research

Damien Adcock and Ann McNeill

University of Adelaide, Roseworthy

Key Messages

- **The length of the wetting and drying cycle (water supply) regulates crop residue decomposition.**
- **Soil type affects the rate and amount of plant available N from crop residues.**
- **Coarser textured soils (greater sand content) generally provided more plant available N.**
- **Below ground residues (roots) are an important source plant available N.**

Why do the trial?

Accurate estimates of a soil's ability to supply plant available N are important for determining the optimum rate and timing of fertiliser applications. The adoption of more intensive cropping sequences (i.e. a greater proportion of cereals) will affect supply of plant available N due to changes in the quantity and quality of crop residues added to the soil. The rate of production of plant available N depends on the amount of soil organic matter as well as the incorporation of previous crop residues. The incubation experiment described below measured the rate of N supply from different residues in three common upper Eyre Peninsula soil types for different wetting and drying cycles.

How was it done?

Intact soil cores (8 cm diameter x 15 cm deep) were collected from Tuckey (loamy sand), Minnipa (sandy loam) and Cungena (calcareous loam) representing a range of soils from across the Upper Eyre Peninsula. All soil cores contained wheat roots from the previous growing season. Medic or wheat residues (cut into 0.5-1 cm lengths) were incorporated into the top centimetre of some of the soil cores at a rate approximately equivalent to 3.5 t/ha. Unamended soil cores were used as control treatments (i.e. no additional residues). Four wetting and drying cycles were used; soil cores were either maintained at a constant 60% of field capacity, or allowed to dry and then re-wetted to 60% of field capacity weekly, fortnightly or monthly and incubated for 56 days at

Table 1: Net change in soil nitrate-N content (kg N/ha) during the incubation period following the addition of nil [1], legume or cereal residues [2] to three Eyre Peninsula soils [3] and four different soil water regimes [4].

SOIL [A]	MINNIPA (1.1)			TUCKEY (1.8)			CUNGENA (≤0.7)		
Moisture	Nil	Cereal	Legume	Nil	Cereal	Legume	Nil	Cereal	Legume
Constant	-4.4	-6.4	13.4	11.2	13.7	32.4	16.2	11.0	24.3
Weekly	26.3	-0.4	20.6	35.8	12.9	36.4	14.2	3.8	34.5
Fortnightly	17.9	-0.6	30.2	19.0	15.1	27.4	12.2	-1.3	26.2
Monthly	17.5	9.5	30.8	18.2	6.1	29.7	20.4	-2.5	18.3

1. Nil residues contain cereal root material from previous year, 2. Legume and cereal residues applied at a rate equal to 3.5 t/ha 3. Minnipa (loam), Tuckey (loamy-sand) & Cungena (calcareous loam), 4. Soil moisture re-wetted to 60% of field capacity.
A. Numbers in parenthesis are average organic carbon values for each soil type.

25ºC. Soil samples were collected at 1, 3, 7, 14, 28, 42, and 56 days after initial wetting and analysed for plant available N (nitrate and ammonium).

What happened?

Plant available N accumulated predominately as nitrate-N during the incubation period (*Table 1*). In the first 7 days, variable amounts of ammonium (17-60kg NH4-N/ha) were produced (data not included). The largest amounts of NH4 were associated with legume residues. After 7 days insignificant amounts of ammonium were produced.

Production of nitrate was generally greater for the Tuckey soil treatment irrespective of the wetting and drying cycle and/or residue type (*Table 1*). Weekly re-wetting combined with legume residues supplied the largest amounts of nitrate-N in the Tuckey and Cungena soils. Larger amounts of nitrate-N were produced with longer wetting and drying cycles (time between re-wetting) in the Minnipa soil.

Cereal residues 'tied up' more plant available N than the nil or legume residue treatments (*as shown by the negative numbers in Table 1*). Similar amounts of plant available N were produced for all soils (13-36 kg N/ha) amended with legumes regardless of the length of the wetting and drying cycle.

What does this mean?

The capacity of a soil to supply plant available N is influenced by soil type, the frequency of wetting and drying and the chemical composition of the residue. The greater production of N from the nil treatment relative to added cereal residues was probably due to differences in C:N ratios between cereal stubble and cereal roots (i.e. cereal roots had a higher N content relative to cereal stubble). The data from this experiment emphasises the importance of soil type when considering estimates of available N supply. Despite these differences observed due to soil water supply and residue quality (C:N ratio), it must be remembered that organic carbon provides the energy for the microbes to decompose crop residues and recycle plant nutrients.

Acknowledgements

I would like to thank Matt, Mignon and Peter Dunn for their continued support and hospitality, and all the staff at the Minnipa Agricultural Centre who assisted with sampling.

Thanks to Penny Day at the University of Adelaide for soil analysis and Annie McNeill for her supervision and advice during the course of this project.

This project was funded by GRDC as part of the Eyre Peninsula Farming Systems Project.

GRDC Grains Research & Development Corporation

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Searching for answers

Tuckey Rotation Trial- Life after Damien?

Ann McNeill[1] and Lyndon Masters[2]

University of Adelaide[1], Rural Solutions SA[2]

Key Messages

- **Wheat yields were 0.3 t/ha higher in the two rotations that had canola grown up to four years previously.**
- **Proteins averaged 9.5% for wheat in the rotations without a legume, but where vetch had been in the rotation once in the last five years the proteins were 11 to 12%.**
- **Chemical fallow (by accident!!) in the second year after a medic produced 203 kg/ha available N in the 0-60 cm soil depth by mid-August and 110kg/ha of this N remained at the end of the growing season.**
- **Rotary hoeing of the claypan at 15cm did not increase wheat yield in this reasonably wet year but reduced the amount of organic carbon and microbes in the surface soil.**

Why do the trial?

The Tuckey Ag Bureau encouraged Matt Dunn to continue the rotation trial that for the previous four years had been Damien's PhD site (*see articles in EP Research Summaries 1999-2002 and this issue*). Continuing the trial presented an opportunity to compare performance of wheat in the fifth year of continuous cropping (wheat, barley, canola) versus wheat in systems that included at least one legume (vetch or medic) as a break during those 5 years. Damien's work had shown that plant water availability at Tuckey was very low in the hardpan clay layer at about 15-20 cm depth. and the Bureau members thought that root growth probably was also being restricted so they decided to rotary hoe some of the site to 15 cm to test the effects of breaking up this hardpan on crop yield and soil properties.

How was it done?

The trial was sprayed with a knockdown herbicide and trifluralin. Canola (Hyden, 4 kg/ha) and vetch (Morava, 40 kg/ha) were sown on the 28th May, wheat (Westonia) and barley (Sloop) at 70 kg/ha on the 5th June using Matt's airseeder. Medic (Herald, Parabinga and Caliph mix) regenerated from seed sown in 2001. Half of the trial (two reps) was kept as a continuation of Damien's work with an alternative phase of either canola, medic, vetch, wheat or barley following wheat in 2002 and the Tuckey group decided to put the other half of the trial into a second phase of wheat on wheat. The different rotation treatments can be seen in the first two lines of Table 1. Plant dry matter and nitrogen content were measured during the growing season (at early tillering on 28th July, stem elongation on 19th August, anthesis on 7th October and maturity on 17th November) and at the same time soils were sampled for organic carbon (OC), available N (nitrate and ammonium), moisture content and amount of microbes. Canola was hand harvested and cereals were harvested on 11th December and grain yield and quality measured. The legumes were not harvested.

What happened?

Growing season rainfall was slightly above average (261mm). Wheat yields were high (averaging 2.5 t/ha) and screenings were low ranging from 0.8 to 2.9%. Barley yielded 3 t/ha, vetch produced 5.9 t DM/ha and medic produced 5.3 t DM/ha.

Rotation history influenced wheat yield and protein

Wheat yields were higher in the two rotations that had canola in the history up to four years previously; 2.8 t/ha in the wheat following a VWCW sequence and 2.7 t/ha in the wheat following a CWBW sequence *(Table 1)*. Wheat yields in the other rotations were marginally lower at 2.4 to 2.5 t/ha. Proteins averaged 9.5% for wheat in the rotations without a legume, but where vetch had been grown in the rotation during the last five years, proteins were 11 to 12%. It is worth noting that the single plot with the highest protein (13.1%) was one with both vetch and canola in the sequence. Unfortunately the trial didn't have the second wheat after medic but it is likely that proteins would have been up in this rotation too as a lot of available N was present in the chemical fallow plots (*see next point*).

2003 was not the year to fallow – lost N opportunities!!

203kg N/ha was available in the 0-60 cm soil depth at mid-August under the fallow following a WMWMW sequence and 110 kg/ha of this N remained at the end of the growing season (*Table 1*). Some of this available N was probably lost below 60 cm by leaching – we can say this because at the October sampling under the fallow the soil moisture was very high (19%) and so was the available N (106 kg/ha) in the 20 – 60 cm soil depth, but at the next sampling (mid-November) the soil moisture had decreased at this depth to 12% and the available N to 82 kg/ha. The losses would mainly be due to drainage of water below the 60 cm soil depth, although there may have been some uptake by weeds. Losses of available N by drainage are far less likely to have occurred in the plots where the crops were actively taking up water and N, and soil moistures recorded in the 20-60 cm depth were always 2-5% lower for these plots.

Searching for answers

Location
Closest town: Rudall
Cooperator: Matt & Mignon Dunn
Group: Tuckey

Rainfall
Av. Annual total: 344mm
Av. Growing season: 254mm
Actual annual total: 325mm
Actual growing season: 261mm

Yield
Potential: 3.02 t/ha
Actual (w): 2.5 t/ha

Soil
Land System: Dune-Swale
Major soil type description: Shallow grey sandy-loam over calcrete rubble

Plot size
45m x 19m

Table 1: Grain yield and legume dry matter production, grain protein, nitrogen (N) in residues and available N in the 0-60cm soil depth at different times in the growing season for the Tuckey Ag Bureau rotation site in 2003.

Rotation 1999-2002	CWBW		VWCW		MWMW		BWVW		WWWW	
Crop 2003	Wheat	Vetch	Wheat	Barley	Fallow	Medic	Wheat	Canola	Wheat	Wheat Rot.Hoe
Yield or Legume DM (t/ha)	2.7	5.9	2.8	3.0	-	5.3	2.4	1.2	2.4	2.5
Protein (%)	9.7		11.4	10.7	-	-	12.4	-	9.0	9.2
N in residues (kg/ha)	21	84	30	35	-	58	38	15	20	17
Available N in soil (kg/ha)										
19 August	59	119	85	62	203	58	66	62	50	51
17 Nov	n.d.	n.d.	n.d.	n.d.	110	29	13	12	39	20

n.d. = not determined

Table 2: Soil moisture (%), organic carbon (%) and amount of microbes (ugC/g soil) at different times during the season in the wheat plots with (+Rot.Hoe) or without (-Rot.Hoe) rotary hoeing.

	28th July		19th August		7th October	
Soil moistures	**(+Rot.Hoe)**	**(-Rot.Hoe)**	**(+Rot.Hoe)**	**(-Rot.Hoe)**	**(+Rot.Hoe)**	**(-Rot.Hoe)**
0-10 cm	11	13	10	10	8	8
10-20 cm	13	15	11	14	9	12
20-40 cm	17	17	14	16	10	11
40-60 cm	14	14	13	14	10	10
Organic Carbon						
0-20 cm	1.33	1.49	1.28	1.42	n.d.	n.d.
Amount of microbes 0-10cm	294	372	217	295	381	482

Crop residue N low in the continuous crops and after canola

N content of the stubbles of the wheat after the WWWW and CWBW sequences was 17-21 kg/ha and was higher (30-38 kg/ha) for the wheat after the sequences with legumes, that is VWCW or BWVW (*Table 1*). Canola stubble was very low in N (15 kg/ha), although we have no information on what contribution the fallen leaves might make, and the legumes residues were high in N (58-84 kg/ha) as no dry matter was removed during the season.

Rotary hoeing didn't increase wheat yields but reduced soil organic carbon and microbes

Breaking the hardpan with the rotary hoe did not increase crop yield *(Table 1)* or increase the moisture content of the top 10cm of soil although the soil moisture content in the 10-20cm layer was slightly lower in the rotary-hoed plots where the clay had been broken up and mixed with surface sand *(Table 2)*. The soil disturbance from rotary hoeing caused a decrease in organic carbon and soil microbes compared to the non-rotary hoed plots.

What does this mean?

Continuous wheat systems will run down the capacity of the soil to supply N and strategic application of bag N during the growing season may be required in good years to manage proteins. Including a legume once every four or five years can offset this N deficiency to some extent. Canola also gives a yield benefit in the rotation but from these results it is not clear whether it confers the protein N benefit that legumes give. The benefits can be quite long-term, so a choice of crop or pasture made in one year will influence things in several years time.

Acknowledgements

Thanks to the Dunn family for never-ending support and an enthusiastic welcome every time we drop by, to Penny Day for cheerfully processing and analysing samples, to the accommodating staff from Minnipa Agricultural Centre for soil and plant sampling, to Hilda Wake at the Arno Bay AusBulk site for grain analysis and to Damien Adcock for advice.

GRDC Grains Research & Development Corporation

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RURAL SOLUTIONS SA

Best practice

Sustainability on the Far West Coast-results from a survey!

Neil Cordon

SARDI, Minnipa Agricultural Centre

Survey

Key Messages

- **Flexibility of farm operations was highlighted as the key for a sustainable system, especially in regard to stock and weed management and tillage operations.**
- **It's the total number of tillage passes in a system rather than the number of tillage passes per year that negatively affects the sustainability of a system.**
- **For continuous cropping to be sustainable in this environment there appears to be two principles that need to be adhered to: firstly, adoption of no-till principles to minimise risk of soil degradation and secondly the use of alternative crop species in the rotation to avoid root disease (crown rot) multiplication.**
- **No single system appears to be more sustainable than another especially if good agronomic practices and management are conducted within each system.**
- **Strategic burning and careful livestock management does not harm the sustainability of a system.**
- **Harrowing or prickle chaining post sowing pre-emergent has a positive effect on reducing grass weed issues in cereal crops.**
- ***Rhizoctonia* is still the main root disease, which limits yield potential and therefore economic sustainability. The lowest *rhizoctonia* levels appear to be in those systems that adopt one or more of the following strategies - zinc addition, deeper soil disturbance and limitation of sulfonylurea herbicide use.**
- **Targeted surveys and monitoring are excellent techniques for trapping information trends and issues of a farming system without the need to conduct long-term expensive research projects.**

Why do the survey?

The aim of this exercise was to gain an appreciation of the relative sustainability of a range of farming systems on the Far West Coast region of Upper Eyre Peninsula.

Numerous studies, trials and experiments have shown the sustainability of farming systems depends heavily on the quantity of organic matter that can be added to the system. These studies also suggested farmers should be encouraged to slow down carbon loss by adopting practices such as no burning, stubble retention and no-till.

Farmers in the far west region of EP identified that their geographical location and weather patterns make it almost impossible to grow a lot of anything, which will make a worthwhile contribution to the system. So the question was asked “Can we identify which of the systems/rotations and/or management practices that we currently carry out that are degrading or beneficial to long term sustainability?”. McNeill and Day EPFS book 2001, page 110 summarised their work on biological activity of UEP soil as “Research needs to be done to clearly define the effect these practices have on soil microbial biomass and on their benefits in terms of soil fertility”. This exercise will hopefully meet some of those needs.

How was it done?

Twelve farmers were selected from group discussions in March 2003 during a meeting to identify research priorities for the district from Mudamuckla to Penong. The targeted farmers involved in the survey had a history of major differences between their farming systems, eg burning, continuous crop, long pasture phases, no-till, minimum till and full tillage etc.

Personal interviews were conducted to gather information on a selected paddock that typifies their farming system and their perceptions on some sustainability indices were also recorded.

The selected paddock was extensively soil sampled in March/April with the following sustainability parameters (0-10 cm) measured; phosphorus, organic carbon, nitrate nitrogen, microbial N, microbial C and root disease DNA.

Economic data was not gathered as it was considered that this sustainability indicator is very much up to an individual’s attitude to risk, lifestyle and how much money they want to make.

Confidentiality has been achieved by issuing each farmer a system number so an individual farmer can compare his parameters against other systems. The system numbers are at random and do not rank systems against one another.

What were the systems surveyed?

Descriptions and comments

System No 1 - Wide rotation with long pasture phase of 7 years and 1 year crop using tillage. Pasture residue is burnt before crop phase and sowing operation uses a splitter system, which produces a 6 cm seed spread. Barley grass is a problem early in the pasture years but the persistent grazing tends to minimise the issue as the crop phase approaches.

Farmer comment: “It’s a good performing paddock which works up cloddy, has no drift risk and hangs on well”.

System No 2 - Continuously cropped with tillage for the past 15 years and no burning. Since 2002 this system has undergone a change to no-till using narrow points. The new system involves soil disturbance 3 to 4 cm below the seed with fertiliser applied through a double shoot arrangement and seed spread in a 6 cm band. Zinc is a major nutrition strategy and grass freeing is carried out in the pasture phase.

Farmer comment: “Disease levels appeared to reach their peak after 5 to 7 years and then declined. Crop species are rotated regularly and alternative crops are grown in the system. There was water erosion in 2002 however it is a good performing paddock which hangs on well especially since breaking up the hard pan layer”.

System No 3 - Continuous cropped using alternative cereal species with tillage for the past 7 years and no burning. Machinery for paddock preparation and sowing can be either disc or tine arrangements depending on the summer weeds (melons) present. Glean® is used on this paddock to sort out 3 corner jacks.

Farmer comment: “Since burning has been excluded there has been no drift and the paddock hangs on well”.

System No 4 - Continuous cropped with wheat (Krichauff) for the past 5 years using tillage and no burning. Previously the rotation was 2 years pasture followed by 2 years crop. The paddock was grass freed at the last pasture phase to set it up for continuous cropping.

Farmer comment: “There has been no recent wind erosion and the paddock is one of our best which hangs on well”.

System No 5 - Wide rotation with 3 to 4 years pasture followed by 1 year crop using tillage. Pastures are spray topped the year before cropping and residue burnt however that has been limited to 7 burns in 33 years. An initial working either wet or dry is done with a disc plough. Rhizoctonia is always a problem unless the workings are timed correctly. Pastures are usually natural regeneration although some are trash sown to oats.

Farmer comment: “I am aware of the paddock being at risk to wind erosion however due to my long pasture phase the soil works up cloddy. The soil type varies considerably and it is an average type paddock”.

System No 6 - Traditional rotation of 1 year pasture followed by 2 years crop with tillage and no burning for 22 years. Pastures are usually natural regeneration with some trash sown to oats and are spray topped for grass seed set control.

Farmer comment: “This system seems to have improved moisture retention with the crops hanging on well compared to the district. As the soil comes up cloddy there has not been a drift issue in recent years”.

Location
Closest town: Penong
Cooperator: Polkinghornes
Group: Charra Ag Bureau

Rainfall
Av. Annual total: 325mm
Av. Growing season: 240mm
2002 annual total: 161mm
2002 growing season: 137mm

Yield
Potential: 1.2 t/ha
Actual: 0.67 t/ha

Paddock History
2001: pasture
2000: pasture
1999: pasture

Soil
grey calcareous loam with magnesia patches

Diseases
High prats

Plot size
40 ha each

Other factors
Poor growing season rainfall

System No 7 - Year in/Year out rotation with no burning and tillage used. The pasture phase is spray topped.

Farmer comment: "This is a soft type of paddock with good soil depth which hangs on well, however although it has never blown the risk is always present".

System No 8 - Pasture for 2 to 3 years followed by 2 years of crop using minimum tillage or one pass sowing. Pasture residue is strategically burnt prior to first crop.

Farmer comment: It's a good paddock with deep soil that hangs on well. There is no drift and my sowing operation leaves the soil cloddy".

Table 1: Comparison of system burnings, tillage passes, row spacing, tine width and sowing speed.

System	Years since last burn	No of tillage passes in last 7 years+	Av. Tillage passes/crop+	Row spacing (cm)	Tine width (cm)	Sowing Speed (km/hr)
1	8	0	3	23	25 *	14
2	15	27	5	18	20 *	13
3	6	17	3	18	15	12
4	8	12	3	18	20 *	10
5	1	10	5	13	15	10
6	22	9	2	23	25 *	10
7	15	11	3	18	20 *	11
8	4	9	4	18	20 *	11
9	8	12	2	18	20 *	11
10	20	3	3	20	20 *	11
11	9	14	3	18	10	10
12	1	10	3	18	13	11

** Sowing with sweeps*
+ The addition of tyre harrows or prickle chain behind a machine or as a separate operation was recorded as a tillage pass.

Table 2: Comparison of system rainfall, fertiliser use, yields and soil type.

System	Annual Rainfall (mm)	Av. GSR mm	Fertiliser			Av. Yield t/ha	Soil Type
			N	P	Zn		
1	300	220	5	10	Nil	0.9	C
2	300	220	26	9	Yes	1.0	A
3	290	220	9	10	Nil	1.1	A
4	308	204	9	10	Nil	1.2	B
5	260	191	7	14	Nil	1.2	B
6	275	191	7	8	Nil	1.0	B
7	312	245	6	12	Nil	1.4	C
8	290	245	9	10	Nil	0.9	C
9	313	245	9	10	Yes	1.0	B
10	300	231	9	10	Yes	1.1	D
11	275	220	5	11	Yes	0.9	B
12	290	231	5	11	Nil	1.0	A

Soil Key A – Reddish brown alkaline sandy loam over clay.
B – Reddish brown alkaline sandy loam over limestone rubble.
C – Greyish brown alkaline sandy loam over limestone rubble.
D – Saline alkaline brown sandy loam over sheet limestone.

Table 3: Comparison of system nitrogen, organic carbon, phosphorus, microbial nitrate and microbial carbon at 0-10 cm

System	Extractable Phosphorus mg/kg	Nitrate Nitrogen kg N/ha	Organic Carbon %	Microbial N mg/kg	Microbial C mg/kg
1	20	29	1.54	65	361
2	19	12	0.67	30	166
3	18	17	0.69	34	189
4	20	39	1.18	54	297
5	21	32	1.16	44	243
6	22	17	1.31	45	246
7	23	15	1.07	60	334
8	23	8	1.28	62	342
9	29	16	0.91	52	290
10	24	16	1.40	84	465
11	17	8	0.98	53	291
12	17	16	0.95	56	312

System No 9 - Continuously cropped with wheat using minimum tillage principles for last 7 years. No burning occurs and grass weed management in crop is achieved by delaying sowing and the use of trifluralin/sulfonylurea herbicides.

Farmer comment: "This is one of our poorer paddocks that used to drift badly however the current system has reduced the drift risk".

System No 10 - Normally 1 year pasture followed by 2 years crop however this paddock has had only 1 crop in the last 7 years. Tillage is part of the system however burning is not. Press wheels are on the seeding machines and occasionally narrow points are used to allow for deeper soil disturbance for *rhizoctonia* control.

Farmer comment: "Gee I didn't realise it hasn't been cropped that often. The paddock has blown after spray topping even with trash retention but generally it is one of our better performers."

System No 11 - One-year pasture followed by 2 years crop using tillage and no burning. Working up is done with either a disc plough or cultivator. Grass weed control in the pasture phase is achieved by using higher spray topping rates, almost a chemical fallow. Pre-sowing knockdowns are strategically applied.

Farmer comment: "This paddock has magnesia patches and the hills are at risk to drift".

System No 12 - Two year pasture followed by 1-year crop with cold burning and tillage utilised. Stock are strategically rotationally grazed. Pastures are chained in February to lay pasture down, kill woody weeds and any snails.

Farmer comments: "Paddock health had improved over the last 20 years however the hills are vulnerable to drift between burning and first working".

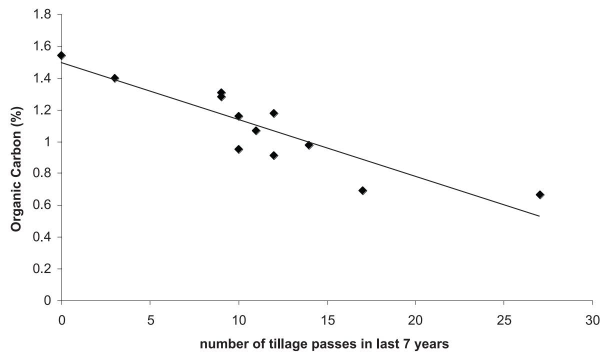

Figure 1: Tillage effect on organic carbon levels.

What did we find?

General - There was little variation between the systems with row spacing, tine width and sowing speed *(Table 1)*, which suggest that this aspect would have similar effects on each system. Number of years since last burn ranged from 1 to 22 and number of tillage passes in last 7 years ranged from nil to 27.

Whilst system 2 had the most number of workings in a continuous crop program, the farmer had recognised some warning signs to sustainability and recently adopted no till principles.

66% of the systems do not burn and 66% use sweeps at seeding time. Summer perennial weeds are a barrier to no-till adoption as the sweep shear is one of the few control mechanisms available to the farmers. Residual type herbicides are not positively seen in this environment so full soil disturbance is required to control the perennial weeds.

The systems used between 8 and 14 kg P/ha *(Table 2)* supplied by either 10:22:0 or 18:20:0 fertiliser. The longest continuous crop system (2) applies the most fertiliser nitrogen (26 kg N/ha) whilst only 33% of those surveyed have applied zinc to their system. The more zinc used, the fewer problems with Rhizoctonia *(Table 5)*. All properties only applied fertiliser during the crop phase with the seed except system 12 where the fertiliser was broadcast prior to working up. Average yield may not be a good indication of a systems performance due to variations between rotational sequence and annual rainfall when that paddock was in crop. For this exercise average crop yields ranged from 0.9 to 1.4 t/ha with no real influence from a system.

Snails - Only system 9 had snails as a problem with that issue probably influenced by close proximity to the highway.

Grain quality - All systems had low screenings except for system 9 which is possibly due to crown rot in that paddock. Grain proteins were high (≥12%) except system 2 whose assessment "slightly lower than others in the district but never below 10%". This lower protein may be considered a warning sign together with other soil fertility *(Table 3)* indicators that the system may be degrading.

Soil fertility is a good indicator of the sustainability of a system since it is ideal for trends to be rising rather than decreasing. Since we don't have starting point measurements we cannot make judgements on the trends within most of the systems studied, however we can evaluate trends between the various systems *(Table 3)*.

Phosphorus - Some systems (2,3,4,9) are applying P every year, whilst others (1 and 10) have only applied P once in the last 7 years. These application regimes are not reflected in the soil P levels.

Nitrate Nitrogen - This is the nitrogen pool that is immediately available at seeding and there doesn't appear to be a system effect on soil nitrate levels.

Organic Carbon - It is here that we begin to see an effect of the system on organic carbon levels. The data shows there is a clear negative correlation between organic carbon and number of tillage passes over time *(Figure 1)*.

Table 4: Comparison of grass control strategies & problems in pasture & crop phase.

System	Pasture Phase			Crop Phase			
	Grass Freeing	Spray Topping	Grass Weed Problem	Pre Sowing Knockdown	In Crop Problem	Sulfonyl urea use	Post Seeding Tillage
1	No	No	Yes	Yes	No	Yes	Harrow
2	Yes	N/A	N/A	Yes	No	Some	P. Chain
3	No	No	N/A	Some	No	Yes	No
4	Once	No	Yes	No	No	No	P. Chain
5	No	Yes	Yes	No	Some	No	Harrow
6	No	Yes	Yes	Yes	No	No	No
7	No	Yes	Yes	No	No	No	Harrow
8	No	No	Yes	No	No	Some	P. Chain
9	No	No	Yes	No	Some	Yes	No
10	No	Yes	Yes	No	No	No	P. Chain
11	No	Yes	Yes	Yes	No	No	P. Chain
12	No	No	Yes	No	No	No	Harrow

N.B: P Chain = Prickle Chain.

Table 5: Comparison of DNA estimated root disease levels.

System	Visual	Measured DNA Analysis				
		Rhizoctonia		*P. neglectus*		Crown Rot
1	Rhizoctonia	68	Medium	3	Low	BDL
2	None	53	Medium	3	Low	BDL
3	None	39	Low	4	Low	BDL
4	None	14	Low	1	Low	20
5	Rhizoctonia	105	High	5	Low	BDL
6	None	84	High	2	Low	BDL
7	Rhizoctonia	98	High	6	Low	BDL
8	Rhizoctonia	96	High	8	Low	BDL
9	Crown Rot	22	Low	5	Low	69
10	None	20	Low	15	Low	BDL
11	Take all	34	Low	5	Low	BDL
12	Rhizoctonia	7	Low	10	Low	BDL

Ratings of low, medium and high equated to the risk of the level of disease measured, which will affect yield. BDL = Below Detectable Limit.

In this environment, burning and number of tillage passes per crop does not appear to affect organic carbon adversely.

Microbial Nitrogen - This provides an indication of how much nitrogen is 'tied up' temporarily in microbes and becomes available to the crop during the season. The two highest levels (system 1 and 10) are from those that have had the longest pasture phase or least number of tillage passes over time.

Microbial Carbon - This is used to describe the 'size' of the microbial biomass and is regarded as the "engine room" of a farming system. Relationships here are similar to that of organic carbon.

Grass Weed Management - This is seen as one indicator of the sustainability of a system through development of herbicide resistance, use of tillage to control weeds and/or the cost of controlling weeds.

No system had any evidence of herbicide resistance which is not surprising due to the use of tillage and stock as weed management tools and the limited use of group A and B chemicals. 75% of the systems use tine harrows or a prickle chain approximately five days post seeding for weed control. This appears to provide excellent grass weed control in this environment regardless of the system.

Barley and ryegrass were the most common grass weeds with brome grass being identified as an increasing threat.

Root Disease - All systems had levels of cereal cyst nematode, take all and *Pratylenchus thornei* which were below detection. The low take all inoculum levels measured may have been influenced by a large rainfall event throughout the district in February 2003 before soil sampling. Large rainfall events will reduce take all inoculum.

It is interesting and pleasing to note that 75% of the farmers had their visual perception of disease levels and type verified by soil DNA analysis. Does this mean that farmers are pretty good at identifying root disease and the effort put into disease identification workshops and field days has paid off?

Rhizoctonia - levels vary from low to high and under close examination do reflect systems. For example system 10 uses narrow points for deeper tillage occasionally, has applied zinc fertiliser and does not use sulfonylurea type herbicides, resulting in low disease levels.

P neglectus - There appears to be no trends here as levels are low for all systems.

Crown Rot - The two systems (4 and 9) that recorded crown rot levels are those that have continuously cropped at least 5 years with wheat, and have not burnt for 8 years. The other continuous cropped system (2) has low levels of crown rot but has used non-host crops regularly.

Livestock - All have a livestock component except for system 2. Stock are strategically rotationally grazed on crop and pasture residues with farmers aware of issues such as erosion and drought. System 12 removes stock from future cropping paddocks in September to retain seeds on soil surface and in seed head. This strategy is believed to assist in better grass weed destruction during crop preparation operations.

Acknowledgements

The Goode and Charra farming communities for their positive attitude towards such a project. The co-operating survey farmers for being so open, honest and patient during the gathering of data and putting up with my painful phone calls. Thanks to Wade Shepperd for assisting me in taking soil samples. *Further information EPFS book 2000 summary Page 98. "Living soils on the Upper EP are they???"*

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Do you need the EP Farming Systems Project to continue?

Whether your answer is yes or no please tell us about it - fill out the survey on page 3 & 4 of this publication and send back to the Minnipa Ag Centre ASAP

MAC Farming Systems Competition

Demo

Proudly sponsored by AWB Ltd

Samantha Doudle and Mark Bennie

SARDI, Minnipa Agricultural Centre

Location
Closest town: Minnipa
Cooperator: MAC

Rainfall
Av. Annual total: 326 mm
Av. Growing season: 241 mm
2003 annual total: 263 mm
2003 growing season: 204 mm

Yield
Potential:1.88 t/ha (wheat), 1.41 (canola)

Soil
Sandy clay loam, pH 8.5

Type of Research
Broadscale competition

Key Messages

- **Farmers last seen wearing new moleskins, driving a new team Landcruiser (all four of them jammed in the front) and drinking Crownies!**
- **Eyre Peninsula's premier consultants take a leaf out of the Researchers book and come unstuck due to poor team communication. This team were last seen in MAC meeting room playing Twister to improve communication skills!**
- **Eyre Peninsula's premier researchers very capably demonstrate why it is so important to stick to canola time of sowing rules!! This team has not been sited since August 2003; at least no one is admitting to belonging to this team!**
- **District practice is the quiet under-achiever. No major disasters but haven't got too much out of some reasonable seasons, either.**

Why do the trial?

This is the fourth year of a broad scale farming systems competition on Minnipa Agricultural Centre (MAC). The success of our farming enterprises is determined by how well we utilise the soil, environmental and financial resources we have. This competition aims to demonstrate the consequences of four different approaches to managing the same bit of land. This "same bit of land" is actually four separate and adjacent paddocks of three hectares on MAC. You can follow the progress of the competition every year at the annual MAC Field Day in either September or October and through this publication.

How was it done?

The competition is divided into three teams – The Farmers (Mid West Farmers Group), The Advisers (both private and Rural Solutions SA) and The Researchers (MAC staff). Each team has been allocated one paddock and have the challenge of farming it to become the most profitable and sustainable team in both the short and long term. A fourth paddock contains 'district practice', a farming system decided by consensus of the three teams. Each team is responsible for planning the complete management of their paddock, with the only constraint being that all operations must be possible using MAC equipment (unless the team can make other arrangements). All teams have access to the full range of marketing options provided by AWB to convert their products into cash.

What happened?

The following is a summary of what the teams had to work with after four years of setting up their systems

2003 Nitrogen & Subsoil Constraints Soil Test Results

(Test taken 4 weeks prior to seeding)

- Microbial nitrogen (N) can be used to work out how much N is "tied up" temporarily in microbes.
- Microbial carbon © is an indication of the size of the microbial biomass.
- Kg N/ha is the level of mineral N or available N prior to seeding

There are no real differences between the levels of microbial nitrogen and carbon between any of the paddocks at this stage.

The only major difference affecting management from these tests is the kg of nitrogen available at seeding. The researchers and the district practice paddocks both had less total nitrogen in the profile than the consultants and farmers paddocks. The consultants had more nitrogen in their 0-10 layer, while the farmers had more nitrogen right throughout their soil profile (due largely to their inheritance of a paddock with a long history of luxuriant legumes!).

Soil Moisture

The soil moisture graphs show the amount of water left in the soil after harvest and the amount of water that would be left in that soil at wilting point (when the plant can't extract any more of it). We recognise that there is a bit of shall we say "wobble" in the wilting point concept, given that plants have certainly been known to extract water below the theoretical

2003 Root Disease Testing Service Results (BDL = below detection level).

Paddock	CCN Risk	Take All Risk	Rhizo Risk	Prat neglectus Risk	Prat thornii Risk	Black Spot Risk	Crown Rot Risk (Provisional Risk Category)	**Too Cockyitis	**Dumb Decisionitis
Researchers	BDL	Low	Medium	Low	BDL	BDL	Medium	Very Low	Very High
Farmers	BDL	BDL	High	Low	Low	BDL	Low	Very, very high	Low
District Practice	BDL	BDL	Medium	Low	Low	BDL	High	BDL	BDL
Consultants	BDL	BDL	High	Low	BDL	BDL	Low	Dropping!	Climbing!

*** Special categories specifically for this competition!*

Rotations

SOIL PROFILE ASSESSMENTS, 2003

Soil tests below were taken end of April, 2003. High - toxic levels of subsoil constraints (boron and salt – approx Ece) in bold and highlighted.

Team	Depth (cm)	Texture	CO_3 (%)	pH (water)	OC (%)	Microbial Carbon (mg/kg)	Mineral N (kg /ha)	Microbial N (mg/kg)	Colwell P (mg/kg)	Boron (mg/kg)	ESP (%)	Approx . Ece
Researchers	0-10	SL	0.92	8.1	1.17	601	15	109	35	1.7	0%	2.3
	10-20	LSCL	1.26	8.4	0.69	185	11	34	15	1.8	1%	2.1
	20-40	SCL	8.06	8.8	0.49	192	7	34	6	2.2	5%	2.8
	40-60	SCL	7.5	9.1	0.53	99	4	18	5	11.3	13%	**9.5**
	60-70	CL	34.6	9.3	0.52	26	2	5	4	**14.8**	13%	**9.7**

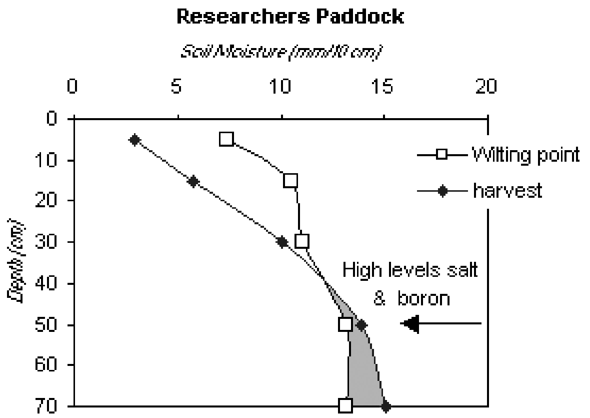
Team	Depth (cm)	Texture	CO_3 (%)	pH (water)	OC (%)	Microbial Carbon (mg/kg)	Mineral N (kg /ha)	Microbial N (mg/kg)	Colwell P (mg/kg)	Boron (mg/kg)	ESP (%)	Approx. Ece
Farmers	0-10	SL	0.54	8.4	1.13	485	13	87	32	1.6	1%	1.4
	10-20	LSCL	1.94	8.7	0.72	138	12	25	16	2.3	3%	1.6
	20-40	SCL	9.9	9.2	0.57	185	25	34	6	7.7	13%	6.1
	40-60	SCL	27.7	9.4	0.56	101	22	18	7	**20.7**	17%	**14.5**
	60-70	CL	19.6	9.4	0.42	36	10	7	4	**18.4**	18%	**14.4**

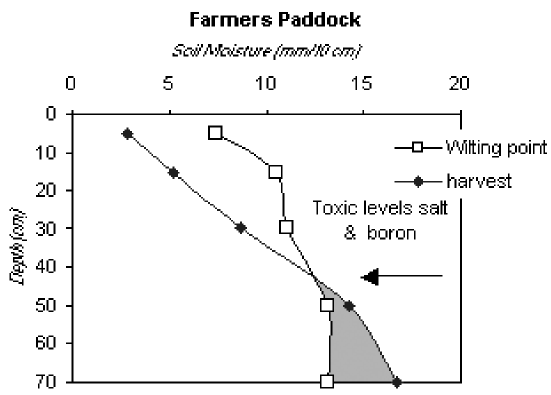
Team	Depth (cm)	Texture	CO_3 (%)	pH (water)	OC (%)	Microbial Carbon (mg/kg)	Mineral N (kg /ha)	Microbial N (mg/kg)	Colwell P (mg/kg)	Boron (mg/kg)	ESP (%)	Approx . Ece
Consultants	0-10	SL	1.48	8.5	1.13	540	20	98	31	1.6	0%	1.5
	10-20	LSCL	5.94	8.6	0.74	168	13	30	10	1.3	1%	1.4
	20-40	SCL	13.4	9	0.51	216	8	39	7	1.9	4%	2.3
	40-60	SCL	22.5	9.2	0.56	107	14	18	6	6.3	10%	**9.2**
	60-70	CL	26	9.4	0.4	46	7	8	6	**15.4**	13%	**10.5**

Team	Depth (cm)	Texture	CO_3 (%)	pH (water)	OC (%)	Microbial Carbon (mg/kg)	Mineral N (kg /ha)	Microbial N (mg/kg)	Colwell P (mg/kg)	Boron (mg/kg)	ESP (%)	Approx. Ece
District Practice	0-10	SL	1.38	8.7	1.11	525	9	95	33	1.9	1%	1.1
	10-20	LSCL	6.32	8.6	0.65	187	8	34	10	1.6	1%	1.3
	20-40	LSCL	8.96	9	0.7	286	8	52	9	2.9	4%	2.2
	40-60	LSCL	24.8	9.5	0.57	109	5	21	4	9.6	13%	6.3
	60-70	CL	7.32	9.7	0.45	64	3	12	4	**20.4**	18%	**9.5**

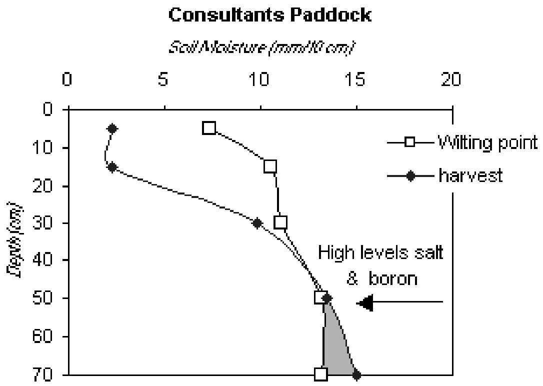
SL = Sandy Loam, LSCL = Light Sandy Clay Loam, CL = Clay Loam

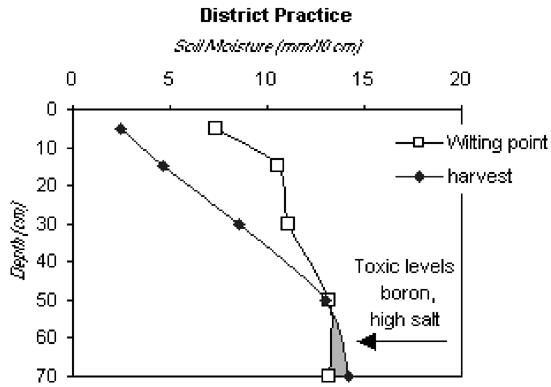
SOIL MOISTURE GRAPHS





SOIL MOISTURE GRAPHS





wilting point. However if you don't take the exact figures literally it gives a good indication of the trends in each of our competition paddocks.

The amount of water left in the profile that the plant did not extract (plant available water) is shaded grey in the soil moisture graphs. The larger the area, the more water left. We've also put an arrow in at the area where the subsoil constraints kick in, based on the information highlighted in bold from the tables above.

As luck would have it, it turns out that the farmers have the most toxic levels of both salt and boron at the highest level in the soil profile *(Soil Profile Assessment Tables)*. This shows out well in the graphs below, with the farmers having the most plant available soil moisture left at the end of the season (ie have achieved the highest yields using the least moisture) – kind of makes their competition achievements even better when you consider this doesn't it! (REH comment – of course the Researchers would have found a way to use all of this valuable resource!!).

We will show you these measurements each year of the competition so we can all learn if/how the subsoil constraints really react to different seasonal conditions and crops. To make our sampling even more accurate we will soon merge our EM 38 maps of the competition paddocks with the yield maps to make soil zones (areas with similar EM and yield readings). We will then sample from these zones each time to ensure we are as accurate as possible in bringing this information to you.

If you are interested in getting some of this type of information for your place, why not get yourself into the "Your Soil's Potential" program by contacting your local Rural Solutions SA office, or indicating your interest at the upcoming EP Farming Systems meetings.

The Not too cocky Cockies!

So what have the teams got to say for themselves?

Team 1 - The Farmers (The Not Too Cocky Cockies)

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

What did we learn last year?

Once again our team was aiming for a relatively low risk profitable option. We felt that since we had a strong paddock history due to maintaining a tight rein on weeds and disease, as well as providing suitable inputs in previous years, we were capable of another wheat crop that would provide us with the returns we wanted. We proved this once again (despite a relatively tight rainfall year) with a yield of 1.21t/ha at 13% protein, 4.1% screenings and a GM of $163 thus maintaining a healthy lead in the competition. These outcomes hinge on careful planning and attention to detail prior to the season and subsequent monitoring of the weed, plant nutrition and disease situation during the year. The seeding systems we use includes deeper pre-tillage and nutrition placement, controlled traffic and in most years no-till, all of which we believe adds to our continuing profitability. The wheat variety Krichauff which was pickled with Jockey® (as a precautionary measure) continues to be successful following wheat and the sowing rate of 40 kg/ha may be contentious (compared to conventional wisdom), however remains successful on this soil type. This may be due to reduced plant-to-plant competition in lower rainfall years, which includes tighter finishes, as was the case in 2003. Importantly at this low seeding rate, all things need to go right during the seeding process in case there are sowing depth problems, low germination and/or chemical damage. We have experienced none of these problems and this is a credit to the MAC farm staff. Lower seeding rates are also reliant on timeliness of sowing and rapid canopy coverage because on lighter undulating soils the amount of wind we experienced in 2003 could be a recipe for disaster. Our protein levels reflected a good dose of N pre-seeding at depth and lower screenings levels were probably due to reduced headlands from controlled traffic and the 40kg/ha sowing rate (which flies in the face of conventional recommendations) on this soil type. The build-up of grass weeds in crop and resultant seed-bank in our continuous cereal situation remains a problem and will be expensive in terms of future yields if allowed to continue unchecked. Our decision to use the AWB National Pool for our grain marketing strategy remains justified for its simplicity and successfulness. Sheep continued to be an important part of our system by not only cleaning up stubbles and weeds but also adding valuable profitability in a below average rainfall year.

2004 Plans

Since we have invested wisely in previous years and are now reaping the rewards this allows us the relative luxury of trying a few things out of the ordinary. Our final decision will however remain very dependant on the way the season begins, the amount of grass weed control we want and the crop that looks the most profitable at the time. An early break to the season would be ideal allowing good grass germination prior to seeding with a knockdown and a chemical brew at seeding. We aim to sow as early as possible and fertiliser use will be much the same as previous years. AWB marketing options will be reviewed during the season.

Our options include another cereal – either wheat or malting barley with some pretty serious chemical OR a break crop if the season is early and has good prospects: legume option – faba beans on wide row spacings (to enable a shielded sprayer) or Kaspa peas, or oilseed option – early sown canola.

Like all good 'Tall Poppies', the Not Too Cocky Cockies continue quietly along a well-planned pathway, eyes aimed straight ahead to our ultimate destination of success and a future for our kids. From the sidelines there are desperate attempts at swaying us from our pathway of good judgement and logical decision-making and this is a reflection of how envy can cloud their own. To the 'dazed and confused' we hold out our hand of peace and goodwill once again with offers of advice, management skills and eventual relinquishing of their 'tortured and destitute' land holdings and minds to the Cockies.

This is a dinky-di (ie not digitally fiddled with) photo of Brett reaping our canola!

Team 2 - The Advisers (De$perately $eeking $olutions)

Team motto - If we get trounced, please blame Ed Hunt!

What did we learn last year?

No in crop herbicide was applied due to a mix up in team member's roles. The extra weed competition resulted in lower yield – Ed's fault *(Ed clarification…that would be Ed Hunt, not Ed..itor!!)*.

Nutritional inputs appeared sufficient to support both crop growth and weeds present. We are happy that our current nitrogen and phosphorous inputs can sustain average production from this paddock into the future.

The decision to work up the paddock prior to seeding was based on marshmallow levels and the lack of rainfall to freshen up the weeds. It was considered unlikely that the weeds would be controlled sufficiently by a chemical application prior to seeding with narrow points.

2004 Plans

Summer holidays are too important, so livestock will be excluded from this paddock over summer and autumn. Early summer weed control will be implemented as required.

Summer/early autumn rainfall may determine our options for this paddock in 2004, but another cereal crop is the aim. Summer rainfall events over 25mm in a single event may help lower the root disease risk that has built up on the previous two cereal crops and low level of barley grass present. An early seasonal opening may assist the control of grasses, and provide additional opportunity for lowering disease inoculum levels in the soil.

Options for another wheat crop depend on summer rainfall and early grass weed control opportunities. Varietal choice is not limited to Krichauff, especially if grade spread indications remain above $10/t between ASW and APW. There is the opportunity to use a seed dressing that suppresses root disease if required.

If summer rainfall is low and an early break/excellent grass germination does not occur, Keel barley may be sown. Sowing could be delayed until a good weed (grass and broadleaf) germination has occurred.

The nutritional programs will continue to be structured around feeding a crop of average yield.

Team 3 - The Researchers (The Starship Enterprise)

Team motto - Boldly going where no man has gone before!

What did we learn last year?

The farm rules for sowing canola on MAC are NOT to sow unless we have had at least 40 mm of rainfall between April 1st and May 20th. The actual 2003 rainfall between these two dates was 35 mm, 13.2mm of which actually fell on May 20th. HOWEVER my friends, the fact of the matter is that during past MAC Field Days there has been some considerable flack floating around on the back of those trucks. The cause of this flack has been people having a "go" at the canola sowing decisions here and the fact that there hadn't been any broad scale canola on MAC for the last few years. The Researcher Team, being the intrepid, broad-shouldered, well-balanced individuals that they are, decided that it was time to get the general public off of the case of the MAC farm staff and prove that we have canola sowing rules here for a reason.

An unfortunate accident at seeding (hooking the airseeder in the fence) carved up the top part of our paddock (as if trying to miss the only stobie pole in the competition isn't bad enough in 3 ha), wiping out our emergence in this area. We tried to retrieve the situation with a plot seeder, however all year this area was very thin. Despite the late start, the rest of the paddock performed admirably…until that nasty dry September cast a blue pall over our crop and our competition hopes once again.

Harvest was also very timely with Brett ripping it off before the impeding thunderclouds opened up and almost getting a zap for his efforts - luckily the moisture level was under!! Things would have been even worse if we had let our marketing slide as well. Fortunately, we locked in our canola at $420 with AWB in November 2002 (if you don't believe us, ask Batesy!) which was much smarter than the cash price last December of $376. We could tell you our back up plan if prices had risen but our lawyers have advised us not to!

Register your interest in this magnificent paddock with Not Too Cocky Real Estate!

Competition Summary

YEAR	DATE	FARMERS	CONSULTANTS	RESEARCHERS	DISTRICT PRACTICE
1999 *(prior to competition)*		Parafield Peas @ .36 t/ha	BT Schomburg Wheat @ 1.33 t/ha	Wallaroo Oats @ .67 t/ha	Chemical Fallow
2000		Chemical Fallow, Summer Crop, Legend Sorghum @ yield 50 kg/ha. GM = -$56.89 /ha	Chemical Fallow/summer weed spray, GM = - $21.48 /ha	Chemical Fallow, GM = -$12.61 /ha	Chemical Fallow, GM = -$10.78 /ha
2001		Yitpi Wheat: Yield- 2.75 t/ha, Prot- 13.6%, Scrn 5.6% & TW-75.4. GM = $599.77 /ha	Yitpi Wheat: Yield- 2.77 t/ha, Prot- 11.6%, Scrn- 4.6% & TW- 75.4. GM = $571.66 ha	Broadcast Frame Wheat: slashed and baled (wild oat problem). Yield:22 round bales. GM = $207.16/ ha	Yitpi Wheat: Yield- 2.79 t/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 Pastue GM = -$3.70
2003 Management	28/2/03	Deep Banded 10:22 @ 30 kg/ha & Zinc @ 10 kg/ha	Worked Up	Roundup Max @ 600 mls/ha, Triflur 480 @ 1.2 L/ha & Lorsban @ 700 mls/ha	Roundup Max @ 650 mls/ha & Triflur 480 @ 800 mls/ha
	28/5/03	Roundup Max @ 650 mls/ha, Triflur 480 @ 1 L/ha & Affinity @ 15 g/ha	Paraquat 200 @ 650 mls/ha & Triflur 480 @ 800 mls/ha	Rivette @ 3.5 kg/ha, 18:20 @ 65 kg/ha & Sulphate of Ammonia @ 35 kg/ha	Yitpi @ 55 kg/ha & 18:20 @ 60 kg/ha
	28/5/03	Krichauff @ 40 kg/ha & 18:20 @ 25 kg/ha	Krichauff @ 70 kg/ha, 18:20 @ 50 kg/ha & Urea @ 24 kg/ha	Endosulfan @ 750 mls/ha	Prickle Chained
	3/7/03	Diuron @ 350 mls/ha & MCPA 500 @ 350 mls/ha		Targa @ 300 mls/ha, Zincsol @ 2 L/ha	Affinity @ 12 g/ha & MCPA @ 500 mls/ha
	14/8/03			Select @ 250 mls/ha & 0.5% Hasten	
	28/11/03	Krichauff Wheat Yield – 1.21 t/ha, Prot - 13%, Scrn - 4.1%, TW – 76, Pot Yield – 66%, GM = $163.06	Krichauff Wheat Yield – 0.99 t/ha, Prot – 12.1%, Scrn - 5.6%, TW – 77.2, Pot Yield – 54%, GM = $117.60	Rivette Canola Yield – 0.50 t/ha, Oil – 40.7%, Foreign Matter – 5.7%, TW – 64.2 GM= $64.92	Yitpi Wheat Yield – 0.85 t/ha, Prot – 14.3%, Scrn - 5.9%, TW – 78.6, Pot Yield – 46%, GM = $117.37
Average Gross Margin/year		**$255/yr** ☺	**$225/yr** 😐	**$112/yr** ☹	**$169/yr** 😐

2004 plans

We think we have reduced our paddock legacy of weeds, disease, lack of nutrition and general bad luck to a state where we will start our upward charge (possibly more of a difficult climb really!) with a run of cereal crops, starting with wheat. We intend to go no-till, using a "secret" weed control method that Fish picked up in the Far West farming systems survey. We will be keeping a close eye on our zinc during the season (marginal levels in tissue test 2001) plus we will be looking for some seeding zinc to toughen our crop roots to stop those rhizoctonia bugs bothering us too much in our no till, early sowing system. We can't use a group A herbicide this year (herbicide resistance in mind), due to our reliance on them thrice in the past to extract us from difficulty (two germinations of barley grass can cause hassles). We will not be bitten on the butt by any unexpected weed problems (ala 2001) this year as our credibility must be starting to crack at the foundations and that was just shoddy – just as well that we make better researchers than we do farmers! To address the cause of all of our past problems we are seriously considering establishing a sub committee, however we haven't had any volunteers yet as no one wants to inherit our appalling bank balance!

Acknowledgements

- AWB Ltd for continued sponsorship of this competition
- MAC farm staff, Brett & Ted McEvoy for sowing, managing and reaping the paddocks (and crashing into the researchers' fence with the airseeder – a hazard of big equipment in tiny paddocks folks!!)
- MAC technical staff for soil and tissue sampling.

AWB

MINNIPA RESEARCH FOUNDATION

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

Best practice

Location
Cowell
Steve Edwards
Franklin Harbour Ag Bureau

Rainfall
Av. Annual: 285 mm
Av G.S.R: 205 mm
2003 Total: 270 mm
2003 G.S.R: 170 mm

Yield
Potential (w): 1.54 t/ha

Fertiliser
18:20:0 @ 70 kg/ha

Soil Type
Red sandy loam

Franklin Harbour Rotation Demo

Neil Cordon
SARDI, Minnipa Agricultural Centre

Demo

Key Message

The contribution of field peas to the farming system can be positive in a low rainfall environment.

Why do the trial?

In 2002, farmer co-operator Steve Edwards sowed half a paddock to field peas and the other half to medic. This created an ideal opportunity to evaluate the performance of wheat on pea and medic stubble over 2003.

How was it done?

Clearfield Janz wheat was sown at 65 kg/ha on the 17th May over both sections of the paddock.

Measurements: 0 – 10 cm soil tests, 0 – 50 cm profile nitrogen and carbon, grain yield and quality.

What happened?

Excellent growing conditions throughout the season produced yields in excess of the potential. Both peas and medic were grass free in 2002, but produced little vegetative growth due to drought. Topsoil analysis shows that the previous crop of peas or medic did not influence nutrient levels (Table 1).

It appears that the peas contributed more available nitrogen to the system (76 kg N) than medic (47kg N), which may be the reason the 2003 wheat had higher yields and protein on the pea stubble (Table 2).

Table 1: Soil nutrient levels at 0 –10cm from medic and pea section at Cowell 2003.

	Medic	Pea
Ext Phosphorus (mg/kg)	31	29
Ext Potassium (mg/kg)	512	422
Ext Sulphur (mg/kg)	3.2	3.2
Soil ph (water)	8.9	8.8
Organic Carbon (%)	1.08	0.93
Conductivity (ds/m)	0.12	0.11
Microbial Carbon (mg/kg)	283	241

Table 2: Profile nitrogen levels at 0 –50cm from medic and pea section at Cowell 2003.

	Medic	Pea
Nitrate Nitrogen (kgN)	47	76
Microbial Nitrogen (mg/kg)	147	129
Microbial Carbon (mg/kg)	810	722

Microbial N is a measure of how much N is "tied up" temporarily in microbes that become converted to available N during the season. Microbial C is an indication of the size of the microbial biomass. The higher this figure the better as this is the material that drives a farming system. Work in the Mallee has given average numbers for Microbial C in the top 10 cms soil of around 250 mg/kg, which is comparable to this paddock.

Subsoil Constraints - Additional soil tests indicated there might be constraints to root growth at 30-50 cm. At this depth the exchangeable sodium increases up to 9% indicating slight sodicity and the calcium/magnesium ratio is less than two. Soil boron ranges from 2.4-to 3.7 mg/kg and soil salinity as measured by electrical conductivity increases to 0.22 ds/m.

What does this mean?

Microbial N and microbial C figures suggest that the general fertility of the paddock is good and there is little difference in contribution to both microbial pools between medic and peas after a drought.

This work has demonstrated that wheat on peas (grass free) can yield equivalent wheat on medic and may be an option if continuous cropping is considered in this environment.

Acknowledgements

Steve Edwards for his interest in farming systems and the ability to keep issuing challenges.

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GRDC Grains Research & Development Corporation

Table 3: Grain yield, quality and income from wheat on peas or medic at Cowell 2003.

Treatment	Protein (%)	Screenings (%)	Test Weight (kg/h L)	Yield (t/ha)	Gross Income * ($/ha)
Wheat on Medic	12.8	1.0	82.6	1.76	369
Wheat on Peas	13.4	0.5	82.4	1.89	407

** Gross income is yield x price (with quality adjustments) delivered to Port Lincoln as at 1st December 2003.*

Section 5

Section editor: Alison Frischke

SARDI, Minnipa Agricultural Centre

United Grower Holdings

SARDI South Australian Research and Development Institute

Disease

The major disease issues of 2003 were:

- Blackleg became a devastating disease of canola again as resistance broke down in some varieties.
- The dry spring favoured crown rot development in many areas.
- Leaf rust was a problem in barley, particularly on YP – the Yorke Peninsula Alkaline Soils Group (YPASG) conducted some very useful trials using fungicides in 2003. Results will be available from Michael Richards at the YPASG office at the Minlaton council chambers.
- The eternally present *Rhizoctonia* caused its usual levels of damage.

Issues for 2004:

- Dennis Hopkins is predicting more locusts in 2004 due to the rains in the north.
- GRDC *Pratylenchus* funding will cease in June 2004 and no field research or further variety testing will occur on EP (or the rest of the state).
- Fungicides for seed and foliar treatments are at very low prices and may now be an economic option where they never have been before.
- Changes in wheat rust strains around the country have meant that variety selection is much more complicated now than it has been in the past, with several popular varieties now at risk to the new rust strains.

Wheat and Barley Rust in Low Rainfall Areas of Eyre Peninsula

Extension

Hugh Wallwork

SARDI, Plant Research Centre, Waite

Key Messages

- **Rust epidemics cannot be reliably predicted so caution is needed each year.**
- **Changes in the rusts populations mean that risks are now higher than in recent years.**
- **Varieties must be selected to avoid VS or "sucker" varieties.**
- **Fungicide sprays are a last resort but can very important.**
- **Stripe rust may become a problem on barley, although perhaps not on UEP.**

Risk and strategies

Predicting the risk of rust outbreaks is more difficult than weather forecasting. The severity of rust outbreaks is after all dependent on seasonal conditions: the timing and intensity of summer rainfall, the opening of the season, winter and spring temperatures, humidity and rainfall. A second major factor which is even harder to predict, is whether and where, if at all, the rust will survive in a region over the summer.

An easier factor to take into account, albeit very important, is the level of susceptibility of crops sown in the region. Clearly, if many growers are using varieties that are very susceptible, then not only will the disease develop much faster in those crops and much more inoculum be produced, but also volunteers of that variety will be much more likely to host the fungus over summer.

An often-overlooked factor is that very susceptible varieties will have a much wider range of conditions in which they will allow rust to survive and reproduce on them. Whilst precise figures are not available, you could suggest that a moderately susceptible variety might be prone to rust infection over say a 10 degree temperature range, whilst a very susceptible variety might be prone to rust infection over a 16 degree temperature range. This could make all the difference between infection and no infection over summer. It could be the difference between rust survival in a region and rust elimination from a region.

In planning risk strategies therefore you cannot become complacent or assume to know better than a weather forecaster what will happen in a season. What you can do is reduce the risks by sowing more resistant varieties and ensuring that summer volunteers are kept to a minimum. Where the risk of rust is particularly high owing to a high incidence the previous season, then a seed treatment using fluquinconazole (eg Jockey) could be used to provide early crop protection.

Variety Choice

With the rapid change in strains of all three wheat rusts, we have entered a period of time when growers have a greatly reduced choice of resistant varieties. Almost every commercially grown variety is vulnerable to yield loss from at least one of the rust diseases. Kukri is perhaps the only variety in SA that is at least moderately resistant to all rusts, although Frame has adequate resistance to stem and stripe rust and is only moderately susceptible to leaf rust. Yitpi whilst similar to Frame in many respects is more susceptible to stem rust and has recently been downgraded to an S to this disease. This variety should therefore be avoided in the more humid coastal zone of the Upper Eyre Peninsula, which has historically been a risk area for stem rust.

Of the new varieties, Wyalkatchem has attracted a lot of attention due to its high yield potential, useful resistance to yellow leaf spot (similar to Krichauff) and resistance to leaf rust. Unfortunately Wyalkatchem is susceptible to stripe rust, although providing the disease is kept under control in the rest of the state, this disease is not likely to be a problem on the Upper Eyre Peninsula. Wyalkatchem is also only MS to stem rust strains in Eastern Australia and it is now an S to a new strain in WA, so this variety should also be avoided in the humid coastal cropping zones.

Pugsley had very strong resistance to all three rusts until the new rust strains emerged. Most evidence suggests that to the new strains, Pugsley now has moderate resistance similar to Frame and is therefore likely to be quite adequate for the UEP. This variety, which has shown good yield potential, should not however be grown into wheat stubbles owing to its susceptibility to yellow leaf spot.

Two of the new varieties from Grain Biotech Australia, GBA Ruby and GBA Sapphire, both appear to have good resistance to all three rusts for the UEP although there is only limited data on their yield potential and other stress tolerances for the area.

The most critical factor in deciding on which variety to grow is to ensure that varieties identified as very susceptible (VS) or "suckers" to any of the rusts is avoided. It is for this reason that Stylet was not released. Amongst the varieties currently being grown or considered that have been identified as VS to one of the rusts, are H45, Westonia and Bonnie Rock, all of which are VS to the new strain of stripe rust.

Leaf rust on barley

Leaf rust in barley was a particular problem in 2003. The rust appears to have developed earliest on self-sown barley on the Yorke Peninsula. Rapid spread from these volunteer plants into early sown crops during autumn resulted in the disease epidemic. The situation was made worse because of the large area sown to Keel barley, which is more susceptible than other current varieties. Growers should be aware of this aspect of Keel and be cautious in its use in areas where leaf rust is an annual problem. Observations in 2003 have also shown that Baudin, a new variety from WA, is even more susceptible than Keel to some strains of the rust and so this variety should be avoided altogether on the Yorke Peninsula and be used with caution elsewhere.

Stripe rust on barley grass and barley

Stripe rust has frequently been observed on barley grass. Until recently this rust would have all been wheat stripe rust. Observations in SA and by the National Rust Control Program have indicated that wheat stripe rust evolved over time such that the severity of stripe rust on barley grass increased through some unidentified change in the rust population. Then in 1998 a new form of stripe rust was identified, now called barley grass stripe rust (BGYR) which was specifically virulent on this host but which was not virulent on wheat. This strain was also found to be virulent on Skiff barley although not on other barleys cultivated in SA. It is believed that this form was a new introduction to Australia rather than the result of a mutation.

In 2002 it was observed that a promising new feed barley, WI3297, was also quite susceptible to a strain of stripe rust. This was also seen in 2003 at a small number of barley trial sites. At Turretfield quite severe stripe rust was also recorded on Keel and a large number of breeding lines. Some stripe rust was also noted on Sloop and Sloop SA. The future significance of these findings is not entirely clear given the very favourable season for stripe rust development in 2003, but it is apparent that in future we are going to have to consider that stripe rust is also a disease of barley in Australia. However, it is not considered likely that this will be a problem for barley growers on the UEP.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Eyre Peninsula Fumigation Trials 2003

“investigating the true potential of EP soils”

David Roget[1], Andrew Taylor[1], Andrew Thompson[2] and Alison Frischke[2]

CSIRO Land & Water[1] and SARDI, Minnipa Agricultural Centre[2]

Research

Key Messages

- **Soil fumigation treatments increased early plant growth by up to 80% and yields by up to 27% indicating that biological factors were significantly constraining plant growth.**
- **Improved nutrition (fluids) provided yield benefits at Streaky Bay and Minnipa but not at Franklin Harbour. The major benefit from the improved nutrition treatments was only obtained once root diseases were controlled.**
- **The combination of improved nutrition and fumigation (root disease control) produced yields of 5.3 t/ha at Streaky Bay which was equal to 100% of yield potential, based on available water. Maximum yields at Minnipa and Franklin Harbour only reached 73% and 53% of yield potential respectively indicating that there were other constraints that had not been addressed.**

Why do the trial?

This was the second year of the fumigation trials that provided the opportunity to confirm results from the previous year and to evaluate impacts in a better rainfall year. Fluid fertiliser responses on the calcareous grey soils of Eyre Peninsula have been demonstrated consistently. The fumigation trial was established to determine if:

1. There were any biological limitations to wheat production that may be limiting the benefits of improved nutrition (fluids).
2. There are other non-biological factors still limiting crops from reaching yield potential.

In many regions crop production is still well below the potential that can be achieved for the available rainfall. The limitations to crop production may be due to a range of physical, chemical or biological constraints. Soil fumigation is a useful research tool to identify if biological factors are significantly affecting crop growth. It is not a viable option for broad-acre farming. The fumigation process removes most of the soil organisms, both the pathogens and the beneficial ones. The fumigated soil begins to be re-colonised quite quickly from adjacent unfumigated soil but not before the fumigation impact on the plant has occurred. Soil fumigation can also release nutrients, particularly N, and this needs to be considered when evaluating any fumigation responses. This work is part of the GRDC National Fumigation Project to assess the extent of soil biological constraints to production and to help identify areas that require research in the future.

How was it done?

See Trial Details.

To fumigate, plots were watered and covered with plastic, then had methyl bromide gas pumped under the plastic, which was removed after 3 days. Plots were then left a minimum of 2 weeks before sowing.

Granular fertiliser was applied as di-ammonium phosphate and urea, while fluid treatments were applied as ammonium polyphosphate with urea ammonium nitrate and zinc, copper and manganese chelates at both sites. Franklin Harbour was sown 26th May with Krichauff wheat; Minnipa and Streaky Bay were both sown to Barque barley on 5th June and 14th June respectively.

The fertiliser treatments were not intended to compare granular and fluid fertilisers, but to compare the district practice application of granular fertiliser, with increased and more available nutrients (i.e. improved nutrition), which were supplied by the fluid fertiliser.

Measurements: Soil moisture at sowing and harvest, dry matter production at early tillering, root disease assessments (tillering), mycorrhiza analysis, grain yield and protein.

Searching for problems

Location
Streaky Bay
Ken, Dion, Kym Williams

Rainfall
2003 April-Oct rainfall:
312mm

Potential yield 5.5 t/ha

Soil
Grey calcareous sandy loam
Colwell P: 32 mg/kg
Calcium Carbonate: 73.3 %

Plot size
1.5 x 7m

Location
Minnipa
Minnipa Agricultural Centre

Rainfall
2003 April-Oct rainfall:
177mm

Potential yield 2.6 t/ha

Soil
Red brown calcareous sandy loam
Colwell P: 25 mg/kg
Calcium Carbonate: approx 1-2%

Plot size
1.5 x 7m

Location
Franklin Harbour
Paul and Jack Kaden

Rainfall
2003 April-Oct rainfall:
218mm

Potential yield: 3.26 t/ha

Soil
Loamy sand over sandy clay
Colwell P: approx 17 mg/kg
Calcium Carbonate: approx 1.2 %

Plot size
1.5 x 7m

Trial Details: Trials were established at Franklin Harbour, Minnipa and Streaky Bay in 2003. Treatments and the nutrients supplied in each are given in the table below.

Fertiliser Treatment	Fumigation Treatment	Nutrients applied (kg/ha)
Granular	Nil Fumigation	14 P, 12.6 N
	Plus Fumigation	
Fluid	Nil Fumigation	18 P, 14 N, 1 Zn, 1 Cu, 1 Mn + foliar TE
	Plus Fumigation	

What Happened?

Streaky Bay. Dry matter production at early tillering was increased by 24 % with the fluid treatment and by 113% with the fluid plus fumigation treatment compared to the standard granular treatment (*Figure 1A*). There was only a small response (23%) to fumigation with the granular fertiliser. These early differences carried through to harvest with the fluid treatment following fumigation giving the highest yield of 5.3 t/ha compared to the granular treatment with 3.0 t/ha (*Figure 1B*). The fluid treatment increased yield by 0.7 t/ha over the granular treatment without fumigation. Maximum production required both the improved nutrition of the fluid treatment and the disease reduction from the fumigation treatment. Rhizoctonia root rot was the major disease at this site and the fumigation responses were largely due to the control of this disease.

This site received a growing season rainfall of 312 mm. Allowing for 60 mm evaporative loss of water (use 60 mm when growing season rainfall is less than 200 mm) that would leave 252mm for crop production and for barley that equates to 5.5 t/ha (252 x 0.022). Once disease had been controlled with fumigation, the yields with the fluid treatments were able to reach their maximum yield potential and was consistent with the results from this area in 2002.

Minnipa. Dry matter production at early tillering was increased following fumigation by 38% for the granular fertilisers and by 59% with fluids (*Figure 2A*). The benefit of the fluid treatment was marginal without fumigation however where the biological constraints had been controlled following fumigation the fluid treatment outperformed the granular treatment by 40%.

Dry spring conditions at the site limited the carry-over of the early crop production effects to final yields (*Figure 2B*) however the fumigation treatments (1.84 t/ha) still out yielded the non-fumigated plots (1.51 t/ha) highlighting the influence of significant soil constraints (*Rhizoctonia, Pratylenchus*). The fluid treatment did not increase yield but the dry matter results at tillering indicate that there can be significant benefits from fluids at the this site in better seasons once soil diseases are controlled. Based on a growing season rainfall of 177 mm and an evaporation of 60 mm, there was a barley yield potential of 2.6 t/ha. The best yields were still 0.7 t/ha below this potential. Some of the lost yield potential may be associated with the June sowing and also the loss of water below the root-zone following 70 mm of rain in August.

Franklin Harbour. Dry matter production at early tillering increased by 80% following fumigation but there was no difference between fluid or granular fertilisers in either the non-fumigated or fumigated plots (*Figure 3A*).

Grain yields were 11% higher in the fumigated treatments (1.74 t/ha) but there was no effect of the fertiliser treatments (*Figure 3B*). The fumigation response was due to the control of a moderate level of rhizoctonia root rot.

Growing season rainfall was 218 mm, which with a 60 mm evaporation loss gave a potential yield for wheat of 3.26 t/ha (158mm x 0.02). The best yields achieved at this site achieved only 53% of the potential yield, which suggests that there is still a significant non-biological limitation to production that has not been addressed.

Role of Mycorrhizae in E.P. Soils

Mycorrhizae are beneficial soil fungi that form associations with plant roots and can aid in obtaining soil nutrients, particularly P and Zn. In the 2002 trials, both at Streaky Bay

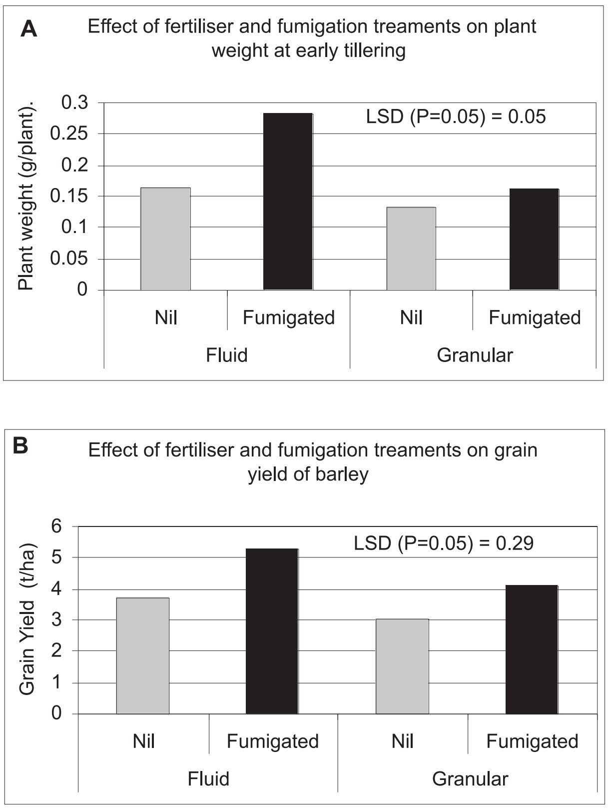


Figure 1: Dry Matter Production (A) and Grain Yield (B) for Streaky Bay

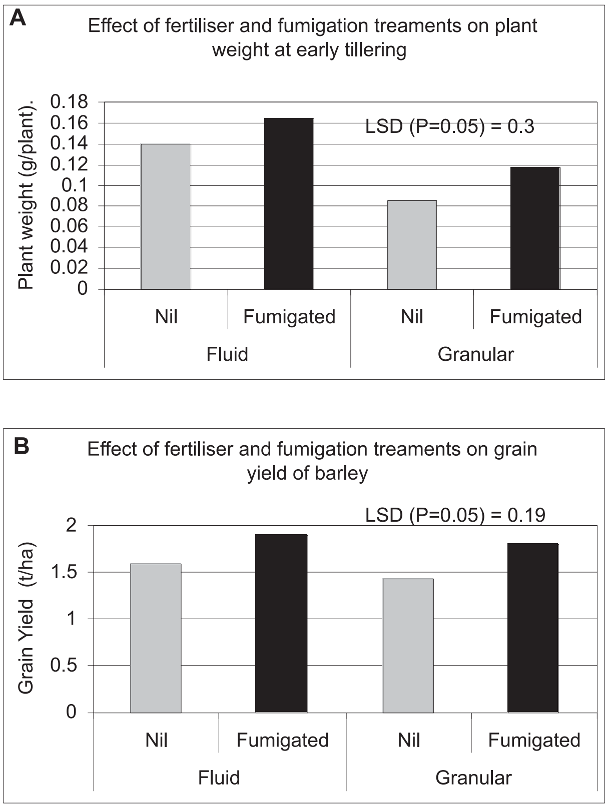
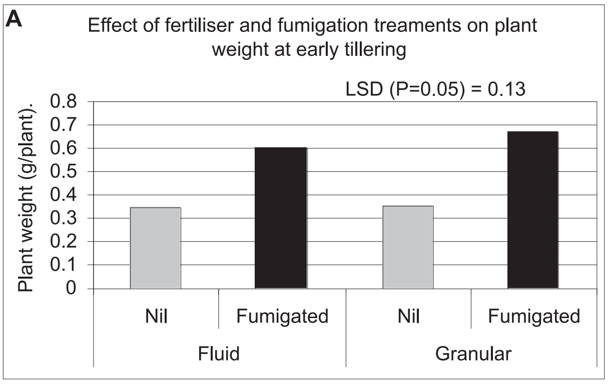


Figure 2: Dry Matter Production (A) and Grain Yield (B) for Minnipa



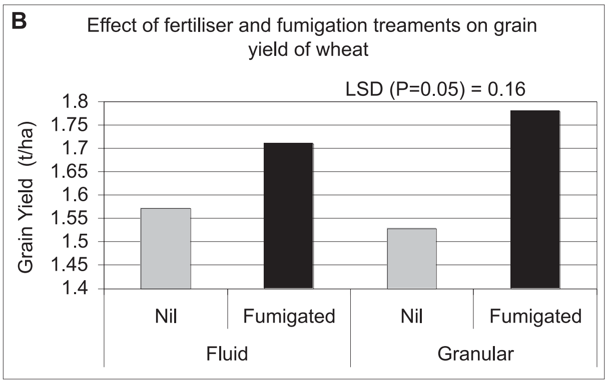


Figure 3: Dry Matter Production (A) and Grain Yield (B) for Franklin Harbour

and Penong, yields of wheat following fumigation in either the nil fertiliser or granular fertiliser treatments decreased compared to non-fumigated plots. Because of the poor availability of P in these soils and the limited P uptake from granular fertilisers it was thought that this yield decline may be due to a reduction in mycorrhizal activity due to fumigation. Assessments of plant roots sampled at early tillering from 2002 and 2003 showed that in non-fumigated soil 20-30% of the root length was colonised by mycorrhizae. Following fumigation the extent of colonisation was reduced to between 10-15%, which supports the idea that the reduced growth of crops after fumigation was due to reduced mycorrhizal activity and reduced P uptake.

In 2003 there was no indication of reduced production in the fumigated with granular fertiliser plots which may be due to better soil moisture conditions early in the season compared to 2002. The response to fluid fertilisers indicates that any potential benefit from mycorrhizal fungi, while useful, is not sufficient for optimum wheat production.

What does this mean?

Improved nutrition has the potential to significantly increase production on a number of the soils of EP however the full or even the main yield benefits are unlikely to be realised were there are biological constraints (root disease) present. Even with improved nutrition (fluid treatment) and disease control (fumigation) yields were still significantly below the potential at Minnipa and Franklin Harbour. This indicates that there are still factors impacting on production that need to be addressed.

The potential to lift production on the grey calcareous soils around Streaky Bay is substantial. The advent of fluid fertilisers has provided a viable option to remove one of the major production constraints. Cereal root disease is now the limiting constraint and practical controls for this issue should be re-evaluated now the nutrition issues can be addressed. In the longer term, as productivity increases with subsequent increases in the production and retention of crop residues, there is the potential for increasing both soil microbial activity and biological suppression of key cereal root diseases.

Acknowledgements

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GRDC Grains Research & Development Corporation

Disease

Research

Interaction between *Pratylenchus* and *Rhizoctonia*

Searching for answers

***Sharyn Taylor*[1]*, Andrew Thompson*[2]*, Michelle Russ*[1] *and Alison Frischke*[2]**

SARDI, Field Crops Pathology Unit[1] *and SARDI, Minnipa Agricultural Centre*[2]

Key Message

High initial *Rhizoctonia* levels were correlated with 40% yield loss on Upper Eyre Peninsula.

Why do the trial?

To determine effect of rotation on multiplication of *P. neglectus* and *Rhizoctonia*, and associated yield loss.

This trial was established at Miltaburra to determine if damage caused by interactions of *Pratylenchus neglectus (Pn, P.neglectus)* and *Rhizoctonia (Rh)* could be evaluated, and whether combinations of these pathogens in the field are effected by rotation. In 2002, canola, wheat, barley and triticale were sown in an attempt to produce varying densities of both Pn and Rh. In 2003, the variety blocks were over-sown with 3 wheat and 3 barley varieties and initial pathogen levels correlated with yield. Similar trials were conducted at Miltaburra and Minnipa Agricultural Centre between 2001-2003 to determine yield loss caused by *P. neglectus* alone. *Results for these trials were presented in FS2002, pp 76-78.*

How was it done?

In 2002 (first year), the following varieties were sown in 6 blocks with each block replicated 6 times: Karoo canola, (Pn susceptible; Rh resistant?); Frame wheat (Pn susceptible; Rh susceptible); Chebec barley (Pn resistant; Rh susceptible); and Tahara triticale (Pn resistant; Rh resistant?). Expected

Location
Miltaburra
Cooperator: Leon, Marilyn, Carolyn and Darren Mudge

Rainfall
Avg Annual total: 300 mm
Avg GSR: 212 mm
2003 total: 319 mm
2003 GSR: 214 mm

Yield Potential: 2.08 t/ha

Paddock History
2002: Trial with Karoo canola, Frame wheat, Chebec barley and Tahara triticale.
2001: Pasture (grass free)
2000: Pasture

Soil Type
Grey, highly calcareous sandy loam.

Diseases
Rhizoctonia

Plot size
4m x 1.8m

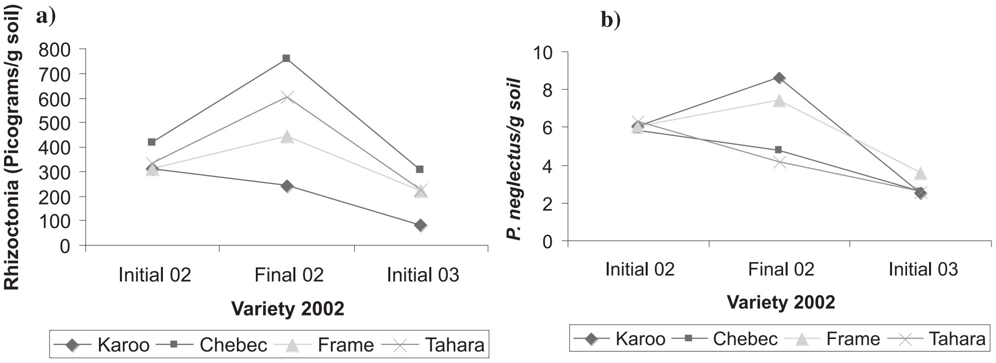

Figure 1: Levels of (a) Rhizoctonia and (b) P. neglectus in soil at sowing 2002 (Initial 02), harvest 2002 (Final 03) and sowing 2003 (Initial 03)

resistance ratings for Rh were speculative, and based on observations from previous trials and farmer paddocks.

In 2003 (second year), these replicated blocks were over-sown with Frame, Krichauff and Machete wheat and Chebec, Mundah and Barque barley varieties on the 10th June. *P. neglectus* and *Rh* levels were assessed using DNA assays at planting and harvest in both 2002 and 2003 and initial pathogen levels correlated with yield in 2003.

What happened?

In 2002, highest levels of *Rhizoctonia* remained after harvest in Chebec barley and lowest levels after Karoo canola (*Figure 1*). For *P. neglectus*, results were as anticipated after harvest in 2002, with highest levels after Karoo and lowest levels after Tahara and Chebec. Grain yields were very low in 2002 as a result of drought stress, especially in canola (average 0.1 t/ha).

At sowing in 2003, levels of both *P. neglectus* and *Rhizoctonia* had decreased compared with levels at the end of 2002. This decrease was most pronounced for P. neglectus, with nematode numbers dropping from 8.6/g soil in Karoo at harvest 2002 to 2.5/g soil at sowing in 2003. At sowing there was no difference between nematode levels following any of the varieties in 2002. *Rhizoctonia* levels also decreased over summer in 2002/03, although the difference still remained between canola and the cereal plots at sowing in 2003. Levels of both *Rhizoctonia* and *P. neglectus* may have been reduced by summer rainfall, (48 mm in February), and break down of organic matter.

During the season in 2003, severe *Rhizoctonia* damage was observed in wheat and barley sown on cereal stubble compared with canola stubble plots from 2002. Patch scores show less damage following canola (*Figure 2*). A negative linear relationship between yield and initial levels of *Rhizoctonia* was observed (P<0.01) and at high levels of Rh, 40% yield loss was seen in wheat and barley varieties sown in 2003 (*Figure 3*).

Initial levels of *P. neglectus* were low, and there was no difference in *P. neglectus* numbers between plots. No visual responses or correlation between yield and *P. neglectus* numbers was recorded in any of the wheat or barley varieties in this trial.

What does it mean?

At harvest 2002, it appeared that the canola, wheat, barley and triticale varieties had produced varying combinations of both *P. neglectus* and *Rhizoctonia*. Numbers of *P. neglectus* significantly decreased over the summer period however, with low initial levels in all plots at sowing in 2003. While levels of *Rhizoctonia* also decreased, differences remained between plots, with canola plots having lower levels than cereals sown in 2002. Differences in initial *Rhizoctonia* densities accounted for 56% in variation of yield of wheat and barley varieties in 2003, with 40% yield loss observed at 100 Rh/g soil.

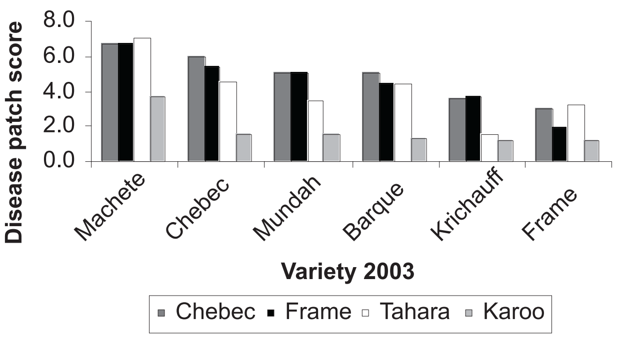

Figure 2: Rhizoctonia disease patch score for wheat and barley varieties, 2002. 0 = no visible disease; 10 = total plot death.

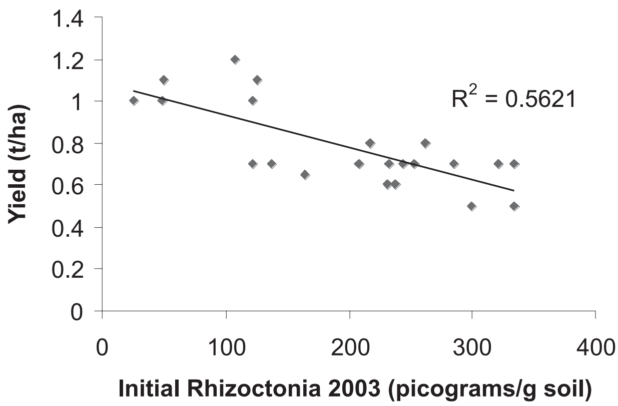

Figure 3: Linear relationship between yield and initial Rhizoctonia levels, 2003. Each data point represents the average of 5 reps for each wheat and barley variety following Karoo, Krichauff, Frame and Chebec in 2002.

These results indicate that *Rhizoctonia* levels may be affected by crop rotation. Significant benefits were seen in cereal varieties in 2003, with Barque following Karoo providing a gross return of $179/ha (based on yield of 1.1 t/ha) and Chebec following Chebec a gross return of only $86/ha (based on 0.5 t/ha).

Further trials are required to confirm that the low *Rhizoctonia* levels observed following canola was a crop effect rather than partial fallow effect as a result of the drought in 2002. Trials are also required to determine if interactions occur between differing levels of both *P. neglectus* and *Rhizoctonia* as a range in *P. neglectus* densities did not occur at this site.

Acknowledgments

The authors would like to thank Leon, Marilyn, Carolyn and Darren Mudge for providing this trial site. SARDI staff at Minnipa (Wade Shepperd, Sue Buddarick, Wendy Payne) who assisted with field trials and sampling. SARDI staff in the Field Crops Pathology Unit (Russell Burns and Ina Dumitrescu) who processed samples through the RDTS. This work was funded by GRDC.

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Pratylenchus Cultivation Demonstration at Mudamuckla

Neil Cordon

SARDI, Minnipa Agricultural Centre

Demo

Searching for answers

Location
Mudamuckla.
Eddie and Anthony Burge.

Rainfall
Av. Annual: 299mm
Av. G.S.R: 220mm
2003 Total: 230 mm
2003 G.S.R: 153 mm

Yield
Potential (w): 1.2 t/ha

Paddock History
Seven years of pasture

Soil Type
Grey alkaline sandy loam over limestone rubble.

Fertiliser
18:20:0 @ 50 kg/ha

Other Factors
Delayed sowing, dry windy weather.

Key Message

Ploughing or cultivation prior to sowing had no effect on *Pratylenchus* numbers, but dramatically reduced *Rhizoctonia* levels.

Why do the trial?

To compare *Pratylenchus* control using either a disc plough or a cultivator.

How was it done?

Single demonstration blocks compared a disc plough and a tine cultivator (23cm shears) to an uncultivated strip. Workings were conducted on the 15th of April to a depth of 6cm. Excalibur was sown on the 3rd of July at 45 kg/ha.

Measurements: Root disease levels before working and prior to sowing. Grain yield and quality.

What happened?

Root disease monitoring showed the site was low in *Pratylenchus* initially, which may explain why the treatments had no effect on *Pratylenchus* (*Table 1*). However, the working dramatically reduced the level of *Rhizoctonia*.

During the season the uncultivated area had poorer growth, but all other treatments showed little visual difference.

At harvest time, there was little difference between the plough and cultivator blocks. Harvest difficulties hindered accurate measurements of yield from the uncultivated area.

Table 1: Root disease levels at Mudamuckla 2003.

	Cereal Eelworm	Take all	Rhizoctonia	*Pratylenchus neglectus*	*Pratylenchus thornei*	Crown Rot
Base level	BDL	BDL	98 High	Low	BDL	BDL
Uncultivated	BDL	BDL	68 High	Low	BDL	BDL
Cultivated	BDL	BDL	14 Low	Low	BDL	BDL
Ploughed	BDL	BDL	20 Low	Low	BDL	BDL

B.D.L. = Below detection limit

N.B. First base sampling was conducted in March whilst the treatments were sampled prior to sowing.

Table 2: Wheat yields & quality from Pratylenchus demo at Mudamuckla 2003.

	Protein (%)	Test Weight (kg/h l)	Screenings (%)	Yield (t/ha)
Plough	16.4	79.2	4.0	0.67
Uncultivated	15.7	79.2	2.0	-
Cultivated	15.9	79.4	3.3	0.65

What does this mean?

It is difficult to draw any conclusions from this demo since the level of *Pratylenchus* was at a low level initially. A secondary outcome was the effect workings had on reducing *Rhizoctonia*, which supports previous observations and trial results, however other strategies should also be considered for *Rhizoctonia* management.

Acknowledgements

Wade Shepperd for his assistance in hot weather sampling, and the Burge family for accepting ownership of the demonstration.

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Searching for problems

Location
Wharminda
Cooperator: Ed Hunt

Rainfall
Av. Annual total: 306 mm
Av. GSR: 235 mm
2003 total: 317 mm
2003 GSR: 266 mm

Soil
Land system: dune swale

Soil type
Siliceous sand over clay

Diseases
Low levels of Rhizoctonia and Takeall

Plot size
26 m x 1.44 m

Other factors
Dry conditions during grain fill

Crown Rot Management Trials on EP, 2003

Research

Jerry Dennis[1] and Andrew Thompson[2]

Plant Research Centre, Waite[1] and Minnipa Agricultural Centre[2]

Key Message

Trials on eastern EP indicate that there are opportunities to reduce disease effects from crown rot by overcoming trace element deficiencies and adopting more resistant cereal varieties.

Why do the trials?

These trials will determine how crop rotations and fertiliser management practices will effect crown rot development and survival on eastern EP.

Crown rot of wheat has become a persistent disease in some low rainfall areas where stubble retention and intensive cereal rotations are maintaining high levels of inoculum in paddocks. Disease development is promoted by moisture stress in the crop. The risk of late season moisture stress is greater in crops with poor root development (eg nutrient deficiency, root diseases) or excessive vegetative growth (eg high initial nitrogen). Successful disease control will depend on the development and implementation of economically sustainable rotations, which avoid inoculum build up, and crop management to alleviate moisture stress.

How was it done?

A trial was initiated at Wharminda in 2003 to determine the effects of several rotation options on crown rot development and compare these with the local practice. Rotation crops were selected on the basis of previous trial results and potential for local adoption (*Table 1*). Treatments were replicated 6 times.

In a second trial, various fertiliser treatments were applied to Frame wheat plots to determine their effects on crop growth and disease development (*Table 2*). All plots had a base treatment of 60 kg/ha granular DAP at sowing and each treatment was replicated 4 times. Soil analysis of 0-20 cm cores indicated 8 mg/kg N, 0.3 mg/kg Cu and 0.5 mg/kg Zn.

Both trials were sown on 7th June at 75 kg/ha with 60 kg/ha DAP by direct drilling into stubble from a wheat crop infected with crown rot in 2002. Initial crown rot inoculum levels in each trial were estimated before sowing by soil DNA assays. Plots in both trials were scored for crown rot development (% infected plants and whiteheads) in October and harvested for grain yield in December. Screenings were measured for the fertiliser treatments using a 2.5 mm sieve.

What happened?

Average soil inoculum levels were moderate to high for both trials but varied considerably between plots. There was good rainfall through most of the growing season and crown rot development was less than would be anticipated from inoculum levels, despite dry conditions in October.

Frame was more susceptible to crown rot infection than Kukri but the lower whitehead score indicated better tolerance to the disease (*Table 3*). Whitehead development was low and crown rot is unlikely to have had any significant effect on yields. The low yield of Frame relative to Kukri appears to be associated with other seasonal factors and is unusual for the region.

Infection levels for Schooner were also unexpectedly low since barley is usually much more susceptible (more prone to initial infection) to crown rot than wheat. The lack of whiteheads in barley compared to wheat reflects its greater tolerance (suffers less yield loss) to crown rot.

The additional fertiliser treatments affected yield and grain quality but had little influence on disease development under the 2003 growing conditions (*Table 4*). Trace elements increased yields and reduced screenings while additional nitrogen, especially at

Table 1: Rotation treatments at Wharminda 2003.

2003	2004	2005	Reason
Barley (Schooner)	Pasture	Wheat	Farmer practice
Wheat (Frame)	Pasture	Wheat	Common alternative rotation
Wheat (Kukri)	Pasture	Wheat	Kukri more resistant to crown rot than Frame
Wheat (Frame)	Wheat (Frame)	Wheat	Continuous wheat Frame
Wheat (Kukri)	Wheat (Kukri)	Wheat	Continuous wheat Kukri
Pasture	Pasture	Wheat	Best crown rot control in previous trials

Table 2: Fertiliser treatments at Wharminda 2003.

Treatment	Additional fertiliser applications.
Nil	No additional fertiliser
Base + N	50 kg/ha urea at sowing
Base + split N	25 kg/ha urea at 8 weeks and 25 kg/ha urea at 12 weeks post sowing
Base + TE	Trace elements* below seed at sowing
Base + N + TE	Trace elements* below seed + 50 kg/ha urea at sowing
Base + split N + TE	Trace elements* below seed at sowing+ 25 kg/ha urea at 8 weeks and 25 kg/ha urea at 12 weeks post sowing
Base + high N	100 kg/ha urea 12 weeks post sowing

**Trace element application was 2 kg Zn/ha, 2 kg Cu/ha and 5 kg Mn/ha applied in solution at 400 L/ha just below the seed.*

a high rate, tended to reduce yield. There was some indication that trace elements also reduced crown rot infection.

What does this mean?

The full effect of different rotation treatments will not be apparent for several years and no conclusions between rotations can be made at this stage. The results so far indicate the partially resistant variety, Kukri, could be successfully grown in the region and would provide a reduction in crown rot inoculum compared to other wheat varieties. This effect of Kukri on disease has been observed in previous trials (*EPFS Summary 2002*) but adoption of this variety needs to be considered carefully since it has not yielded as well as Frame in previous years.

The fertiliser trial highlighted crop response to trace elements at this site and gave some indication that improved crop vigour from better nutrition will help reduce the effects of crown rot. This supports observations from previous trials at this site (*EPFS Summary 2002*).

There was no detrimental effect on disease development and crop yield in 2003 from the current district practice of applying 60 kg/ha DAP at sowing compared to other N regimes. The effect of N management on disease development, however, will be influenced by seasonal conditions and significant disease responses to N management may occur in other years. This study should continue over several seasons to clarify these issues since N application practices which minimise risk of crown rot development in high risk situations could be adopted as standard practice if they have no detrimental effect on crop yield and quality.

Results from these trials so far have indicate opportunities in eastern EP to reduce disease effects from crown rot by overcoming trace element deficiencies and adopting more resistant cereal varieties.

Table 3: Comparison of varieties for disease development and yield in the rotation trial.

Variety	% Infected plants	Whiteheads/plot	Yield t/ha
Frame	32.1	65.4	1.64
Kukri	19.3	133.7	2.18
Schooner	19.5	0	3.55
lsd (P<0.05)	6.6	37.7	0.16

NB - Frame and Kukri results are the mean for 2 treatments.

Table 4: Effect of fertiliser treatments on disease development and grain yield

Treatment	% Infected plants	Whiteheads/plot	Yield t/ha	% Screenings
Nil	21.0	81.0	1.50	15.1
Base + N	24.7	81.5	1.42	15.1
Base + split N	17.2	84.5	1.43	15.4
Base + TE	14.1	91.3	1.75 *	11.7 *
Base + N + TE	19.5	85	1.56	14.3
Base + split N + TE	20.1	91	1.63*	13.7
Base + high N	24.9	115.8	1.39	15.2
lsd (p<0.05)	*NS*	*NS*	*0.13*	*2.1*

** = significantly more or less than the nil treatment*

Acknowledgments

This work was funded by GRDC and would not have been possible without the valuable assistance of Wade Shepperd (Minnipa Agricultural Centre). SARDI Diagnostic Group provided valuable support in testing soil samples.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

Disease

Fungicides and Aphicides for Barley

Research

Neil Cordon

SARDI, Minnipa Agricultural Centre

Best practice

Location
Lock
Michael Zacher

Rainfall
Av Annual: 320mm
Av G.S.R: 246mm
2003 Total: 333mm
2003 G.S.R: 273mm

Yield Potential: (B) 3.66 t/ha

Paddock History
2002: Peas
2001: Wheat
2000: Pasture (Grass Free)

Soil Type
Sand loam over clay

Diseases
Barley leaf rust

Plot Size
10m x 1.5m x 3 reps

Key Messages

- **Good prediction of leaf disease infection and the timing of fungicides sprays are essential to achieve economic yield responses to foliar fungicides.**
- **In medium to low yielding environments the widespread use of foliar fungicides appears to be unwarranted.**
- **Seed treatments should always be viewed as insurance against disease in cereals.**

Why do the trial?

Previous work has shown the use of foliar fungicides in barley has inconsistent economic yield improvement, mainly because of the unpredictable nature of leaf disease infection. With the decreasing cost of fungicides and evidence to support the use of aphicides to reduce the population of disease spreading aphids, a trial was set up to look at the influence of controlling aphids and/or leaf diseases in barley crops on grain yield and quality.

How was it done?

A replicated trial of Sloop barley was conducted alongside the S4 wheat evaluation site at Lock.

Date sown: 12th June.

Sowing rate: 75 kg/ha.

Fertiliser: 18:20:0 with 2.5% Zn at 100 kg/ha.

Two applications of a foliar fungicide and/or aphicide at a water rate of 70 L/ha with the first application at early tillering on 16th June or 4 weeks post sowing. The second application was at late tillering on 19th August or 10 weeks post sowing. These sprayings was conducted as a preventative measure rather than trying to cure an existing problem.

Treatments:
Control - no spray.
Fungicide - propiconazale (250 g/L) at 250 mL/ha.
Aphicide - alpha-cypermethrin (100 g/L) at 120 mL/ha.
Fungicide plus Aphicide - above rates.

Measurements: Grain yield and quality.

What happened?

In a season excellent for crop growth we saw crops achieve 90% of potential yield. Growing conditions (misty rain with canopy continually wet) was ideal for the manifestation of leaf diseases. Like many barley crops in the district, the trial had barley leaf rust with no visual infection difference between treatments. There were no yield differences between treatments and also no real differences in gross incomes.

Table 1: Grain yield, quality and income of foliar fungicides and aphicides at Lock 2003.

Treatment	Protein (%)	Screenings (%)	Test Weight (kg/hL)	Treatment Cost ($/ha)	Yield (t/ha)	Gross Income* ($/ha)
Control	13.6	3.0	67.2	-	3.12	495
Fungicide	13.6	2.9	67.6	26.50	3.34	492
Aphicide	13.4	2.9	67.4	4.26	3.28	506
Fungicide + Aphicide	12.6	2.0	68.2	30.76	3.43	503

** Gross income is yield x price less treatment costs delivered to Port Lincoln as at 1st December 2003.*

What does this mean?

The economic yield benefits from foliar fungicides and/or aphicides only just covered the cost of application in 2003. The foliar fungicide treatments applied to identify possible yield limiting factors at the low to medium rainfall S4 barley evaluation sites (*Table* 2), supports our data, showing lack of yield improvements from foliar fungicides. Since 1998 over a range of seasons and disease levels at three sites there has been no significant differences between the fungicide treatment and the control.

The control is pickled with either Real® or Baytan®. The foliar fungicide has been Tilt® at 500 mL/ha as well as a seed dressing. Fungicides have not always been applied at the most ideal time as the crop evaluation team only spray when they visit the sites for normal inspections. Since 1998 there is no yield response to foliar fungicides in the rainfall districts shown. Data for 2003 at these sites was not available at the time of printing. Leaf disease infection and multiplication in trials may differ with paddock conditions due to factors such as better air movement between plots, which reduce the effects of leaf diseases.

Acknowledgements.

Brian Purdie and Ashley Flint from the crop evaluation team at Port Lincoln for sowing and harvesting the trials, and Wade Shepperd and Ben Ward for spraying during the year. Michael Zacher for hosting these trials. Thanks to Ken Webber for supplying the fungicides and insecticides.

Table 2: Grain yield (t/ha) comparisons for foliar fungicide treatment on Sloop barley at Streaky Bay, Wharminda and Elliston; 1998 - 2002.

	Streaky Bay				Elliston				Wharminda			
	2002	2001	1999	1998	2002	2001	1999	1998	2002	2001	1999	1998
Control	1.24	1.52	0.74	1.12	1.10	1.34	0.61	1.79	0.96	1.81	1.39	1.71
Foliar Fungicide	1.28	1.62	0.73	1.08	1.12	1.42	0.61	1.88	1.02	2.0	1.33	1.65

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SARDI South Australian Research and Development Institute

Section 6

Section editor: Nigel Wilhelm

SARDI, Minnipa Agricultural Centre

Nutrition

Many of the articles in this section report on activities which were in direct response to priorities identified by farmers in last year's planning meetings. Not all the requests for new nutritional information could be catered for in 2003 but we hope that the information to follow will go a long way towards satisfying most of those issues. One of the most frequently listed issues was the relative merits of different N application strategies. In the pages which follow there are several articles which address this issue, varying from intensely monitored "scientific" field experiments attempting to understand what happens to bagged N through to large scale demonstration strips comparing a couple of application alternatives for yield and grain quality.

Another large group of articles report on the performance of fluid fertilisers across upper EP; this is a major R&D effort locally because fluids offer such exciting prospects for improved productivity in many environments of upper EP.

Note that there is also a batch of articles in the soils section which address the issue of deep placement of nutrients for improved productivity.

FLUID FERTILISERS
After six years, where the heck are we? Where are we going?

Bob Holloway, Brendan Frischke, Dot Brace [1], Mike McLaughlin, Enzo Lombi, Caroline Johnston, Thérése McBeath, Sam Stacey [2] and Roger Armstrong [3]

SARDI, Minnipa Agricultural Centre[1], CSIRO Land and Water, Adelaide[2], DPI Horsham[3]

Research

Key Messages

- **In 101 trial comparisons there were 68 yield increases due to fluids compared to granular, 4 yield decreases (all on one soil) and 29 with no differences.**
- **Fluid fertilisers are likely to give positive yield increases above granular on highly calcareous grey soils in low rainfall areas. There are also likely to be benefits on red brown calcareous soils.**
- **Best results with phosphoric acid or technical grade MAP solutions came from applying N (as urea) and micronutrients in the same solution at sowing.**
- **When there is a likelihood of deficiency of more than one nutrient they are best applied together in a single solution if possible. If not, they should be applied at the same time to the same soil via a separate system.**

Why do the trials?

We now have more than 100 comparisons of a range of fluid and granular fertilisers conducted by our group on central and upper Eyre Peninsula over the past six years. With all this data, can we now say whether fluids have a place in our South Australian farming systems, or even in other states? The first step is to look at what we have from Eyre Peninsula, and then see what is now happening in other areas.

Results from EP are restricted to grain yields from replicated wheat trials and all comparisons are from trials where the rates of nutrients have been balanced to ensure valid results. In some cases, more than one comparison was made in the same trial, eg. between two different products.

Table 1: Summary of Fluid Fertiliser Trials

	Total trial Comparisons	Increase in Yield	Decrease in Yield	No significant difference
GREY CALCAREOUS	50	45		5
RED CALCAREOUS	40	23		17
RED LOAMY SAND	11		4	7

How was it done?

To begin with "all fluids ain't fluids". The different kinds of fluids available often perform differently in different soils, even in different areas of the same paddock. We compared:

- ammonium polyphosphates (APPs) (often mixed with urea ammonium nitrate UAN),
- phosphoric acid-based products (usually with urea and micronutrients),
- technical grade MAP or DAP dissolved in water (often with micronutrients and extra nitrogen), and
- suspension fertilisers - mixtures of fine granular fertiliser with water, clay and micronutrients.

These were compared with granular fertilisers like TSP, TSP Mn5%, MAP, DAP, 13:15 Mn6%, 17:19 Zn2.5%, urea, urea Zn5%. We preferred to use the granular fertilisers already containing micronutrients if possible. Comparisons were made at rates of between 2 and 35 kg P/ha and 5 and 40 kg N/ha, according to the rainfall.

Trials were conducted on three soil types: Grey highly calcareous sandy loams with 15-70% calcium carbonate content; Red-brown calcareous sandy loams with 5-15% calcium carbonate and; Red-brown loamy sands with up to 5% carbonate and low nitrogen fertility. Refer to EPFS summaries 1998-02, Nutrition section. The results are shown here with the number of comparisons on each soil type and are summarised below. All comparisons are at the same rates of P and other nutrients.

What happened?

Refer to Table 1 for summary.

Grey highly calcareous sandy loams

- APP – 21 comparisons. 19 had a mean yield increase of 15% above an equivalent rate of nutrients supplied in a granular fertiliser. In 2 comparisons there were no yield differences – no micronutrients were added in one of these, in the other manganese caused a precipitation in the preparation.
- Phosphoric acid products – 11 comparisons. 8 had a mean yield increase of 23%. In 3 comparisons there were no yield differences – (low nitrogen in 1 of these).
- Technical grade MAP/DAP - 11 comparisons, with a mean yield increase of 20% in all comparisons. Micronutrients were mainly applied in the NP solution at sowing.
- Suspensions – 7 comparisons, with a mean yield increase of 20% in all comparisons. Micronutrients were applied in the suspension at sowing.

Red-brown calcareous sandy loams

- APP – 10 comparisons. 7 had a mean yield increase of 14%. In 3 comparisons there were no yield differences - one of these was due to a low water rate (when the water rate was doubled, yield increased by 8%).
- Phosphoric acid products – 16 comparisons. 9 had a mean yield increase of 11% - all had micronutrients applied in solution with the phosphoric acid and urea. In 7 comparisons there were no yield differences. In these, either no micronutrients were applied, or they were applied pre-sowing to the soil surface or foliar, i.e. at a different time to the P solution.
- Technical grade MAP/DAP - 9 comparisons. 3 had a mean yield increase of 15% - all had micronutrients applied in solution at sowing. In 6 comparisons there were no yield differences. In these, micronutrients were applied pre-sowing to the soil surface or foliar.
- Suspensions – 5 comparisons. 4 had a mean yield increase of 12.5%. In the 5th comparison there was no yield difference.

Red-brown loamy sand (low carbonate, low fertility)

- APP- 6 comparisons. 2 had a mean yield decrease with fluids of 10%. In 4 comparisons there were no yield differences.
- Phosphoric acid products – 1 comparison had a yield decrease of 7% with fluid.
- Technical grade MAP/DAP- 2 comparisons, no yield differences.
- Suspensions – 2 comparisons. 1 yield decrease with fluids of 12%, 1 no yield difference.

Overall comparisons

In some of the 'no difference' comparisons, there were early dry matter increases due to fluids but these had disappeared by harvest. For instance, on the red-brown loamy sand soil in 2003, a fluid mixture of APP with UAN and ammonium thiosulfate produced 31% more dry matter at mid tillering than MAP with UAN, but there were no grain yield differences.

Trials conducted by Dr Nigel Wilhelm in 2002 and 2003 showed positive responses to fluid fertiliser (Tech grade MAP, APP and/or phosphoric acid cf MAP) at Warooka and Pt Rickaby (Yorke Peninsula) on highly calcareous sand, at Orroroo (Upper North) on grey calcareous soil, 10% calcium carbonate and red mallee soil, <5% calcium carbonate. There was no response at Minlaton (Yorke Peninsula) on a calcareous brown loam, 10% calcium carbonate.

After failure of Victorian field trials in 2002, trials by Dr Roger Armstrong to assess the relative efficacy of fluid and granular P fertiliser in wheat were successful in 2003. Soil types chosen represented > 90% of Victorian dryland cropping soils. Despite early dry matter responses at all sites, fluid P fertilisers produced significantly higher grain yields at only one site (Birchip). The reduction in yield responses is possibly due to a very dry finish, especially in the Wimmera, preceded by average to good pre-anthesis rainfall.

Of 30 soils chosen from all major grain producing areas of SA and Vic in a pot trial, 70% showed significant dry matter responses to P. Of P responsive soils, fluid fertilisers were more efficient than granular in more than 50%. In more than 90% of the soils where fluid P outperformed granular, pH was > 8 or less than 6.

There were positive responses to fluids (yield increases) in 2003 on a grey calcareous sandy clay loam and a red clay at Buckleboo, but no response on a sandy loam soil, although the sandy loam was non responsive to P. Fluid fertiliser was also tested at Arno Bay, but again the site was not responsive to P. See Sam Douldle's article in this section.

In 1999–2000, Brenton Growden and Terry Blacker conducted trials on Lower EP, one at Coomaba on a grey highly calcareous soil. The site at Coomaba was sprayed before sowing with Zn at 2.5 kg/ha. Technical grade MAP and urea in solution were compared with MAP and urea. All plots received 20 kg N/ha and P rates ranged from 0 to 20 kg P/ha. The Colwell P value was 91 mg P/kg. There were no differences between the two fertilisers at this site. Nigel and Kay Breed, on whose farm the trial was situated, also had a series of test strips nearby and compared 13:15 Mn6% with APP. In these strips, APP was more effective in producing yield per kg of P applied. In a second trial at Wildeloo on a calcareous loam soil, a range of products were compared at a constant rate of 25 kg P/ha. N was applied at 40 kg N/ha and where products differed in N content, the shortfall was made up with urea. Zinc was added with both fluid and granular products. DAP performed as well as all of the fluid products.

What does this mean?

Fluid fertiliser performance above granular MAP/DAP is reliable on the grey calcareous soils of Eyre Peninsula. APP seems to be able to improve the uptake of micronutrients from these soils because of its chemical nature. Phosphoric acid applied alone rarely provides any yield improvement over MAP/DAP unless it is applied with micronutrients and in most cases urea in solution with it. Technical grade MAP should also be applied mixed with micronutrients.

On red brown calcareous soils (like Emerald Rise and Karcultaby) good results with phosphoric acid and tech grade MAP/DAP depend on adding micronutrients (and urea to phosphoric acid).

On red sandy mallee soils, loss of N from fluid nitrogen could be a problem, especially in wet years. Generally granular urea performs better in these conditions. It is possible that the use of ammonium thiosulphate could help reduce N loss if urea is dissolved in the solution but more research is needed to test this further. On the basis of the results so far, (from only one site) we would recommend the use of granular urea as the major source of N if fluids are tried on red sandy soils.

On Lower EP, fluids are most likely to perform well on ironstone soils and on grey highly calcareous soils on the western coastal areas. In medium and higher rainfall areas, at this stage it seems best to use granular urea as the major source of N until the performance of fluid N applied at sowing is better understood.

Table 2 compares the economic performance in a wheat crop of a standard application of 17:19 Zn 2.5% applied at 52 kg/ha (to give 10 kg P, 8.8 kg N and 1.3 kg Zn/ha) with a range of fluid products. The crop yield is 1.5t/ha. Where there is only one row for a product in the table (eg APP 14:21), the cost is based on current prices on farm. Where there is more than one row (eg Suspensions) a range of speculative costs /kg P is given.

The break even % yield increase is the increase in yield of a 1.5t/ha crop required to cover the extra cost of the fluid fertiliser, eg at current prices, a mixture of 10 kg P/ha, 8.8 kg N/ha and 1.3 kg Zn/ha would have to increase yield by 7.8% if wheat prices were $165/t to break even. In the change in marginal return columns a 20% yield increase with the same product in a 1.5t/ha crop (ie 1.5t/ha with a 17:19 Zn2.5% and 1.8t/ha with the fluid) would increase income (minus fertiliser costs) by $30.08/ha.

Products now available in SA include 9:14 Zn 0.6% and APP. Mixtures of phosphoric acid, urea and zinc sulphate may have to be made up on the farm. Liqui-NP and MAPZFlo are

Table 2: Economic analysis of selected fertiliser treatments in fluid fertiliser research trials since 1988.

				BREAK EVEN % YIELD INCREASE		CHANGE IN MARGINAL RETURN $/ha @ $165/t	
PRODUCT	**COST OF P $/kg**	**COST $/ha**	**Differential COST**	**Wheat $165/t**	**Wheat $200/t**	**10% YIELD INCREASE**	**20% YIELD INCREASE**
17:19 Zn2.5%	2.58	25.80					
Phosphoric acid based							
PA, urea, Zn sulphate	3.36	45.22	19.42	7.8	6.5	5.33	30.08
PA, urea, Zn sulphate	3.00	41.62	15.82	6.4	5.3	8.93	33.68
PA, urea, Zn sulphate	2.50	36.62	10.80	4.4	3.6	13.93	38.68
9:14 Zn0.6%	6.64	70.83	45.03	18.2	15.0	-20.28	4.47
Liqui-NP® 9:12	3.17	37.13	11.33	4.6	3.8	13.42	38.17
MAPZFlo5:13	3.03	34.43	8.63	3.5	2.9	16.12	40.87
Suspensions							
11:12 Zn1%	4.17	43.26	17.46	7.1	5.8	7.29	32.04
11:12 Zn1%	3.33	34.86	9.06	3.7	3	15.69	40.44
11:12 Zn1%	2.50	26.56	0.76	0.3	0.3	23.99	48.74
APP							
APP 14:21	7.05	80.97	55.17	22.3	18.4	-30.42	-5.67
Powdered MAP							
12:27	3.33	41.25	15.45	6.2	5.2	9.30	34.05
12:27	2.96	37.55	11.75	4.7	3.9	13.00	37.75
12:27	2.22	30.15	4.35	1.8	1.5	20.40	45.15

currently available in WA and costs are based on WA prices. Suspensions are still in the experimental stage. Powdered MAP may be available in future.

Acknowledgements

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FLUID FERTILIZER FOUNDATION

GRDC Grains Research & Development Corporation

CSIRO

Searching for answers (on other soils)

Almost Ready (on calcareous soils)

Location:
Warramboo

Cooperator:
Tim & Tracey van Loon

Rainfall
Av. Annual total: 350mm
2003 annual total:
2003 growing season:

Soil
60% calcium carbonate
35 mg/kg available P

Plot size
1.5m x 15m

FLUID FERTILISERS What About Residual Effects?

Bob Holloway, Brendan Frischke and Dot Brace
SARDI, Minnipa Agricultural Centre

Research

Key Messages

- **First measurement of higher residual value of P in shoots from a fluid fertiliser, on grey highly calcareous soil.**
- **There was little contribution of either fluid or granular applications in 2002 to grain yield in 2003.**

Why do the trial?

The aim of the trial was to measure the residual effects of fluid APP and granular MAP/TSP on a grey highly calcareous soil. Many trials have shown good responses to fluid fertilisers on grey highly calcareous soils. However, there is no information about how useful the residues of fluid fertiliser are in following years. We know that on these grey soils, most of the phosphorus added as granular is fixed rapidly and although there are often very high total P concentrations in the soil, most of it is unavailable to plants. This trial was designed to assess the residual effects of fluid and granular fertilisers.

How was it done?

Treatments:

The site was at Warramboo and has a grey highly calcareous sandy loam with 60% calcium carbonate. The trials were sown in 2002 with Tahara triticale and consisted of either fluid ammonium polyphosphate (APP) with added UAN and Zn and Mn sulfates applied in a separate solution, or granular 13:15 Mn 6% with triple superphosphate and urea Zn 5%. Rates of P applied were 0, 4, 8, 16, 24 and 35 kg P/ha. A constant rate of 23.4 kg N/ha, 3.2 kg Mn/ha and 1.5 kg Zn/ha was applied to every plot. The 2002 trial plots were re-sown with Frame wheat in 2003, but only N, Zn and Mn were applied so that the relative effects of residual P could be measured. Frame wheat was also sown with the P fertilisers on new plots in 2003. These new plots and the 2002 plots will be sown again in 2004 without any P fertiliser to further measure the residual effects.

Measurements:

Shoot growth was measured at mid tillering and analysed for nutrient content. The numbers of fertile tillers and grain size were also measured as well as grain yield. These measurements were made on the residual (no P) plots as well as on those fertilised in 2003.

What happened?

In 2002, P concentrations in young triticale shoots were 6% higher with the APP compared with the granular, zinc concentrations were 7% higher, zinc uptake was 39% higher and at 8 kg P/ha, P uptake was 30% higher. In Frame grown in 2003 without P, only the 35 kg P/ha as APP (in 2002) produced higher P uptake in the shoots. Also, at a common application rate of 8 kg P/ha, the residual APP produced 15% more dry weight of shoots than the residual granular plots. In the plots with fertiliser applied in 2003, the APP produced 38% more shoot weight at 8 kg P/ha. The dry weights of shoots are shown in Figure 1.

A common symptom of P deficiency in wheat is reduced tillering. Measuring the number of heads containing grains assessed the degree of tillering. Overall, plants grown on residual APP produced 8% more fertile heads than those grown on residual granular plots. Plants grown on plots fertilised with APP in 2003 produced 16% more fertile heads than those grown on plots fertilised with granular. With both the residual and 2003 applications of fertiliser, the number of heads/m^2 also responded positively to increasing P application rates. The number of heads/m^2 produced on residual APP applications of 35 kg P/ha was 222 heads/m^2 and on residual granular at the same P rate, 200 heads/m^2. Plots fertilised with 35 kg P/ha as APP in 2003 produced 342 heads/m^2 and with the granular fertiliser, 240 heads/m^2.

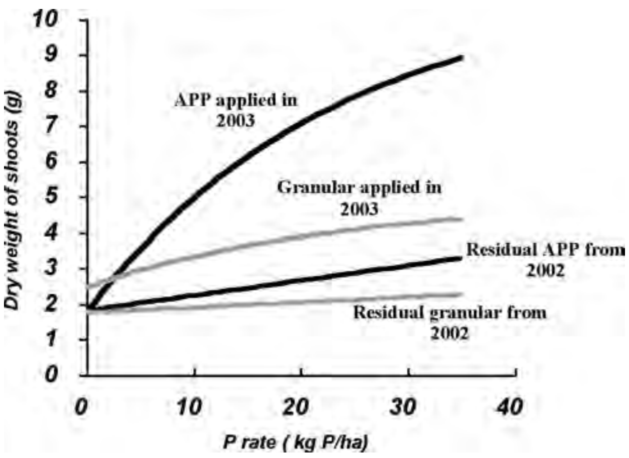

Figure 1: Dry weight of shoots of Frame wheat from plots treated with APP and granular fertiliser in 2003 and residual plots treated with APP and granular in 2002, but no P in 2003.

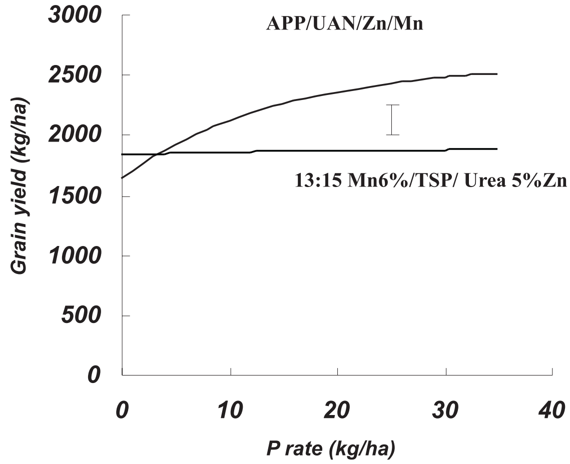

Figure 2: Relationship between grain yield of Frame wheat in 2003 and rate and forms of fertilizer applied in 2003

In 2003, grain yield on the residual plots increased with increasing P rate in both APP and granular plots. Mean yield over all APP treatments was 2005 kg/ha and for all granular treatments 1907 kg/ha - a difference of 5%. The grain yield difference between residual fluid and granular was the same at all rates of P. It is possible that the difference was due to fluid and granular N as only Zn and N were applied to these plots in 2003. Mean Zn concentrations in the shoots were high in both groups.

In the 2003 P application plots, yield increased with increasing P applied as APP but there was no response to increasing rates of P applied as granular. There is no explanation for the lack of response to the granular except that the granular fertiliser was applied at a constant rate of 13:15 Mn6% (to keep the rate of Mn applied constant) while the increasing rates of P contained more TSP. See Dr Enzo Lombi's article which points out that TSP is a very poor performer in these highly calcareous soils.

What does this mean?

The results show that APP increased yields above granular in both years when it was applied. The residual effects of the APP were greater than the granular in the second year in shoot growth but in terms of grain yield there was very little difference and very little contribution of residual P to yield. In this result we have not taken into account the fact that in 2002 more P was also removed from the APP plots than the granular. It is important that P fertilisers are able to provide P to plants for more than one season. More research is intended in this field.

Acknowledgements

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GRDC Grains Research & Development Corporation

Nutrition

WAITING FOR SUSPENSIONS
Is the suspense worth it?

Bob Holloway, Brendan Frischke and Dot Brace

SARDI, Minnipa Agricultural Centre

Research

Searching for answers

Location
Elliston

Cooperator
Keith & Julie Tree

Rainfall
Av. Annual total: 417 mm
Av. Growing season: 343 mm
2003 annual total: 469 mm
2003 growing season: 404 mm

Soil
70% calcium carbonate
46 mg/kg available P

Diseases
Leaf rust – sprayed with Tilt® 250 mL/ha

Plot size
1.5 m x 15 m

Key Messages

- **Suspension fertilisers can be made in SA and should be a very cost effective form of fluid fertiliser.**
- **They are the easiest way to mix nitrogen, phosphorus and micronutrients in a single fertiliser.**
- **Suspensions seem to perform as well as other fluid fertilisers on EP.**

Why do the trial?

The aim of the trial was to compare suspension fertilisers with other fluid and granular fertilisers. Suspension fertilisers seem to offer most of the benefits of fluid fertilisers without the high freight and manufacturing costs. They can be made in SA and they can be mixed to a recipe with just about any combination of nutrients. They may be more difficult to store and handle but we are impressed with the two points that seem to be emerging – our local fertiliser companies can make good suspensions and they should be very cost competitive. *See a previous article in -EPFS2002 -pg 90.*

Searching for answers

Location
Warramboo

Cooperator
Tim & Tracey van Loon

Rainfall
Av. Annual total: 350 mm

Soil
64% calcium carbonate
35 mg/kg available P

Plot size
1.5 m x 15 m

Location
Karcultaby Area School

Rainfall
Av. Annual total: 310 mm
2003 annual total: 228 mm
2003 growing season: 167 mm

Soil
15% calcium carbonate
8.2mg/kg available P

Plot size
1.5 m x 15 m

Other factors
Very dry season, growth poor

How was it done?

Trials were sown at Elliston and Warramboo on grey highly calcareous soils and at Karcultaby on a red-brown calcareous sandy loam. Plots were sown to Krichauff wheat at Warramboo and Karcultaby and Frame wheat at Elliston. Plots were sown on May 31 at Elliston, June 7 at Warramboo and June 13 at Karcultaby at a sowing rate of 60 kg/ha.

Treatments

At Elliston, granular 17:19 Zn2.5% plus urea was compared with ammonium polyphosphate (APP), and an experimental suspension manufactured by Pivot, Pivot A. All plots were supplied with 10 kg P, 20 kg N and 1.3 kg Zn/ha. To equalise nitrogen, UAN was added to APP and to the suspension. In the case of APP, zinc sulphate solution was applied in a separate pumping system at sowing. The suspension contained some zinc but more was added as zinc sulphate to balance nutrients. The same products were compared at Warramboo and Karcultaby, but an extra experimental suspension product supplied by Incitec, Easy NP, was included. The granular mix was applied with the seed at sowing and the fluids were applied about 30 mm below the seed. The suspensions were applied with 240 L/ha of water because of their viscous nature. The fluid applied had the consistency of iced coffee and there were no blockage problems, although all filters were removed from the system, apart from a main tank filter, to remove large particles.

Measurements

At mid/late tillering, plots were sampled to measure the dry weight of shoots and the shoots were also analysed for nutrient concentrations. Grain yields were measured at harvest.

What happened?

At Elliston and Warramboo, on the grey highly calcareous soils the suspension fertilisers performed very well, exceeding the yield of granular treated plots and matching the performance of APP.

Urea can be used as a substitute for UAN in the suspensions or with APP. It can be mixed directly with APP (plus water) or added straight to the suspensions. It could also be used as granular.

What does this mean?

Future tests will involve making suspensions with the cheapest possible ingredients and with the same ratio of nutrients as 17:19: Zn2.5% etc. so that valid economic comparisons can be made. Suspensions will be tested as neat concentrations in 2004 using more suitable pumping equipment acquired over summer. This will reduce application rates from 240 L/ha to rates below 100 L/ha.

ELLISTON

	Dry weight shoots mid tillering (g)	P concentrations shoots (g/kg)	P uptake shoots (ug/plant)	Zn uptake in shoots (ug/plant)	Grain yield (kg/ha)
Pivot A	4.3	2850	488	66	2416
APP	4.7	2825	535	75	2352
17:19 Zn 2.5%	3.0	2675	319	43	2198
LSD (P=0.05)	*1.1*	*119*	*133*	*16*	*135*

WARRAMBOO

	Dry weight shoots mid tillering (g)	P concentrations shoots (g/kg)	P uptake shoots (ug/plant)	Zn uptake in shoots (ug/plant)	Grain yield (kg/ha)
Pivot A	5.99	2500	598	6.9	2939
Easy NP	5.79	2475	574	6.7	2785
APP	5.41	2475	540	6.3	2745
17:19 Zn 2.5%	3.46	2475	343	3.9	2512
LSD (P=0.05)	*1.55*		*165*	*2.2*	*186*

At Karcultaby, only APP increased grain yield above the granular control. The season was very dry and growth was poor throughout the season.

KARCULTABY

	Dry weight shoots late tillering (g)	P concentrations shoots (g/kg)	P uptake shoots (ug/plant)	Zn uptake in shoots (ug/plant)	Grain yield (kg/ha)
Pivot A	17.9	2325	1661	22.4	1165
Easy NP	18.4	2450	1810	24.7	1168
APP	18.0	2353	1697	27.7	1218
17:19 Zn 2.5%	14.2	2450	1391	13.9	1093
LSD (P=0.05)				*7.4*	*92*

Acknowledgements

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GRDC Grains Research & Development Corporation

FLUID FERTILIZER FOUNDATION

Chemistry of Fluid and Granular Fertilisers in Soils of Southern Australia

E. Lombi1, M.J. McLaughlin[1], C. Johnston[1], T. McBeath[1], S. Stacey[1], R.D. Armstrong[2] and R.E. Holloway[3]

Research

CSIRO Land & Water, Adelaide[1], Department of Primary Industries, Horsham, Vic.[2], SARDI, Minnipa Agricultural Centre[3]

Searching for answers

Location
Elliston

Cooperator
Keith & Julie Tree

Rainfall
Av. Annual total: 417 mm
Av. Growing season: 343 mm
2003 annual total: 469 mm
2003 growing season: 404 mm

Soil
70% calcium carbonate
46 mg/kg available P

Diseases
Leaf rust – sprayed with Tilt• 250 mL/ha

Plot size
1.5 m x 15 m

Key Message

Fluid P fertilisers are highly effective in calcareous soils, the extent of responses on other soils is less clear.

Why do the trial?

Calcareous and acid soils are widespread in Australia and their agricultural use accounts for a large fraction of crop production nationwide. However, these soils provide significant challenges for management of crop P nutrition due to rapid fixation of P (reactions which "lock up" fertiliser P into forms that are not available to crops). Fluid fertilisers have produced significant yield increases over and above those achieved with conventional granular products on some of these soils. However, to date, trials have only been undertaken on a narrow range of alkaline soils. Fluid fertilisers need to be tested on a wider range of soil types so that farmers will know whether fluid fertilisers will benefit their own farming enterprises. Furthermore, a mechanistic understanding of the chemistry of granular and fluid P fertilisers is needed before benefits, and possible limitations, of these fluid products can be confidently predicted ?

How was it done?

We conducted pot experiments on 29 soils from Victoria, South Australia and Western Australia, to compare their responsiveness to fluid and granular P. The P fertilisers tested were triple superphosphate (TSP), phosphoric acid (H_3PO_4), ammonium polyphosphate (APP) and a control of no P fertiliser. The amount of P applied to each pot was the equivalent of 12 kg P per hectare.

Furthermore, a detailed laboratory trial was conducted to assess the dissolution of P granules, and the solubility, diffusion and availability of P from granular and fluid fertilisers in two calcareous sandy loam soils from the EP and a non-calcareous alkaline cracking clay from Victoria.

What happened?

Which soils responded to fluids?

Wheat responded to P application on 70% of the 29 soils used (*Table 1*). This response was not well correlated with soil tests commonly used to assess P availability such as Colwell-P.

Table 1: Dry weight of wheat (g/pot) according to fertiliser type, averaged over all soil in each soil group. . N is the number of soils tested, control is no P fertiliser, APP is ammonium polyphosphate, H_3PO_4 is phosphoric acid and Triple P is triple superphosphate. Values in the same row denoted by the same letter are not significantly different ($P \leq 0.05$).

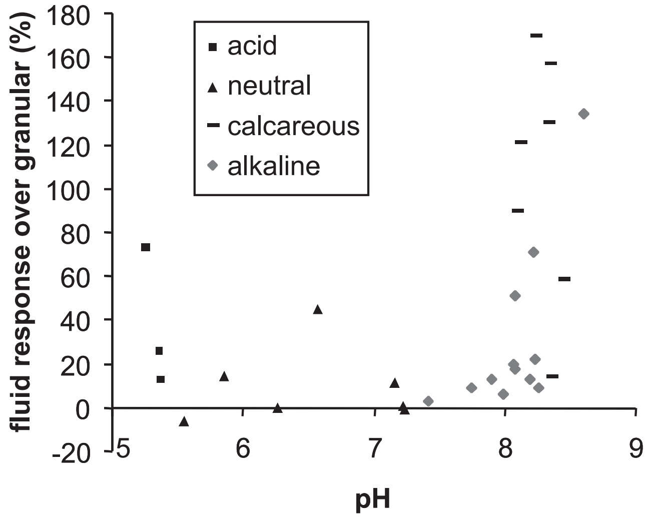
Soil type	N.	Control	APP	H_3PO_4	TSP
Acid	3	0.40 c	1.22 a	1.14 a	0.89 b
Neutral pH	7	1.06 b	1.55 a	1.59 a	1.48 a
Alkaline	12	0.87 c	1.54 a	1.57 a	1.25 b
Calcareous	7	0.54 b	1.03 a	1.06 a	0.60 b

Table 1: Dry weight of wheat (g/pot) according to fertiliser type, averaged over all soil in each soil group. N is the number of soils tested, control is no P fertiliser, APP is ammonium polyphosphate, H_3PO_4 is phosphoric acid and Triple P is triple superphosphate. Values in the same row denoted by the same letter are not significantly different ($P \leq 0.05$).

Among the soil properties, soil pH and calcium carbonate content were the key soil characteristics that controlled crop response to fluid P fertilisers (*Figure 1*). Surprisingly, fluid formulations also performed well in some acidic soils. It is also interesting to see that fluids had no benefit on neutral soils.

The greater cost of fluids, and equipment issues, need to be assessed against any possible yield advantages, although there may be general logistical advantages with the use of fluid fertilisers.

Figure 1: Dry matter response of wheat to fluid fertilisers (APP and phosphoric acid), expressed as a percentage benefit over granular P fertiliser (TSP).



Diffusion, solubility and availability of P from fluid and granular fertilizers

Several reasons have been suggested to explain the effectiveness of fluid P on alkaline soils, ranging from a simple "placement" effect to changes in chemical and physical processes in the fertilizer band. According to the "placement theory", in highly calcareous and P-fixing soils the more

Nutrition

uniform distribution of fluid fertilizers in comparison to granular products may result in a greater number of crop roots intercepting the applied fertilizer. This hypothesis is schematically represented in Figure 2.

Placement may indeed represent an important factor in fertilizer efficiency. However, we believe that placement is not the key factor responsible for the differential efficiency of granular and fluid fertilizers in calcareous soils. For instance, a simple calculation reveals that the theoretical gap between fertilizer granules along a row is not large enough to assume that crop roots will not intercept fertilizer P. Under Australian conditions, we can assume that applying 10 kg P per hectare in the form of DAP granules, and with the weight of a single granule of DAP ≈ 27 mg and a row spacing of 20 cm, the average distance between DAP granules along a row is only 1.2 cm.

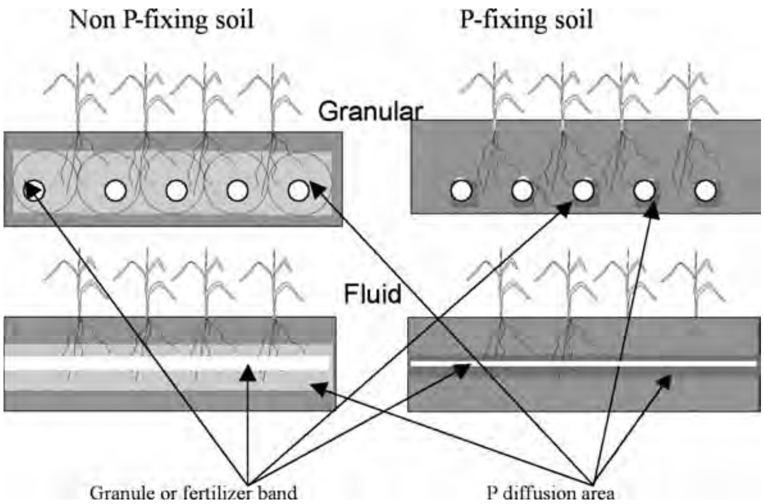


Figure 2: Granular and fluid fertilizers distribution, P diffusion areas, and possibility of fertilizer interception by root crops in a non P-fixing and in a P-fixing soil.

The results from our laboratory experiments have confirmed that fluid forms of P have very different physical and/or chemical effects on soil in the fertilizer band, and hence improve plant P uptake. Diffusion of P from granular products was reduced in highly calcareous soils. In contrast P derived from liquid formulations not only diffused further from the point of application, but a greater proportion of the applied P remained in potentially available forms. The yield advantages offered by fluid formulations in calcareous soils is likely due to this differential chemistry in the soil fertilizer band. Similar experiments in a non-calcareous (but alkaline) cracking clay, with low P retention capacity, found few differences between the chemical behaviour of P in granular and fluid products.

Do fertilizer granules dissolve in high pH soils?

We looked at granules of TSP, MAP and DAP in a red calcareous soil, a grey calcareous soil and a cracking clay from the Wimmera.. Soil type had little effect on granule dissolution, After 5 weeks of incubation in soil the weight of MAP and DAP granules decreased by 80 and 84 % respectively. By contrast, TSP granules did not dissolve very well and after 5 weeks 30% of the granule weight remained. The amount of P remaining in the MAP, DAP and TSP granules after 5 weeks corresponded to 13, 9.5 and 18 % of the total P initially present in the granules, respectively. The residue remaining in the granules after 5 weeks probably reflects the effect of high soil alkalinity in preventing the dissolution of the citrate-soluble P fraction contained in the fertilizer granules, and for TSP this can be up to a fifth of the total P in the fertiliser.

What does this mean?

- Highly alkaline and calcareous soils are very likely to respond to use of fluid P fertilisers (i.e. fluids are likely to be more effective than granular formulations). The greater the content of calcium carbonate in the soil, the greater the likelihood that fluids will offer yield advantages.
- Our future research will investigate crop response to fluid fertilisers on acidic soils.
- The superior performance of fluid over granular fertilisers observed in a number of field trials on the EP is probably not solely the result of a placement effect but also of physical and chemical processes around the fertiliser band.
- The dissolution of granular P fertilisers (especially TSP) is not complete in high pH soils. Part of the P contained in the granules does not diffuse into the soil.

Acknowledgements

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State Government Victoria Department of Primary Industries

FLUID FERTILIZER FOUNDATION

CSIRO

Fluids Fertilisers - did they work on soils at Buckleboo and Arno Bay?

Research

Samantha Doudle[1], Nigel Wilhelm[1] & Brenton Growden[2]

SARDI, Minnipa Agricultural Centre, EP Farming Systems Project[1], [2]SARDI Port Lincoln[2]

Location
Closest town: Buckleboo
Cooperator: Bill Lienert
Group: Buckleboo Farm Improvement Group

Rainfall
Av annual total: 325 mm
Av. GSR: 250 mm
2003 annual total: 330 mm
2003 growing season: 235 mm

Yield
Potential: 3.02 t/ha
Actual paddock: 2.55 t/ha (loam), 2.64 (grey)
Paddock sowing dates: 14/5 (loam), 26/5 (grey)

Paddock History
2003: Carnamah Wheat
2002: Medic pasture
2001: Wheat - Westonia

Soil
See table 1

Diseases
Rhizoctonia

Plot size
1.5 x 20m

Key Messages

- **Fluid fertilisers outperformed granular yield at two research sites on eastern Eyre Peninsula in 2003.**
- **Fluid nitrogen at seeding outperformed granular nitrogen on a red soil at Buckleboo.**

Why do the trial?

To assess the relative performance of fluid and granular fertilisers on a range of typical soil types of eastern Eyre Peninsula under similar seasonal conditions.

How was it done?

Four trial sites were chosen responding to farmer group requests for fluid fertiliser research, three at Buckleboo and one at Arno Bay. At the Buckleboo sites we used the fluid fertiliser trials to value add to the subsoil constraints work the group were already doing (*see Table 1 for crop details*).

One granular P fertiliser and one fluid fertiliser were compared at 6 increasing rates of P at each site (*Table 2*).

Treatments

All 13 treatments in each trial received 11 kg/ha of nitrogen as either granular (urea) or fluid (UAN).

Fluid P(14:21) treatments: 0P, 4P, 8P, 12P, 16P, 4 P + 0.5 Zn, 2 Mn, 0.5 Cu (soil applied TE) and 4 P + 0.1 Zn, 0.5 Mn, 0.05 Cu (foliar applied TE). The fluid was ammonium polyphosphate.

Granular(10:22) treatments: 0P , 8P, 12P, 16P, 20P and 12 P + 0.5 Zn, 2 Mn, 0.5 Cu (foliar applied TE)

Trace elements were applied in the chelated form.

What Happened ?

Buckleboo loam site- There was no response to phosphorus in this trial and yields averaged 1.9 t/ha regardless of treatment. This means that we could not test the effectiveness of fluid fertilisers in this trial.

Buckleboo grey site – Grain yield was responsive to phosphorus fertiliser.

Site very patchy due to areas of subsoil sheet limestone, which burnt off the crop at end of season. Despite this background variability, fluids outperformed their granular equivalents by an average of 0.2 t/ha at the same rate of P. From the curve in figure 1 it could also be assumed that fluid would out-yield granular applied at a P rate of 4 kg/ha.

Buckleboo red site – Grain yield was responsive to phosphorus fertilisers. Fluid NP fertiliser out yielded granular fertiliser by an average of 0.22 t/ha. However, fluid nitrogen outperformed granular nitrogen by 0.2 t/ha when no phosphorus was applied (*Figure 2*) which suggests that most of the benefit of fluid fertiliser in this trial was due to a response to nitrogen, not phosphorus.

Arno Bay site - Grain yield was not response to phosphorus fertiliser. Yields averaged 2.3 t/ha, regardless of fertiliser type.

Economics

The best return on investment, over and above district practice (12 units of P granular) at the Buckleboo red site was granular 16 kg/ha P + 11 kg/ha N (an extra $15/ha over district practice), followed by fluid 12kg/ha P + 11 kg/ha N (an extra $7/ha over district practice) (*Table 2*). At the Buckleboo grey site the best return on extra investment was fluid 4 kg/ha P + 11 kg/ha N, with no other treatment returning more than district practice.

Table 1: Trial Details.

Location	Crop Type	Trial Sowing Date
Buckleboo Red	Frame	May 28th
Buckleboo Grey: (Paddock code name 56…cans!!)	Carnamah	May 28th
Buckleboo Loam	Carnamah	May 28th
Arno Bay	Yitpi	June 5th

Table 2: Soil Characteristics at fluid fertiliser research sites on eastern EP, 2003.

Location	Texture	pH(water)	Fizz	$CaCO_3$	Subsoil constraints
Buckleboo Red	Clay	9.8	Medium	0.14	Roots to 30cm where free lime increases to very high. Surface extremely hard when dry.
Buckleboo Grey 56	Sandy clay loam	9.5	High	8.38	Roots to 75 cm, where boron, salt & sodicity reach toxic levels. Surface sealing after large rainfall event post seeding.
Buckleboo Loam	Sandy loam	9.8	Medium	0.14	Roots to 25 cm, possibly soil structural barrier, columnar clay.
Arno Bay	Sandy loam	8.5	Medium	4.68	No information available.

Location
Closest town: Buckleboo
Cooperator: Rowan Ramsey
Group: Buckleboo Farm Improvement Group

Rainfall
Av annual total: 300 mm
Av. GSR: 210 mm
2003 annual total: 334 mm
2003 growing season: 220 mm

Yield
Potential: 2.2 t/ha
Actual paddock: 1.63 t/ha

Paddock History
2003: Yitpi
2002: Grass free pasture
2001: Wheat

Soil
See table 1

Diseases
Rhizoctonia

Plot size
1.5 x 20m

Other factors
Rye grass

Location
Closest town: Arno Bay
Cooperator: Ben Ranford
Group: Arno Bay Ag Bureau

Rainfall
Av annual total: 320 mm
Av. GSR: 230 mm
2003 annual total: 290 mm
2003 growing season: 214 mm

Yield
Potential: 2.08 t/ha
Actual paddock: 1.9 t/ha

Paddock History
2003: Yitpi
2002: Medic, grass free
2001: Wheat, H45

Soil
See table 1

Diseases
Rhizoctonia

Plot size
1.5 x 20m

Trace Element Reponses: Trace elements did not increase wheat yields in any of the trials.

What does this mean?

An important point to remember with fluid fertiliser trials is that in order to assess the yield benefits of fluid compared with granular phosphorus, the soil type actually needs to respond to phosphorus as a bare minimum. Despite soil testing these research sites and assessing paddock records prior to sowing, we still managed to have 50% of our sites non responsive to P. However, on identified P responsive sites fluids were more effective than granular products.

It is unclear whether the higher yields of fluid fertilisers at the Buckleboo red site are entirely due to the better performance of the fluid nitrogen over granular, or whether there is also some benefit of fluid phosphorus over granular, however the former scenario is most likely. Fluid nitrogen outperforming granular nitrogen has also been seen in some other trials (but so also has fluid N performed worse than granular N!).

Economics

Despite the fluid phosphorus source used in these trials being approximately three times more expensive than the granular used, the fluid treatment at 12 units of P was still able to financially outperform district practice. The treatment with 4 kg P/ha also performed well with similar yields to district practice on two soil types but with lower rates of product and better return. This margin could be widened further by using cheaper sources of fluid P and N or perhaps considering slurries.

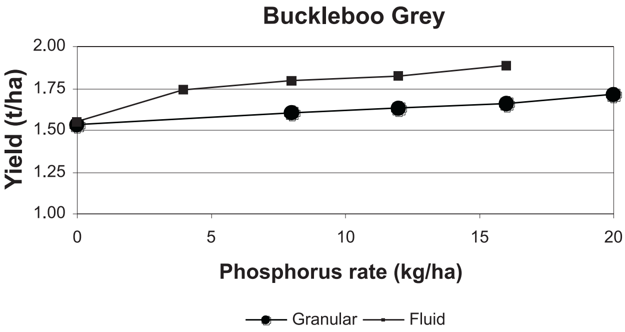

Figure 1: Yield results from fluid fertiliser trial @ Buckleboo grey site, 2003 (P=0.05, LSD = 0.16)

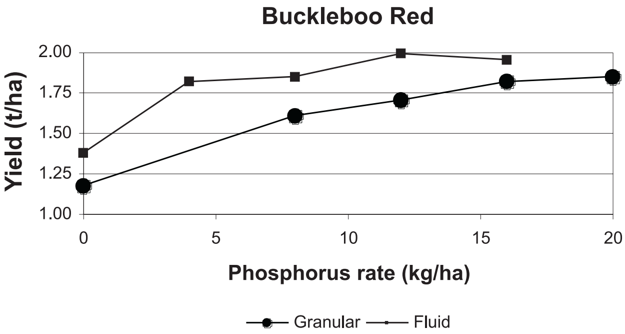

Figure 2: Yield results from fluid fertiliser trial @ Buckleboo red site, 2003 (<P.001, LSD = 0.15)

Acknowledgments

- The Buckleboo Farm Improvement group (in particular Bill and Gadge Lienert and Rowan Ramsey) for hosting these trials and keeping us "motivated" throughout the season at various BIG FIG group events!
- SARDI and GRDC for sponsoring this work through the Eyre Peninsula Farming Systems project
- Terry Blacker (SARDI, Pt Lincoln), Ben Ward, Wade Shepperd and Willie Shoobridge (SARDI, MAC) for technical support during the season.

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Do Fluid Fertilisers work in the Lock District?

Research

Alison Frischke

SARDI, Minnipa Agricultural Centre

Key Messages

- **Trial plots sown with fluid fertilisers in the Lock district have generally yielded the same as those sown with granular fertilisers.**
- **In trial plots gross income from fluid treatments has been similar or uneconomic compared with granular fertiliser, given high fertiliser costs. However, when making decisions about fluids many other factors, that are all part of a farming system, should also be taken into account (eg. sustainability, ease of use), not just the economic factors.**
- **Fluid fertiliser responses are very dependent on soil type - responses increase as pH rises above 8, coupled with $CaCO_3$ levels over 10%.**
- **Before adapting machinery to fluid fertilisers, identify soil types likely to respond by taking a soil test for pH and percentage $CaCO_3$. The fizz test for lime is not adequate to base decisions on.**

Why do the review?

This article summarises 5 years of fluid fertiliser research in the Lock district undertaken by SARDI and Landmark. This review was conducted as a response to local farmer requests. Note that trials were designed to compare the performance of different fertilisers and rates – they were not designed for economic comparisons.

What happened?

For all trials, a selection of treatments only has been chosen to make comparisons about the performance between fluid and granular fertilisers and reported here. Full sets of results are available from Ali Frischke at Minnipa Ag. Centre, and Darren Rule of Landmark, Cummins.

1999 – Trials were sown on Andrew and Jenny Polkinghorne's property; the site had a high calcium carbonate content ($CaCO_3$ above 30%), and low extractable phosphorus. Below average rainfall was received, but a kind spring helped grain fill.

In a small fertiliser formulation trial (*Trial 1*), Tech Grade DAP (liquid form) produced a higher yield in Frame wheat compared to granular DAP (0.2 t/ha) (*Table 1*). Phosphoric acid yielded similarly to DAP.

In trial 2 (which looked at using fertiliser mixes and treatments to control take-all), grain yields were higher for all 4 APP (ammonium polyphosphate) treatments compared to MAP (150-225 kg/ha) (only APP + UAN has been included in the table). The fluid control (APP + UAN) also had higher tissue P levels than MAP. Despite the same or higher yields for fluid treatments, gross income was equal or less compared with granular treatments due to the higher cost of the fertiliser.

2000 – Two sites were sown with Frame wheat; one on David Foster's, and the other on Ian Burrow's property. These sites had much lower levels of carbonate and much higher Colwell P levels compared with the 1999 trial sites (*see the site detail box*).

In all 4 trials sown between the two sites, there were no yield responses to applied phosphorus, and hence no difference between granular or fluid fertiliser. This is probably due to the high phosphorus reserves at these sites, which indicate that there is adequate stored P and available P for plant uptake. Also, the year 2000 was a very good season which would have meant that there is greater mobilisation of nutrients into soil solution, and therefore more available for plant uptake.

Table 1: Fluid vs Granular Fertiliser performance in Frame wheat at Polkinghorne's, 1999.

	Fertiliser	Cost of Fertiliser ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
Trial 1				
	Tech Grade DAP + Urea	63.68	1.91	285
	Phos. Acid + Urea	77.70	1.79	249
	DAP + Urea	27.98	1.71	284
	LSD ($P \leq 0.05$)		0.15	
Trial 2				
	APP + UAN	80.56	1.85	257
	Phos. Acid + UAN	77.70	1.65	224
	MAP + Urea	30.01	1.63	268
	LSD ($P \leq 0.05$)		0.14	

All fertilisers were balanced to deliver 15 kg N/ha and 12 kg P/ha.
**Gross income is calculated as yield x price, delivered to Pt Lincoln as at 1st Dec 2003, less fertiliser costs. Protein and screenings were not measured and so have been assumed to be 10% and 5% respectively.*
APP = Ammonium polyphosphate, UAN = Urea ammonium nitrate.

Almost ready

Location
Lock

Andrew Polkinghorne
Grey calcareous sandy loam
CaCO3: high fizz (above 30%)
Colwell P: 19 mg/kg
1999 GSR: 201 mm

David Foster
Greyish calcareous sandy loam
CaCO3: 7%
Colwell P: 54 mg/kg
2000 GSR: 273 mm

Ian Burrows
Grey calcareous sand over clay loam
CaCO3: 3.3%
Colwell P: 50 mg/kg
2000 GSR: 290 mm

Jeff Longmire (2001, 2003)
Sandy loam over clay
CaCO3: low fizz (under 5%)
Colwell P: 25 mg/kg
2001 GSR: 280 mm
2003 GSR: 302 mm

Murray, Andrew and Lyall Wiseman
Heavy loam
CaCO3: moderate fizz (under 5%)
Colwell P: not available
2002 GSR: 239 mm

2001 – A fluid trial was planted on Geoff Longmire's property. A total of three DAP treatments were compared against 7 APP mixes in the trial.

There were no grain yield differences between fertiliser treatments. However, when APP was applied at 25 L/ha it yielded as much as the DAP treatment, but slightly lower protein and higher screenings meant that the gross income was slightly lower. The season received average rainfall.

2002 – A fluid trial was planted on Murray, Andrew and Lyall Wiseman's property, where a nil and 2 DAP treatments were compared against 11 APP mixes.

There were no grain yield differences between fertiliser treatments. The season was below average resulting in low yields, and nil fertiliser actually achieved the highest gross income.

2003 - Another fluid trial was planted on Geoff Longmire's property in 2003. A nil, a MAP and 2 DAP treatments were compared against 11 APP mixes.

The season was reasonably good for the district, and the site responded to applied fertiliser. There was no grain yield response to APP applied at 25 L/ha, but yields improved by over 330 kg/ha when 18 kg N/ha and 20 kg P/ha was applied either as DAP @ 100 kg/ha, or APP @ 95 L/ha + UAN @ 14.5 L/ha. The DAP granular fertiliser crops achieved the highest gross income by achieving the highest protein, and by having low input costs.

There was no response to applied fertiliser for 3 of the Lock trials where nil treatments were included. This means that at these sites, the performance of fluid and granular fertilisers cannot really be compared because the P available in the soil has been sufficient to meet the needs of the crop. However, this is by no means a recommendation to go out and sow without fertiliser! As already mentioned, it means that there is adequate stored P and available P for plant uptake. However, for every crop of wheat that is harvested from the paddock you will remove 21 kg N/t, 3 kg P/t and 3 kg S/t of production. Figures are similar for barley and other crops, except legume species where nitrogen removal rate jumps to more than 40 kg N/t of production. Darren Rule intends to crop the same site at Longmire's for the next 2 seasons to measure the effects of sowing without fertiliser.

Darren commented that early growth responses seen in fluid plots aren't necessarily translating into higher yields later in the season. Ali and Bob have had the same experience on less calcareous soils.

During 2003, Andrew Polkinghorne and Vaughan Habner used fluid fertilisers in their cropping program for the first time. It is recommended that you contact these farmers for more detail of their experiences.

Andrew made the following comments: "These trials alone do not fully reflect the benefit of fluids. For example, the early vigour promoted by fluids provides much quicker ground cover and far better weed competition in a paddock situation, and the yields are much more even across the paddock. This can't be reflected in a trial because a trial site needs to be uniform. The higher carbon inputs from the increased dry matter production should contribute to a more sustainable farming system and higher yields in the future. Your research has shown that fluids make the crops more robust in the face of disease pressure. We can use that information to abuse our rotation and grow more of the profitable crops instead of going

Table 2: Fluid vs Granular Fertiliser performance in Krichauff wheat at Longmire's, 2001.

Fertiliser Treatment	Nutrients Applied (kg/ha)		Cost of Fertiliser ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
	N	P			
DAP @ 80 kg/ha	14.4	16	33.76	5.54	990
APP @ 25 L/ha	3.5	5.2	30.00	5.55	982
APP @ 25 L/ha + UAN @ 34 L/ha	14.4	5.2	59.63	5.48	951
APP @ 50 L/ha + UAN @ 23 L/ha	14.4	10.4	82.12	5.74	979
LSD (P≤ 0.05)				*0.27*	

**Gross income is calculated as yield x price (with quality adjustments) delivered to Pt Lincoln as at 1st Dec 2003, less fertiliser costs.*

Table 2: Fluid vs Granular Fertiliser performance in Yitpi wheat at Wiseman's, 2002.

Fertiliser Treatment	Nutrients Applied (kg/ha)		Cost of Fertiliser ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
	N	P			
Nil	-	-	-	1.69	346
DAP @ 80 kg/ha	14.4	16	33.76	1.73	326
APP @ 25 L/ha	3.5	5.2	30.00	1.64	304
APP @ 75 L/ha	16	10.5	90.00	1.64	251
APP @ 50 L/ha + Urea @ 50 kg/ha	30	10	79.10	1.82	304
LSD (P≤ 0.05)				*0.18*	

**Gross income is calculated as yield x price (with quality adjustments) delivered to Pt Lincoln as at 1st Dec 2003, less fertiliser costs.*

Table 3: Fluid vs Granular Fertiliser performance in Krichauff wheat at Longmire's, 2003.

Fertiliser Treatment	Nutrients Applied (kg/ha)		Cost of Fertiliser ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
	N	P			
Nil	-	-	-	3.81	666
DAP @ 100 kg/ha	18	20	41.00	4.29	720
APP @ 25 L/ha	3.5	5.2	30.00	3.98	642
APP @ 95 L/ha + UAN @ 14.5 L/ha	18	20	127.00	4.14	564
LSD (P≤ 0.05)				*0.324*	

**Gross income is calculated as yield x price (with quality adjustments) delivered to Pt Lincoln as at 1st Dec 2003, less fertiliser costs.*

to risky break crops. This impacts significantly (positively) on farm profitability – therefore, to just view trial results in making decisions about fluids is a narrow analysis that does not take into account many other factors that are all part of a farming system. We believe that using fluids was worth an extra 300-400 kg/ha of grain compared to if we had used granular fertiliser in the 2003 season. These comments are applicable to our soil type."

Vaughan Habner made the comment that it got the crop out of the ground quicker and had much better early vigour. This increased the target area for foliar trace element application. There is no storage for granular fertiliser on the property where they applied fluids, but they were able to store the fluids in the shuttles and tanks, and got their crop in the ground faster as they could sow 200 acres without having to stop to fill up on fertiliser. Vaughan ran a replicated trial (4 reps) with fluid and granular strips, but measured no appreciable difference in grain yield at harvest. At present Vaughan calculates his fluid P input rates to match what he would invest in P applied as granular. He is happy with the performance of fluids and will continue using fluids on this property for a couple more seasons, depending on fluid price movements.

What does this mean?

- Similar to trial experience in other areas, responses to fluid fertilisers in the Lock district have been dependent on soil type, and consequent nutrient availabilities/deficiencies. While there have been early growth responses, in most cases trial plots sown with fluid fertilisers have yielded the same as those sown with granular fertilisers. At trial sites with higher soil carbonate levels and lower phosphorus availability, the response to fluid fertilisers has improved. Large yield increases have not been seen in the Lock district in trial plots, as seen elsewhere on highly calcareous soils of Eyre Peninsula.
- However, in most trial and paddock situations, emergence of plants sown with fluids has been faster compared with granular, and early vigour has been greater. This is favourable for the ability of seedlings to cope with stresses such as disease, wind, nutrient uptake etc.
- In trial plots gross income from fluid treatments has been similar or uneconomic compared with granular fertiliser, given high fertiliser costs. However, when making decisions about fluids many other factors that are all part of a farming system must be taken into account (eg. sustainability, ease of use), not just the economic factors.
- Get a soil done to measure the pH and percentage calcium carbonate to get an idea of the response you would expect from using fluid fertilisers. The fizz test is not sufficiently accurate, as anything over 5% $CaCO_3$ will give you a high fizz. As pH drops below 6 or rises above 8, coupled with $CaCO_3$ levels over 10%, you will be much more likely to achieve a yield response to fluids.
- Fluids can provide a useful medium for delivering trace elements at sowing time.

Acknowledgements

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Response of Cereal Varieties to Fluid Fertiliser

Research

Rob Wheeler[1], Leigh Davis[2], Michael Bennet[2]

SARDI, Waite Research Precinct[1] and SARDI, Minnipa Agricultural Centre[2]

Key Messages

- **Fluid fertiliser increased grain yields in wheat and barley over and above granular fertiliser at Streaky Bay and Piednippie in 2003.**
- **Grain yield improvement with fluid fertiliser averaged 7% in barley and 11% in wheat at the same rate of P and N.**
- **H45 wheat and Torrens and Gairdner barley were the most responsive varieties to fluid P and Krichauff wheat and Schooner barley the least responsive.**
- **While the ranking of wheat and barley varieties was generally similar under granular and fluid fertiliser, some differences in varietal response warrant further investigation.**

Why do the trial?

To investigate the performance of individual cereal varieties with regard to fluid or granular fertilisation.

Increasing interest and adoption of fluid fertiliser technology in highly calcareous soils across Eyre Peninsula raises the possibility of differences in crop varietal performance under this new management strategy. Few studies on fluid P fertiliser have considered the impact of varietal choice and if differences can be reliably demonstrated, varietal choice for farmers may

Searching for answers

Location
Streaky Bay
Cooperator: Ken Williams

Rainfall
Annual total: 296 mm
Growing season: 243 mm

Yield
Potential: 3.05 t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Chebec Barley

Soil
Highly calcareous sand over sandy loam

Diseases
Rhizoctonia

Plot size
10m x 1.44m

Location
Piednippie
Cooperator: Simon Patterson

Rainfall
Annual total: 341 mm
Growing season: 270 mm

Yield
Potential: 3.2 t/ha

Paddock History
2002: Pasture
2001: Krichauff Wheat
2000: Pasture

Soil
Highly calcareous sand

Diseases
Yellow leaf spot, Rhizoctonia and Leaf rust.

Plot size
10m x 1.44m

Table 1: Effect of granular and fluid fertilisers on wheat and barley variety yield in 2003

Piednippie wheat variety site						Streaky Bay barley variety site					
	Granular		Fluid				Granular		Fluid		
Variety	**kg/ha**	**rank**	**kg/ha**	**rank**	**Response***	**Variety**	**kg/ha**	**rank**	**kg/ha**	**rank**	**Response***
Yitpi	1582	1	1682	1	106	Barque	3296	1	3722	1	113
Excalibur	1494	2	1681	2	113	WI3804	3260	2	3670	2	113
Krichauff	1476	3	1368	7	93	Keel	3160	3	3578	3	113
Camm	1393	4	1488	4	107	Schooner	3118	4	3226	8	103
Frame	1380	5	1424	5	103	Baudin	3112	5	3415	5	110
Wyalkatchem	1359	6	1532	3	113	WI3297	3091	6	3264	7	106
Machete	1308	7	1369	6	105	Sloop	3076	7	3293	6	107
Kukri	1202	8	1312	8	109	Gairdner	2966	8	3454	4	116
H45	1092	9	1264	9	116	Torrens	2704	9	3143	9	116
Average	1365		1458		107		3087		3418		111
CV%	6.6						7.4				
LSD (P=0.05)	156						385				

**Response of fluid as a percentage of yield with granular fertiliser.*

need to consider the type of P fertiliser to be used.

How was it done?

The 2003 Streaky Bay Stage 4 barley trial and Piednippie Stage 4 wheat trials were identified as suitable sites in which to include supplementary treatments of fluid fertiliser applied to selected varieties. The Streaky Bay barley site was sown with 60 kg/ha granular 12:13:0 + 3% manganese. The Piednippie wheat trial was sown with 70 kg/ha of 17:19:0 + 2.5% zinc. Identical (in nutrient content) fluid mixes were applied at a water rate of 200 L/ha to all the fluid treatments. The fluid mixes included tech grade MAP and DAP, phosphoric acid and ammonium nitrate. Zinc sulphate was included at Piednippie and manganese sulphate at Streaky Bay to match the granular applications. Both sites received a foliar application of 400 g/ha Mn, 200 g/ha Zn and 60 g/ha Cu post tillering.

The Piednippie and Streaky Bay sites were sown on the 12th and 16th of June respectively. Both sites received a Sprayseed, trifluralin knockdown with an in-crop application of 10g/ha Glean, which aggravated a *Rhizoctonia* issue.

The wheat varieties, Yitpi, Wyalkatchem, Krichauff, Frame, Excalibur, Camm, H45, Machete and Kukri and barley varieties, Sloop, Torrens, Baudin, Gairdner, Barque, Schooner, Keel, WI3297 and WI3804 were examined. These varieties were selected to represent a range of agronomic types, diverse breeding pedigrees and known variation to nutritional stresses.

What happened?

See Table 1.

What does this mean?

At both sites, use of fluid fertiliser increased grain yield above granular, with an average response of 11% in wheat and 7% in barley. Yitpi wheat and Barque barley were the highest yielding varieties for each crop irrespective of fertiliser type.

Differences in varietal response to fertiliser treatment ranged from –7 % to 16 % in wheat varieties, and 3 % to 16 % in barley varieties. Excalibur, Wyalkatchem and H45 wheat and Barque, WI3804, Keel, Gairdner and Torrens barley were the most responsive to fluid fertiliser. In contrast, Krichauff wheat and Schooner barley were the least responsive varieties. This contrasts with a varietal response observed by Krichauff in previous fluid fertiliser trials. (*See EPFS 2000 pg 91*)

These differences in grain yield response between varieties resulted in some variation in ranking between the fertiliser application methods although the highest and lowest yielding wheat and barley varieties ranked similarly under each fertiliser regime. Interestingly, among the varieties sharing similar parentage ie Schooner and Sloop, Frame and Yitpi, Machete and Wyalkatchem, only the latter pair did not respond similarly.

These trials have indicated some variation in wheat and barley variety response to method of fertilisation and the area may be further investigated in 2004.

Acknowledgements

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High Pressure N Injection - The First Test

Brendan Frischke, Bob Holloway and Dot Brace
SARDI, Minnipa Agricultural Centre

Key Messages

- **High-pressure injection shows promise as an alternative method for applying post emergent in cereal crops.**
- **Applying with stream bars and disc coulters gave similar yield and protein to broadcast.**
- **Banded at seeding performed better in a loam compared to a sand.**

Why do the trial?

As part of the fluid fertiliser project based at Minnipa, high-pressure injection is being evaluated as an alternative method of fertiliser application. High-pressure injection is being investigated because it may be a way of applying fertiliser into soil without tilling to the same depth or without tillage altogether. Two trials were conducted to evaluate the potential of high-pressure injection to apply (N) in established cereal crops N.

How was it done?

Two trials with the same treatments were established, one at Mt Cooper with Sloop barley and the other at Tooligie Hill with Barque barley. In each trial there was a control treatment with no additional N, a banding at seeding treatment (20-40 mm below seed), four post emergent treatments that were applied at two timings each and two post emergent foliar treatments. For the post emergent treatments, except foliar, it was hoped that one application would be immediately before rain (ideal for broadcasting-BC) and the second with no rain in sight (not ideal for broadcasting) and as close as possible to the first post emergent application. Because of varying seasonal fortunes timings were several weeks apart. Except for foliar treatments, additional N was applied at 24 kg N/ha from either granular or dissolved urea. The foliar treatments were applied at late tillering, but only received 6 kg/ha of additional N. One foliar treatment used dissolved urea and the other urea ammonium nitrate (UAN). Foliar treatments were applied in the evening to minimise losses. Each trial received 70 kg/ha DAP at seeding and micronutrient foliar sprays at late tillering. Mt Cooper was sown on May 27th and Tooligie Hill was sown on June 16th.

The four post emergent treatments at two timings were broadcasting (BC) granular, high-pressure fluid injection with the root zone injector (RZI), disc injected fluid and stream bar fluid. In detail, the new methods can be described as:

High-pressure injection. A machine developed in Canada referred to as a root zone injector (RZI) was used for these trials. The RZI operates at 345 bar pressure and with an intermittent output. Special valves open for short periods several times every second to supply fertiliser solution to nozzles in short bursts. Nozzles are mounted on skid plates that run along the soil surface. The valves pulse between 5 and 18 times per second (user selectable from an electronic controller) and open for 5 milliseconds each time resulting in fertiliser being injected in short strips (up to 50 mm long) down each nozzle row. RZI penetration generally varies from 50 to 100 mm into the soil depending on soil type, conditions and operating parameters. Each nozzle was spaced 225 mm apart in this trial. Note: 1 bar = 100 kPa = 14.5 psi.

Disc injected fertiliser uses disc coulters to open a slot in the soil approximately 5-10 cm deep in which fluid fertiliser is injected at low pressure (1 bar). The disc coulters used in this trial were a ripple type 430 mm diameter and spaced 300 mm apart.

The stream bar method utilised a boom spray fitted with orifice discs and dropper tubes at 25 cm spacing rather than spray nozzles at 50 cm, running close to the soil surface to prevent the wind from blowing solution over plants.

What happened?

The first application of post emergent N was at late tillering immediately after rain (not ideal for broadcasting) on July 25th at Mt Cooper and July 29th for Tooligie Hill. However, following application, both sites received more rain (5 mm at Mt Cooper and 16 mm at Tooligie Hill) within a week reducing volatilisation losses. The second application of N was on August 19th at both sites (2nd node stage). Both sites received at least 5 mm rainfall the day after application. In the week after application, Mt Cooper received 73 mm rainfall and Tooligie Hill received 32 mm.

Crop Damage - Many of the treatments had the potential to cause major crop damage at application that might cause yield loss. Specific dangers were; low germination from high N with the seed for the banded at sowing treatment, physical crop damage from coulters and high pressure liquid streams and

Searching for answers

Location
Mt Cooper
Closest town: Pt Kenny
Cooperator: K & T Kelsh
Group: Mt Cooper

Rainfall
Av. Annual total: 425 mm
Av. Growing season: 335 mm
Actual annual total: 372 mm
Actual growing season: 326 mm

Yield
Potential: 4.7 t/ha
Actual: 3.9 t/ha

Paddock History
2002: Frame wheat
2001: Fiesta faba beans
2000: Frame wheat

Soil
Major soil type description:
Red/brown sandy loam

Plot size
Dimensions: 1.5 x 20 m

Location
Tooligie Hill
Closest town: Lock
Cooperator: V & C Habner
Group: Lock/Murdinga

Rainfall
Av. Annual total: 375 mm
Av. Growing season: 290 mm
Actual annual total: 375 mm
Actual growing season: 285

Yield
Potential: 4.4 t/ha
Actual: 1.44 t/ha

Paddock History
2002: Krichauff wheat
2001: Frame wheat
2000: Canola

Soil
Major soil type description:
Sand over clay

Diseases
Slight leaf rust

Plot size
Dimensions: 1.5 x 20 m

Figure 1: Root Zone Injector (RZI) demonstration with the skids raised off the ground. Note: only four jets were photographed in the firing phase, the other four are between pulses.

Figure 2: Disc coulters applying dissolved urea to late tillering barley at Tooligie Hill.

leaf burning from foliar and stream bar treatments. Only visual assessments were made.

Seed separation of 20-40 mm from additional N in the banding treatment, where 37 kg N/ha was applied at sowing, was enough to ensure germination rates were not adversely affected. With the foliar applied N, there was no evidence of leaf burn at these low N rates with urea or UAN. Dropper tubes on the stream bar were adequate to prevent any leaf scald.

The RZI occasionally severed a leaf or tiller from a plant when the liquid nozzle was positioned above a plant when it fired. However, because the nozzles were running parallel to the crop rows and rarely directly above them and the nozzle only emits liquid less than 10% of the time due to its pulsing nature, actual damage caused is extremely small and insignificant. The skids that the nozzles were mounted on, which ran along the ground and through the crop, did not cause any crop damage either.

Disc coulters could only be run parallel to crop rows due to the physical layout of small plots, where it had the potential to cause considerable damage if a coulter ran on a crop row. It was a case of just driving and not looking back at the damage that might have occurred. In North America, where applying N with coulters in crop is quite common, applicators run at an angle or across the crop rows so that the coulters cut through the rows rather than along them to minimise damage. Auto steer guidance may have a future role here. In the trial there was nearly always one of five coulters running along a crop row. Many plants had multiple tillers severed and damage quite visible. However, because plants are scattered across a narrow band rather than a straight line, there were more unaffected plants among the damaged plants and two weeks after application, there was hardly any visible damage.

Crop Yield and Protein data are shown in Table 1. Both sites had above average rainfall and high yields with low protein indicating that crop N demand exceeded supply. The main points from yield and protein trends are:

- N applications at 2nd node stage were able to increase yield compared to the control
- RZI produced higher yields than broadcasting when applied at the same time on 3 out of 4 occasions.
- RZI produced similar or better yields than banding at seeding
- Proteins were maintained with RZI, even with higher yields
- RZI achieved maximum N recovery at both sites.

Table 1: Yield and protein of Sloop barley (Mt Cooper) and Barque barley (Tooligie Hill) from alternative N application methods. Values in each column followed by the same letter are not statistically different at P=0.05.

	Mt Cooper		Tooligie Hill	
	Grain Yield t/ha	Protein %	Grain Yield t/ha	Protein %
RZI immediately after rain @ late tillering	4.01 a....	9.5 ab..	2.86 a...	9.0 abc.
Banded Urea @ sowing	3.94 ab...	9.2 abcd	2.50 ..c.	9.1 ab..
Disc injected immediately after rain @ late tillering	3.82 .bc..	9.0 .bcd	2.57 .bc.	8.7 .bcd
RZI immediately before rain @ 2^{nd} node	3.81 .bc..	9.7 a...	2.83 ab..	8.8 .bcd
BC Urea immediately after rain @ late tillering	3.80 .bc..	9.2 abc.	2.51 ..c.	8.6 .bcd
BC Urea immediately before rain @ 2nd node	3.74 ..c..	9.4 ab..	2.47 ..c.	9.4 a...
Disc injected immediately before rain @ 2nd node	3.74 ..c..	9.2 abcd	2.58 .bc.	9.0 abc.
Stream bar imediately after rain @ late tillering	3.74 ..cd.	8.7 ..cd	2.49 ..c.	8.6 .bcd
Stream bar immediately before rain @ 2nd node	3.69 ..cde	9.4 ab..	2.51 ..c.	8.8 .bcd
Foliar Urea (6 kg N/ha) @ late tillering	3.57 ...de	9.0 .bcd	2.18 ...d	8.5 ..cd
Control	3.56 ....e	8.6 ...d	2.10 ...d	8.3 ...d
Foliar UAN (6 kg N/ha) @ late tillering	3.55 ....e	8.7 ..cd	2.17 ...d	8.5 ..cd
F pr.	<0.001		<0.001	

- Banded N at seeding yielded equal highest at Mt Cooper and similar to the better post emergent treatments at Tooligie Hill, but not as good as RZI.
- Stream bar and disc applied N yielded similarly to broadcast at both timings and sites.
- Low rates of foliar UAN or urea did not increase yield compared to the control.
- Generally the highest yielding treatments also had the highest protein indicating that those treatments best matched nitrogen supply and demand.

Screenings, retention and test weights met targeted grain classification requirements for all treatments at both sites very easily, so despite some small differences they would have had little impact on the economics of N treatments.

What does this mean?

High-pressure injection with the RZI proved to be an effective method of N application. However, more experience with this approach under a wide range of conditions would be required to justify adoption of this technology. In practice, applying fertiliser with the RZI was very simple. Calibration procedures are similar to boom sprays. Once calibrated driving at a constant speed is all that is required. Protein levels in both trials reported indicate N rates may have been too low to maximise yield. However, increasing up front N beyond the levels used here in these low rainfall environments carries higher risk and good broadcasting opportunities can be limited. The RZI's advantage maybe a broader window of opportunity to apply N, reduced risk when applying higher inputs in low rainfall areas and more efficient use of N applied.

Stream bars generally produced similar yield and protein to broadcasting when applied at the same time. Stream bars may be an alternative for producers to consider if they don't have broadcasting equipment and have a boom spray that they could utilise.

These trials were unable to determine the detrimental effect of crop damage from coulters or if there was an advantage from applying N deeper into the soil. However it does show that the combined effects resulted in similar yield and protein to stream bars and broadcasting.

Acknowledgements

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GRDC Grains Research & Development Corporation

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MINNIPA RESEARCH FOUNDATION

Nutrition

Micronutrients Make Fluid Phosphorus Perform Better at Miltaburra!

Brendan Frischke, Bob Holloway & Dot Brace

SARDI, Minnipa Agricultural Centre

Research

Almost ready

Location
Closest town
Miltaburra
Co-operator: Leon, Marilyn, Carolyn & Darren Mudge.
Group: Nunjikompita.

Rainfall
Av. Annual total: 306 mm
Av. Growing season: 212 mm
Actual annual total: 319 mm
Actual growing season: 214 mm

Yield Potential: 2.40 t/ha
Paddock yield: 1.6 t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Barque Barley

Soil
Calcareous sand

Plot size
Dimensions: 2 x 15 m

Key Messages

- **Fluid fertilisers at Miltaburra performed much better with the addition of low rates of micronutrients.**
- **Fluid P at 6 kg/ha had the highest economic return and caused a net increase of P in the system.**
- **Foliar micronutrients were more economic than micronutrients in granular fertiliser in the year of application.**

Why do the trial?

- To compare performance and economics of correcting micronutrient deficiencies with fluid and granular fertilisers on highly calcareous soils.
- Assess whether micronutrients perform differently when applied as fluid fertilisers compared to granular fertilisers.
- Assess the potential of increasing grain nutrient content with fluid fertilisers and hence improve seed quality.

How was it done?

A replicated small plot trial was conducted at Miltaburra comparing several fertilisers containing micronutrients. Four fertilisers, 3 fluids and 1 granular, had the same phosphorus and nitrogen rate. The granular fertiliser was a mixture of manganese coated DAP and zinc coated urea. The 3 fluid fertilisers were phosphoric acid and urea mixes. The fluids had either the same rate, half rate or no micronutrients compared to the granular. Another fluid fertiliser which had higher rates of all nutrients and 2 DAP fertiliser treatments were also included in the trial. One of these DAP treatments received 2 foliar micronutrient sprays, one at early-mid tillering and the other at flowering. Table 1 shows the nutrient input of each treatment.

All fertilisers, except foliar micronutrients, were banded with the seed in the case of granular or up to 30 mm below for fluids, at sowing. Krichauff wheat was sown at 55 kg/ha on 11th June.

Whole plants were sampled at late tillering (4 weeks after foliar spray) to measure early dry matter and then tested to determine nutrient uptake. Grain samples were also tested for nutrient content. At the time of writing seed weights had not been measured, so we are unable to report nutrient content of seed.

Table 1: Total nutrients applied in each fertiliser treatment (kg/ha).

Fertiliser Treatment	P	N	Zn	Mn
Phos acid urea 6P 10N 1Zn 2.4Mn	6	10	1	2.4
Phos acid urea 6P 10N 0.5Zn 1.2Mn	6	10	0.5	1.2
Phos acid urea 6P 12N	6	10		
13:15 Mn6% + Urea Zn5% granular	6	10	1	2.4
Phos acid urea 15P 20N 2Zn 3Mn	15	20	2	3
DAP granular with 2 foliar TE's	10	9	0.44	1.3
DAP granular (control)	10	9		

What happened?

The high input treatment (15P as phosphoric acid) produced the greatest dry weight (*Table* 2), which was approximately 20% more than the dry weight from 6P (as phosphoric acid) and urea with micronutrients in solution. With phosphoric acid at 6P, adding micronutrients at either rate increased dry weight by 30% compared to when no micronutrients were added. There were no differences in dry shoot weight between any granular treatments regardless of the higher P rate in DAP treatments or whether micronutrients were added. These produced the same dry weight as phosphoric acid with no micronutrients.

There were no differences in phosphorus concentration in shoots between any treatments but there were differences in plant tissue concentrations of zinc and manganese. Foliar sprays on DAP produced the highest concentrations of both zinc and manganese. However it is possible some micronutrient remained on the leaf following foliar application. Manganese concentrations were adequate and zinc concentrations were low but still adequate. Phosphorus concentration was also low (2.2 g/kg), adequate concentrations would be 3-6 g/kg indicating that P availability was probably having the biggest impact on growth.

Grain yield was highly correlated with early growth so that increased early growth resulted in higher yield. Treatments that produced similar early growth also produced similar yields. All treatments had the same protein, 11.4%. Grain concentrations of Zn and Mn appeared to be inversely related to yield, indicating dilution. However late foliar micronutrients in the DAP + foliar TE's did increase zinc concentration from 18-19 to 26 mg Zn/kg and manganese from 45 to 48 mg Mn/kg.

Table 2: Dry weight of shoots, phosphorus uptake and micronutrient concentrations of wheat sampled at late tillering.

Treatment Description	Dry weight		P uptake		Zn Conc.		Mn Conc.	
	g/plant		ug/plant		mg/kg		mg/kg	
Phos acid urea 15P 20N 2Zn 3Mn	1.09	a...	2108	a..	21.4	.b	56.2	...d
Phos acid urea 6P 10N 1Zn 2.4Mn	0.92	.b..	1763	.b.	19.8	.b	57.0	..cd
Phos acid urea 6P 10N 0.5Zn 1.2Mn	0.86	.b..	1741	.b.	20.4	.b	58.0	.bcd
Phos acid urea 6P 12N	0.67	..c.	1399	..c	20.8	.b	59.5	.bcd
DAP granular with 2 foliar TE's	0.66	..c.	1515	.bc	26.8	a.	65.1	a...
13:15 Mn6% + Urea Zn5% granular	0.64	..c.	1524	.bc	24.5	a.	61.1	.b..
DAP granular	0.56	..c.	1242	..c	20.6	.b	60.0	.bc.

Note: Values in each column followed by the same letter are not statistically different (P=0.05)

Table 3: Yield, grain P uptake and marginal return of multinutrient fertiliser combinations at Miltaburra, 2003.

Treatment Description	Yield		P uptake		Marginal Return
	t/ha		kg/ha		$/ha
Phos acid urea 15P 20N 2Zn 3Mn	1.56	a..	3.40	a...	3.62
Phos acid urea 6P 10N 1Zn 2.4Mn	1.43	.b.	3.15	.b..	20.92
Phos acid urea 6P 10N 0.5Zn 1.2Mn	1.41	.b.	3.00	.bc.	25.32
Phos acid urea 6P 12N	1.25	..c	2.78	..cd	0.93
DAP granular with 2 foliar TE's	1.24	..c	2.86	..c.	7.02*
DAP granular (control)	1.19	..c	2.62	...d	0
13:15 Mn6% + Urea Zn5% granular	1.17	..c	2.60	...d	-11.74

** It is unlikely that the second foliar spray would have contributed to yield; therefore the cost of this spray has not been included. If "supercharging" is required to increase seed micronutrient content, $7.20/ha needs to be deducted from the marginal return.*

Note: Values in each column followed by the same letter are not statistically different (P=0.05)

What does this mean?

The addition of micronutrients to fluid NP fertiliser was beneficial to early growth and increased grain yield compared to fluid NP without micronutrients. This shows that comparisons with P alone or even P and N can easily give a false result if other nutrients are limiting. We are unable to determine whether micronutrient coated granular fertiliser was a benefit compared to non coated because the DAP was applied at a higher rate of P. This is because the geniuses that designed the trial applied DAP at district practice rates rather than equal P.

Foliar micronutrients on DAP did not increase early growth or yield compared to DAP only, despite increasing zinc and manganese concentrations in plant tissue. This indicates that the crop under these treatments was not limited by zinc or manganese but more likely P.

Table 3 shows the marginal return of each treatment compared to district practice. The most economic treatment was phosphoric acid and urea (6P + 10N) with low rates of micronutrients. Even though this treatment has low P input, it still exceeded P removal in the grain by 3 kg/ha. The high input treatment with 15 P had the same economic result as district practice but had increased yield. In time if fluid P becomes cheaper, this amount of P may have an economic benefit as well as building fertility with higher P input.

Micronutrient coated granular fertilisers did not increase yield and had a negative marginal return because of their increased cost.

Given that the concentrations of manganese in early plant tissue and grain appear to be adequate, it is questionable whether manganese needs to be applied at this site at these production levels.

Seed nutrient content still needs to be assessed prior to seed being sown in 2004 to determine if fluid fertilisers can be used to improve the quality of grain used for seed.

Acknowledgements

Thanks to the Mudge family for allowing access to their property for trial work. This work is part of the GRDC funded project CSO-321; Fluid fertilisers the next step toward raising yield potentials.

GRDC Grains Research & Development Corporation

Which fertiliser Nitrogen strategy is the best for cereals?

Research

Nigel Wilhelm[1] and Brenton Growden[2]

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

Almost ready

Location
Closest town: Mangalo
Cooperator: Paul Briese
Group: Crossville Ag Bureau

Rainfall
Av. Annual total: 340 mm
Av. Growing season: 248 mm
Actual annual total: 349 mm
Actual growing season: 273 mm

Yield
Potential: 3.3 t/ha (W) 3.7 t/ha (B)
Actual: 1.9 t/ha (W) 3.5 t/ha (B)

Paddock History
2002: Wheat

Soil
Low hills with medium textured red soils
Major soil type description: red loam over red clay

Diseases
Yellow leaf spot early in wheat; some B toxicity, Arno Bay blotch in barley

Plot size
6 rows x 25 m

Other factors
Similar to many other districts, wheat performed poorly relative to barley.

Nutrition

Key Messages

- **None of the N treatments increased yield of wheat or barley in a paddock with high soil N reserves.**
- **Increases in grain protein from extra N were not sufficiently large to be economic.**
- **Wheat performed very poorly relative to barley.**

Why do the trial?

This trial was conducted to compare the effects of different N fertiliser options on grain yield and quality of wheat and barley.

It is part of a wider programme assessing the effectiveness of alternative N fertiliser strategies for improving cereal grain quality. It is also a response to the needs of farmers in the Cleve hills who are having a lot of trouble delivering high protein wheat to the silo and who are keen to know if they can change their N fertiliser management to solve this problem. Given that applying foliar N, especially as urea ammonium nitrate (UAN), has also become popular over the last few years, they were also keen to see this technique compared against alternatives under the same conditions. Barley was also included in this trial following reports that foliar applications of N had reduced head loss in barley in 2002.

See FS2002, p 107 for a summary of similar information from 2002.

How was it done?

The trial was seeded on 3rd June with Yitpi wheat at 85 kg/ha or Sloop barley at 65 kg/ha. All plots were seeded with 75 kg/ha of 18:20 as a base fertiliser and received a foliar spray of Mn, Cu, Zn mid season (*except for the two treatments listed in Table 1*). Broadcast N treatments at tillering were applied on 11 July immediately prior to 8 mm of rain, but foliar N treatments were not applied until 15 August (first appropriate opportunity to apply foliar N under calm, cool and moist conditions without getting bogged). Second node stage treatments were applied on the 5 (foliar) and 8 September (broadcast).

Treatments – see Table 1. Note: the NZ strategy is a simulation of the approach used in high production areas of NZ where N is withheld from the crop until after tillering and then large rates are applied for the rest of the season. They claim that this approach avoids lots of straw and results in very high yields (10+ t/ha).

Measurements – grain yield, protein and screenings for wheat and barley.

What happened?

Despite placing the trial in a district which struggles to produce high grain proteins (suggesting widespread N deficiencies during the season) and on a wheat stubble in a good season, extra N did not increase yields of wheat or barley (*see Table 1*). A soil analysis taken prior to seeding showed that 100 kg mineral N/ha was present in the root zone, which together with the 15 kg N/ha which all treatments received, must have been sufficient for maximum yields. For wheat, which did not perform well and yielded barely one half of barley, these N reserves appeared to be ample because grain protein with no extra N was 12.3%. For barley, grain protein without extra N was only 7%, which would normally indicate an inadequate N supply but high rates of N did not increase yields.

Grain proteins were lowest in the "no extra N" controls for both cereals and for barley. All N treatments except stream bar application of UAN at tillering increased grain proteins in barley but all the other treatments produced similar increases of about 1%. In wheat, all treatments with extra N increased grain proteins by 0.7-2.3% but no clear trends were present which could identify whether any particular N source or application technique was more effective.

Screenings for both cereals were low in all treatments. Any effects of individual N treatments were small and inconsistent.

Table 1: Fertiliser treatments and performance of wheat and barley at Mangalo in 2003. N rates are in kg N/ha. Screenings for wheat were < 2.0 mm, for barley < 2.5 mm. Note that our lab technique may not produce exactly the same screenings as the silo.

Variety	Seeding N		Tillering N		Second node N		Flowering N			Grain yield (kg/ha)	Protein (%)	Screenings (%)
	Form	Rate	Form	Rate	Form	Rate	Form	Rate				
Yitpi	NP fert	15	-	-	-	-	-	-	No extra N control for wheat	1.87	12.3	1.3
Yitpi	NP fert+urea	60	-	-	-	-	-	-	Seeding N	1.84	13.4	0.7
Yitpi	NP fert+urea	44	Broadcast urea	16	-	-	-	-	"Standard" split application	1.83	14.1	0.9
Yitpi	NP fert+urea	44	Broadcast urea	16	-	-	Broadcast urea	16	Does late N work ?	1.81	13.5	0.8
Yitpi	NP fert+urea	44	Broadcast urea	16	-	-	Foliar urea	16		1.72	14.5	0.9
Yitpi	NP fert	15	Broadcast urea	16	Broadcast urea	16	Broadcast urea	13	NZ strategy	1.86	13.0	0.9
Yitpi	NP fert	15	Foliar urea	16	Foliar urea	16	Foliar urea	13		1.94	13.6	1.1
Yitpi	NP fert	15	Foliar UAN	16	Foliar UAN	16	Foliar UAN	13		2.04	14.6	1.1
Yitpi	NP fert	15	Foliar urea	16	-	-	-	-	Are some N sources or application techniques more effective ?	1.92	13.3	1.3
Yitpi	NP fert	15	Streambar urea	16	-	-	-	-		1.87	13.0	1.5
Yitpi	NP fert	15	Foliar UAN	16	-	-	-	-		1.99	13.5	1.1
Yitpi	NP fert	15	Broadcast urea	16	-	-	-	-		1.89	12.7	1.2
Yitpi	NP fert	15	Streambar UAN	16	-	-	-	-		1.75	13.2	1.1
Sloop	NP fert	15	-	-	-	-	-	-	No extra N control for barley	3.54	7.0	4.5
Sloop	NP fert+urea	60	-	-	-	-	-	-	Seeding N	3.64	7.7	5.7
Sloop	NP fert	15	Broadcast urea	16	Broadcast urea	16	Broadcast urea	13	NZ strategy	3.65	8.6	6.8
Sloop	NP fert	44	Broadcast urea	16	-	-	-	-	No trace elements at tillering	3.62	8.7	7.9
Sloop	NP fert	44	Foliar urea	16	-	-	-	-		3.57	8.3	7.6
Sloop	NP fert	44	Broadcast urea	16	-	-	-	-	Are some N sources or application techniques more effective ?	3.51	8.3	7.7
Sloop	NP fert	44	Foliar urea	16	-	-	-	-		3.55	7.9	6.9
Sloop	NP fert	44	Foliar AN	16	-	-	-	-		3.61	8.5	8.6
Sloop	NP fert	15	Foliar UAN	16	-	-	-	-		3.62	8.1	8.1
Sloop	NP fert	15	Streambar UAN	16	-	-	-	-		3.44	7.3	5.0
									Wheat LSD (P=0.05)	*149*	*0.7*	*0.4*
									Barley	*ns*	*0.7*	*1.5*

What does this mean?

In the absence of a yield response to extra N, it is not possible to determine whether there had been any merit in the "NZ strategy" under local conditions.

Although few reliable trends could be discerned in this trial the pattern of the results were consistent with a lot of recent research on the effectiveness of N application techniques. These trials tended to show that all N sources (eg. urea, urea ammonium nitrate, ammonium nitrate) are equally effective at supplying N to cereal crops in most situations, that for in-crop N applications broadcasting granular urea is usually as good as anything. N applied at flowering can boost grain proteins but the increases are rarely profitable. Seeding N continues to be a reliable, convenient and cost-effective technique for applying extra N to a cereal crop. Stream bar applications of fluid N did not show the promise here that it has in other areas.

Although extra N treatments produced increases in grain protein (but no yield increases), none of these increases would have been financially attractive. For example, the cheapest N treatments used urea at 16 kg N/ha (costing approximately $20/ha) but the largest increase in grain protein which these treatments produced was 1.8% in wheat (which would be worth about $15/ha).

Acknowledgements

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SARDI

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Manipulating Grain Yield with Strategic Nitrogen Applications

Jon Hancock
SARDI, Minnipa Agricultural Centre

Research

Location
Closest town: Wharminda
Cooperator: John Masters
Group: Wharminda

Rainfall
Av. Annual total: 274 mm
Av. Growing season: 204 mm
2003 total: 291 mm
2003 growing season: 236 mm

Yield
Potential: 2.8 t/ha
Actual: 1.4 t/ha

Paddock History
2002: Grass Free Pasture
2001: Excalibur Wheat
2000: Grass Free Pasture

Soil
Land System: Sand over Clay

Plot size
1.5 x 18m

Other factors
Bad drift in some patches caused severe crop damage early in the season.

Location
Closest town: Wirrulla
Cooperator: L, M, C & D Mudge
Group: Wirrulla

Rainfall
Av. Annual total: 305 mm
Av. Growing season: 235 mm
2003 total: 319 mm
2003 growing season: 214 mm

Yield
Potential: 2.3 t/ha
Actual: 15 t/ha

Paddock History
2002: Pasture
2001:
2000:

Soil
Grey calcareous sandy loam

Plot size
1.5 x 13m

Key Messages

- **Grain yield and protein improved at Wharminda with applications of nitrogen fertiliser regardless of whether the nutrients were applied to 40 cm or not.**
- **At Wharminda, applying nutrients to the subsoil with the MAC deep ripper increased yield, however the response was uneconomic.**
- **In-crop nitrogen, applied at Wharminda under ideal weather conditions increased grain yield, however the high cost of some products limited profitability.**
- **At Miltaburra, applications of nitrogen in-crop did not benefit grain yield.**
- **All sources of nitrogen appeared to be equally effective but timing of the application was important.**

Why do the trial?

Two trials were set up to assess the benefits of late (N) applications to wheat crops grown on grey calcareous soils at Miltaburra and sand over clay duplex soils at Wharminda and compare the effectiveness of different nitrogen (N) products and methods of application.

In past seasons at Miltaburra, the application of 15kg N/ha has lifted grain yields considerably when applied with reasonable rates of fluid phosphorus fertiliser (15 kg P/ha). Through better matching plant demand for N with supply by applying the N in-crop, plants can potentially utilise N more efficiently.

In previous trials at Wharminda, in-crop applications of broadcast urea have led to increased wheat yields and grain protein levels in situations where other nutrient limitations were removed through deep ripping the site and applying fluid fertiliser brews containing phosphorus, sulphur, zinc, copper and manganese to the top 40cm of soil. In these situations, plant performance was limited by N and so the addition of urea had positive economic benefits.

Many N fertiliser products are available and vary considerably in their cost per unit of N. Their efficiency of uptake in plants can also vary between products and environmental conditions. Thus there is a need to assess different N products when applied in different ways and assess their performance when applied in "standard" and modified farming systems.

How was it done?

Miltaburra

The trial was sown to wheat (cv Frame) on the 12th of June with 15 kg P/ha of fluid phosphorus (as phosphoric acid) and a trace element mix containing 1.5 Zn, 1 Cu & 3.2 kg/ha Mn. Those plots to receive N fertiliser in-crop received half of their N at sowing (7.5 kg N/ha) as granular urea, which was deep banded beneath the seed. The remaining 7.5 kg N/ha was applied at tillering as either urea, urea ammonium nitrate (UAN) or ammonium sulphate (AS). These were either broadcast in granular form or applied as a fluid through stream bars or boom spray nozzles.

Wharminda

A nutrient blend containing 20kg P, 2kg Zn, 2kg Cu and 3kg/ha Mn was applied throughout the top 40cm of soil to half of the plots in the trial with the MAC deep ripper on the 8th of May (*refer to EPFS 2002 Summary, pg 123 for MAC deep ripper description*). The trial was sown to wheat (cv Frame) on the 6th of July with 60 kg/ha of triple super. In-crop N fertiliser treatments were applied in the same way as Miltaburra, except that twice the rate of N was used and in-crop N applications were also applied at anthesis.

Soil samples were taken for N prior to sowing, at tillering, anthesis and maturity. Plant samples were collected from both trials at tillering, anthesis and maturity for dry matter. Plots were harvested at maturity and grain samples were retained for grain protein and screenings.

What happened?

Miltaburra

Soil tests revealed that 56 kg mineral N/ha was present in the top 60 cm of soil at sowing. The addition of fertiliser N did not benefit grain yield, which averaged 1.50 t/ha. However, the application of N in-crop resulted in a small increase (0.3% over sowing or no application) to grain protein levels but there was no difference between methods of application. 13.1mm of rain fell during the two days following application which would have been sufficient to move the N into the soil profile. Grain screenings were unaffected by any treatment, averaging 1.3%. On average, 28.9 kg N/ha was removed in the grain (average yield of 1.50 t/ha and average protein of 11%).

Nutrition

Table 1: The Influence of N on Grain Yield, Protein and Gross Margin at Wharminda.

TREATMENT (kg N/ha)	GRAIN YIELD (t/ha)	PROTEIN (%)	GROSS MARGIN ($/ha)
No N Applied	1.15	8.7	54
15 at sowing	1.25	8.7	59
30 at sowing	1.36	9.4	74
15 at sowing + 15 as UAN at tillering	1.35	9.4	52
15 at sowing + 15 as AS at tillering	1.56	9.2	69
15 at sowing + as urea at tillering	1.54	9.1	99
15 at sowing + as UAN at anthesis	1.30	9.2	43
15 at sowing + 15 as AS at anthesis	1.40	9.1	39
15 at sowing + 15 as urea at anthesis	1.31	8.9	59

Wharminda

At sowing, 101 kg mineral N/ha was present in the top 75 cm of soil. Grain yield was increased through placing nutrients to 40 cm but only when N was also part of this nutrient mix. Overall, deep placement of nutrients to 40 cm increased yield from 1.29 to 1.48 t/ha. The addition of N increased grain yield and protein in all treatments. The tillering applications of N which were followed by 17 mm of rainfall from 2 to 5 days after application resulted in the greatest yield advantage (*Table 1*). The anthesis applications of N did not markedly improve grain yield and were no better than when all of the N was applied at sowing. Rain didn't fall for a fortnight after the anthesis applications of N and consequently they were of little benefit to the crop. Grain protein was reduced from 9.4% to 8.8% where nutrients were applied to 40 cm, probably due to dilution in the higher yield but was increased with N applications. Grain screenings levels were low (2.7%) and were unaffected by any treatment. On average, 22.1 kg N/ha was removed in the grain (average yield of 1.39 t/ha and average protein of 9.1%).

When half of the N was applied as urea at tillering, the economic return was better than if all of the N was applied at sowing but none of the other treatments were better than applying all of the N at sowing.

Is it worth mentioning that the soil N levels at seeding are extremely low. Also that grain proteins at Wharminda suggest that N deficiency was not fully corrected in any treatment, so higher rates may have given even better yields

What does this mean?

Miltaburra

The application of N did not result in any worthwhile benefits to wheat production when applied with reasonable levels of phosphorus and trace elements. The site had a reasonable level of N available at sowing which was able to fulfil crop requirements without the need for any further N applications.

Wharminda

In this environment, the addition of 30 kg N/ha increased grain yield when deep banded at sowing or applied at tillering, however the application of urea at tillering was the only economically viable option. Whilst the addition of ammonium sulphate and urea ammonium nitrate also resulted in improved grain yield, the higher cost of N in these forms meant that their economic return was no better than when N was applied as urea at sowing. The lack of response to the anthesis N applications is largely explained by the reasonable amounts of nitrogen available in the soil and the lack of rainfall after application, which would have been conducive to loss of N through volatilisation. Generally, 10 mm of rainfall is required during the 2 days following application to move the N into the soil where it is not subject to volatilisation and available for plants to use 10 mm seems pretty high, especially on sand. Consequently, none of the anthesis applications were economically favourable. Deep banding of urea at sowing is one of the more simple and effective options of getting N into plants but additional N applied as urea during the growing season can give further improvements to yield and increase overall profitability. In this trial, similar responses were achieved when the in-crop N was broadcast, sprayed or applied in streams, however at higher rates of N, leaf burn with spray applications could be an issue.

Acknowledgements

I would like to thank Leon, Marilyn, Darren and Carolyn Mudge and John Masters for the provision of trial sites. I would also like to thank Annie McNeill, Glenn McDonald and Bob Holloway for supervision and advice throughout the year and Willie Shoobridge and staff of MAC who gave assistance throughout the year.

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SAGIT

GRDC Grains Research & Development Corporation

Granular Nitrogen on Barley - tops again!

Research

Neil Cordon and Brendan Frischke

SARDI, Minnipa Agricultural Centre

Key Messages

- **Granular nitrogen sources again prove to be the best bet for economic yield responses.**
- **Foliar sources of nitrogen give unreliable yield responses unless they are applied at similar rates of nitrogen as granular sources.**

Why do the trials?

The replicated trials were part of a project to investigate new techniques of injecting fertilisers into the soil. A secondary objective has been to evaluate various foliar nitrogen application techniques, which were compared to applying granular urea.

How was it done?

Mt Cooper – Sloop barley @ 60 kg/ha sown on 27th May.

Tooligie Hill – Barque barley @ 60 kg/ha sown on 16th June.

Base Fertiliser: 70 kg/ha of 18:20:0

Measurements: Grain yield, quality and gross income.

What happened?

At both sites there were no differences between the control and either foliar applied urea or UAN nitrogen. At Mt Cooper granular urea applied at seeding had the highest gross income and was higher yielding than all other treatments except the urea applied at late tillering. At both sites there was no difference between applying urea through stream bars (SB) or broadcasting (BC). At Tooligie Hill all the treatments that applied 24 kg N/ha were different to the control and foliar applied nitrogen. Those treatments also made the most income.

The late tillering applications were applied immediately after a rain event whilst that applied at 2nd node was immediately prior to rain.

What does this mean?

The data in these trials show that foliar nitrogen is not a more efficient technique of getting nitrogen into the plant, and economically can be a waste of money compared to doing nothing. Nitrogen strategies and management must be flexible to account for various environments, soil types, rotations, crop species and machinery. The best bet nitrogen strategy is still granular urea drilled at seeding or strategic use during the tillering phase of crop growth.

The full trial treatments and site details are reported in article "High Pressure Nitrogen injection – the first test!"

Nutrition

Table 1: Grain yield, protein and income for nitrogen treatments at Mt Cooper and Tooligie Hill 2003.

Treatment	Mt Cooper			Tooligie Hill		
	Protein %	Yield t/ha	Gross Income * $/ha	Protein %	Yield t/ha	Gross Income * $/ha
Band Urea @ Sowing 24 kg N/ha	9.2	3.94	711	9.1	2.50	376
B.C Urea @ late tillering 24 kg N/ha	9.2	3.80	681	8.6	2.51	374
B.C Urea @ 2nd node 24 kg N/ha	9.4	3.74	669	9.4	2.47	361
S.B Urea @ late tillering 24 kg N/ha	8.7	3.74	568	8.6	2.49	370
S.B Urea @ 2nd node 24 kg N/ha	9.4	3.69	662	8.8	2.51	370
Foliar Urea @ late tillering 6 kg N/ha	9.0	3.57	635	8.5	2.18	324
Foliar UAN @ late tillering6 kg N/ha	8.7	3.55	538	8.5	2.17	320
Control	8.6	3.56	564	8.3	2.10	333
LSD, P = 0.05	-	*0.17*	-	-	*0.28*	-

Note: Gross income is yield x price (with quality adjustments) less on farm treatment cost delivered Port Lincoln as at 1st December 2003.

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Best practice

Location
Cleve
Laryn Harris & family
Crossville Ag Bureau

Rainfall
Av Annual: 360mm
Av G.S.R: 250mm
2003 Total: 408mm
2003 G.S.R: 310mm

Yield Potential (B) 4.4 t/ha

Paddock History
2002: Barley
2001: Wheat
2000: Wheat

Soil Type
Red sandy loam

Location
Minnipa Agricultural Centre

Rainfall
Av Annual: 325mm
Av G.S.R.: 242mm
2003 Total: 263mm
2003 G.S.R: 204mm

Yield Potential: (B) 2.3 t/ha

Paddock History
2002: Wheat
2001: Vetch
2000: Wheat

Soil Type
Reddish brown sandy loam

Other Factors
Dry conditions in September, delayed sowing

Foliar Nitrogen Demo's - did it work?

Neil Cordon
SARDI, Minnipa Agricultural Centre

Key Messages

- **Little evidence to support claims that foliar UAN is more efficient than granular sources of nitrogen.**
- **Farmers should be careful in relying on foliar sources of nitrogen for yield unless they are applying similar rates of nitrogen per hectare to urea, and using rainfall to wash it in thus reducing the risk of losses.**
- **Granular urea in most situations applied early is the best-bet nitrogen strategy.**
- **Nitrogen strategies need to be individually tailored for each system, rotation and environment.**
- **Replicated trial work supports these findings and can be found in other articles in this section.**

Why do the trial?

The aim of the work was to compare a range of in-crop nutrition treatments with particular emphasis on the economics of foliar nitrogen versus granular nitrogen at tillering crop stage. The trials were assessed for grain yield, quality and gross income.

MID SEASON NUTRIENT APPLICATIONS AT CLEVE - HARRIS

How was it done?

The paddock was sown to Barque barley at 55 kg/ha on the 25th May, using a base fertiliser of 18:20:0 at 75 kg/ha (14 kg N/ka and 15 kg P/ha). On the 20th July, with the crop actively growing at the mid tillering stage, single demonstration strips of nutrition treatments were either foliar sprayed or broadcast. The granular urea was broadcast in misty rain, whilst the boom spraying was conducted late in the evening.

Soil Test: (0 – 10cm) Ext. Phosphorus 60 mg/kg, Organic Carbon 1.2 %. Profile mineral nitrogen (0 – 50cm) is 57 kg N/ha.

What happened?

Seasonal conditions were excellent for crop growth with growing season rainfall well above average. Grain proteins were low and yields only reached 65% of the potential. The highest yield and gross return was achieved with the tillering application of granular nitrogen. There was little difference in gross incomes between other treatments.

What does this mean?

The low protein concentrations indicate nitrogen was still limiting production, with yield increases could be possible with additional nitrogen. In a season like 2003, if a farmer crops 2000 ha and top dressed with granular urea, they would make an extra $114,000 profit over using foliar UAN. The multiple foliar trace elements are low cost and risk, and in combination can produce good returns over doing nothing.

Table 1: Grain yield and quality measurements of nutrition demo at Cleve, 2003.

Treatment	Protein (%)	Screenings (%)	Test Weight (kg/hL)	Treatment Cost ($/ha)	Yield (t/ha)	Gross * Income ($/ha)
Control	7.3	3.7	63.2	-	2.26	358
Urea @ 23 kg N/ha	8.5	3.6	64.6	19.10	2.75	413
UAN @ 5 kg N/ha	7.4	5.1	62.8	13.05	2.36	356
Cu	7.1	3.7	62.8	0.60	2.17	338
Zn + Mn	7.4	3.9	62.2	2.82	2.22	344
Cu + Zn + Mn	7.1	3.3	62.8	3.42	2.36	366

N.B. Trace elements applied at 35 gm Cu/ha, 160 gm Zn/ha and 255 gm Mn/ha.
** Gross income is yield x price less treatment costs delivered to Port Lincoln as at 1st December 2003.*

Table 2: Grain yield, quality and income of foliar nitrogen at Minnipa 2003.

Treatment	Protein %	Test Weight kg/h L	Screenings %	Treatment Cost $/ha	Yield T/ha	Gross * Income $/ha
UAN	15.8	68	1.9	27.19	1.06	144
UREA	16.1	68	1.6	8.30	1.08	158
Control	14.5	68	1.4	-	1.22	193

** Gross income is yield x price less on farm treatment costs delivered Port Lincoln as at 1st December 2003.*

Acknowledgements

The Harris family for conducting the trial in a professional way and assisting at harvest.

FOLIAR UAN vs FOLIAR UREA AT MINNIPA

How was it done?

A paddock of Sloop barley, sown at 45 kg/ha on the 8th June using a base fertiliser of 18:20:0 at 60 kg/ha, suddenly showed symptoms of nitrogen deficiency in late August.

With the crop at late tillering growth stage (2nd September) single demonstration strips of foliar urea and urea ammonium nitrate (UAN) were sprayed out with a 75L/ha water rate.

Weather was ideal for foliar spraying nitrogen, ie overcast conditions at 16°C.

Nitrogen was applied @ 10 kg N/ha.

What happened?

Well below average rain during the season, coupled with hot dry weather in September, limited production potential and crop growth struggled.

There was no visual difference between the treatments, and at harvest the control had the highest yield and gross income (*Table 2*).

What does this mean?

A suggestion that foliar applied nitrogen is a more efficient technique of improving yields is not supported by this demo even though the conditions for leaf uptake were ideal. The similar protein levels for UAN and urea is some evidence that both are equally effective at the same rates of N.

Acknowledgements

Mark Bennie, Brett McEvoy and Kym McEvoy for doing the demo.

FOLIAR UAN vs GRANULAR UREA AT ARNO BAY – D. SIVIOUR

How was it done?

A paddock of Sloop barley was sown at 50 kg/ha on the 27th May using a base fertiliser of 18:20:0 at 40 kg/ha. With the crop at mid tillering growth stage (mid August) single demonstration strips of foliar urea ammonium nitrate (UAN) was sprayed out with 50 L/ha water rate applying 5 kg N/ha. This was compared to granular urea broadcast at 28 kg N/ha.

Weather was ideal for broadcasting urea as 4 mm of rain fell immediately post application and UAN was applied in the evening in overcast conditions.

What happened?

The barley was sown in excellent soil moisture with rainfall well above average through to September. The good conditions produced massive growth however tillers were shed during the dry September resulting in yield reductions. Visually the granular urea strip was a better colour, however the foliar UAN was not visually different to the control. The granular urea had the best yield but was $2/ha lower in gross income that the control (*Table 3*).

What does this mean?

Foliar UAN is not more efficient than granular urea.

Acknowledgements

Dean Siviour for conducting the trial and Kym Villis for assisting in harvest.

Best practice

Location
Arno Bay - Arno Bay Ag Bureau

Rainfall
Av Rainfall: 325 mm
Av GSR: 225 mm
2003 Total: 377 mm
2003 GSR: 308 mm

Yield Potential: (B) 4.4 t/ha

Paddock History
2002: Barley
2001: Wheat
2000: Wheat

Soil Type
Clay loam

Location
Arno Bay
Arno Bay Ag Bureau

Rainfall
Av Annual: 325 mm
Av G.S.R: 225 mm
2003 Total: 377 mm
2003 G.S.R: 308 mm

Yield Potential: (B) 4.4 t/ha

Paddock History
2002: Wheat
2001: Wheat
2000: Peas

Soil Type
Heavy clay to deep sand over clay

FOLIAR UAN vs PRE-DRILLED UREA AT ARNO BAY – A. SIVIOUR

How was it done?

A paddock was sown to Barque barley at 60 kg/ha on the 28th June using a base fertiliser of 18:20:0 at 40 kg/ha. Single demonstration strips of urea were pre-drilled at 23 kg N/ha, with some having no urea applied. Foliar UAN was applied at 5 kg N/ha on the 1st August at mid tillering to get a comparison of various nitrogen strategies.

What happened?

The trial was sown into wet soil, one month after the optimum sowing date. Rhizoctonia and a dry September also affected yields.

There was little difference between treatments for test weight, grain protein and screenings. This data shows foliar UAN had the highest gross income.

Table 3: Grain yield, quality and income of nitrogen demo at D Siviours 2003.

Treatment	Protein %	Test Weight Kg/h L	Screenings %	Yield T/ha	Gross Income * $/ha
Control	9.7	69.4	3.1	2.6	492
Urea	9.1	69.6	2.9	2.8	490
UAN	10.4	69.3	2.8	2.6	480

** Gross income is yield x price (with quality adjustments) less on farm treatment costs delivered Port Lincoln as at 1st December 2003.*

Table 4: Grain yield and income of nitrogen demo at A Siviours 2003.

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Urea	9.1	69.6	2.9	2.8	490
UAN	10.4	69.3	2.8	2.6	480

** Gross income is yield x price less on farm treatment costs delivered Port Lincoln as at 1st December 2003.*

What does this mean?

This demonstration is one of the few on EP during 2003 that has indicated UAN is more efficient than granular urea, although there was no direct comparison of urea application on crop tillering. There is a possibility that the pre-drilled urea was leached during the above average winter rains.

Acknowledgements

Alan Siviour for conducting the trial and Kym Villis (Landmark) for assisting in harvesting.

Rainfall
Av Annual: 323 mm
Av G.S.R: 244 mm
2003 total: 285 mm
2003 G.S.R: 238 mm

Yield
Potential: (B) 2.96 t/ha

Paddock History
2002: Wheat
2001: Pasture

Soil Type
White sandy rises, reddish brown loamy flats

Diseases
Rhizoctonia

Other Factors
Delay sowing, dry spring

Minnipa Research Foundation Nutrition Field Day Site

- how did things turn out?

Demo

Neil Cordon
SARDI, Minnipa Agricultural Centre

Why do the site?

The Minnipa Research Foundation organise an annual, issue specific Field Day as a reward for members.

For the first such day in 2002 the focus was on herbicides and for the second event in 2003 the focus was on nutrition. These field days consist of a combination of field plot demonstrations, workshops, guest speakers and working demonstrations. This article presents the results from the broad scale field demonstrations section established at the 2003 Nutrition Field Day site. In order to show responses to different nutritional strategies, the field day site was chosen on the property of Jim Endean, rather than the MAC. This site was chosen due to its close proximity to MAC and variation in soil types, ranging from heavy red loam rising up to deep sand over clay soil (*Tables 1 & 2*).

How was it done?

The site was used to demonstrate four basic nutrition principles; subsoil management strategies, fluid fertilisers, trace elements and nitrogen management. The site was sown to Sloop barley at 60 kg/ha on the 23rd June with no-till into wheat stubble. Individual treatment details are outlined Tables 3-6.

Measurements: grain yield and quality, tissue analysis, soil nutrient levels and soil moisture levels.

What happened?

The demonstration site was sown in moist soil and grew vigorously through to mid September. Hot dry conditions in September and October severely affected the barley with the more vigorous treatments suffering most; all treatments suffered on the red loamy flat. With delayed sowing, dry spring weather and subsoil constraints, yields were limited to 61% of the potential. The sandy soil yielded up to 300% better than the red loamy soil. There was little variation between the soil types for test weight and screenings, however the sand had an average protein of 16% compared to the red flat of 18%.

Demonstration 1: Ripping and Subsoil Nutrition

Aim: to investigate benefits from deep ripping alone or deep ripping with subsoil nutrition.

What happened?

See Table 3.

All treatments received a base fertiliser of 60 kg/ha of DAP applied at seeding with the seed. Shallow fluid treatment was placed 2 cm below the seed @ 150 L/ha water rate. Phosphoric acid, urea and trace elements (sulphates) were mixed into a fluid and placed deep throughout the profile to 40 cm @ 760 L/ha water rate. Visually the ripping treatments looked better until September when dry conditions affected crop growth. Due to little variation in crop yields and grain quality the treatment with less costs was the best. Tissue test levels for Mn, Cu, Zn and P and S were similar for all treatments however the control was slightly lower in zinc. No yield measurement was taken from the sand soil due to sheep damage.

Demonstration 2: Fluid Fertiliser

Aim: to compare a range of fluid fertilisers with commercially available granular products.

What happened?

See Table 4.

The DAP Zinc cote 1% with extra urea treatment had the extra

Table 1: Soil profile description of sand soil type at the 2003 MAC Nutrition Field Day site.

Soil Type	Depth (cm)	EC (dS/m)	CO_3 (%)	pH (water)	Boron (mg/kg)	P (mg/kg)	K (mg/kg)	OC%	S (mg/kg)	Moisture @ sowing (mm)
Sand	0-10	0.13	5.2	8.6	1.3	31	295	0.9	5.6	5.7
	10-30	0.13	5.2	8.7	1.4	8	136	0.73	4.6	13.2
	30-50	0.15	8.5	8.8	1.5	7	90	0.58	7.5	12
	50-70	0.18	13.1	8.9	2.1	6	84	0.46	10.0	10
	TOTAL									40.9

Table 2: Soil profile description of red flat soil type at the 2003 MAC Nutrition Field Day site.

Soil Type	Depth (cm)	EC (dS/m)	CO_3 (%)	pH (water)	Boron (mg/kg)	P (mg/kg)	K (mg/kg)	OC%	S (mg/kg)	Moisture @ sowing (mm)
Red flat	0-10	0.24	8.8	8.4	2.1	27	706	1.94	7.4	23.4
	10-30	0.49	15.2	8.5	2.0	10	258	1.45	21	28.6
	30-50	1.49	21.1	8.8	2.2	7	156	0.71	42	29.9
	50-70	1.45	25.6	9.1	8.4	6	186	0.5	165	37.1
	TOTAL									119.0

N applied at tillering. Visually the suspension brew looked better until September when dry conditions affected crop growth.

The granular fertiliser 18:20:0 at 60 kg/ha had one of the highest yields and lowest treatment costs giving the best economic return. There was little variation in grain quality and tissue nutrient levels between treatments.

No yield measurement was taken from the sand soil due to sheep damage.

Demonstration 3: Trace Element Nutrition

Aim: To compare a range of trace element application techniques.

What happened?

See Table 5.

Foliar products (TE) were in the sulphate form and applied on 18th August @ 1.0 kg Zn SO4/ha and 0.2 kg Cu SO4/ha. Seed coat product was BSN-10® at 5.0 L/t, a registered product of R.L.F.

Visually there was little difference between treatments. However, at harvest time the soil applied trace element treatments increased yield on the lower fertility sand but not on the red loam soils. Seed coating had little yield advantage on either soil type. Treatments did not affect grain quality on either soil type.

Table 3: Grain yield from subsoil nutrition treatments at Minnipa 2003.

Treatment	Nutrients Applied (kg/ha) of elemental nutrient					Treatment Cost ($/ha)	Yield t/ha (Red loam)
	N	P	Zn	Mn	Cu		
Ripping to 40cm	11 (DAP)	12 (DAP)	-	-	-	63	1.19
Ripping plus nutrients to 40cm	11 (DAP) 15 (urea)	12 (DAP) 12 (PA)	2	3	1	145	1.01
Ripping plus Nutrients @ 2cm	11 (DAP) 15 (urea)	12 (DAP) 12 (PA)	2	3	1	145	0.98
Nutrients @ 2cm	11 (DAP) 15 (urea)	12 (DAP) 12 (PA)	2	3	1	105	1.10
Control (DAP)	11 (DAP)	12 (DAP)	-	-	-	23	0.99

PA = Phosphoric Acid

Table 4: Grain yield from fluid fertilisers at Minnipa 2003.

Treatment	Nutrients Applied (kg/ha) of elemental nutrient			Treatment Cost ($/ha)	Yield t/ha (Red loam)
	N	P	Zn		
Control (DAP)	11	12	-	23	0.99
APP + Zinc *	4	6	0.4	34	1.03
APP + Zinc *	12	12	0.4	79	0.89
Tech Grade MAP/DAP + Zinc *	4	6	0.4	24	0.83
APP at equivalent cost *	3	5	0.4	32	0.66
Tech Grade MAP/DAP + Zinc *	8	12	0.4	46	0.59
Phos acid at equivalent cost **	8	8	0.4	32	0.61
DAP Zinc cote 1% + urea	26	6	0.3	32	0.63
Fluid Brew **	8	12	0.4	197	0.54
Suspension Brew **	22	12	1.0	Experimental	0.48

Fluid Brew also had 1.5 kg Co/ha and 3.4 kg Mo/ha.
Fluid treatments were placed 2 cm below the seed @ 150 L/ha (*) or 240 L/ha (**) as indicated.
APP – ammonium polyphosphate.

Table 5: Grain yield from trace element treatments at Minnipa 2003.

Treatment	Nutrients Applied kg/ha of elemental nutrient			Treatment Cost ($/ha)	Yield (t/ha)	
	N	P	Trace elements		Sand	Red loam
DAP Control	11	12	-	23	-	0.99
DAP + Foliar TE	11	12	0.22 kg Zn, 0.04 kg Cu (foliar)	31	1.50	0.58
DAP with Streaky Bay seed	11	12	-	23	1.56	0.54
Seed Coat + DAP	11	12	Trace (seed coat)	26	1.57	0.56
Seed Coat + Soil TE + Foliar TE	11	12	3 kg Mn, 1 kg Cu, 2.2 kg Zn (soil) + 0.22 kg Zn, 0.04 kg Cu (foliar) + Trace (seed coat)	57	1.81	0.54
Soil TE	11	12	3 kg Mn, 1 kg Cu, 2.2 kg Zn (soil)	47	1.71	0.55

TE – Trace elements

Demonstration 4: Nitrogen Nutrition

Aim: To compare a range of nitrogen products and application techniques.

What happened?

See Table 6.

Post emergent nitrogen treatments were applied on 24th July (tillering N) or on 11th September (stem elongation). Timing of nitrogen was ideal with rainfall (2.5 to 9 mm) immediately after application and/or overcast weather conditions.

Grain quality was similar across all treatments within each soil type, with the exception where double the screenings were recorded for the treatment that had 57 kg N/ha. On the heavier red soil there was no difference between the treatments so the 60 kg/ha of DAP would have the best return due to a lower input cost. On the sand the highest yield was with 34 kg N/ha from an application of DAP at seeding and granular urea at tillering. It also had the highest gross income of 222 $/ha (Table 6). Granular urea out performed sulphate of ammonia whilst foliar nitrogen spray (UAN) did not perform as well as granular urea.

Table 6: Grain yield and income from nitrogen treatments at Minnipa 2003.

Treatment	Treatments Applied		Treatment Cost ($/ha)	Yield (Sand) (t/ha)	Gross Income Sand ($/ha)	Yield Red loam (t/ha)
	N	P				
DAP + Urea (tillering) + Urea (Stem Elong)	57 (11+23+23)	12	75	1.37	142	0.47
Urea + DAP	34 (23+11)	12	42	1.54	202	0.52
DAP + Urea (tillering)	34 (11+23)	12	46	1.69	222	0.55
DAP	11	12	23	0.94	126	0.60
DAP + UAN (tillering) *	17 (11+6)	12	45	1.11	131	0.71
DAP + UAN (tillering) **	34 (11+23)	12	91	0.98	64	0.73
DAP + Sul of Amm (tillering)	34 (11+23)	12	68	1.02	94	0.68

** UAN (urea ammonium nitrate) applied through a boom on 25th August.*
*** UAN applied with stream bar on 10th August.*
Note: Gross income is yield x price (with quality adjustments) less on farm treatment cost delivered Port Lincoln as at 1st December 2003.

Acknowledgements

A big thank you to Jim Endean for the use of his land for the demonstration plots and field day. Sponsors of the Minnipa Research Foundation Nutrition Field Day - Hifert, Fertisol, Agrichem, Bank SA, Incitec Pivot. Thanks to all the MAC staff for helping in some way, which ensured the nutrition day was a success and the site was well prepared and presented throughout the year.

Searching for answers

Location
Haslam
John Linke

Rainfall
Av Annual: 286mm
Av G.S.R.: 210mm
2003 Total: 282mm
2003 G.S.R.: 210mm

Yield
Potential: (W) 2.0 t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Pasture

Soil Type
Alkaline grey calcareous sand

Disease
Rhizoctonia

Granular P vs Fluid P - a Farmer Demo

Neil Cordon
SARDI, Minnipa Agricultural Centre

Demo

Key Messages

- **If a farmer is considering changing their seeding from granular to fluid fertiliser then it is vital to consider all the trial data across a range of similar soil types, and ensure that yield increases are economic.**
- **Trial small areas on your farm before committing to the expense of changing fertiliser sources.**
- **Ensure that fluid sources of fertiliser have a combination of phosphorus and nitrogen.**
- **Ensure when using any fertiliser the application rate of phosphorus at least matches the crop removal.**

Why do the trial?

This work was conducted to compare the yield responses between granular phosphorus and fluid phosphorus.

How was it done?

The paddock was sown to Excalibur wheat at 50 kg/ha on the 27th June. A single demonstration strip of granular 18:20:0 at 55 kg/ha (10kg N/ha and 11 kg P/ha) was applied at sowing to compare with the paddock fertiliser of phosphoric acid (6 kg P/ha) placed with the seed. The fluid P was applied with a water rate of 60 L/ha.

Measurements: Grain yield, quality and nutrient content.

What happened?

Crops grew well during the year but were limited by late sowing and lack of rain in September, achieving only 60% of potential yield. There was little difference between the treatments (*Table 1*) however due to the cost of the fluid P a higher gross income ($26/ha) was achieved with granular 18:20:0. There was no visual difference between the treatments.

Grain analysis showed the granular fertiliser had a higher nutrient content and concentration of several nutrients (*Table 2*), which suggests the granular seed is preferable to retain for next year, especially on the soil types in the district.

Table 1: Grain yield, quality and gross income for phosphorus source demonstration at Haslam 2003.

Treatment	Test Weight (kg/hL)	Protein (%)	Screenings (%)	Treatment ($/ha)	Yield (T/ha)	Gross * Income ($/ha)
18:20:0	75.2	13.3	1.2	23.21	1.20	204
Phosphoric Acid	76.4	13.1	1.0	32.34	1.10	178

**Gross income is yield x price (with quality adjustments) less on-farm treatment costs delivered Port Lincoln as at 1st December 2003.*

What does this mean?

Research work by Dr. Bob Holloway on this soil type has identified consistent economic yield improvement of fluid sources of P (in combination with nitrogen) over granular sources of P. The comparison of granular 18:20:0 with fluid phosphoric acid is unfair since the granular fertiliser also applied 10 kg N/ha, which we know will often provide yield advantages over fertiliser containing only phosphorus.

Table 2: Seed nutrient content and concentration levels for phosphorus source demonstration at Haslam 2003.

	Seed Concentration (mg/kg)		Seed Content (_g/seed)	
	Fluid P	Granular P	Fluid P	Granular P
Mn	11	46	0.4	1.61
Cu	2.6	5.7	0.09	0.20

This demonstration suggests that the use of the fluid P source of phosphoric acid alone is not suitable for this farming system and environment, and that a fluid source containing nitrogen and phosphorus should be used.

The seed nutrient levels in this trial is interesting, as retaining large plump grain high in nutrient content and concentration is beneficial for next year's crop.

Acknowledgements

John Linke for taking the time to do the demonstration.

Impact of Alternative Fertilisers on Canola at Tuckey in 2003

Neil Cordon

SARDI, Minnipa Agricultural Centre

Demo

Best practice

Location
Tuckey
Jason and Julie Burton
Tuckey Ag Bureau

Rainfall
Av Annual: 324mm
Av G.S.R: 241mm
2003 Total: 297mm
2003 G.S.R: 257mm

Yield
Potential: (C) 2.2 t/ha

Paddock History
2002: Wheat
2001: Wheat
2000: Pasture

Soil Type
Red sandy clay loam

Other Factors
Drying winds, dry September

Key Messages

- **Fertilisers with low levels of nitrogen depress canola yields.**
- **Alternative fertilisers had a negative impact on canola gross returns.**

Why do the trial?

To evaluate the performance of a range of alternative fertilisers through a rotational phase of five years.

Crop nutrition accounts for a third of cropping input costs. There is a keen interest in alternative fertilisers but claims made by companies who market these fertilisers need to be verified.

Previous replicated trial work has rarely shown economic yield benefits from past ranges of alternative fertilisers.

How was it done?

This is the second year of single demonstration strips, which compare a range of alternative nutrition systems to a farm control of 19:13:0 and urea. The site was sown to Surpass 501 canola on the 14th May at 3 kg/ha. Gypsum (2.5 t/ha) was applied over all plots for soil amelioration and provision of sulphur.

Seed coat 4 in 1® is a range of minerals, vitamins, amino acids, chelating agents, carbohydrates, cell-sensitisers, hormones and living micro-organisms coated on to the seed.

NUTRI-BLEND® was applied through the broadcaster pre-seeding, and comprises of nutri-phos colloidal soft rock phosphate, volcanic basalt and organic humates.

Treatments were decided from soil tests taken by the farmer co-operator and Mr Mick Dennis who is an agent for Life-Force programs.

Measurements: Grain yield and quality, plant nutrient levels.

What Happened?

Above average growing season rainfall was compromised by hot drying winds during crop establishment and flowering time. Therefore the yield achieved was only 67% of the

Table 1: Treatment details at Tuckey in 2003.

Treatment No.	Seed Coat BSN 10 ® (L/t)	Seed Coat 4 in 1 ® (L/t)	NUTRI-BLEND ® (kg/ha)	Humates (kg/ha)	Zelolite (kg/ha)	19:13:0 plus Urea (kg/ha)
1	10	-	200	-	-	-
2	-	8	200	8	-	-
3	-	8	200	8	-	70 + 50
4	-	8	200	8	-	40 + 30
5	-	8	-	8	10	40 + 30
6	-	-	-	-	-	70 + 50

Note: BSN – 10 ®. Registered product – R.L.F
Seed Coat 4 in 1® and NUTRI-BLEND®. Registered product – Life Force.

Nutrition

potential. A visual appraisal during mid August when tissue testing, showed less vegetative growth for treatments 1 and 2 than the other treatments. The highest gross return ($522/ha) was the farmer practice of 19:13:0 and urea (*Treatment 6, Table 2*).

The alternative fertilisers without additional nitrogen and phosphorus (*Treatments 1 and 2*) had the lowest yields and did not perform well. This is also indicated by their high oil content, as there is an inverse relationship between oil levels and crop yield.

Nutrient analysis of plant tissues showed that treatments 1 and 2 that had less nitrogen applied were nitrogen deficient (*Table 3*). Other nutrients were adequate at the time of sampling in all treatments with no indication of seed nutrient coats raising plant nutrient levels.

Table 2: Canola yield, oil content and gross income of alternative fertilisers at Tuckey 2003.

Treatment No.	Yield (t/ha)	Oil (%)	Treatment Cost ($/ha)	Gross Income * ($/ha)
1	1.18	44.7	43	435
2	1.14	43.5	73	381
3	1.47	42.9	121	460
4	1.28	41.2	103	389
5	1.27	42.8	65	432
6	1.41	44.5	48	522

**Gross Income is yield x price (with quality adjustments) less on farm treatment cost delivered, Port Lincoln as at 1st December 03.*

What does this mean?

The treatments 3 and 6 had similar nitrogen and phosphorus applied, however treatment 3 had a lower gross return due to the higher costs of the additional inputs. Over 100 ha of canola, treatment 6 would have made an extra $6,200 over other treatments demonstrated. The alternative fertiliser brews used are expensive and do not offer an economic yield advantage over current farmer practices.

This demonstration will continue for a further 3 years, but at this stage traditional nitrogen and phosphorus type products and combinations remain the most suitable products for this environment.

Acknowledgements

Jason Burton and Mick Dennis for their commitment to the demonstration.

Table 3: Pre-flowering petiole nitrogen and Y.O.L nutrients levels in canola tissue at Tuckey 2003.

Treatment No.	Nitrogen (%)	Copper (mg/kg)	Zinc (mg/kg)	Manganese (mg/kg)	Phosphorus (%)	Sulphur (%)
1	2.46	4.7	28	29	0.62	0.95
2	2.61	4.7	27	38	0.57	1.03
3	4.55	5.2	28	40	0.75	0.99
4	4.35	5.5	30	45	0.73	1.08
5	3.43	5.6	34	40	0.78	0.96
6	4.44	5.1	35	37	0.77	0.98
Critical Levels	**2.9**	**4.0**	**25**	**30**	**0.35**	**0.60**

**Gross Income is yield x price (with quality adjustments) less on farm treatment cost delivered, Port Lincoln as at 1st December 03.*

Try yourself

Treating Seed with Micronutrients

Neil Cordon

SARDI, Minnipa Agricultural Centre

Demo

Key Messages

- **Coating seed with nutrients won't do any harm however farmers need to make a judgement on if it's the "best bang for their buck"!**
- **More independent EP research work on microbial or micronutrient seed dressing can be found in the following publications;**

  1998 Crop Harvest Report, page 134.

  1999 EPFS research summary, Page 68.

  2001 EPFS research summary, Page 100.

Why do the trial?

This demo aims to evaluate the economic yield performance of a commercially available seed nutrient coating product. The technique is used extensively by producers for the perceived benefit of improved crop emergence, root growth, crop vigour and hopefully grain yield.

How was it done?

The farmer sowed single demonstration strips of Barque barley seed which was untreated with nutrient product compared to seed which was treated with BSN-10® at 5 L/t.

Date Sown: 25th May 2003.

Sowing Rate: 55 kg/ha

Base fertiliser: 18:20:0 @ 55 kg/ha

Measurements: Grain yield, quality and nutrient levels.

Table 1: Grain yield, quality and gross income for seed treatment on Barque barley at Streaky Bay, 2003.

Treatment	1000 Grain Weight (g)	Protein (%)	Screening (%)	Test Weight (kg/hL)	Yield (t/ha)	Gross * Income ($/ha)
Seed Coat	51.46	10.5	1.8	61.4	3.24	495
Control	50.56	11.5	2.8	61.2	3.15	484

** Gross income is yield x price less treatment costs delivered to Port Lincoln as at 1st December 2003.*

Table 2: Concentrations of selected seed nutrients at Streaky Bay, 2003.

Nutrient	Seed Concentration (mg/kg)		Seed Content (g/seed)	
	Seed Coat	Control	Seed Coat	Control
Mn	12	42	0.62	2.12
Cu	3.1	5.4	0.16	0.27
Zn	18	25	0.93	1.26
P	1750	2100	90	106
S	1330	1750	68	89

Best practice

Location
Streaky Bay
Ian and John Montgomerie
Streaky Bay Ag Bureau

Rainfall
Av Annual: 325mm
Av G.S.R: 250mm
2003 Total: 377mm
2003 G.S.R: 291mm

Yield
Potential: (B) 4.0 t/ha.

Paddock History
2002: Wheat
2001: Pasture
2000: Pasture

Soil Type
Alkaline grey calcareous sand

What happened?

The treated seed had a marginally higher yield, lower screenings, lower protein and $9/ha extra income (*Table 1*). The cost of seed treatment was $2.25/ha.

Table 2 shows a selection of seed nutrient content and concentration of the seed harvested from the plots. The control had higher Mn, Cu, Zn, P and S seed concentrations and content which may be an advantage when saving the seed for next year's crop. There was no visual difference between the treatments.

What does this mean?

At this site during 2003 there was a small economic yield advantage from seed coated with nutrients. Previous replicated trial work since 1997 over a range of environments has shown inconsistent economic yield benefits from seed coating cereals however the technique "won't do any harm".

Retaining large plump seed, high in nutrient content and concentration is beneficial for early crop growth, tillering ability, fertile heads and grain yields. The grain nutrient analysis suggests that the control is the better seed to keep for next year, especially on the soil types at Streaky Bay.

Acknowledgements

Ian and John Montgomerie for their effort in following this work through to harvest.

BSN-10®. Registered product; R.L.F.

Notes

Section 7

Section editor: Samantha Doudle

SARDI, Minnipa Agricultural Centre

United Grower Holdings

SARDI South Australian Research and Development Institute

Soils

A few soil issues of note:

- **We didn't manage to get the compaction surveys with the penetrometer done at Sticky Beak Day time – it was too dry. If this is still a priority with groups in 2004 we will aim to send someone around the Peninsula in July 2004.**
- **The Wharminda clay spreading research site suffered badly in the early ferocious winds. There was no yield result in 2003. We still hope to final sample for soil moisture, microbial activity, weed seed banks, water repellence and nutrition.**

Subsoil Nutrition - Residual Benefits

Searching for answers

Research

Samantha Doudle & Nigel Wilhelm

SARDI, Minnipa Agricultural Centre, Eyre Peninsula Farming Systems Project

Key Messages

- **After five years of trying we were finally able to measure residual effects of subsoil nutrition at two research sites!**
- **Subsoil nutrition was detrimental to crop in the following year at Wharminda.**
- **Soil applied trace elements beneficial to the following crop at Kelly on clay spread site.**

Why do the trial?

To determine if applying subsoil nutrition gives any residual benefit to the crop in subsequent years.

For three years we have tried to measure a residual benefit from subsoil nutrition at the Wharminda research sites, always to no avail. Several times we have been able to visually pick out better performing plots during the season and correlate them to some of the better treatments the year before, however we had never been able to reap a conclusive result from any of our trials. Reasons for this over the years have included poor trial set up, nitrogen deficiency and severely drought affected crop. In 2003 we finally jagged two sets of excellent residual trials, one at Wharminda and one at Kelly, both on the 2002 research sites.

In 2002 a large yield increase was measured at Edillilie on plots treated with subsoil nutrition in 2001 (*EPFS 2002, pg 125*).

How was it done?

Table 1, 2 & 3.

Deep ripping machine - para plow. All trials rolled after ripping.

Treatments - all nutrients applied as fluid fertilisers – Phosphoric Acid (H_3PO_4), Urea, Zinc Sulphate ($ZnSO_4$), Manganese Sulphate ($MnSO_4$), Copper Sulphate ($CuSO_4$).

Marginal Returns over two years - Marginal return over two years = (sum of gross income/treatment for two years - variable input costs* in year 1) – sum district practice gross income for two years.

*variable costs = anything above standard trial management and 18:20 at seeding, including the cost of deep ripping and rolling. Deep ripping estimates are based on contract prices from Western Australia.

Base Price – APW = $194. Approximate deep ripping costs: 40 cm = $40/ha, 20 cm = $20/ha

NB: Lower ripping costs were used in 2002 calculations; they have now been updated to the above costs.

What Happened ?

Residual Deep Ripping Response?

In 2003 none of the trials at Wharminda or Kelly showed any improvement in yield of the following crop from the deep ripping only conducted in 2002.

Location
Closest town: Wharminda
Cooperator: John Masters
Group: Wharminda Ag Bureau

Rainfall
10 yr av annual total: 274 mm
10 yr av. GSR: 204 mm
2002 annual total: 291 mm
Actual growing season: 236 mm

Yield
Potential: 2.92 t/ha
Actual paddock: 2.02 t/ha

Paddock History
2003: Chebec barley
2002: Frame wheat
2001: Grass free, medic dominant pasture

Soil
Land System: Dune swale
Major soil type description: 30 – 40 cm siliceous sand over sodic clay

Plot size
1.5 x 20m

Location
Closest town: Kimba
Cooperator: Gary & John Grund
Group: Kelly Landcare Group

Rainfall
Av. Annual total: 341 mm
Av. Growing season: 242 mm
Actual annual total: 353mm
Actual growing season: 224 mm

Yield
Potential: 2.28 t/ha
Actual Paddock: 1.3 t/ha

Paddock History
2003: Clearfield Stilleto
2002: Wheat
2001: Pasture

Soil
Land System: low hills with sand spreads
Major soil type description: deep siliceous sand over clay

Plot size
2002: 1.5 x 20m.
2003: entire area from 2002 sown over with airseeder

Other factors
Crop was sown with 100 kg/ha of 32:09 fertiliser single shoot and this thinned the crop out (fertiliser toxicity) limiting potential yield.

Residual Nutrient Response?

Despite similar responses to nutrient treatments in 2002, both sites responded completely differently to the residual nutrients in 2003.

Wharminda

The general trend at Wharminda was for the best yielding treatments in 2002 to be the lowest yielding treatments in 2003 (*Figure 1*). In the financial assessment of these two years of data all deep placed treatments in 2002 returned less money than district practice. The only treatment to return more money than district practice over two years was high levels of nutrients placed shallow (5 cm), the lowest yielding treatment in 2002.

Kelly

The highest yielding treatments at Kelly in 2003 all contained soil applied trace elements. Placement depth of the trace elements was not important in the 2003 season - they were equally effective at 40, 20 or 5 cm (*Figure 2 & 3*). All treatments returned more money than district practice over two years, with the 5 cm placement being best in the "How Deep?" trial (*Figure 2*) and 0 – 40 cm being the best in "Best trace element applications method" *(Figure 3)*.

What does this mean?

Residual Deep Ripping Response?

In 2003 across five trials in two different locations there was no residual response to deep ripping.

Wharminda

At the new 2003 research site at Wharminda (approx 1 km from the 2002 residual site) there was also no response to deep ripping in 2003. It is not clear whether this lack of deep ripping response in the first year of the new site was due to the good seasonal conditions (there was no ripping response at Wharminda in 2000, another good season) or whether the site was simply not responsive to deep ripping. If the former was the case then it may follow that there would be no residual response to deep ripping in the 2002 site either.

Kelly

At Kelly there was a huge response to deep ripping alone at the new 2003 trial site (approx 20 km west of the 2002 residual site). There was no residual deep ripping response at the 2002 site. Given that these sites are distant from each other and have been subject to different management over the years, it is not possible to compare responses. However, both trial sites have been clay spread with highly calcareous clays inducing trace element deficiencies in the past and potentially contributing to compaction in the sandy soil during the operations of spreading and mixing the clay – hence the response to ripping in the initial year.

Table 1: Trial Establishment & Management Details, 2002/2003.

Location	Wharminda	Kelly - clayed
Trial Establishment, 2002		
Ripping & Nutrient Placement date	May 7th	May 3rd
Sowing Date	June 11th	June 4th
Base Fertiliser	------------60 kg/ha of 18:20 just below the seed------------	
Wheat variety	Krichauff	Krichauff
Soil Type	10-40 cm of sand over sodic clay	Deep sand (over 1m deep). Clay spread @ approx 200t/ha in Sept 2001.
Trial Management, 2003		
Sowing Date	June 10th	June 6th
Base Fertiliser	68 kg/ha 18:20	100 kg/ha of 32:09
Cereal Variety	Chebec Barley	Clearfield Stilletto

Table 2: Treatments applied at Wharminda and Kelly in 2002 "How deep?" trials. Urea was the N source in all deep N treatments and H_3PO_4 was the P source in all deep P treatments.

Treatment	Deep Nutrients (kg/ha)	Depth of Placement (cm)	Treatment Cost /ha in 2002
5 cm	34N + 20P + 2Zn + 3Mn + 2Cu	5	$122
0 – 20 cm *	34N + 20P + 2Zn + 3Mn + 2Cu	20	$142
2 – 40 cm **	34N + 20P + 2Zn + 3Mn + 2Cu	20-40	$162
0 – 40 cm ***	34N + 20P + 2Zn + 3Mn + 2Cu	40	$162
District practice	-	5	$0

* *ripped to 20 cm and nutrients applied throughout top 20 cm*
** *ripped to 40 cm and nutrients applied throughout bottom 20 cm of rip, ie. from 20 to 40 cm*
*** *ripped to 40 cm and nutrients applied throughout entire 40 cm*

**Treatment costs only include the cost of extra fertiliser, deep ripping and rolling used in that treatment, over and above the input costs common to all treatments.*

	Treatment	TE application		
		Product	*Rate (kg/ha)*	*Depth (cm)*
1	Foliar TE	$ZnSO_4 + MnSO_4 + CuSO_4$	0.33 Zn + 1.1 Mn + 0.1 Cu	Foliage
2	With seed	$ZnSO_4 + MnSO_4 + CuSO_4$	2 Zn + 3 Mn + 2 Cu	5
3	Subsoil	$ZnSO_4 + MnSO_4 + CuSO_4$	*2 Zn + 3 Mn + 2 Cu	40
4	Nil	$ZnSO_4 + MnSO_4 + CuSO_4$	0 Zn + 0 Mn + 0 Cu	0
-----All treatments also received 34 N + 20 P (urea & H_3PO_4) @ 40cm, prior to seeding -----				

Table 3: Treatments applied in "Trace Element Application Methods on Clay" Experiment at Kelly Clay 2002.

**Treatment 3 TE applied prior to seeding with N & P*

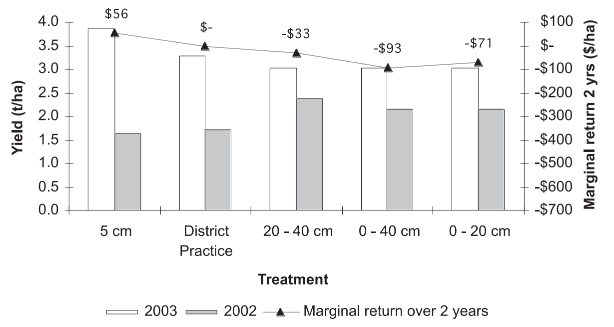

Figure 1: Yield in 2003 (, LSD=0.22, P=0.05) and 2002 (LSD=0.15, P=0.05) and estimated marginal return over 2 years from "How Deep?" trial, established at Wharminda in 2002 and over-sown with barley in 2003.

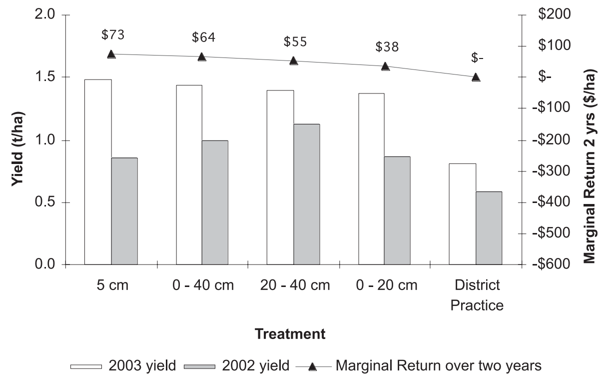

Figure 2: Yield in 2003 (LSD=0.12, P=0.05) and 2002 (LSD=0.13, P=0.05) and estimated marginal return over 2 years from "How Deep?" trial, established at Kelly in 2002 and over-sown with wheat in 2003.

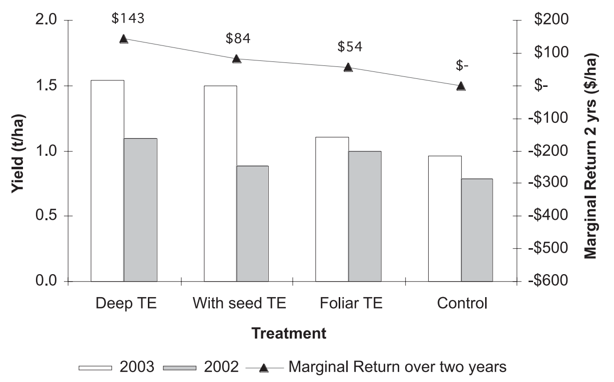

Figure 3: Yield 2003 (LSD=0.2, P=0.05) and 2002 (LSD=0.14, P=0.05) and estimated marginal return over two years from "Trace Element Application Methods?" trial, established at Kelly in 2002 and over-sown with wheat in 2003. NB: all treatments in this trial also had a base of N + P applied to 40 cm in 2002.

Residual Nutrient Response?

Wharminda

There was certainly no residual response to 2002 applied nutrients at Wharminda in 2003, the reverse in fact. Given that the highest yielding treatments in 2002 were the worst yielding in 2003, there is an indication that highest yielding treatments in 2002 have removed more applied and soil reserve nutrients, thereby causing a deficiency in those treatments in 2003. Nitrogen seems the most likely nutrient to cause such an effect and all grain proteins were low in these trials. The highest yielding 2003 treatments had slightly higher protein than the lowest yielding plots.

Kelly

There was a definite yield response to residual nutrients at Kelly, in particular the trace element mix. The grain analysis from the residual site showed all grain had deficient levels of copper, hinting at one of the major drivers for the trace element response. Grain levels of manganese and zinc were adequate although this does not rule out the possibility of deficiency in these nutrients early in the season.

The Future

This is the first time out of four attempts that we have had worthwhile experiments from which to measure residual responses from subsoil nutrition experiments. The fact that this is one years' data only must be kept in mind when considering these results. There are still many pieces missing from the puzzle of residual ripping and nutrient responses that can only be discovered by following this work through across a number of years, locations and seasonal conditions. The two 2002 sites at Wharminda and Kelly will both hopefully be sown and monitored again in 2004, as will the two 2003 sites. New long-term research sites will be established under the GRDC Subsoil Constraints project.

The challenge ahead is to develop packages of deep placed nutrients which will achieve the high yields in the year of application, but will not cause yield depressions in the following crop.

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GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Searching for answers

Subsoil Nutrition - 2003 Results

Research

Samantha Doudle and Nigel Wilhelm

SARDI, Minnipa Agricultural Centre, EP Farming Systems Project

Key Messages

- **Results from Wharminda site compromised due to severe wind erosion at site.**
- **Placement of multi-nutrient fertilisers to a depth of 40 cm was the highest yielding treatment for the fifth consecutive year of subsoil nutrition experiments across Eyre Peninsula.**
- **Subsoil nutrition research will now be conducted on Eyre Peninsula by a major new GRDC Subsoil Constraints research project.**

Why do the trial?

To investigate aspects of subsoil nutrition across a variety of soil types and climatic conditions on upper EP.

In 1999 the Wharminda Ag Bureau became involved with the EP Farming Systems project with the aim of investigating ways to improve nutrition on their inherently infertile sandy soils. Applications of a combination of nutrients distributed throughout the soil profile to 40 cm massively increased yield in 1999, 2000, 2001 and 2002. Complete summaries of all results are available in the annual Eyre Peninsula Farming Systems Summaries. In 2003 the major subsoil investigation sites were again focussed on sandy soils; at Wharminda and Balumbah (south west of Kimba).

At the two major sites several research questions were targeted:

- How deep do the nutrients need to be placed for maximum yield benefit? (3rd year of this experiment)
- Do all of the nutrients need to be applied together, or can they be applied in a variety of ways to achieve the same result? (1st year of this experiment)
- What is the most effective distance between ripping tines? (2nd year of experiments)
- How does subsoil nutrition perform across a variety of seasons (5th year of experiments)

How was it done?

Deep ripping machine: MAC the Ripper – purpose built, 5 tine, straight-shanked ripper.

Treatments: all nutrients applied as fluid fertilisers – Phosphoric Acid (H_3PO_4), Urea, Zinc Sulphate ($ZnSO_4$), Manganese Sulphate ($MnSO_4$), Copper Sulphate ($CuSO_4$), Tech Grade MAP (TGMAP), Ammonium Nitrate (AN), Ammonium Polyphosphate (APP).

Measurements: tissue tests, early dry matter, yield, grain nutrients, screenings, protein.

Marginal Return: Marginal return = (gross income/treatment - variable input costs*) – district practice gross income.

*variable costs = anything above standard trial management and 18:20 at seeding, including the cost of deep ripping and rolling. Deep ripping estimates are based on contract prices from Western Australia.

Base Price – APW = $194. Approximate deep ripping costs: 40 cm = $40/ha, 20 cm = $20/ha

What Happened ?

Were the sites ripping responsive?

Balumbah – yes, over 4 trials an average of 0.4 t/ha from deep ripping alone (*Figures 1,2, 3*).

Wharminda – no, despite severe wind erosion damage there did not appear to be any response to deep ripping in any of the five trials at this site in 2003.

How deep?

In 2002 the highest yielding treatment in this trial at both sites was nutrients distributed from 20 – 40 cm in the soil profile. This again proved to be the case in the 2003 trial at Balumbah with 20 – 40 cm equalling the yield of 0 – 40 cm (*Figure 1*). At Balumbah, the full 40 cm depth was 0.3 t/ha better than the 20 cm placement, 0.5 t/ha better than the 5 cm placement and 1 t/ha better than district practice (*Figure 1*).

There was no difference between 20 – 40 cm, 0 – 40 cm, nor 0 – 20 cm at Wharminda with trial variation due to wind erosion masking any clear result.

How much?

At Balumbah there was an extra 0.5 t/ha simply by increasing nutrient rates (with shallow placement), compared to district practice nutrient rates (*Figure 1*).

One trial at Wharminda compared high and low nutrient rates however results were inconclusive due to wind erosion damage.

Width between ripping tines

This trial was only located at Wharminda and therefore suffered severe wind erosion. Yields varied from 2.7 – 1.76 t/ha, with the higher rates of nutrients returning the best yields. The 75cm width (the widest ripping width, compared to 30 cm and 50 cm) yielded highest at both nutrient rates, however there was too much damage to the trial to be confident in this result.

What kind, what cost?

The addition of any of the nutrient combinations increased yield at both sites compared to deep ripping or district practice. However, any subtle differences between nutrient treatments have been masked by the wind erosion at Wharminda.

At Balumbah, apart from the very high rates of nutrients in the Supermix (highest yielding treatment over the five years of this research), there was no yield difference between any of the other nutrient combinations (*Figure 2*). Treatment costs of these combinations varied from $232/ha for Supermix and $200/ha for the acidified APP treatment to $66/ha for urea and trace elements only (*Table 4*). The addition of any of the nutrient combinations increased yield at Wharminda compared to deep ripping or district practice, however once

Table 1: Trial Details

Location	Wharminda	Balumbah - clayed
Ripping & Nutrient Placement date	May 7th	May 6th
Sowing Date	June 6th	May 30th
Base Fertiliser	60 kg/ha of 18:20 just below the seed	
Wheat variety	Frame Wheat	Westonia Wheat
Soil Type	10-40 cm of sand over sodic clay	75 cm sand over sodic clay. Clay spread @ approx 200t/ha in Sept 97.
Treatment after ripping	Rolled	Prickle chained

Table 2: Treatments used in "How deep?" trials. NB: 18:20 @ 60 kg/ha was applied just below the seed in all treatments @ seeding, urea was the N source in all deep N treatments and H_3PO_4 was the P source in all deep P treatments.

Treatment	Deep Nutrients (kg/ha)	Depth of Placement (cm)	Treatment Cost ($/ha)
5 cm	34 N + 15 P + 2 Zn + 3 Mn + 1 Cu	5	$97
0 – 20 cm *		20	$100
20 – 40 cm **		20-40	$140
0 – 40 cm ***		40	$140
Rip only	-	-	$42
District practice	-	5	$0

* *ripped to 20 cm and nutrients applied throughout top 20 cm,*
** *ripped to 40 cm and nutrients applied throughout bottom 20 cm of rip, ie. from 20 to 40 cm,*
*** *ripped to 40 cm and nutrients applied throughout entire 40 cm*

again differences between treatments have been masked by the wind erosion.

Can we get the same result using other nutrient application methods?

At Balumbah any combination of nutrient application methods was successful as long as they placed either nitrogen and phosphorus and/or trace elements at depth (*Figure 3*). NPTE shallow with deep ripping also performed well.

Yields at Wharminda ranged from 1.79 (NP deep, TE shallow) to 1.17 t/ha (district practice), however trial variation due to wind erosion has masked any difference between the individual treatments (data not presented).

What does this mean?

NOTE: ALL OF THE FOLLOWING COMMENTS RELATE TO EFFECTS SEEN IN THE YEAR OF APPLICATION ONLY. REFER TO "SUBSOIL NUTRITION RESIDUAL BENEFITS?" ARTICLE IN THIS SECTION TO CONSIDER THESE BENEFITS IN RELATION TO RESIDUAL EFFECTS.

Were the sites ripping responsive?

Deep ripping alone has increased yield at Wharminda three years out of five. The 2003 results were inconclusive due to wind erosion however site trends suggest no response to deep ripping. Assuming there was no ripping response in 2003, this would then be consistent with the 2000 results (both 2003 and 2000 were good rainfall seasons) where there was no response to deep ripping. However, at Balumbah deep ripping has increased yield in both trial years. These yield increases have all occurred on siliceous sand over clay soil profiles and across a range of paddocks, management and seasonal conditions. We have never measured a residual yield benefit from deep ripping alone in the following year (*see the article in this section "Subsoil Nutrition – residual benefits?"*).

How deep?

Whilst applying nutrients from 0 - 20 cm has always increased yield compared to the shallower 5 cm treatment, the highest yields have always come from the treatment applied from 0 - 40 cm. Over the last two years the success of the treatment containing no extra nutrition in the 0-20 cm zone (apart from the 18:20 applied at seeding to all treatments) and all of the extra nutrition at 20-40 cm is encouraging and requires further investigation. If it is essential to go to at least 40 cm to achieve the biggest yield increases, having less nozzles or outlets on the tines to that depth will mean less blockages and hassles!

How much?

Increasing nutrient inputs above district practice levels and placing them shallow has proven a risky practice in the past four years. Each year these treatments have produced better early growth than most other treatments, yet when the traditional Eyre Peninsula dry spell in later winter or spring hits, these treatments have never finished their potential and have often suffered large yield penalties. In 2003 the finish to the season was very mild, allowing this treatment to finish better than in previous seasons.

Location
Closest town: Wharminda
Cooperator: John Masters
Group: Wharminda Ag Bureau

Rainfall
10 yr av annual total: 274mm
10 yr av. GSR: 204mm
2003 annual total: 291mm
Actual growing season: 267mm

Yield
Potential: 3.1 t/ha
Actual paddock: 1.55 t/ha
Variety: Frame

Paddock History
2002: pasture, grass free
2001: Excalibur wheat
2000: pasture, grass free

Soil
Land System: Dune swale
Major soil type description: 30 – 40 cm siliceous sand over sodic clay

Plot size
1.5 x 20m x 4 reps

Other factors
Lack of nitrogen, severe wind erosion in some areas, especially over the trial site!

Location
Closest town: Kimba
Cooperator: Trevor & Kerry Cliff
Group: Balumbah Landcare Group

Rainfall
Av. Annual total: 340mm
Av. Growing season: 235mm
2003 total: 347mm
Actual growing season: 259mm

Yield
Potential: 2.98 t/ha
Actual: 2.77 t/ha

Paddock History
2002: Yitpi Wheat, 1.26 t/ha
2001: Lupins, 1.42 t/ha
2000: Sloop Barley, 2.36 t/ha

Soil
Deep siliceous sand over clay

Plot size
1.5 x 20 m x 4 reps

Table 3: Treatments used in "Application Techniques" trials. NB: 18:20 @ 60 kg/ha was applied just below the seed in all treatments @ seeding, urea was the N source in all deep N treatments while H3PO4 was the P source in all deep P treatments.

Treatment	Nitrogen & Phosphorus – rate (kg/ha), placement (cm)	Trace Elements – rate (kg/ha), placement (cm)	*Treatment Cost ($/ha)
NP shall, TE deep	34 N + 20 P @ 5 cm	2 Zn, 3 Mn, 2 Cu to 40 cm	163
NPTE deep	34 N + 2 0P to 40 cm	2 Zn, 3 Mn, 2 Cu to 40 cm	163
NP deep, TE shallow	34 N + 2 0P to 40 cm	2 Zn, 3 Mn, 2 Cu @ 5 cm	163
NPTE shallow	34 N + 20 P @ 5 cm	2 Zn, 3 Mn, 2 Cu @ 5 cm	108
NP deep, TE foliar	34 N + 20 P to 40 cm	0.3 Zn, 1.1 Mn, 0.1 Cu foliar	141
NP shallow, TE foliar	34 N + 2 0P @ 5 cm	0.3 Zn, 1.1 Mn, 0.1 Cu foliar	99
NP shallow, rip, TE foliar	34 N + 20 P @ 5 cm + deep ripping	0.3 Zn, 1.1 Mn, 0.1 Cu foliar	141
NPTE shallow, rip	34 N + 2 0P @ 5 cm + deep ripping	2 Zn, 3 Mn, 2 Cu @ 5 cm	163
Rip only	-	-	42
District practice	-	-	0

**Treatment costs only include the cost of extra fertiliser, deep ripping and rolling used in that treatment, over and above the input costs common to all treatments.*

Table 4: Treatments used in "Best Performance vs Least Cost Mixes" trials. NB: 18:20 @ 60 kg/ha was applied just below the seed in all treatments @ seeding. All treatments were applied to 40 cm.

Treatment	Nutrient rates (kg/ha)	Products Used	*Treatment Cost ($/ha)
Best Bet – super mix	34 N + 20 P + 10 Zn + 10 Mn + 4 Cu	TGMAP, AN, $ZnSO_4$, $MnSO_4$, $CuSO_4$	232
Best bet – APP mix	34 N + 20 P + 1 Zn + 1 Mn + 0.5 Cu	APP, H_3PO_4, Urea, $ZnSO_4$, $MnSO_4$, $CuSO_4$	200
Best bet – H_3PO_4, AN mix	34 N + 20 P + 5 Zn + 5 Mn + 2 Cu	H_3PO_4, AN, $ZnSO_4$, $MnSO_4$, $CuSO_4$	187
Cheap option – P, N, Cu	20 N + 10 P + 1 Cu	H_3PO_4, Urea, $CuSO_4$	136
Cheap option – N, Cu	20 N + 1 Cu	Urea, $CuSO_4$	66
Cheap option – N, TE	20 N + 1 Zn + 1 Mn, + 0.5 Cu	Urea, $ZnSO_4$, $MnSO_4$, $CuSO_4$	79
Rip only	-	-	42
District practice	-	-	0

**Treatment costs only include the cost of extra fertiliser, deep ripping and rolling used in that treatment, over and above the input costs common to all treatments.*

On the other hand, increasing nutrition to the same level and placing it throughout the soil profile from 0 - 40 cm has proven an exceptionally good combination. The plants from these treatments don't set as much potential early in the season as their shallow counterparts. The deeper treatments start to boost growth later in the season and this combined with deeper and more prolific root systems has allowed the crops on these treatments to finish their potential in all seasonal conditions experienced (some of which have been very dry). The only exception to this rule is in 2002 at one end of the Wharminda trial site with very shallow sand over clay (10-15 cm) and at Buckleboo where subsoil constraints existed in the potential root zone.

Width between deep ripping tines

Results from two years of this trial are still inconclusive. In 2002 this was the trial located on the shallow end of the trial site and in 2003 the area was severely wind blasted. One issue arising from the apparent success of the high rate of nutrient at 75 cm ripping width from this trial in 2003, and the 20 – 40 cm depth placement from the "how deep trial" in 2002 and 2003, is that both of these treatments have the nutrients applied in a more concentrated area. Further investigation is required here.

What kind, what cost?

Initial results from the first year of this experiment are cautiously optimistic. In 2003 we used nutrient combinations costing much less than one of the best performing treatments in the past but with similar yield results. In 2003 at both sites the majority of these combinations were as good as the standard treatment. Results from Balumbah in 2003 show it is possible to get the same yield response with a treatment cost of $66/ha compared to the usual higher input treatment cost of $140/ha (phos acid, urea, and TE sulphates), giving a marginal return of $88 compared to the usual higher input treatment with $64. The highest marginal return from any treatment at the Balumbah research site was $120/ha using 20 N, 1 Zn, 1 Mn and 0.5 kg Cu/ha placed to 40 cm. The treatment with the lowest marginal return at the Balumbah site was -$6 using the Best APP mix (*Table 4 for ingredients , Figure* 2). There appears to be plenty of potential to experiment with various nutrient combinations to work out the most effective least-cost option for a particular soil type.

Can we get the same result using other nutrient application methods?

The application methods trial contained a lot of variation at Balumbah, however it indicated that it wasn't important whether the NP or the TE combination was placed deep, as long as one of them was, the other could be applied as either a shallow soil application or foliar with no yield penalty. The same could be said of the treatment where everything was placed shallow, with a ripping treatment as well. The 2003 season had an extremely mild finish so these results could easily prove different in harsher years where shallow soil applied trace elements may be unavailable due to lack of soil

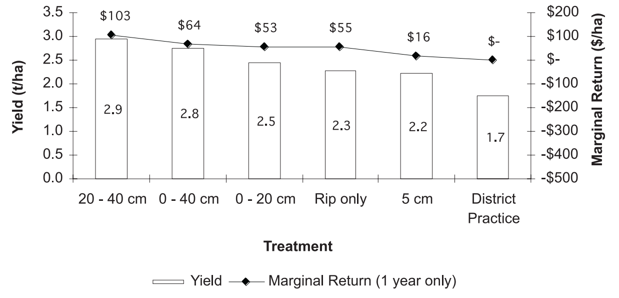

Figure 1: Yield (LSD=0.29, P=0.05) and marginal return estimates for wheat in the "How Deep" trial at Balumbah, 2003.

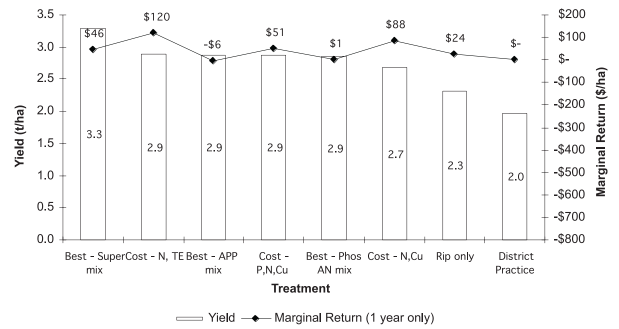

Figure 2: Yield (P=LSD=0.291, 0.05) and marginal return estimates for wheat in the "Best Performance vs Least Cost Mixes" trial at Balumbah, 2003.

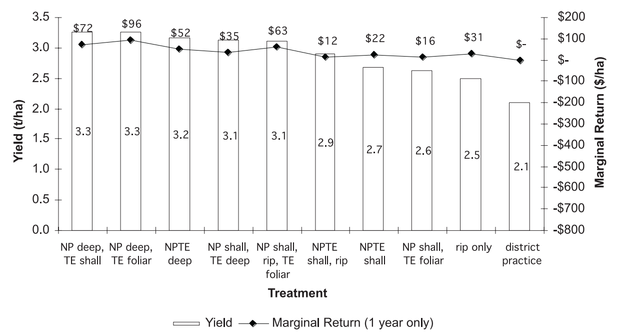

Figure 3: Yield (LSD=0.4, P=0.05) and marginal return estimates for wheat in the "Application Techniques" trial at Balumbah, 2003.

moisture. More work needs to be conducted on this issue for definitive answers, however if deeper root systems are linked as closely to the deep ripping procedure as this research would indicate, then applying the nutrients whilst down there would seem to make sense.

Are we getting any closer to making this more practical?

A new GRDC funded major research initiative focussing on subsoil constraints across Vic and SA will begin in 2004. On EP the project will be focussing on this subsoil nutrition issue in an attempt to better understand what is driving responses on various soil types in various seasons. A long-term research site will be established at Wharminda aiming to establish a farming system using subsoil nutrition (and potentially controlled traffic) that will prolong the initial benefits of ripping and deep placement of nutrients over many years. With more growth being returned into the system on a regular basis there may be potential to generate a more robust 'living' system in our siliceous sands. Satellite sites for this project will potentially be established at Kelly/Balumbah (subsoil nutrition focus) and Buckleboo (subsoil constraint focus).

At this stage there is still no easier or cheaper way to apply nutrients at depth than the deep ripping method we have used for the past five years. Work is still continuing on the machinery aspect of subsoil nutrition through the GRDC funded Fluid Fertiliser project with Brendan Frischke – refer to "High Pressure Nitrogen Injection – the first test" article for an update. There is certainly evidence to show that the cost of subsoil nutrition can be reduced by experimenting with various nutrient combinations and products, however more work needs to be done in this area over a number of seasons and soil types.

Acknowledgments

- GRDC for providing the funding for this research as part of the Eyre Peninsula Farming Systems Project
- John "Chompy" Masters and family for hosting these trials and assisting us above and beyond the call of duty every year!
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- The Kelly Landcare Group, in particular Gary & John Grund and Trevor Cliff & Spog, the Buckleboo Farm Improvement group, in particular Bill and Gadge Lienert and Rowan Ramsey, for hosting the trials and assisting with trial management.

GRDC Grains Research & Development Corporation

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Searching for answers

Innovative Deep Nutrient Application with Fluid Fertilisers

Research

Brendan Frischke and Sam Doudle

SARDI, Minnipa Agricultural Centre

Key Messages

- **High-pressure injection shows promise as an alternative method for applying fertiliser into the soil.**
- **Deep banding fluid fertilisers with extra long knife points is another option which also showed promise.**
- **This research is still in its early days.**

Why do the trial?

- To identify suitable machinery for deep nutrient placement with economic and practical potential.
- To evaluate the potential of injecting fluid fertilisers into soil using high pressure.
- Refer to Subsoil Nutrition articles in the "Soils" section in previous Eyre Peninsula Farming Systems summaries.

For several years massive yield increases have been achieved by deep tillage and nutrient application in infertile sand over clay soils. The largest yield increases to date have occurred when multi-nutrient fluid fertilisers with phosphorus, nitrogen, zinc, copper & manganese are placed pre sowing throughout the profile to a depth of 40 cm or between 20 cm to 40cm below the surface. Despite the spectacular increases in cereal yields, this practice has not been adopted because deep tillage is slow, expensive and traction is a problem on sands, fluid fertilisers are expensive and application volumes exceed 500 l/ha.

How was it done?

High-pressure injection and other methods were evaluated in a pilot trial to assess whether they could be used to place multi-nutrient fertilisers at depth more easily but still produce yields similar to deep tillage with fertiliser placement to 40 cm. The methods tested were:

- Deep ripping with nutrients (control) – Deep rip tines working at 40 cm deep fitted with four spray jets equally spaced down the trailing edge *(Figure 1)*. To reduce application volume and improve practicality, speed was increased to 7.5 km/hr from 5 km/hr as used in past years. This is the standard treatment used in all previous deep placement trials.
- High-pressure injection - Each deep rip tine was fitted with a solid stream nozzle on the foot pointed downwards *(Figure 2)*. This system uses a combination of tillage and the penetration of high pressure to apply fertiliser at depth. Injection pressures used were 345 bar (5000 psi) and 86 bar (1250 psi) at tillage depths of 10 & 30 cm.
- Deep coulter banding – 76 cm Yetter coulters fitted with a rear knife and fluid tube operating at 30 cm. Fluid fertiliser was placed in a band from a single outlet at low pressure (1 bar) fixed to the bottom of the knife.
- Deep knife banding – 225 mm knifepoints were fitted to Ausplow DBS seeding tines. A fluid delivery tube was fixed to the rear of the knife, banding fluid at the working depth of the knifepoint, approximately 200 mm below the surface.
- No deep nutrients (district practice).

Deep placed nutrients were applied well before sowing (2-4 weeks) except with 'deep knife banding' where subsoil nutrients were applied during seeding. Nutrients applied at depth were 12 kg P/ha, 25 kg N/ha, 2.25 kg Mn/ha, 1.5 kg Zn/ha & 0.75 kg Cu/ha from phosphoric acid, urea and zinc, manganese and copper sulphates. The row spacing for deep rip tines and coulters was 50 cm. DAP was applied at 60 kg/ha with seed during sowing for all treatments. Shorter 150 mm knife points were used to sow the trial compared to those used in 'deep knife banding'. Frame wheat was sown on June 17.

What happened?

The trial was intended as a first step in identifying ways to make deep placement of nutrients more practical and economic and test high pressure as an option to achieve this goal. Grain yield results from 2003 *(Table 1)* indicated that the method, which applied nutrient the deepest, tended to produce the highest yields. This is consistent with past work at several sites.

High-pressure injection - Higher yields were achievable by reducing tillage depth and using high pressure to apply nutrients deeper. At 5000 psi and tines at 30 cm yields were better than deep ripping to 40 cm with nutrients, the consistently highest performer previously. However there was no difference in yields between 88 and 345 bar pressure at either depth. This is important from a practical point of view because high pressure requires a high power input (approximately 4 hp/nozzle @ 5000 psi). Reducing pressure to a medium level of 1250 psi reduces power input and application volume by approximately half each. There hasn't been any accurate assessment of penetration distance from the nozzle. However from observation 100 – 150 mm seems achievable, possibly more in the sands. Deep ripping unfortunately causes considerable soil surface disturbance which often requires levelling or firming with a light roller before sowing can occur, particularly when sowing with knife points.

Deep coulter banding - was considered as an alternative to high pressure. The first advantage observed from coulters was the minimal soil disturbance. In these sandy soils coulters were also able to reach maximum depth without extra weight to aid penetration. They also yielded very well.

Deep knife banding - was included as a one-pass seeding and deep fluid banding system. In this system deep nutrients were applied at the same row spacing as seed (225 mm). We can't say from the trial whether this is an advantage or not. Yields under this system were less than the best treatment but still yielded 20% more than district practice. Because district

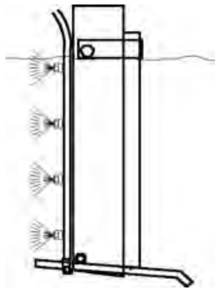

Figure 1: Deep ripping tine diagram showing position of fluid nozzles. Benchmark system for maximum yield used for past 2 years.

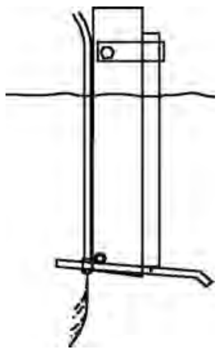

Figure 2: Deep ripping tine diagram showing position of high-pressure nozzle.

practice received a lower amount of nutrients than the deep placement treatment, we are unable to determine whether the yield increase is from nutrients at depth, increased nutrient input or a combination of both. However in past trials on these soils, increasing nutrients in the top 5 cm hasn't increased yields to the same magnitude as placing some nutrients deeper. The extra length knife points did not cause excessive soil throw or seedling establishment problems. In the interim this method would be worth considering on a larger area until we know more about the other alternatives.

What does this mean?

This trial has shown that fertiliser application with high pressure injection from shallower working tines and banding from coulters or long knife points have potential to improve the economic viability of deep nutrient placement. Further research is required to overcome the limitations of deep tillage to 40 cm (high application volumes, power & fertiliser costs) and identify methods with similar benefits. Future research will concentrate on:

- Measuring yield response to various pressure and tillage depth combinations.
- Adapting high pressure to coulters.
- Using suspension fluid fertilisers, which are cheaper to purchase.
- More accurate input power estimates to estimate real costs.

Acknowledgements

Thanks to John Masters for providing access to land for trial work and assistance from EP Farming Systems project.

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SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

Location
Wharminda
Closest town: Arno Bay
Co-operator: John Masters
Group: Wharminda

Rainfall
Av. Annual total: 274mm
Av. Growing season: 204mm
Actual annual total: 291mm
Actual growing season: 236mm

Yield
Potential: 2.8 t/ha
Actual: 1.55 t/ha

Paddock History
2002: Grass free pasture
2001: Excalibur wheat
2000: Grass free pasture

Soil
Major soil type description: Sand over Clay

Plot size
Dimensions: 2 x 20m

Other factors
Severe sand blasting at 2-4 leaf stage

Table 1: Yield and protein from alternative methods of deep placed nutrient application at Wharminda, 2003. Note: district practice received lower P, N and micronutrient inputs.

	Application Volume	Grain Yield		Protein	
	L/ha	t/ha		%	
Deep ripping to 30 cm + fluid injection @ 5000 psi	653	1.90	a..	9.7	ab...
Deep ripping to 30 cm + fluid injection @ 1250 psi	316	1.82	ab.	9.5	.bcd.
Deep ripping to 10 cm + fluid injection @ 5000 psi	653	1.81	ab.	9.6	.bc..
Deep ripping to 40 cm + fluid sprays on trailing edge	361	1.78	.b.	9.5	.bcd.
Fluid banding @ 30 cm with large coulters	200	1.78	.b.	9.4	..cd.
Knife banding @ 20 cm with DBS while sowing	200	1.75	.b.	9.3	..cd.
Deep ripping to 10 cm - fluid below @ 1250 psi	316	1.73	.b.	10.0	a....
District practice - Nil deep fertiliser	Na	1.47	..c	9.3	...d.
P-value		>0.001		>0.001	

Soils

Gypsum reduces transient salinity

Pichu Rengasamy and Jim Kelly

Soil and Land Systems, The University of Adelaide

Survey

Key Message

Application of gypsum has reduced transient salinity levels in soil profiles in low rainfall areas of Eyre Peninsula.

Why do the trial?

Ed note: Subsoil constraints have been a major issue with nearly all farmer groups across upper Eyre Peninsula over the last few years. As another way of addressing this priority, in 2003 Pichu Rengasamy and Jim Kelly participated in many of the EP Farming Systems group meetings and Sticky Beak days. Their role has been to increase the awareness of transient salinity and the limited management options currently available. Renga and Jim also sampled some local EP farmer gypsum demonstrations, the results of which are in this article.

Background

Salt accumulation in the root zone of soils where water tables are deep (>5m) is known as "transient salinity". The soils affected by transient salinity are also referred to as "dry saline lands". The salinity of the groundwater, because it is deep, does not influence the salt build-up in the soils.

When subsoils are sodic and highly compacted, water infiltration and movement are restricted. This means that salts which have accumulated due to high evaporation in summer are not leached and stay in the subsoils. Over the years, salt concentration in subsoils can increase to above a threshold level tolerated by crops. Even when there is plenty of moisture in the root zone, the presence of these salts can prevent the use of some of this water by crops. More than 50% of soils on Eyre Peninsula are affected by transient salinity, which is sufficiently severe to depress crop yields.

In paddocks affected by transient salinity, salt tolerant varieties of crops can have an advantage. The other way of managing transient salinity is to leach the salt below the root zone by having 'enough' water moving through subsoils to carry a lot of the salt with it. The large amounts of water used in irrigated systems allows leaching of salts easily, whereas in dryland regions the amount of rainfall will dictate how much salt is washed down. Furthermore, soil conditions should be optimum for the easy movement of rainwater through subsoils. However, water movement is highly restricted in sodic soils.

Sodic soils are notorious for having bad physical properties with poor soil structure. Application of gypsum ameliorates soil sodicity and improves soil structure which will, in turn, enhance water movement. Generally, the yield of crops can be improved by 10 to 70% by applying gypsum to sodic soils. This yield increase can be realised even in the first year of application. However, as shown in our experiments at St Arnaud in Victoria, application of gypsum to sodic soils, which also have transient salinity, may not result in an increase in yield until subsoil salts are completely leached.

Even though gypsum application to sodic soils with transient salinity may not result in a yield increase in the beginning, it still improves soil structure and facilitates the leaching of salts from subsoils. Eventually, this should improve crop yields. But now we have to find out how long it takes to leach the salts, how much gypsum has to be applied, how gradual the yields increases will be and hence, the total economics of gypsum use. With this in mind, as a part of the GRDC project, we are conducting field experiments and also collecting information from farmers' paddocks where gypsum has been applied.

What happened?

In the tables of results below, salinity has been measured as electrical conductivity (EC) in a 1:5 mix of soil and water. Levels of EC which can cause damage to wheat vary with soil texture; levels above 0.4 in a sand can be toxic but in a clay levels need to be above 0.7 for damage to occur. Soil textures between a sand and a clay have intermediate minimum levels for damage.

EYRE PENINSULA DEMONSTRATIONS

Minnipa Ag Centre

Andrew Thompson (a MAC Researcher in 2003) conducted a demonstration on Minnipa Ag Centre farm where he applied gypsum (2.5 and 10 t/ha) to a sodic soil with transient salinity. He irrigated the plots at the beginning with 1000 mm of water to see if that would move gypsum into the subsoil and flush salts down the profile. These results show that if enough water is available and gypsum is applied, salts can be leached below the current root zone. However, this situation may be a far cry from low rainfall conditions with only 300 to 450 mm of rain per year.

Cleve

We collected soil samples in October 2003 at Cleve, from a replicated trial in which the farmer had applied 5, 10 or 15 t/ha of gypsum five years ago. The crop in 2003 was canola. These results show that even with 2.5 t/ha of gypsum, salts are being leached in an area where the average rainfall is only 350 mm/year *(Table 2)*. Further analysis showed that application of gypsum at the rates of 10 and 15 t/ha reduced sodicity levels down to a depth of 60 cm. Average exchangeable sodium percentage in soil layers from 0 to 60 cm was reduced from 14 (highly sodic) to 5 (non-sodic).

Lock/Murdinga/Tuckey

The soil analysis from both of the Lock/Murdinga sites and the Tuckey site support what was found in the replicated trial on Geoff Bammann's property at Cleve, in that gypsum rates of 2.5 or 5 t/ha appear to have flushed salt from the root zone *(Tables 3, 4 and 5 respectively)*.

FIELD TRIAL – YORKE PENINSULA

As part of the development of management strategies for transient salinity a field trial has been conducted at Petersville on Yorke Peninsula. The soil is a thin gritty loamy sand to

Table 1: Salinity levels in soil layers expressed as $EC_{1:5}$ (dS/m) due to NaCl, Minnipa Ag Centre, 2003

Soil Depth (cm)	Soil Salinity Levels EC 1:5 (dS/m) Gypsum Rate (t/ha)		
	Nil (control)	*2.5 t/ha*	*10 t/ha*
0-30	0.12	0.10	0.10
30-50	0.29	0.12	0.12
50-70	0.60	0.13	0.13
70-120	0.83	0.38	0.20

Table 2: Salinity levels in soil layers expressed as $EC_{1:5}$ (dS/m) due to NaCl, Cleve (G Bammann), 2003. Gypsum application in 1994/95.

Soil Depth (cm)	Soil Salinity Levels EC 1:5 (dS/m) Gypsum Rate (t/ha)			
	Nil (control)	*2.5 t/ha*	*10 t/ha*	*15 t/ha*
0-20	0.19	0.14	0.14	0.13
20-30	0.24	0.13	0.12	0.12
30-60	0.76	0.16	0.14	0.12

Table 3: Salinity levels in soil layers expressed as $EC_{1:5}$ (dS/m) due to NaCl, Lock (R Cummins), 2003. Gypsum application in 2002 (there was also another gypsum application by previous owners in the early 90's).

Soil Depth (cm)	Soil Salinity Levels EC 1:5 (dS/m) Gypsum Rate (t/ha)	
	Nil (control)	*2.5 t/ha*
0-10	0.19	0.08
10-20	0.16	0.07
20-40	0.25	0.07
40+	0.28	0.11

Table 4: Salinity levels in soil layers expressed as $EC_{1:5}$ (dS/m) due to NaCl, Murdinga (M Zacher), 2003. Gypsum application in 2003 (this area has had gypsum applications every 2 years since the late 80's).

Soil Depth (cm)	Soil Salinity Levels EC 1:5 (dS/m) Gypsum Rate (t/ha)	
	Nil (control)	*5 t/ha*
0-20	0.08	0.11
20-40	0.64	0.31
40-60	0.70	0.36

Table 5: Salinity levels in soil layers expressed as $EC_{1:5}$ (dS/m) of soil due to NaCl, Tuckey (J Burton), 2003. Gypsum application in 2000.

Soil Depth (cm)	Soil Salinity Levels EC 1:5 (dS/m) Gypsum Rate (t/ha)	
	Nil (control)	*2.5 t/ha*
0-20	0.28	0.17
20-30	0.23	0.12
30-40	0.63	0.38
40+	0.58	0.39

sandy loam over coarsely structured red clay with a history of poor structural stability when wet. When dry it has high soil strength with problems of surface crusting and seedling emergence. Treatments include gypsum and lucerne.

The purpose of the trial has been to map the movement of applied gypsum to soil and to assess its effects on the accumulation and movement of salt. The trial will run for the remaining life of the project. Gypsum will be re-applied to appropriate treatments.

As a consequence of the strong visual response on the site, the farmer is planning to apply gypsum to the remainder of the paddock. We will assess the site for changes in soil properties and look at broad scale benefits including cost benefit analysis.

What does this mean?

The results from the initial testing of historical gypsum applications on Eyre Peninsula show promise with regard to lowering transient salinity levels. Further work needs to be done over a number of years to gain more definitive information regarding exact gypsum rates required and identifying how long it takes to gain a yield increase as a result of the salt flushing effect.

The potential for improvement has been seen in laboratory experiments using soil columns. By applying gypsum at 2.5 t/ha, the hydraulic conductivity of highly sodic soils can be improved by >200%. A sodic soil (exchangeable sodium percentage 19.8) had a hydraulic conductivity of 2 mm/day. After gypsum application, the hydraulic conductivity improved to 40 mm/day.

GRDC Grains Research & Development Corporation

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Your Soil's Potential

Lyndon Masters
Field Crop Consultant, Cleve, Rural Solutions SA

Extension

Why do the program?

Understanding your subsoils could be the missing link in your knowledge of crop performance.

Many farmers have a paddock that gives disappointing yields at harvest after looking promising all year. It is a frustrating outcome when adequate rainfall has fallen and good agronomic practice has been followed. There is a general understanding that many subsoils have constraints, but few have specifically measured or mapped their farm. Farmers are being challenged with the question "What is your main subsoil constraint: boron, sodicity or transient salinity?". The challenge to understand subsoil constraints leads to the realisation that if you can't measure it, you can't manage it!

As part of a State focus project called "Your Soil's Potential", Rural Solutions SA is working with farmers on the Eyre Peninsula to help unravel this problem. This project is giving farmers practical understanding of how to measure plant available water in the soil and to use kitchen tests for transient salinity and sodicity. Soil samples are taken for available water, fertility, and soil structure.

Eighty farmers are working with Rural Solutions SA Field crops consultants on Eyre Peninsula. Linden Masters is working with groups in the Cleve Hills & Flats, Wharminda, Arno Bay & Cowell, Mark Habner has been working in the Western Area with 2 groups, and Jeff Braun is starting new groups at Tumby Bay, Tumby Hills and Butler /Ungarra. The direction groups take vary from district to district.

What happened?

Some interesting, and sometimes unexpected, results have been obtained from the 45 properties sampled on eastern Eyre Peninsula.

Boron?

Only two samples had high boron levels but a large percentage had medium to high transient salinity readings. This was a surprise to many as most have, over the years, selected varieties that have some boron tolerance believing that this was the major problem. This raises the question, "Can these varieties handle not only boron but a higher transient salinity level?"

Sodicity? or transient salinity?

Many have assumed that sodic sub soils are a problem. One farmer on testing found the sample was only mildly sodic but had a level of transient salinity that can decrease wheat yields by 20% (an Ece, or electrical conductivity, of 8 dS/m) but could grow barley with minimal penalty. With this understanding wheat will only be grown when significant early rains indicate above average rainfall years, or used only for barley production.

Mechanical constraints

Western Eyre and several eastern Eyre sites had a very shallow topsoil over a limestone calcareous sub soil. It has proved very hard to grow good crops in these situations. With high pH causing lock up of nutrients and with shallow soil depths, plant available water is limited.

Many paddocks we are working with can grow excellent early bulk but often doesn't translate into yield because they are subjected to a spring drought with not enough water being available to sustain the vegetative matter. Knowing what the soil constraints are and what water is available to the plant will allow better fertiliser decisions and improve risk management.

Plant available moisture

The soil is sampled to depth at intervals of every 10-20 centimetres. This is texture tested, weighed, dried in the microwave, weighed again and the results graphed allowing farmers to see what water is available. Sampling just before harvest shows how deep the roots have taken water from the profile and any water "bulges" are good indicators of a problem at that level.

Fertiliser application

The "Your Soils Potential" program brings nutrition, available plant water, crop growth and soil constraints into one complete package. Soil is sampled at 0-10 cm for nutrition, 0-30 cm for nitrate and ammonium N, and the subsoil (30-60 cm) for nitrate and ammonia N and a comprehensive soil analysis which at this level often indicates constraints. The presence of constraints is also estimated by estimating plant available moisture in each sample. Fertiplan is being used a tool to estimate the fertiliser required. It has the ability to adjust fertiliser requirements to allow for soil constraints. Decisions can be made early in the season, or later as the rainfall deciles for the growing season become clearer. This allows farmers to add additional fertiliser to maximise their yield potential if there is sufficient plant available water. One farmer went from a maximum previous yield of 14 bags per acre to 17 bags by understanding the constraint, measuring the water in the profile and applying additional nitrogen late in the season to reap the benefit of the season.

What does this mean?

- The "Your Soils Potential" program enables you to bring together many soil aspects (constraints and properties) into a holistic, practical approach for management of any soil type on your farm.
- Deep N tests have little value if the plant roots cannot access N at depth because of constraints.
- Knowledge learnt enables smarter use of fertilisers, tailored to soil profile and plant available moisture.
- Having a "Red Hot Go" paddock allows farmers to test the theories, increase their understanding and move towards improving crop performance.

RURAL SOLUTIONS SA

Deep Ripping/Working - Farmer Demos

Demo

Samantha Doudle

SARDI, Minnipa Agricultural Centre, EP Farming Systems Project

Location
Closest town: Buckleboo
Cooperator: Bill Lienert
Group: Buckleboo Farm Improvement Group

Rainfall
Av annual total: 325mm
2003 total: 330mm
2003 growing season: 235mm

Yield
Potential: 3.02 t/ha
Actual paddock: 2.55 t/ha

Paddock History
2003: Wheat - Carnamah
2002: Medic pasture
2001: Wheat - Westonia

Location
Closest town: Ceduna
Cooperator: Anthony "Mario" Nicholls
Group: Goode Ag Bureau

Rainfall
Av annual total: 300mm
2003 annual total: 294mm
2003 growing season: 210mm

Yield
2003 paddock: 1 t/ha

Paddock History
2002: Triticale, 2 t/ha
2001: Wheat
2002: Echidna oats

Location
Closest town: Koongawa
Cooperator: Trevor & Graham Payne
Group: Central Eyre Ag Bureau

Rainfall
Av annual total: 325mm
2003 annual total: 242mm
2003 growing season: 205.5mm

Yield
2003 paddock: 1.5 t/ha

Paddock History
2002: Lupins
2001: Barley
2000: Pasture

Key Messages

- **Yield increases from deep ripping/working are unpredictable as they vary between soil types, paddock management and seasonal conditions.**
- **One of the best ways to see if your soil will respond to deep ripping/working is to try ripping on a small area for yourself.**
- **On sandy soils at Wharminda and Kelly we have not been able to measure yield benefits in subsequent years from deep ripping to 40 cm, even though it has often improved yields in the year of the operation.**

Why do the trial?

To see if deep ripping/working will improve yields across a variety of soil types and management practices.

In 2003, during farmer group priority setting meetings, soil compaction and deep ripping were a big issue for many groups.

In response to these requests two activities were planned for 2003. The first was for farmers involved in the groups to set up their own deep ripping/working demonstrations. The second was to conduct a random soil compaction survey with the penetrometer (a gadget that measures soil resistance) at Sticky Beak Day time. Unfortunately by the time Sticky Beaks Days came around in 2003 the soil was too dry to get useful readings from the penetrometer, so this activity has been postponed until this season (obviously some time around July/August).

This article contains a summary of results from some of the deep ripping/working demos set up by members of the Buckleboo Farm Improvement Group, Streaky Bay Ag Bureau, Goode Ag Bureau and Central Eyre Ag Bureau.

How was it done?

See Table 1.

What happened?

NB: It must be noted that the demonstrations at Streaky Bay, Goode and Koongawa were all broad scale and unreplicated, therefore the results need to be considered not as actual figures, but more as general trends. Both Buckleboo sites were part of replicated trials.

Only two of the trials appear to have improved yields using a deep ripping/working technique; Streaky Bay and Koongawa (*Table 3*).

At Streaky Bay (Williams) deep working appears to have increased yields on a deep highly calcareous sand at both ripping depths used, 9 and 15 cm. At the other Streaky Bay site on Cronin's it also appears that deep working with the Aeroway Stubble King has marginally increased yield. Cronin's also noticed increased root growth in the area where this machine was used. There is a similar report of modest yield increases using this machine from another property in the area.

At Koongawa clay delving massively increased yield. The delving process not only deep ripped to 80 cm, but also bought clay up through the rip lines and onto the surface of the sand hill where the trial was set up.

There was no response to ripping at either Buckleboo site, despite the red soil being extremely hard when dry and the loam soil having a hard sodic layer at 25 cm.

At the Goode site a hard layer was identified throughout the paddock at about 15 cm. Soil boron reached toxic levels in the 10 – 30 cm layer and salinity was high enough to effect crop growth in the 30 – 40 cm layer. Actual yields were not obtained from this site. We fully expected the two deeper worked strips in this paddock to fail simply because we had encouraged crop roots down to the toxicities faster through the deep ripping process. Given the variable nature of how both boron and salt can occur across a paddock, we are not confident that deep working did increase grain boron levels (*Table 4*); if we had taken another batch of grain samples a different pattern may have resulted. All that can be said of the grain boron levels in table 4 is that they are all high, with the worst boron and screenings being in the nil worked strip. Of all the strips in the paddock, the worst looking crop was on this area with no working.

What does this mean?

BUCKLEBOO: Given that deep ripping alone could not improve rooting depth at Buckleboo, the Buckleboo Farm Improvement group are going to establish several long term monitoring sites across various rates of gypsum in these same paddocks to see if they can improve the soil structure and subsequent crop rooting depth by altering the soil chemistry and therefore eventually the structure.

Soils

Table 1: Trial establishment details in 2003

Location	Buckleboo loam	Buckleboo red	Streaky Bay Williams	Streaky Bay Cronin	Goode	Koongawa
Paddock History	*See trial summaries*					
Ripping date	May 6th	May 6th	April 15th	April 10th	March 25th	Delved in Oct '02; Austral clay delver
Ripping/working depth	40 cm	40 cm	9 and 15 cm (approx.)	20 cm (approx)	Sweeps 15 cm Knife points 20 cm (approx)	70- 80 cm (approx)
Sowing date	May 14th		June 5th	May 23rd	June 29th	June 8th
Base fertiliser	60 kg/ha of 18:20 just below the seed		55-60 kg/ha 18:20	Fluid fertilisers (kg/ha): 15.4 Phosphoric Acid, 8.7 Urea, 2.5 $ZnSO_4$, 1.5 $MnSO_4$	50 kg/ha of 17:19 1% Zn	90 kg/ha of 27:12
Crop variety	Carnamah Wheat	Frame Wheat	Chebec Barley	Excalibur Wheat	Yitpi Wheat	Excalibur Wheat
Type of ripper	MAC 5 tine ripper		Pedrick Ripper - 30 cm spacing	*Aeroway Stubble King	Shearer 170 Scarifier, initially with 7" sweeps, then knife points	Clay delver
Treatment after ripping	Driven over with plot tractor		Able to sow straight over	Able to sow straight over	Able to sow straight over	Western ripper between delved rows to spread clay (20-30cm)
Type of trial	Replicated small plot		Broad scale paddock strips with two controls	Broadscale paddock areas (0.73 ha each)	Broad scale paddock strips	Broad scale paddock strips

Table 2: Soil description of deep ripping trial sites.

Location	Topsoil Texture	pH (water)	Fizz	CO_3	Subsoil constraints
Buckleboo Red	Clay	9.8	Medium	0.14%	Roots to 30 cm where free lime increases to very high. Surface extremely hard when dry.
Buckleboo Loam	Sandy loam	9.8	Medium	0.14%	Roots to 25 cm, possibly soil structural barrier, columnar clay.
Streaky Bay Williams	Calcareous Sand	8.7	Very High	73.3%	Very high levels of free lime throughout profile. No toxicities recorded.
Streaky Bay Cronin	Calcareous sandy loam	8.5	Very High	No data	Not measured, magnesia patches occur in paddock, indicating subsoil salt and possibly boron may be present. Limestone rocks!
Goode	Sandy loam	8.5	High	3.53%	No root depth data available. Boron at toxic levels from 10 - 30 cm layer. Salt at toxic levels from 30 – 60 cm layer.
Koongawa	Sand	Delved clay 9.5	Delved clay High	No data	Clay analysis – high pH and free lime could induce manganese deficiencies when used for clay spreading.

GOODE: It is not possible to tell from this demonstration whether the nil worked strip was worse because the other two deeper worked strips really did disrupt the hard pan and give a yield advantage OR whether the un-worked strip was simply in an area of the paddock with higher levels of subsoil toxicities. Further investigation is required such as EM and yield mapping to "zone" the soil types in the paddock (with deep worked and un-worked broad scale strips), then a subsoil constraint survey and penetrometer survey in these various zones. This type of investigation would provide a much more accurate picture of how crops respond to deep working on soils with subsoil toxicities at a paddock rather than small plot scale.

STREAKY BAY: No measurements were taken at either site to assess if there were a hard pan present, but given the yield increases it is likely there was some form of physical barrier to root growth, especially at the Williams site. It would be worth investigating the potential soil barrier further. If the barrier turns out to be wide spread soil compaction resulting from paddock traffic on this highly calcareous sandy soil type, then maybe a controlled traffic farming system, with deeper working for the initial few years to break up the hard pan, may realise long term yield benefits –certainly worth looking into further. Limestone presents a problem to deeper working in these soils of course, although Cronin's reported the Aeroway Stubble King managed well with the rocks by riding over them, then continuing it's progress.

Table 3: yield results from deep ripping trials

Location	Yield (t/ha)		Potential Yield (t/ha)
	Ripped	*Unripped*	
Buckleboo Red	1.54	1.55	3.02 (wheat)
Buckleboo Loam	1.93	2.03	"
Streaky Bay W 9 cm	2.63	2.36	3.25 (barley)
Streaky Bay W 15 cm	2.52	2.10	"
Streaky Bay Cronin	1.47	1.38	1.21 (wheat)
Goode	No yield data available		2.16 (wheat)
Koongawa *	3.3	1.1	1.91 (wheat)

**approximate yield from harvest cuts. NB this demo was done using a clay delver, not a deep ripper.*

Table 4: Grain analysis results from Goode

Treatment	Protein (%)	Screenings (%)	Boron (grain mg/kg)
Deep working with sweeps	15.8	1.2	2.8
Deep working with knife points	14.8	1.9	4.4
Nil working	15	4.6	5.1

KOONGAWA: See the clay survey article in this section for more information on delving as a technique for bringing clay to the surface to overcome water repellent soils. Given that we have regularly achieved yield increases from deep ripping alone (in the year we ripped, not following years) on soils similar to this site at Koongawa, it is likely that the huge yield response at the site is from a combination of deep ripping and clay spreading (overcoming water repellence). The fact that there is now some clay mixed throughout the delved lines means that the advantage from deep ripping may well be preserved for longer than the one year we find from using deep ripping alone (as has certainly been seen at other delved sites across the Peninsula).

IN SUMMARY: Plenty of work to do in this area yet! If you are going to set up your own demonstrations this year why not check our hints for making your trial or demo as meaningful as possible in the front of this book, "Understanding Trial Results and Statistics – non-replicated trials or demonstrations".

Acknowledgements

- Mario Nicholls, Bill & Gadge Lienert, Rowan Ramsey, Ken & Dion Williams, Brent Cronin and Trevor and Graham Payne for setting up these farmer trials and making their data available for this article – thanks fellas!
- Brenton Growden and Terry Blacker for believing Peterlumbo Hill was Ayers Rock upon their arrival at Buckleboo (these boys obviously need to get out more)!!! Oh, they also assisted with sowing the site.
- Willie Shoobridge, Jono Hancock and Ben Ward for technical assistance at Buckleboo during the year.
- Ashley Barns of WCT Wudinna for supplying Paynes clay soil data.

Grains Research & Development Corporation

Location
Closest town: Streaky Bay
Cooperator: Ken & Dion Williams
Group: Streaky Bay Ag Bureau

Rainfall
Av annual total: mm
2003 annual total: 292.5mm
2003 growing season: 252.5mm

Paddock History
2002: Pasture
2001: Pasture
2000: Chebec Barley

Location
Closest town: Streaky Bay
Cooperator: Brent Cronin
Group: Streaky Bay Ag Bureau

Rainfall
Av annual total: 312mm
2003 annual total: 227mm
2003 growing season: 170.5mm

Yield
Potential: 2.1 t/ha
2003 paddock: 1.4-1.5 t/ha

Paddock History
2003: Excalibur wheat
2002: Excalibur wheat
2001: Excalibur wheat

Survey

Eyre Peninsula Clay Spreading & Delving Survey - a summary of results to date

Rachel May[1], Samantha Doudle[2]

Rural Solutions SA, Cleve[1], SARDI, Minnipa Agricultural Centre[2]

Try this yourself now

Location
Closest town
All over EP
Cooperator: 21 clay spreaders and delvers across EP

Rainfall
Av. Annual total: 250mm-550mm

Soil Land System: Various
Major Soil Type Description: Predominantly deep non-wetting sands over clays in various rainfall zones across EP. Clays varied from yellow sodic clays to grey calcareous clays and red buckshot clays of Lower EP.

Key Messages

- **When clay spreading or delving, it is important that you understand the types of clays you are applying, particularly if they are calcareous, high pH clays. There is potential for manganese deficiency and other nutritional problems in subsequent years crops.**
- **It is important to get your clay tested before spreading. This can be done either by sending samples away for a lab analysis or doing basic field-tests to determine estimates of free lime, pH, sodicity and clay percentages. Remember, a "bad" clay for a subsoil could be a "good" clay for spreading!**
- **Work out why you are actually claying? If it is only to improve the overall management of the soil you may only need minimal amounts of**

clay to reduce with the non-wettingness of the soil. In many cases the heavier the rate applied, the greater chance there will be other problems, physical and chemical, later on down the track.

- **Appropriate incorporation is an important factor in the success of your clay spreading.**
- **An Eyre Peninsula clay spreading/delving manual or a series of fact sheets will be published in mid 2004 with complete results from this survey.**

Why do the survey?

To collect some actual paddock data in an attempt to answer some of the questions that have arisen regarding the varying responses to clay spreading and delving on Eyre Peninsula.

Since 1996 there have been many thousands of hectares of sand spread with clay on Eyre Peninsula, with varied results. Most of the advice given in the early years was based on information coming from the South East, where farmers had already been clay spreading for many years. This survey aims to identify the issues of concern specifically on Eyre Peninsula and hopefully find a few answers to the concerns identified. The final outcome of the survey will be a published report of the results. This article is only a summary of the key points identified through the result analysis to date.

This project was commissioned by the EP Farming Systems project in response to issues raised many groups across Eyre Peninsula.

How was it done?

A clay spreading survey was sent out in 2001 to all landholders via "The Long Run" newsletter. The initial survey identified the main issues people were encountering with clay spreading: clay rate, incorporation methods and nutrition issues following clay spreading. During the 2003 Farming Systems group meetings it was identified that more information was also required on delving.

Twenty-one properties across Eyre Peninsula were chosen from the initial survey forms as case studies and in October 2003 extensive soil analysis were undertaken. Samples were taken from sites that had clay applied (spread or delved) and corresponding unclayed areas. Where possible, samples were also taken of the clay from the clay pits. Around 150 samples were sent away for analysis (including pH, trace elements, % clay, sodicity, free lime, boron, salinity, microbial carbon and a non-wetting rating.

From the results, field notes and farmer comments we are able to start pulling together a picture of what is happening to the soils following clay application on Eyre Peninsula.

What happened?

The soil analysis from the 21 case studies have enabled us to better identify the types of clays used for spreading and delving, and what things to look out for when using particular clays. The following trends have been established from the data so far:

Highly calcareous, high pH clay

The majority of the clays used on EP are highly calcareous and have a high pH. This has led to problems with nutrient tie-up and deficiencies in subsequent crops, particularly with trace elements such as manganese. This is a particular problem where high rates (150 t/ha and over) of calcareous clays are used.

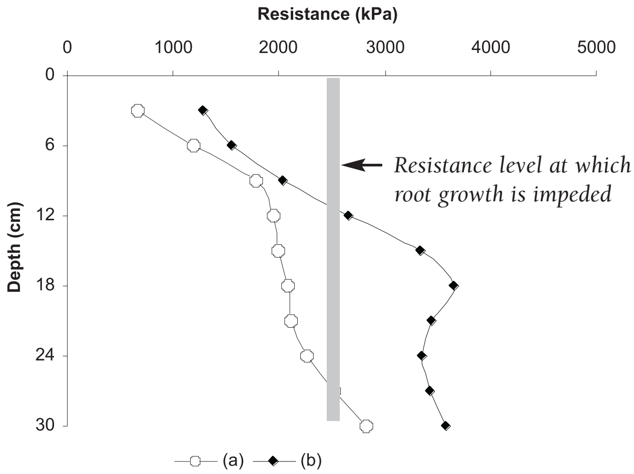

Figure 1: Penetrometer readings from adjacent clay spread sites at Edillilie, 2003.

Table 1: Microbial Carbon results at Koongawa, 2003.

Sample depth	Microbial carbon ugC/g dry soil	
	Delved	Undelved
0 to 10cm	71.07	147.75
10 to 20cm	13.88	0.00
20 to 30cm	36.42	0.00
30 to 40cm	12.77	1.03
TOTAL	134.14	148.78

There did not seem to be any major problems identified with using non calcareous, neutral to low pH clays at high rates (over 150 t/ha), as long as they were well incorporated. These clays were generally found on Lower EP.

Soil Compaction

Physical soil problems occurred when inadequate incorporation techniques were used. In many cases soils were quite compacted in the first 10 to 15cm as a result of poor incorporation. This was evident even in situations where lower rates (less that 150 t/ha) were used.

Figure 1 shows penetrometer readings taken from 2 adjacent paddocks at Edillilie. Both had 150 to 200 t/ha clay applied, paddock (a) in 1999 and paddock (b) in 2000. Paddock (a) was incorporated an off set disk to 18cm depth, whereas paddock (b) was incorporated with a wideline. Other than this difference both paddocks have had similar cultivation and cropping histories. Figure 1 shows that paddock (b) was becoming compacted for good root growth at 10 cm depth, whereas paddock (a) only started to show a problem at around 26 cm. It must be noted that these readings were taken when the soil was very dry (2% moisture), so these figures demonstrate a comparison between two incorporation methods, not an exact figure of resistance and depth of root penetration.

Delving

Delving raised the question as to whether the act of delving had more of a ripping and mixing response rather than simply a response from the clay application? This was particularly evident in a delved site at Koongawa where there was a noticeable mixing of organic matter through the soil profile in the delved lines. This site was delved in 1999 and the mixing of organic matter could still be seen by the darker colours through the sand profile down to the subsoil clay. Microbial samples were taken from both the delved line and between the delved lines, where the soil had not been disturbed. Table 1 shows that total microbial numbers were very similar in both the delved and undelved sections but that the microbial carbon was distributed throughout the profile in the delved line and only existed in the top 0-10 cm in the undisturbed areas.

The crop growing over the delved lines was clearly higher and greener at the time of soil sampling. Another example of crop improvement from delving was at Midgee (north of Cowell) where the delved section gave a yield increase of up to 0.5 t/ha on triticale in 2002. This site was delved in 2002. The microbial results were also very similar to those seen in Table 1 above.

What does this mean?

The key messages from this survey to date are:

- There are generally two types of clay used for spreading and delving on EP. These are the inert, low pH, high clay content clays (found mostly on Lower EP), and the high pH, highly calcareous clays found throughout the rest of EP. The key point is to be aware that if using the calcareous clays you are less likely to suffer severe manganese deficiency if you use below 150 t/ha.
- Manganese deficiency was a problem on a majority of the sites sampled in the survey, so it is important to be aware of this and monitor crops for Mn deficiency following claying or delving and apply manganese when needed.
- Highly calcareous and high pH clays are raising soil pH by up to 1 unit after mixing with the sand. This could lead to possible further nutritional problems. Monitoring crops for nutritional requirements after clay spreading/delving is recommended.
- All clays need to be well incorporated in the first year to reduce surface compaction and subsequent plant emergence and root growth problems.
- Delving may have more of a ripping and mixing response by mixing organic matter through the profile. In many cases the effects of delving or ripping can be seen for many years to come, particularly where sand compaction is a problem.
- All clays need to be tested before spreading, this can be done either through basic field tests, such as “ribboning” to determine clay %, fizz tests to determine free lime and simple pH tests. Alternatively samples can be sent away for lab analysis available through various agents.

In summary, on Eyre Peninsula claying hasn’t shown the huge yield increases originally anticipated. However, farmers are finding that claying makes the general management of paddocks easier, for example, weeds are easier to control due to a more even weed seed germination after improving the non-wetting status of the sand with clay. Claying has also enabled farmers to crop more continuously and in some cases has increased rotation options, ie lupins were able to be used for the first time (a non calcareous clay was used in this example.)

These are only the initial findings of the survey results, there are still a lot more answers that need to be found, but hopefully these will be addressed in the final project document.

Acknowledgements

Special thanks to all those that returned the initial survey in 2001 and also everyone that let us take the soil samples and quiz them for more information in October last year.

Thanks also to Wade Shepperd and Ben Ward for helping collect the soil samples and to Sam Doudle, Fish Cordon, Nigel Wilhelm, Dave Davenport, Brian Hughes and Annie McNeill for their comments on the results.

Thanks also to the project sponsors GRDC, EP Soil Conservation Boards and the Natural Heritage Trust.

GRDC Grains Research & Development Corporation

EP Soil Conservation Boards

Natural Heritage Trust
Helping Communities Helping Australia

RURAL SOLUTIONS SA

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Location
Closest town: Wharminda
Cooperator: Shane Malcolm
Group: Wharminda Ag Bureau

Rainfall
Av. Annual total: 330 mm
Actual annual total: 298 mm

Paddock History
2002: Wheat
2000: Ripped & cross ripped to 20 cm
1999: Calcareous sandy clay loam spread @ 250-300 t/ha

Plot size
50 m x 9 m

Clay Spreading with Highly Calcareous Clays

Demo

Shane Malcolm[1], David Davenport[2] and Sam Doudle[3]

Farmer, Wharminda[1], Rural Solutions SA[2], SARDI, Minnipa Agricultural Centre[3]

Key Messages

- **Clay spreading with calcareous clay can induce manganese deficiency.**
- **Single foliar trace element applications may not be sufficient to correct deficiencies.**
- **Placement of copper, zinc and manganese below the incorporated clay layer appears to have partially addressed the problem.**
- **Type and rates of clay and the effect on topsoil pH needs to be considered when clay spreading.**

Why do the trial?

To compare deeper tillage (to 18 cm) and fertiliser placement (to 16 cm) to normal sowing practice on clayed and unclayed areas on a shallow sand over clay soil at Wharminda in the hope of improving the performance of some heavily clay spread ground.

Shane Malcolm commenced clay spreading non-wetting sands in 1998. He considers that clay spreading has reduced wind erosion and made management of these paddocks easier, but has also observed yield reductions on some clay spread areas. The clay used had varying levels of carbonate (lime), which is known to "tie up" phosphorus and some trace elements, partly because soil pH levels have been raised, which makes these elements less available. Plant analysis has identified manganese deficiency as an issue in previous crops and crops have responded well to 2 foliar sprays of manganese. However, yields on the clayed areas still haven't equalled those of unclayed areas in the same paddock. This factor, combined with the difficulties and cost involved in applying 2 foliar sprays per crop has raised the following questions:

- Are there other issues affecting yield on this clay spread ground?
- Is there a better way to apply the required nutrients
- Will placement of nutrients below the band of incorporated highly calcareous clay improve nutrient availability to the plant?

How was it done?

The site selected was a paddock with 20-40 cm siliceous sand over sodic clay. Clay was spread in 1999 @ 250-300 t/ha. A portion of the paddock was left unclayed to provide a comparison.

Unreplicated plots were sited across the boundary of a clayed and adjacent unclayed area with a 50m strip on each side with a 10m buffer along the boundary. Deep tillage to 18 cm and deep fertiliser placement to 16 cm was done with a 6 row Alfarm chisel plough. Urea was predrilled at 50 kg/ha and all treatments (except treatment 5) were fertilised with 60 kg/ha of 18:20. Treatment 5 was fertilised with the equivalent levels of N and P to the other treatments but comprising 30 kg/ha of 18:20 and 80 kg/ha of Carbonite 12, an organic fertiliser provided by Mattingly minerals.

Trial Details

13/5/03 - Urea predrilled @ 50 kg/ha

14/5/03 - Deep treatments

30/5/03 – Schooner Barley sown with 6 row Alfarm

Fertiliser

Standard - 18:20 @ 60 kg/ha

Treatment 5 – 18:20 @ 30 kg/ha, Carbonite 12, @ 80 kg/ha

Trace elements:

Soil copper & zinc oxy-sulphate (20% Cu, 20% Zn) @ 5kg/ha elemental manganese mono-sulphate @ 5kg/ha elemental

Foliar zinc sulphate @ 1.6 kg/ha, manganese sulphate @ 2 kg/ha

Treatments

1 Deep Tillage to 18 cm
2 Deep placement of N & P (16 cm)
3 Deep placement of N, P, Cu, Zn & Mn
4 Deep placement of N & P, foliar spray of Zn & Mn
5 Carbonite 12, @ 80kg/ha + 18:20 @ 30kg/ha
6 N&P shallow (Control)
7 N&P shallow, foliar spray of Zn & Mn
8 N&P shallow (Control)

Measurements

YEB analysis for major and trace elements, grain weight, screenings, protein, and grain nutrient analysis.

Table 1: Clay analysis used in Shane Malcolm's clay spreading demonstration

Texture	CO_3 (%)	pH ($CaCl_2$)	DTPA Mn**	DTPA Cu	DTPA Zn	Boron (Hot HCl)	Kg N/ha	Colwell P (mg/kg)	Colwell K (mg/kg)	OC%	S	ESP%	Approx. ECe
loam	2.5	8.2	1.39	0.27	0.43	5	43.4	15	364	0.77	7.1	3%	1.75

*** Note that soil DPTA manganese is not considered a reliable indicator of manganese availability, particularly on high pH soils. Also that clay samples were collected from the surface of the paddock at harvest in 2002 and it is therefore likely that the ECE, boron, ESP are now lower than when it was originally spread.*

Table 2: Shane Malcolm - Yield and Grain Analysis Results, 2003.

Treatment	Yield (t/ha)		Test Weight (kg/hL)		Screenings %		Protein %	
	Clayed	Unclayed	Clayed	Unclayed	Clayed	Unclayed	Clayed	Unclayed
Deep Tillage to 18 cm	1.82	4.46	66.7	63.1	3.3	1.2	14.8	9.5
Deep placement of N & P (16 cm)	2.28	3.95	63.6	65.1	1.3	3.0	9.2	15.9
Deep placement of N, P, Cu, Zn & Mn	3.05	3.91	66.1	58.9	1.6	1.5	14.7	9.9
Deep placement of N & P, foliar spray of Zn & Mn	1.48	3.35	62.9	63.5	2.0	1.1	16.1	11
Carbonite 12® @ 80 kg/ha + 18:20 @ 30 kg/ha	1.65	3.50	64.3	64.9	4.7	2.1	15.2	11.3
N & P shallow (Control)	1.96	3.49	74.4	62.6	4.0	1.4	15.8	10.1
N & P shallow, foliar spray of Zn & Mn	1.25	3.50	63.9	63.2	7.3	1.5	15.4	10.2

What happened?

See Table 1.

Emergence - Unclayed plots appeared to have better plant establishment than clayed plots.

Mid-tillering – Generally plants were higher and darker coloured on the unclayed plots. On clayed plots the plants were yellow with poor vigour, except for deep placement with N, P, Cu, Zn & Mn which was better. There were no visual differences between treatments on unclayed ground.

Tissue tests indicated marginal to deficient levels of manganese on all treatments (both clayed and unclayed) where manganese had not been applied either to the soil or as a foliar spray. Also grain nutrient analysis suggested deficiencies on clayed treatments where manganese had not been applied.

What does this mean?

This is not a replicated trial which means there is some difficulty in confidently quantifying the impact of different treatments. Despite this, there does appear to be a yield response to trace elements placed at 16 cm in the profile in clayed ground. There may also have been a response to N & P at this depth. Trace elements as foliar sprays did not appear to be effective in this demonstration.

Deep tillage to 18 cm on unclayed ground increased yields by 1 t/ha, or by 30%, without reducing grain quality. Deep placement of N & P also produced a marked increase in barley yields but also caused a lift in grain protein which would have lost malting quality. The benefits of deep placement of N & P may have largely been due to the deep ripping benefits, rather than the placement of the fertiliser.

This data is consistent with our existing knowledge of reduced manganese availability at increasing pH and high levels of calcium carbonate. This work also supports previous demonstration work conducted on clayed ground at Edillilie in 2000 where trace elements including manganese, applied below the level of incorporated clay, resulted in yield increases in barley. Lower clay rates when using highly calcareous clays may reduce the negative effects of that clay. Further work is required to identify the most effective and economical means of supplying manganese to clay spread soils.

Future Recommendations

Replicated trials need to be conducted to determine if higher rates or different combinations of trace elements may improve the response and/or be more economical. Also, whether seed dressings overcome initial deficiencies prior to extensive root development to the depth of trace element placement.

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Shane Malcolm.

Brian Purdie, Mick Lakin, SARDI.

Soils

Notes

Section 8

Section editor: Brendan Frischke

SARDI, Minnipa Agricultural Centre

United Grower Holdings

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Tillage

A request from the farmer group meetings in March 2003 was for information on good web sites to access tillage information, including row spacing, points, no-till and precision farming. The following are some of our recommendations:

- Most useful was www.wantfa.com.au and access the LINKS section to look at other sites
- CANADIAN Prairie Agricultural Machinery Institute (PAMI) was worth a look at www.pami.ca
- Otherwise use the agriculture search engines www.web-agri.com or www.agsearch.com and look up tillage (may be useful to type in Australia as a key word if you don't want heaps of overseas stuff)
- HAPPY SURFING !!

Controlled Traffic on the Minnipa Ag Centre - effect on cereal yields in 2003

Survey

Nigel Wilhelm and Mark Bennie

SARDI, Minnipa Agricultural Centre

Key Messages

- **CT has been a positive introduction onto the Minnipa Ag Centre farm because of the ease and comfort of seeding and spraying operations.**
- **Permanent and bare wheel tracks did not reduce the yield of barley in 2003 providing the tracks were clean of weeds.**
- **Permanent and bare wheel tracks reduced yields of wheat in 2003 by 60% (ie 3% across the whole paddock) providing the tracks were clean of weeds. With weedy tracks, the wheat was unable to compensate and no yield was gained from the wheel tracks (ie 5% yield loss across the whole paddock).**

Why do the trial?

- To demonstrate the impact of CT systems on farming operations, subsequent crop performance and soil condition.
- To further improve efficiencies in the management of the MAC farm.
- To measure the impact of permanent wheel tracks on paddock yields.

How was it done?

Controlled traffic (CT) systems were introduced onto the MAC farm in 2002. The plan has been to employ a range of CT approaches on the farm, each one onto an individual paddock, and to keep some paddocks under conventional management for comparison. In this way, we hope to monitor the impact of CT systems on crop performance and soil condition in an upper EP environment.

Best practice

Location
Closest town: Minnipa
Cooperator: MAC farm
Group: Minnipa Ag Centre

Rainfall
Av. Annual total: 326
Av. Growing season: 241
Actual annual total: 263
Actual growing season: 200

Yield
Potential: Wheat – 1.9 t/ha, Barley – 2.3 t/ha
Actual: Wheat – 1.04 to 1.42 t/ha, Barley – 1.07 t/ha

Soil
Red brown calcareous sandy loam

Plot size
One metre of crop row for each tine of the MAC seeder, 4 locations per paddock, seven paddocks sampled

The features of our CT system are:-

- Permanent wheel tracks are maintained in all CT paddocks, and either left bare (one seeding tine behind each track of the CAT tractor removed) or seeded (all seeding tines left in place).
- Our Gason 5100 seeder bar is 9 m wide, our Croplands boom spray is 18 m wide but our header has a 6 m front. We do not intend to adapt the header to the 9 m swaths at this stage.
- Although the widths of the seeder and boom spray line up for CT management, we have not yet adapted their wheels to all travel on the same tracks. The air seeder cart has three wheels, the two outside ones partly straddle the tractor tracks but the central wheel is well away from either track.
- The boom spray is towed by a Land Cruiser whose wheels travel inside the CAT tracks. The boomspray is manually steered and has not been electronically guided (although an Outback S precision guidance package will be used in 2004).
- Track width for our system is 2 m, which is the maximum width our tractor can be set to.
- Wheel tracks in all CT paddocks, with the exception of one, are now managed with the Beeline autosteer unit and have been operated in an up and back pattern (accurate to +/- 2 cm). The single exception is a paddock which is managed with Haukaas marker arms but still in an up and back pattern. All conventional paddocks are managed in a round and round pattern.
- Weeds in wheel tracks have not been controlled except by way of general paddock operations.

At harvest in 2003, seven paddocks were sampled for grain yield to estimate the impact of wheel tracks on paddock yield because one of the most frequent criticisms of CT systems is the reduction in cropped area due to bare wheel tracks (and hence lost income). Grain yield from one metre of crop row from each and every tine of the seeder was measured at four locations in each paddock. Adjacent seeder passes were sampled to ensure that tracks which had, or had not, been used by the boom spray vehicle were both measured. Actual swath width was also measured in the first CT and conventional paddocks sampled and this measurement was used in all subsequent calculations of "paddock yields". The weediness of wheel tracks at each sampling point was also noted.

What happened?

By the end of seeding in 2003, CT had been introduced into 11 of the 28 paddocks on the Centre. Of the rest, three paddocks were broadcast seeded and the rest were managed conventionally. This means that 50% of the 971 arable hectares on the Centre are now under CT management, and nearly all of those are under systems with bare wheel tracks maintained with the Beeline row crop and autosteer unit. Three paddocks (for a total of 76 hectares) were managed with permanent wheel tracks which were seeded. One paddock of 45 hectares is under CT management with seeded wheel tracks maintained with marker arms. Six paddocks have now been cropped twice under CT management.

When the original wheel tracks were laid out, a basic oversight resulted in the swath width being one row too narrow so that now the outside rows on each pass are very close to each other. We have decided not to redo the tracks as the slightly narrower swath widths give us a margin for error with the manually steered boom spray. It would also give us a small margin of error for the header, should we ever go to a 9 m front.

Seeding, spraying and harvesting operations seem to be more efficient and easier on the operator in the CT paddocks, especially with spray operations because the wheel tracks near the vehicle are much easier to follow than blobs of foam at the end of the boom. Following wheel tracks and crop rows has made harvesting a gentler operation as well, compared to crossing furrows in conventional round & round seeded paddocks.

Cereal yields under different management systems.

Yields in each metre of crop row were highly variable across the seeder bar, with the highest row yield typically being 5 times higher than the lowest (*see Figure 1 for a typical situation*). Plant densities down each row were also highly variable which suggests that much of the yield variability was due to inconsistent flow of seed along each crop row.

Individual row yields across the whole seeder were measured at four locations in one paddock which had been managed conventionally and seeded to Yitpi wheat. The average yield across the whole machine was exactly the same as the average yield of all crop rows not in, or next to, the CAT tracks (3 rows for each track). This suggests that the wheel tracks had no impact on wheat yields in that paddock in 2003. By extending this result to all cereal paddocks on the Centre last year, we tested for the impact of CT systems on paddock yields by comparing average row yields of the whole machine against average yields of all rows not in, or next to, the CAT tracks ("non-track" yield).

Average grain yield across the whole machine for one paddock seeded to wheat and managed with CT and bare wheel tracks was 3% lower than non-track yields. Mathematically, if CT with bare wheel tracks had no effect on cereal yields except the loss of 2 crop rows in every seeder pass, paddock yields should drop by 5%. However, yields only dropped by 3% because the rows next to each CAT track yielded 24% better than non-track yields.

This compensatory effect of the rows next to each bare wheel track was more pronounced with barley, where in the average of two paddocks seeded to barley and managed with CT and bare wheel tracks, whole machine yields were 1% higher than non-track yields. Rows next to wheel tracks yielded 55% better than non-track yields (*Figure 2*). This suggests that there was no loss of paddock yield in these barley paddocks despite the presence of bare wheel tracks.

Even though barley appeared to have a greater capacity to compensate for the presence of bare wheel tracks, another important factor is the weediness of the wheel tracks. In one large paddock of wheat, four locations were sampled with bare wheel tracks thick with barley grass and four with weed-free wheel tracks. In the weed-free areas, whole machine yields averaged 3% lower (and rows next to tracks 24% higher) than non-track yields. Where the barley grass was thick, whole machine yields were 4.7% lower, and rows next to tracks only 4.4% higher, than non-track yields.

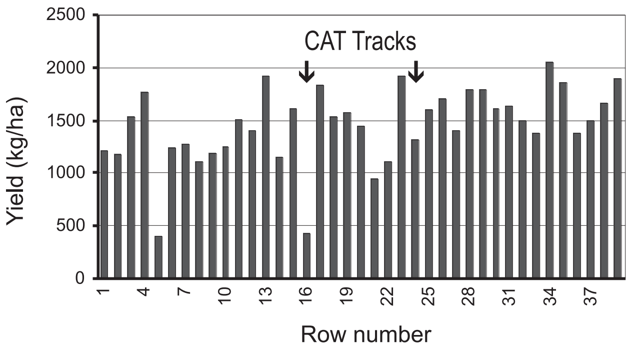

Figure 1: Grain yields of Yitpi wheat for each row across the Gason 5100 seeder bar, paddock S5, 2003, managed conventionally.

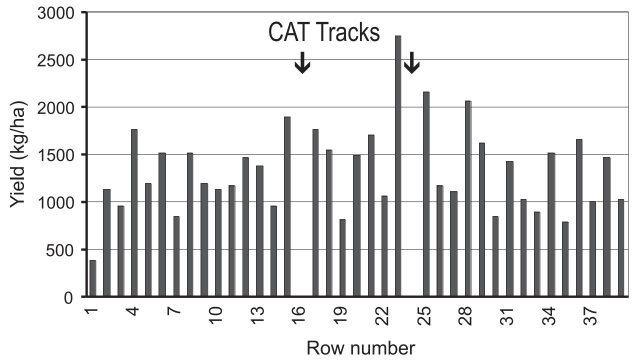

Figure 2: Grain yields of Sloop barley for each row across the Gason 5100 seeder bar, paddock N8, 2003, managed with CT and bare wheel tracks.

The boom spray appeared to have had no effect on crop yields because yield patterns across the seeder were similar in all passes, even though the boom spray was used on every second pass only.

There were insufficient paddocks with suitable management histories to test the effect of duration of CT on yield patterns across the seeder.

What does this mean?

Shifting from conventional round and round management of cropping paddocks on the Centre to CT with permanent wheel tracks and up & back working has been a positive step in terms of the comfort and accuracy of operations. With our seeder now configured with narrow points and press wheels paddocks had become quite rough for in crop operations. However, in CT paddocks all operations are either on unworked, permanent wheel tracks or in the same direction as crop rows. This same outcome could have been achieved by doing nothing else but shifting to up & back workings except that turning back on the previous run at seeding caused problems with damaged hoses on the air seeder. With the Beeline row crop unit in operation (and where permanent wheel tracks already existed and remain visible), we have now shifted to a pattern of seeding alternate passes(rip-skip) to avoid tight turns. This would not have been possible or imaginable in a conventional system.

Based on the measurements taken from 2003 crops, the penalty in yields for introducing permanent and bare wheel tracks was about 3% in wheat paddocks, providing the tracks are clean of weeds. If the tracks are weedy, then the yield reduction is about the same as the loss in cropped area, ie 5%. In barley, there appears to be no loss in yield with bare clean wheel tracks. We will continue to monitor crop yields in this way in future years to see if this pattern is maintained in different seasons with different crops and with increasing duration of the same wheel tracks and non-trafficked cropping areas.

Our plan is to continue to monitor bare wheel tracks for weeds in future years. We hope that the tracks will pack down sufficiently to suppress weed germination and plant vigour but if that does not occur, then we may have to selectively control these weeds to minimise the impact of the loss in crop area on paddock yields (probably with shielded sprayers).

We will continue to maintain CT systems with either bare or seeded wheel tracks because this will give us the best opportunity for measuring the impact of CT on soil condition and whether this results in improved crop productivity.

Our plan is to gradually modify our equipment so that it all lines up on the same 2 m wide wheel tracks, although we do not intend to include the header in this plan. The first priority in this plan is to adjust the air seeder cart, especially since the boom spray appeared to have little impact on crop performance.

One spin-off from the introduction of CT onto the Centre is that the marker arms are now also used in the conventional paddocks because it is much easier to drive straight with them rather than following the worked edge.

Acknowledgements

MAC committee for initiating and supporting the concept of CT on the Centre.

To the Centre farm staff for taking on CT with such enthusiasm.

Haukaas and Barundo Hill for donation of marker arms.

Beeline Technologies for provision of row crop and autosteer unit.

Willy Shoobridge, Sam Doudle and Ben Ward for completing the sampling process after N Wilhelm had finished his token effort.

Searching for problems

No-till adoption issues for EP growers

Survey

Frank D'Emden and Rick Llewellyn

CRC Australian Weed Management, School of Agricultural & Resource Economics, University of Western Australia

Key Messages

- **Overall, no-till adoption is expected to increase on EP, mainly due to perceived soil and seeding time benefits.**
- **Machinery costs and perceived weed control/resistance issues are the main reasons given for non-adoption.**
- **Most growers believe use of no-till systems will lead to greater risk of herbicide resistance, particularly glyphosate.**

Why do the trial?

To identify no-till adoption issues and opportunities by determining trends in no-till use and the factors influencing the decisions of users and non-users.

How was it done?

As part of a broader national survey, 80 growers in parts of the Eyre Peninsula (i.e. Streaky Bay, Wudinna, Minnipa, Kyancutta, Cummins, Yeelanna, Wanilla, Kimba and Cleve) were interviewed by phone in 2003. Growers were called at random with a 55% response rate. Growers were asked about their current and intended seeding practices in five years time. They were also asked why they had or hadn't adopted no-till and, if they had reduced their use of no-till, why they had done so. Growers were asked how they thought weed management factors and soil erosion would differ under long term (i.e. 10 yr) no-till with stubble retention as opposed to long-term full-cut seeding with stubble removal.

What happened?

Fifty eight percent of EP respondents were using no-till (defined as seeding with narrow points or discs with no prior cultivation) on some area of their farm, with 64% using some direct drill or minimum till and 30% using some form of cultivation prior to seeding with discs or narrow points. The number of no-till users is expected to increase, with 71% stating that they intend to be using some no-till within 5 years. For no-till users, the average proportion of crop expected to be sown using no-till is expected to increase from 66% in 2003 to 73% by 2008.

Table 1: Reasons given by users for adopting no-till

REASON FOR TRYING NO-TILL	% of growers*
Soil conservation	74
Seeding time, timeliness and better yields	57
Soil structure/organic matter/moisture conservation	37
Stubble retention	24
Seed placement and seedbed preparation/deep banding	15
Weed control	4
Input cost savings	4
Observations, recommendations and experimentation	4

Reasons for adopting no-till

The main reasons given by users for adopting no-till were for soil conservation and shorter seeding times and seeding timeliness (*Table 1*). Other commonly cited reasons included the improvement of soil structure, organic matter retention and moisture conservation and stubble retention.

Table 2: Reasons given by non-users for not adopting no-till

REASON FOR NOT TRYING NO-TILL	% of growers*
Machinery costs	38
Weed control and herbicide resistance	29
Not seen good enough results	18
Soil diseases	18
Hard, stony soils	15

** Numbers sum to over 100% due to more than one reason being accepted from each respondent*

Reasons for reducing no-till use

Thirty percent of no-till users had reduced their use of no-till. The main reason for growers reducing their no-till area was weed control, with both woody weeds and grass weeds being specified as problems. Other reasons included low yields, disease control and snails (*Table 3*).

Table 3: Reasons given by users for reducing no-till area.

REASON FOR REDUCING NO-TILL	% of growers*
Weed control	57
Low yields	14
Disease control	14
Snails	7

** Numbers sum to less than 100% due to one unusable response*

Perceived weed management and soil erosion under no-till with stubble retention vs. full cut seeding with stubble removal

Fifty three percent of growers believed that long term weed emergence would be lower under no-till with stubble retention (NTSR), as opposed to 19% who thought it would be higher. Eighty six percent of respondents thought that herbicide costs would be higher under NTSR. Most respondents thought that the risk of herbicide resistance under no-till would be higher (64%), with 70% believing that the risk of resistance to glyphosate would be higher under NTSR. Most growers (89%) believed that soil erosion would be lower under NTSR.

What does this mean?

Machinery costs and weed control issues, in particular herbicide resistance, appear to be the main barriers to EP growers getting into no-till systems. The vast majority of growers expect that no-till systems will lead to more herbicide resistance, particularly glyphosate resistance. Weed management problems including herbicide resistance are the main reasons for some growers reducing their use of no-till. However, growers perceive major soil and seeding time benefits and these are the main reasons driving no-till adoption. As growers overall intend to increase their use of no-till in the future, integrated weed management options that fit within no-till systems are required.

Acknowledgments

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Seeding Systems for Stony Soils

Research

Jack Desbiolles

Agricultural Machinery Research & Design Centre, University of South Australia

Location
Millewa (Vic)

Key Messages

- **Using the right seeding system for prevailing soil conditions can optimise crop establishment and lead to increased yield response in traditionally lower-yielding areas of paddocks.**
- **When setting up seeding systems for stony environments consider the type of seeding unit, point selection, seed boot configuration and contour-following ability, break-out system characteristics and operational settings (depth, speed). Investment costs and product durability are also key considerations.**

Why do the trial?

To identify the seeding mechanisms that provide the best foundation for crop performance in stony soils.

Stony soil conditions are a significant issue in many farming districts. They can occur as patches of loose stones within paddocks or as shallow limestone reefs.

Seeding success in these rough ground conditions is measured by the quality of crop establishment, which depends on the ability of the seeding system to maintain seeding depth uniformity and provide an adequate furrow environment.

Trials have shown that superior technology can optimise crop establishment and lead to increased yield response in traditionally lower-yielding areas of paddocks.

What happened?

Trials conducted in the Millewa (Vic) district during 2000 showed the technology of seeding systems can significantly affect:

1. the uniformity of seeding depth obtained under intense stump-jumping activity
2. the resulting crop establishment and yield performance of a crop.

These results showed that enhanced seeding depth uniformity and extra soil moisture obtained through deep tillage improved wheat establishment in stony soils, but deep tillage also increased paddock roughness.

Under the experimental conditions (conventionally farmed sandy-loam stony paddock, drying topsoil at seeding with adequate moisture below, 9mm follow-up rains 9-12 days after sowing, overall a decile 7 growing season rainfall), the following was observed:

- Frame wheat establishment was better (150-160 plants/m^2) with some tillage (90-95mm depth) below the seed zone compared to the single-shoot control (119 plants/m^2) or where a low-disturbance disc system (135 plants/m^2) was used.
- Higher stump-jumping intensities, due to deeper tillage or lower tine breakout, reduced seeding depth uniformity and crop establishment. Increased working depth (125-130mm) reduced the tillage response (by as much as 17%) due to over-riding penalties suffered under more intense stump jumping. At equal tillage depth, higher breakout rating (250kg vs 130kg spring systems) improved emergence by 23% with rigid-mounted seed boots.
- Deep tillage (90-95mm) produced yield responses of 10-30% (0.23-0.69 t/ha), with no additional benefits from working to 125-130mm. Crops sown with independently mounted seed boots yielded 10-11% (0.25 t/ha) better than where rigid seed boot systems were used. Treatments with the poorest establishment produced the lowest yields (5-16% below site average).

What does this mean?

Optimising seeding depth

The sowing depth accuracy of tine-based seeding systems in stony ground conditions can be improved by:

i) Shallower tillage depth and/or use of a higher breakout rating.

ii) Sowing at tillage depth (i.e. no tillage below seeding depth, minimising soil disturbance and eliminating the need for backfilling).

iii) Using low-disturbance narrow point openers to minimise interactions with stones.

iv) Adjusting individual seed boots to compensate for ridging effects on each row. Harrow covering devices can help remove some of the ridging effects and smooth out variability in soil cover along and across seed rows.

v) Seeding on a ledge with side banding or paired row sowing rather than relying on closer plates for furrow backfill where deeper tillage below the seed zone is used. Furrow closer plate performance in stony soils is typically variable but can be improved by facing seed boot outlets rearward. Offsetting closer plates from the furrow centre can increase interaction with soil tilth.

Minimising paddock roughness

Stone disturbance and resulting paddock roughness are important issues when sowing into stony ground.

Paddock roughness can sometimes be adequately corrected with subsequent rolling but machinery options to minimise stone lifting and exposure to the surface include:

i) using disc openers rather than points

ii) targeting shallower tillage depths

iii) using lower breakout rating trip systems

iv) selecting narrower point width

v) higher rake angle (steeply inclined) openers

Low breakout rating and low disturbance openers can reduce crop establishment.

Disc or narrow point?

Disc openers are usually not perceived as stone friendly. The limited width at the disc cutting edge makes them prone to quicker wear and damage under high-stress situations, such as when penetrating harder or stony ground. However, they are able to roll over a stony patch with minimal stone disturbance, limiting the amount of lifting and exposure to the surface.

The vertical up forces generated by discs make them very sensitive to changes in ground conditions. Disc systems relying on gauge wheels to regulate their operating depth require a proportional adjustment to breakout pressure to maintain working efficiency when soil hardness varies (eg transition from shallow stony to deeper/softer patches) in a paddock. Too little pressure results in the opener disc riding out and poor seed placement/furrow closure. Too much pressure can result in "bulldozing" and excessive soil throw/ridging.

Down pressure adjustments can be achieved through automated (sensor based) or manual (in-cab) control of the hydraulic pressure system. Maximum pressure is limited by actual machine weight.

In stony soils, narrow points have a better ability to generate soil tilth from depth (eg. moisture delving) and their forward rake angle minimises upward force reactions. However, stone disturbance is comparatively increased.

Reducing point width and increasing the rake angle of points will minimise stone lifting and disturbance effects, but steeper inclined points are less efficient when operating deep and can require higher draft.

Figure 1: Superior sowing technology improved seeding success in stony soils.

Figure 2: Independently mounted seed boots offer greater tillage flexibility in stony soils.

Figure 3: The ideal trip system in stony soils combines mechanical and hydrailic breakaway characteristics.

Point wear and impact resistance

Life span of points is a major issue when operating in stony soils.

Impact resistance (toughness property) is critical to enduring the high stump-jumping intensity that occurs in these conditions.

Effective hard-facing or tile protection (hardness property) is equally critical in managing wear to maintain point size and shape over its life span.

These two properties are mutually opposite and a practical approach should integrate the following:

1. Aim for a balance between toughness and hardness when choosing tungsten carbide grades (also considering brazing strength quality), hard-facing coatings, point size and material. It is advisable to seek local experience and test unit samples before committing to a full-set change-over and to include items such as associated machine downtime during the season when assessing per-hectare costs.
2. Minimise stresses and impact loadings by operating at lower travelling speeds and at shallower tillage depths. Using slow recoil speed hydraulic trip systems will also reduce stress because the maximum impact potential occurs during the return stroke following stump-jumping. Hydraulic trip systems reduce impact energies by dampening point return speeds into the ground but significantly "stiffen" the tine during the loading phase, temporarily increasing its break-out characteristics well beyond its set (static) value. The higher the travelling speed at which stump-jumping occurs and the more tines simultaneously tripping together, the greater the stiffening effect. High-capacity hydraulic accumulators and hose-line designs and reduced sowing speeds are important in minimising this "dynamic" peak force. An ideal trip design would include an adjustable spring release system, dampened on its return stroke with a gas strut-like device.
3. Avoid the use of new points in adverse stony conditions. Farmer experience shows that wearing-in new tungsten carbide protected points in easy soil conditions long enough to at least round off their sharp edges (sharp corners increase stresses) significantly improves the durability of points.

Contour-following seed boot systems

Stump-jumping reduces the performance of seed delivery systems solidly fitted to the tillage unit. When seeding into stony paddocks, greater flexibility is achieved with seed boot designs partially or fully independent from the preceding tillage unit (coulter disc or narrow point). The "autonomy" of the seed boot in such set-ups means they often need to be regulated by a press wheel, allowing some contour-following ability regardless of tillage depth.

Some of these systems may also minimise or cancel the penalising effects of stump jumping on seeding depth. Depending upon design, contour-following systems can improve seeding results in stony areas by enabling more accurate sowing at shallower tillage depths; significantly minimising paddock roughness and stump-jumping intensity.

Contour-following seed boot systems include:

1. Flexible seed boots (eg polyurethane Agmor® design) that are self tracking within the furrow. Their length and spring characteristics allow some limited contour-following ability and may compensate adequately for minor stump-jumping actions.
2. Pivoting arm seed boot systems. These can adequately follow land contours, but when attached to the tillage unit (eg side banding Conserva-Pak®) they remain sensitive to severe stump-jumping actions. Systems fitted to the tool bar (eg. V twin discs system – Gessner, K-Hart, Morris XPress etc - or Knuckeys sow and press assembly) are not unaffected by the stump-jumping actions of the preceding tillage unit.
3. Parallel displacement seed boot systems. These are good contour followers, but being fitted onto tine shanks (eg. Ausplow DBS, Gason parallelogram sowing assembly, Primary Nichols roller guide system), they also remain sensitive to stump-jumping actions, particularly when lower hitch points on the shank render them subject to higher-amplitude shaking.

The seeding performance of combined tillage plus seed boot contour-following systems (eg Janke, Garnelle, Gyral etc. parallelogram planter units) are comparatively similar to a rigid seed boot system when stump-jumping occurs.

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The Minnnipa Research Foundation presents

Eyre Peninsula Tillage Field Day

Proposed dates: 4th August (open to general public @approx $100 per head)
5th August (MRF members day and dinner)

Proposed location: Minnipa Agricultural Centre

What would YOU like to see/hear/do at such a day?

We are currently in the planning stages for this event. This is your chance to nominate issues, speakers and activities for the upcoming tillage day. It's easy, if you have an idea or some feedback on the suggestions below just ring or fax Sam Doudle, Brendan Frischke or Fish Cordon at Minnipa Agricultural Centre by April 5th, 2004 – phone (08) 86805104, fax (08) 86805020 (if you prefer email, our addresses are in the back of this book).

How do the following suggestions rate with you?

- Tyne types and horse power requirements
- Sowing into stony soils
- Demonstration of fluid nitrogen with coulters in crop
- Comparison between disc seeders
- Hardpan identification
- Seed bed utilisation – row spacing, ribbon seeding, nitrogen rates
- No-till demo's
- Trifluralin incorporation –s oil throw, speed of sowing, tyne and point types, sowing depth
- Role of harrows post-sowing in conventional and no-till systems
- Stubble Management
- Tractor/machinery matching horse power vs. width for least cost

After the event entertainment:

- History of tillage demonstration – from Clydesdales to CAT tractors!
- Who is the straightest seeder on Eyre Peninsula competition (no guidance allowed!)

Make sure your Minnipa Research Foundation membership is up to date so you don't miss this highlight on the Eyre Peninsula agricultural calendar.

Section 9

Section editor: Carly Bennet[1], Neil Cordon[2]

Rural Solutions SA, Streaky Bay[1], SARDI Minnipa Agricultural Centre[2]

United Grower Holdings

Weeds

A Survey of Brome Grass on the EP

Survey

Sam Kleemann and Gurjeet Gill

The University of Adelaide, Roseworthy Campus

Key Messages

- ***Bromus rigidus (B. rigidus)*, which has a protracted germination pattern as compared to *Bromus diandrus (B. diandrus)*, appears to be the dominant brome grass species infesting cereal crops on Eyre Peninsula. In some paddocks in-crop densities of *B. rigidus* were in excess of 300 plants/m^2, highlighting the success of this species in invading cereal crops in this region.**
- **The combination of the staggered germination pattern of this species with non-wetting soils can sometimes result in little or no benefit from delayed sowing. The impact of non-wetting soils on the persistence of *B. rigidus* seed-bank is poorly understood and requires further investigation.**

Species characteristics

Both *B. diandrus* and *B. rigidus* are widely disturbed across southern Australia but it is unclear whether these species co-exist as mixed infestations. *B. rigidus*, as its name suggests has a more rigid inflorescence (head) (*Figure 1*), which turns a deep reddish brown colour as the plant nears maturity. B. diandrus on the other hand, has a more flaccid and larger inflorescence of less striking colour (*Figure 2*). Both *B. diandrus* and *B. rigidus* are aggressive competitors with crops, with studies showing that 100 plants/m^2 of brome can reduce wheat yields by as much as 50%.

Another common species of brome in the southern Australian wheat belt is *Bromus rubens* (*B.rubens*) (*Figure 3*). *B. rubens* is more commonly found along the fence lines and in pastures, it has a soft inflorescence, with tight glumes, making it look somewhat similar to barley grass.

Why do the survey?

The field survey in 2003 was undertaken with following objectives:

- To determine the species of brome grass present on Eyre Peninsula.
- Quantify in-crop densities of brome grass, which would be a useful indicator of on-farm losses in productivity due to the presence of this weed species.

How was the survey it done?

A survey of farmer paddocks on the Eyre Peninsula was undertaken in the spring of last year to determine which species of brome were present and to assess their relative composition within the cereal phase. The survey was undertaken in 25 paddocks sown to either barley or wheat, in a zone encompassing Wharminda, Kimba, Lock and Tooligie Hill.

Sites were randomly selected along different transects within this region. At each site, species composition was recorded within the crop as well as along the fence line. In each selected paddock, in-crop density of brome was recorded in 20 quadrats (25cmx25cm) placed at 20m intervals along an inverted W transect. Observations of paddock soil type and topography were also recorded. Samples of mature brome panicles were collected from each site for further analysis.

What happened?

Regardless of site location on the Eyre Peninsula, *B. rigidus* was the most frequently observed species (*Table 1*), and was found at every site surveyed (100%). *B. diandrus*, on the other hand, was present at a much lower frequency in the cereal crops sampled (12%) and showed clear preference for infesting undisturbed fringes of paddocks where it was observed along the fence lines of 96% of sites surveyed. Similarly, *B. rubens* was only found along the fence line of 8% of sites surveyed. The results clearly indicate that *B. rigidus* is the dominant species of brome infesting cereal crops of the Eyre Peninsula. Averaged over all paddocks sampled, *B. rigidus* was present at a density of 53 plants/m^2, but at some sites brome densities exceeded 300 plants/m^2. The survey has clearly shown the seriousness of this weed to grain growers of the Upper Eyre Peninsula. There is no doubt that a research effort is needed to develop management strategies for brome that are compatible with local soil types and farming systems.

Table 1: Summary of survey results for three common brome grass species to the EP. Number of paddocks assessed =25.

***Bromus* spp.**	**Frequency (%)**		**Mean occurrence density (no/m²)**	**Maximum occurrence density (no/m²)**
	In-crop	Fence line	In-crop	In-crop
Bromus rigidus	100	84	53	304
Bromus diandrus	12	96	24	32
Bromus rubens	0	8	-	-

Studies on the ecology of brome grass from Western Australia (Gill, 1985) have shown that *B. rigidus* has a slower release of dormancy than *B. diandrus*, resulting in a more protracted germination in the field. Delayed field germination would reduce the effectiveness of pre-sowing control tactics and favour colonisation of the crop by this weed species, making management difficult particularly in the cereal phase. Presence of non-wetting (water repellent) soils on Upper Eyre Peninsula is also likely to contribute to the delayed emergence and extended survival of the seed-bank of this and other species (*B. diandrus*). Further research is required to determine the exact impact of non-wetting soils on the persistence of brome grass on Eyre Peninsula.

What does this mean?

Determination of brome species distribution is an important precursor to developing suitable management strategies for this troublesome weed. For example, delayed sowing as a management strategy maybe of little or no benefit in the control of *B. rigidus* which is known to have a staggered germination pattern. Establishment of late cohorts (germinations) will enable escape from pre-emergent knockdown herbicides and cultivation. Furthermore, it would be difficult to justify using such a technique due to its impact on reduced crop vigour and decline in yield potential. A better approach may involve re-structuring crop rotations, growing a more competitive crop like barley or increasing the crop density by sowing at a higher seeding rate.

Further research will be undertaken on the samples of brome seed collected from sites on the Eyre Peninsula. Chromosome counts will be undertaken to confirm species identification, which is carried out on the basis of morphological characteristics. Ecological studies will also be conducted to compare loss of seed dormancy among brome species as well as the rates of phenological development of the different populations from Eyre Peninsula. These studies will enhance our understanding of the behaviour of brome species on Eyre Peninsula. Additional studies are also being undertaken on selected farms (A. & M. Edwards & A. Polkinghorne) on Eyre Peninsula to investigate the performance of different management strategies for improving the control of this weed species.

Acknowledgements

The Grains Research & Development Corporation (GRDC) for project funding.

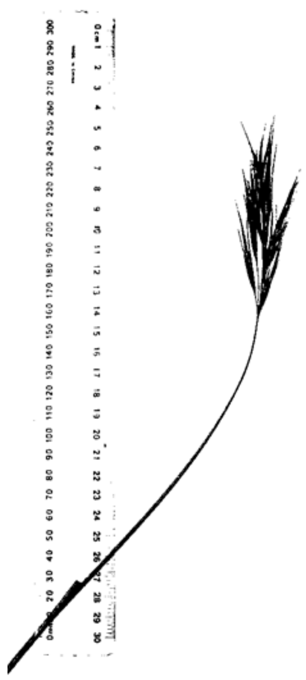


Figure 1: Bromus rigidus

Figure 2: Bromus diandrus

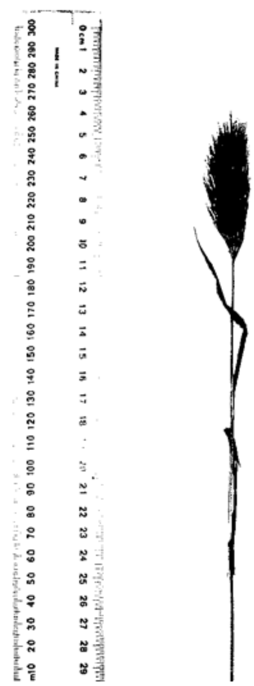


Figure 3: Bromus rubens

Summer Weeds - are they worth controlling?

Research

Mark Habner[1] and Neil Cordon[2]

Rural Solutions SA, Murray Bridge[1], SARDI, Minnipa Agricultural Centre[2]

Best practice

Location
Courela
Closest town: Streaky Bay
Cooperator: Daryl Johnson
Streaky Bay Ag Bureau

Rainfall
Av. Annual : 300mm
Av.G.S.R : 200mm
2003 total: 300mm
2003 G.S.R: 192mm

Yield Potential
(W) 1.64 t/ha

Paddock History
2002: Pasture
2001: Pasture
2000: Triticale

Soil Type
Grey calcareous sand

Plot size
2.2m x 15m

Other factors
Delayed sowing, dry conditions

Key Messages

- **The benefits from controlling summer weeds (grain yield and quality, soil moisture, root disease and soil fertility) are not clear or consistent in a season like 2003. Predicting follow-up rains after initial weed germinations is the real key to deciding whether or not to spray.**
- **Spraying summer weeds early for trash handling purposes may be a valid reason for control, rather than for economic benefits only.**
- **Common sense, flexibility and seeking advice are vital elements for spraying summer weeds. The impact of a herbicide is dependent on spraying conditions, chemical rates, tank mixes, plant growth stage and target weeds, which may have a greater impact than the type of chemical used.**
- **The best summer spraying time for Lincoln weed is at 20% flowering after a summer rain.**

Why do the trial?

Trials were set up to investigate the impact of various methods and timings of summer weed control on weed numbers, soil moisture levels, soil nutrient and disease status, grain yield and income.

Summer weed control research began at four sites across Eyre Peninsula in 2000 (*EPFS 2000, pg 128*). 2002 was the second year that summer weed research had been possible, due to lack of summer rain in the intervening years (*EPFS 2002, pg 155*). Prior to the summer of 2003, a review of summer weed research was conducted and it was decided we would focus our efforts on three separate sites covering three different weed spectrums – Lincoln weed, heliotrope (potato weed) and melons. All treatments were reviewed and considered on individual merit. It was necessary that herbicide treatments were able to be compared with tillage treatments.

These trials were established because many farmers on Upper EP identified that summer weeds (Lincoln weed in particular) are a major barrier to the adoption of some latest farming techniques (eg no-till).

How was it done?

Summer weed control trials were set up at Courela (Lincoln weed), Minnipa (heliotrope) and Wharminda (melons). Three different categories of weed control methods were applied over the 2002/2003 summer at each site, generalised as complete control, early weed control, late weed control and no summer weed control.

Soil samples were taken at the time of early spraying and pre-sowing for all sites. The soil moisture and nutrients at depth were also taken to give an indication of the impact of summer weeds down the profile.

Measurements: Grain yield and quality, soil moisture (at summer spraying and sowing) and soil nutrients.

What happened?

All sites chosen had significant rainfall events prior to the end of 2002, resulting in summer weeds proliferating and were suitable for spraying in the 2nd week of January for the early treatment.

Soil Fertility: At all sites the summer weed control treatments had no influence on extractable P, organic C or nitrate nitrogen. As a general trend, the control (no spray) was amongst the lowest soil nitrate measurements.

Sub soil constraints were identified at Wharminda (sodic below 30cm), which limited crop production.

Disease Scores: An initial site root disease test was taken in January prior to early spray treatments, and individual treatments were sampled pre-sowing to analyse the effect of summer weed control treatments on root disease risk. *Rhizoctonia* was the main threat for all three sites. None of the

Table 1: Crop management details of Summer Weed trial sites, 2003.

	Courela	Minnipa	Wharminda
Sowing date & rate	6th June @ 60 kg/ha	10th June @ 65 kg/ha	6th June @ 60 kg/ha
Fertiliser rate	DAP @ 70 kg/ha	DAP @ 70 kg/ha 10 kg/ha zinc sulphate	DAP @ 70 kg/ha + ammonium sulphate
Variety	Frame (+BSN10®)	Frame	Krichauff
Other in-crop herbicides	500mL/ha Credit® & Bonus® + 1 L/ha Triflur 480®	800 mL/ha Roundup Powermax® + 700 mL/ha Triflur 480®	500 mL/ha Roundup Powermax® + 800 mL/ha Triflur 480®
Early Spray	13th January	11th January	9th January
Late Spray	6th March	3rd March	4th March & 21st March
Early Tillage	13th January	11th January	9th January
Late Tillage	6th March	5th March	4th March

Table 3: Costs, yield and gross margin of summer weed control treatments for Lincoln weed, at Courela in 2003.

Tmt no.	Treatment	Treatment Cost ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
1	Complete (early) 1. Metsulfuron methyl @ 5 g/ha + LVE MCPA® @ 800 mL/ha + wetter (late) 2. Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	25.91	1.08 ab	168
2	(early) Metsulfuron methyl @ 5 g/ha + LVE MCPA® @ 800 mL/ha + wetter	11.29	1.04 ab	175
3	(early) Metsulfuron methyl @ 5 g/ha + Glyphosate 450 @ 1 L/ha + wetter	9.00	1.10 a	189
4	(early) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	14.62	0.90 c	147
5	(early) Tillage	3.97	0.91 bc	159
6	(late) Metsulfuron methyl @ 5 g/ha + LVE MCPA® @ 800 mL/ha + wetter	11.29	1.13 a	192
7	(late) Metsulfuron methyl @ 5 g/ha + Glyphosate 450 @ 1 L/ha + wetter	9.00	0.93 bc	159
8	(late) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	14.62	0.77 c	124
9	(late) Tillage	3.97	0.91 bc	159
10	Control - not treated	-	0.84 c	151
	Least significant difference (P<0.05)		0.17	32

**Gross income was calculated using the long-term average wheat price of $180/t, exclusive of GST, less treatment costs.*

Table 4: Costs, yield and gross income of summer weed control treatments for heliotrope, at Minnipa in 2003.

Tmt no.	Treatment	Treatment Cost ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
1	Complete (early) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter (late) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	27.23	1.76 a	289
2	(early) Spray.Seed® @ 1 L/ha + wetter	12.24	1.52 ef	262
3	(early) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	14.62	1.52 ef	259
4	(early) Amine 625® @ 1.5 L/ha + wetter	12.37	1.60 cde	275
5	(early) Tillage	3.97	1.47 f	261
6	(late) Spray.Seed® @ 1 L/ha + wetter	11.29	1.70 ab	295
7	(late) Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	9.00	1.60 cde	280
8	(late) Amine 625® @ 1.5 L/ha + wetter	14.62	1.60 cde	273
9	(late)Tillage	3.97	1.61 cd	286
10	Control - not treated	-	1.54 def	277
11	(early) Spray.Seed® @ 1L/ha + wetter (late) + Glyphosate 450 @ 1 L/ha + Surpass® @ 1.5 L/ha + wetter	24.86	1.67 bc	276
	Least significant difference (P<0.05)		0.08	16

**Gross income was calculated using the long-term average wheat price of $180/t, exclusive of GST, less treatment costs.*

Table 5: Yield, gross income and marginal return of summer weed control treatments for melons, at Wharminda in 2003.

Treatment	Cost ($/ha)	Grain Yield (t/ha)	Gross Income* ($/ha)
Complete – 1. Glyphosate 450 @ 1 L/ha + Ester @ 270 mL/ha + wetter 2. Invader® @ 120 mL/ha + Amine 625® @ 600 mL/ha + wetter 3. Glyphosate 450 @ 2 L/ha + Ester @ 250 mL/ha + Invader® @ 80 mL/ha + wetter	39.64	1.8 ab	285
Glyphosate 450 @ 1.1 L/ha + Ester @ 270 mL/ha + wetter (early)	10.15	1.72 ab	299
Invader® @ 90 mL/ha + Amine 625® @ 865 mL/ha + wetter (early)	14.31	1.7 ab	291
Invader® @ 130 mL/ha + Amine 625® @ 650 mL/ha + wetter (early)	15.30	1.55 b	263
Tillage (early)	3.97	1.76 ab	312
Glyphosate 450 @ 1 L/ha + Ester @ 300 mL/ha + wetter (late)	10.04	1.57 b	273
Invader® @ 80 mL/ha + Amine 625® @ 800 mL/ha + wetter (late)	13.19	1.51 b	259
Invader® @ 120 mL/ha + Amine 625® @ 600 mL/ha + wetter (late)	14.54	1.66 ab	284
Tillage (late)	3.97	1.91 a	340
Not treated	-	1.81 ab	326
Glyphosate 450 @ 1.1 L/ha + Ester @ 270 mL/ha + wetter (early) + Invader® @ 120 mL/ha + Amine 625® @ 600 mL/ha + wetter (late)	22.69	1.73 ab	289
Glyphosate 450 @ 1.2 L/ha + Ester @ 250 mL/ha + Invader ® @ 80 mL/ha + wetter (late)	15.72	1.6 ab	273
Least significant difference (P<0.05)		0.32	58.2

**Gross income was calculated using the long-term average wheat price of $180/t, exclusive of GST, less treatment costs.*

Table 2: Weed Counts at Sowing for Summer Weed Control sites, 2003. (initial plant counts for each site (plants/m²): Courela = 1.9, Minnipa = 49, Wharminda = 43).

Trt no.	Courela	Minnipa	Wharminda
	Lincoln Weed	Heliotrope	Melons
1	0	0.6	0
2	0.2	1.3	5.0
3	0.2	1.3	0.7
4	0.9	6.7	0.5
5	2.9	3.1	1.5
6	0	0	3.3
7	0.2	3.8	0.2
8	0.2	7.2	0.2
9	0.6	3.2	1.6
10 (control)	2.5	6.3	2.1
11	-	0.9	0.2
12	-	-	1.7

NB. Treatment numbers relate to treatments given in tables 3, 4 and 5 below, for each site.

tillage treatments (dry workings) reduced the risk of *Rhizoctonia*. No clear trends were apparent that any particular treatment changed the root disease risk.

Target Weed Control and Soil Moisture: At Wharminda and Minnipa where the target weeds were melons and heliotrope respectively, the control weed populations were reduced dramatically, without any treatments, simply due to seasonal conditions (dry autumn). At Courela however, where the Lincoln weed, which is a perennial, showed the nature of the beast by at least maintaining plant numbers through to sowing where there was no control, or control was inadequate.

At Courela, all treatments reduced weed populations compared to the control, except early tillage (Trt 5). Treatments 4, 5 and 10 had the highest weed populations at sowing. Lowest soil profile water content at seeding were Treatments 5 (80 mm) and 10 (79 mm). However, at harvest this did not necessarily correlate to grain yields (*Table 3*). Treatment 1 (complete control) had the highest soil moisture content (96 mm) and one of the highest grain yields.

At Minnipa, treatments 1 and 6 had the lowest weed populations at seeding, and the highest grain yields (*Table 4*). These treatments were also amongst the highest relative soil moisture content prior to sowing. Treatment 1 had 90 mm, and treatment 6 had 81 mm in the profile, compared to the control which had 74 mm.

At Wharminda, all treatments reduced the initial weed population by sowing time, even the control, due to limited follow-up rains. Profile moisture at seeding ranged from 87 mm (Trt 3 and 7) to 106 mm (Trt 9), with the control having 97 mm. Summer weed control treatments had a variable influence on soil moisture levels, and final crop yields.

Grain Quality: Summer weed control had no influence on grain quality at any of the sites.

Gross Income: Gross income was calculated for each treatment at each site.

On Lincoln weed at Courela in 2003, treatment 3 (5 g/ha metsulfuron methyl + 1 L/ha of Glyphosate 450) applied early, and the treatment 6 (5 g/ha metsulfuron methyl + 800 mL/ha LVE MCPA®) returned amongst the highest yields, and were the highest gross income earners and therefore gave the 'best bang for your buck' (*Table 3*).

On heliotrope at Minnipa in 2003, treatment 1 (complete control) and treatment 6 (1 L/ha of Spray Seed® in March) achieved amongst the highest yields and gross income (*Table 4*). The use of tillage in January resulted in the smallest yield and subsequently income, also exposing the soil to the greatest erosion risk.

On melons at Wharminda in 2003 there was little influence of treatments on grain yields, however, treatments of nil or least cost resulted in higher gross incomes (*Table 5*).

What does this mean?

The Wharminda site demonstrated summer weed control may not always be economically viable. The reasonable rains that began the 2003 season probably evened up differences in soil moisture caused by summer weed treatments.

Timing of weed control is important. In this trial, all of the chemical brews were applied at close to the ideal time (sometimes by fluke) and achieved optimum weed control.

Future summer weed control trials should take into account what the ideal spraying conditions are, using Delta T concepts and other measures of weather conditions. Delta T is an application concept developed by ASK G.B. which uses relative humidity and air temperature as a guide for effective spraying. Farmers are trying to broaden the spraying window, and are often spraying in less than ideal conditions.

Summer weed control is still a debatable issue and the conclusions drawn seem to vary from year to year.

Best practice

Location
Minnipa
Cooperator:
Neville & Tim Markey
Minnipa Ag Bureau

Rainfall
Av. Annual: 306mm
Av.G.S.R : 235mm
2003 total: 244mm
2003 G.S.R.: 181mm

Yield Potential:(W)1.54 t/ha

Paddock History
2002: Pasture
2001: Excalibur wheat
2000: Excalibur wheat

Soil Type
Light calcareous sand

Plot size
2.2m x 15m

Other factors
Wind damage, delayed sowing, dry spring

Location
Wharminda
Cooperator: Bevan & Darren Millard
Wharminda Ag Bureau

Rainfall
Av. Annual: 358mm
Av.G.S.R. : 285mm
2003 total: 424mm
2003 G.S.R.: 353mm

Yield Potential:(W) 4.86 t/ha

Paddock History
2002: Pasture (spray-topped)
2001: Krichauff wheat
2000: Pasture

Soil Type
Siliceous sand over sodic clay

Plot size
2.2m x 15m

Other factors
Slight wind damage, delayed sowing, dry spring, Zn deficiency, hostile sub soil.

A review of all of the research work conducted under the EPFS Summer Weed project, and the Mallee Sustainable Farming Systems project will conducted during 2004. Summarised results from both programs will be in this publication in 2004 edition.

Acknowledgements

Nufarm, EP Soil Boards, EP Community Landcare, Advisory Board of Agriculture, GRDC, and SARDI, Bayer Crop Science and Syngenta. We also thank the co-operators for their time and provision of trial sites, and the legwork of Wade Shepperd, Ben Ward and Willie Shoobridge from Minnipa.

Spray Seed® - is a reg. product of Crop Care. BSN-10® - is a reg. product of RLF. Invader®, Amine 625®, LVE MCPA®, Surpass®, Credit®, Bonus®, Roundup Powermax® and Triflur 480® are all reg. products of Nufarm.

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Natural Heritage Trust
Helping Communities Helping Australia

EP Soil Conservation Boards

Best practice

Warning - Sleeping with Caltrop!

Extension

Neil Cordon[1] and Rob Coventry[2]

Senior Extension Agronomist, Minnipa Agricultural Centre[1],

Authorised Officer, Elliston LeHunte APCB[2]

Caltrop is a summer growing annual weed which, if not controlled, will invade agricultural land.

Caltrop (*Tribulus terrestris*) produces sharp, spiny fruits and will grow rapidly in almost any soil type after often minimal summer rains.

Caltrop is a proclaimed pest plant throughout the Eyre Peninsula. It is the landholder's responsibility to control caltrop on their properties under the Animal and Plant Control Act (Agricultural Protection), 1986.

Germination

Staggered germinations make control difficult as flowering and fruiting can continue for several months throughout summer and autumn. This is why it is very necessary to monitor the infested areas often so as to catch new plants before they set seed. Caltrop's success as a weed is due to its ability to germinate and then set seed within 14 -18 days. Each plant has approximately 200 seeds. Buried seeds remain viable for several years.

Impacts

- The burrs contaminate and down grade wool, hay and low growing crops.
- The foliage is toxic to stock, and may inhibit the growth of other plants around it.
- The plants block up machinery and can be a barrier to no-till systems.
- The burrs are very painful to the feet of animals and humans (imagine changing a tyre where there is caltrop)!

The key is to control the plant before burrs form!

Control of Caltrop

Prevention - The best strategy is to keep caltrop off your property.

Fodder – Be careful when buying in hay or other fodder from properties. Your local Animal and Plant Control Board offers a free hay checking service to detect the presence of weed seeds.

Stock - If stock are brought in from infested areas (or any area for that matter), they should be kept for at least 14 days in a holding paddock that can be checked for weed seedlings later.

Ground Cover - Caltrop loves bare ground, so try to keep as much cover on the ground as possible. That's why farm yards and tracks are the ideal breeding and spreading ground for the weed.

Vacuuming - Physical vacuuming of isolated small patches is effective for removing the seed source.

Cultivation - After each successive germination and before seed set, but how sustainable is that?

Hoeing - Some hard yards in small patches is the most effective option.

Chemical - A variety of options exists, but usually must be repeated due to successive germinations. Residual herbicides can effectively control several germinations.

Timing is important as caltrop can quickly set seed.

Spray Before Burrs Form!

Spot Spray Options

Seedlings:

1 125 mls 2-4, D Amine per 100 litres water.

2 10 gm Ally® per 100 litres water.

Before 1st flower:

1 1 litre Credit® + 1 litre Bonus® per 100 litres water.

2 5 gms Ally® + 750 mls 2-4, D Amine per 100 litres water.

3 800 mls Glyphosate (450g/l) per 100 litres water

Plants with burrs:

1 125 mls 2-4, D Ester + 10 litres Diesel.

Boom Spray Options

Pre emergent:

1 15 gm/ha Logran®

Seedlings:

1 2.0 to 3.0 l/ha 2-4, D Amine

Before 1st flower:

1 1.6 l/ha Glyphosate (450 g/l)

2 1.4 to 2.1 l/ha 2-4, D Ester

3 7 to 10 g/ha Glean®

4 Credit® +1 l/ha + Bonus® 1 l/ha + 800 ml/ha 2-4, D Ester

Having made the decision to spray caltrop it's important to maximise your chances of controlling it using the following guidelines:

- Spray small, actively growing weeds.
- Spray during the cooler parts of the day to reduce the evaporation risk.
- Increase water volumes to at least 100 litres / ha.
- Add spraying oil to assist uptake.
- Remember to seek advice, as the most expensive program can often be the one that does not work.

Develop a Plan and Strategies for Caltrop Control and Prevention

Do I have to control Caltrop? – Legally, Yes.

The local Authorised Officers from the Animal and Plant Control Board's don't want to use the "big stick" approach, however there is a legal requirement for control.

- Caltrop is a proclaimed plant for the entire state of South Australia.
- Landholders are required to control plants on their own properties and control on adjoining road reserves.

Sale or movement of the plant is prohibited throughout the state.

Types of Work in this Publication

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	n/a	Usually summary of research results

Do you need the EP Farming Systems Project to continue?

Whether your answer is yes or no please tell us about it - fill out the survey on page 3 & 4 of this publication and send back to the Minnipa Ag Centre ASAP

Notes

Section 10

Section editor: Brian Ashton

Rural Solutions SA, Port Lincoln

United Grower Holdings

SARDI

Livestock

The gross margin returns from sheep remain high this year. This is despite the considerable drop in wool prices. Returns from the live animals, meat and skins make up for the drop in wool price.

Hopefully, wool prices will recover because we are now producing much less wool than the world normally uses. Also, the average fibre diameter of the clip has dropped to better match market requirements.

Sheep and lamb prices are high, and are expected to remain so, as exports increase and we rebuild the national flock.

In 2004 a new EP wide project has been submitted to the Grain & Graze program through the EP Farming Systems project. If funded, this project aims to conduct some specific research/demonstration/extension on livestock and how they fit into current day farming systems and their impact on the triple bottom line (economic, social and environmental).

Merino Mothers Making Meat

Searching for problems

Demo

Brian Ashton

Senior Livestock Consultant, Rural Solutions SA, Port Lincoln

Key Messages

- **The relative importance of both meat and wool has changed.**
- **SA Merinos are good dual-purpose sheep.**
- **Because we can't know what future relative prices will be, it's desirable (and possible) to improve meat and wool characters at the same time.**
- **EBV's (Estimated breeding values) give the genetic merit of an animal for meat and wool characters.**

Why do the work?

The Merino ewe provides half the genetics of a lamb, however the ewe is often overlooked in breeding programs. If producers are to improve their sheep they need to accurately identify the genetics of both the ewes and the rams.

EBV's can be used to estimate the genetics of many characters but they are not widely used or understood. Group members are keen to learn about EBVs and to see for themselves how the EBVs of the ewes influence the growth rate of the progeny.

How was it done?

The Lower E.P. Prime Lamb Group members produce both cross-bred and Merino lambs out of Merino ewes.

They obtained funding from MLA to compare the growth rate of lambs from Merino ewes. The ewes involved in the trial have a range of EBV's for growth. Half the ewes will be mated to a Merino ram and half to a White Suffolk ram. Both rams have across-flock EBV records on them.

Ewes and lambs will be run together at all times except during mating. Lambs will be identified to their mother.

Growth rates of the lambs will be recorded until sale date.

We will calculate the relationship between the ewe's EBV for growth and the growth rate of the lamb. We will compare production of the Merino lambs to the first cross lambs.

What happened?

No results yet as the ewes will be mated in late February 2004.

Acknowledgements

Funding of $8,000 provided by MLA under the Prime Time on-farm program.

RURAL SOLUTIONS SA

MEAT & LIVESTOCK AUSTRALIA

Monitoring Sheep Growth

Demo

Brian Ashton

Senior Livestock Consultant, Rural Solutions SA, Port Lincoln

Key Messages

- **Growth rate of lambs in their first year of life is a good indicator of their health and nutrition.**
- **Measuring growth rate is worthwhile to assess how your sheep are going.**

Why do the work?

Sheep are seen as a vital part of the farm system in drier cereal growing areas. However, producers are often frustrated by not knowing how they can improve their sheep – or indeed if they can improve.

How was it done?

Producers in the Elliston and Streaky Bay districts have formed producer groups to work on improving their sheep production.

In 2002 we reported on mineral deficiencies in sheep and this work continued in 2003 – with similar results.

Last year (2003) an additional approach was to monitor the growth rate of lambs on a number of properties. We put a numbered ear tags in about 20 lambs at marking or weaning time. These 20 lambs were weighed when they were in the yards during the first year of their life – about three or four times.

What happened?

The growth rate, in grams a day, was calculated for each period. A lot of very useful information was gained. Producers found it very interesting to compare and discuss the growth rates.

The calculations are only approximate because we did not adjust for wool weight, or gut fill, and time was taken from the start of lambing (not the average birth date). However, the data is sufficient for the purpose.

Growth rate of Merino lambs ranged from -86 to 269 grams a day. Some SAMM first cross lambs grew up to 293 grams a day.

Producers could look at the growth rate up to weaning, after weaning, on dry feed and on stubbles.

This allowed people to identify problem periods and, if necessary, adjust their management.

For example;

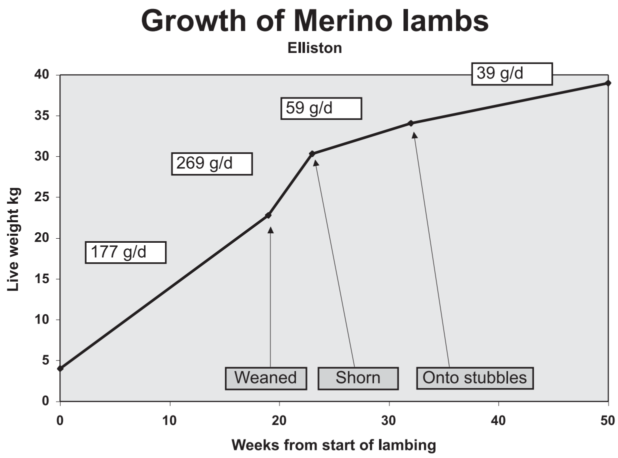
- there was usually no set-back after weaning and growth rate after weaning was good. This means producers could try weaning earlier – which would benefit the ewe and makes management easier.
- one producer had a month with no growth and the weaners were found to be worm infested.

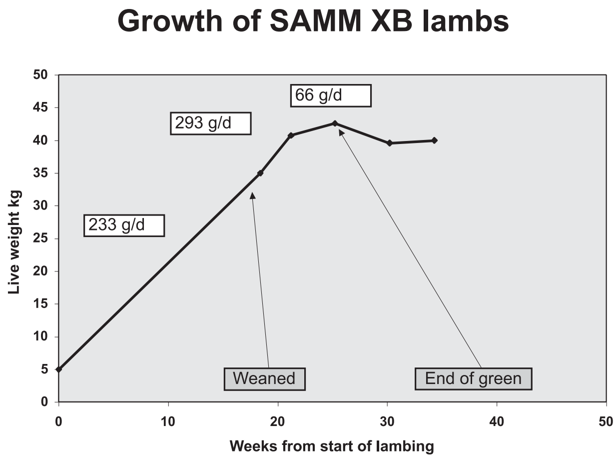
Recommendations

- Weigh a sample of lambs when they are in the yards and calculate the growth rate in grams a day.
- Compare the achieved growth rates of lambs to others in your district.
- If growth rate is poor, try to identify why.

Acknowledgements

Funding for the Elliston Sheep Producer Group is from Meat and Livestock Australia (MLA) under the PIRD program.





RURAL SOLUTIONS SA

MEAT & LIVESTOCK AUSTRALIA

Section 11

UNITED GROWER HOLDINGS

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Risk Management

Although a small section, this year we have two quality articles. One catalogues for you more sites about weather forecasting and climate predictions than you could ever dream of. The other has some very concrete information about that elusive devil which is frost damage (nowhere to be seen for weeks or months and then Whammo, time for the hay conditioner instead of the header!).

Frost Research - The Importance of Management

Research

Searching for answers

Christopher Lynch and Melissa Truscott

SARDI, Waite

Key Messages

- **Frost risk can be influenced by crop management.**
- **Clay delving & rolling are showing useful frost protection on sandy soils.**
- **Min-max thermometers are valuable in detecting incidence and severity of frost.**
- **Research is continuing in 2004.**
- **Have a 'Frost Management Plan' and remember it when planning the season ahead.**

Why do the trial?

Frost frequently causes crop losses in the Southern Mallee, Upper South East, Mid North, and Eastern Eyre Peninsula of SA. However, frost damage has been more severe than normal in recent years. There is concern that this may be attributed to modern farming systems which are growing crops with higher yield potentials and using stubble retention. Thick crop canopies and stubble are suspected to act like insulation. Firstly, the amount of sunlight reaching and heating the soil during the day is reduced. Then at night, they inhibit the release and rise of any heat stored to mix with the cold air around the crop heads.

Most frost protection advice available has focused on frost avoidance strategies such as delaying flowering (ie delaying sowing or using longer maturing varieties) until the chance of frost is less. However, this often compromises yield potentials due to the increased risk of terminal drought. We are currently investigating the economics of delayed sowing in frost prone areas of southern Australia. However, the aim of this research report is to identify alternative agronomic practices that reduce frost risk. (*See pg 169-170 EPFS 2002 Summary for more background information.*) This was the second year of a three year GRDC funded project.

How was it done?

We conducted a literature review of agronomic practices that may reduce frost risk. Most literature showed anything that increases the soil's ability to store heat during the day and radiate this heat at night will reduce frost damage. Secondly, anything that creates or facilitates air movement will increase heat exchange between the cold air at crop head height with warmer air from above and below. Research by Marcellos & Single (1984) found that seed mortality can change from 0% to 100% with just a 1°C drop in temperature. This is encouraging since a small improvement in temperature within the crop could greatly reduce yield losses. Furthermore, if it can be found that a number of agronomic practices give a small but additive increase in temperature, then perhaps losses to frost can be considerably reduced.

A select number of treatments were investigated in 2003 based on the review of literature and anecdotal evidence from the field. The treatments included: Rolling, stubble management, seeding rate, row spacing, nitrogen rates, delving clay, blend of varieties and variety comparison between durum wheat (awned & broad leaves) vs Buckley (awnless & erect leaves). Measurements included grain yield, visual frost score and temperature of the soil surface and at crop head height.

What happened?

Three core trials were conducted in renowned frost areas: Mintaro in the Mid North (black cracking self mulching clay), Parilla in the Southern Mallee (sand), and Keith in the South East (sand). All three sites had frost damage but the results are still being fully analysed. Shown here are some preliminary results.

Keith

Preliminary data suggests that clay had the single biggest impact on reducing frost damage as measured by warmer soil and canopy temperatures, higher grain yields and less visual frost damage. Temperatures at head height on clayed soils were up to 1.3°C warmer than on sand. In 18 comparisons, wheat on clay delved ground had an average visual frost score of 5% compared to 25% for the sandy ground. The clay delved ground yielded 1.18 t/ha (76%) more grain than the undelved sandy ground.

The typical fall in temperature at the soil surface and canopy head height during a radiation frost event can be seen in Figure 1. The clay delving operation clearly increased the temperature of the soil leading to warmer temperatures at crop head height. The effect of seeding rate is less clear (50kg vs 100kg/ha).

Parilla

This site was severely frosted with the events on the 28th & 30th September doing the most damage. In fact, many heads were frosted in the boot after a –6.5°C event recorded at head height. Meanwhile, the local BOM weather station only reached a minimum of 1.1°C. This highlights the need of having your own temperature monitoring equipment in frost prone areas. An indication of the occurrence of a potentially damaging frost event as well its severity can help with frost decision making. The cheapest equipment available to do this is minimum-maximum thermometers.

Temperature on rolled ground was up to 1.5°C warmer at the soil surface compared to the unrolled ground. This resulted in up to 1°C warmer air temperature around the crop heads.

Mintaro

The most obvious difference in this trial is the visual frost damage score of 6.5% on the soft wheat Buckley compared to 27% on the durum. Buckley yielded on average 15% more than the durum. The difference is not thought to be related to flowering as it occurred at about the same time with Buckley perhaps a day earlier.

Where to from here?

While we may never eliminate frost, we can be optimistic that changes to cropping management can reduce the risk. Clay delving and rolling sandy soil appears to be clearly beneficial in reducing the frost risk. The effects of the other treatments and their combinations are still being analysed. Collaboration is also occurring with frost projects in WA and Vic. Trials will continue in 2004 to build on the results so far and ultimately develop frost risk decision rules for farmers to use based on their frost risk, farming system, soil type etc.

Last year, a series of workshops were held in which farmers discussed their frost experiences with frost experts. They assessed the importance it has on their own business, mapped their farm into zones according to level of frost risk, and flagged possible frost minimisation strategies for each of these areas based on the discussions of the day. The end result was the development of a 'Frost Management Plan' specific to their farm for which they can refer to when planning the season ahead. A continuation of these workshops will be available in 2004 and will incorporate latest research and the possibility of becoming involved with on-farm demonstrations. Contact us for interest or further information.

Acknowledgements:

GRDC. Mick Faulkner of Agrilink for advice and field work. Thanks to John & Chris Faulkner, Darryl & Faye McNeilly and Trevor & Tricia Menz for the use of their land, machinery and time.

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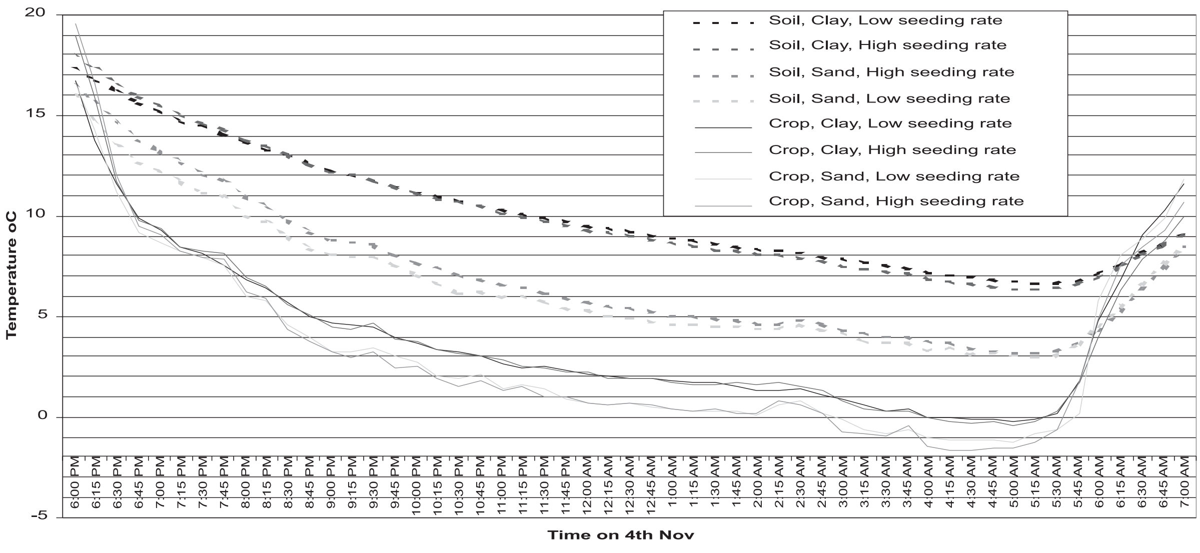

Figure 1: Comparison of sand vs clay, & high and low seeding rate on temperature at soil surface and crop head height at Keith in 2003. (dotted lines = soil temperatures; lighter shades = sand treatments.)

Grains Research & Development Corporation

Seasonal outlook and forecast services

Extension

Melissa Truscott

SARDI, Climate Risk Management Unit, Waite

Key Messages

- **Seasonal climate forecasts are improving in accuracy**
- **To reduce confusion individual studies of forecasts and relevance to a region have been done by the SARDI Climate Risk Management Unit.**
- **For updated state seasonal forecasts see the Stock Journal weather page**
- **For individualised forecasts, the Climate Risk Information Management Email Service (CRIMES) is available**

Why summarise seasonal climate forecasts

Climate experts have been developing more accurate methods of seasonal climate prediction based on an emerging understanding of climate factors such as ocean currents, sea surface temperatures, and the El Niño -Southern Oscillation (ENSO) phenomenon.

In previous articles we have talked about what parameters are measured to produce seasonal climate forecasts, such as the SOI, El Nino and La Nina and Sea Surface Temperatures (SST). It is important to understand these to know which forecasts are accurate and relevant for your region.

In this article we will list the current seasonal climate forecasts, and how to access them. Seasonal climate forecasts relate to climate over 3-6 month periods with lead times of 1-12 months. To learn more attend a climate risk management workshop or purchase the latest Climate Risk Management Resource Manual. For interpreted forecasts specific for your property, enquire with us about CRIMES (Climate Risk Information Management E-mail Service).

Seasonal Climate Forecasts

There are two types of long-term forecasts - statistical/empirical and dynamical/coupled ocean atmosphere models. Some modellers combine both statistical and dynamical forecasting methods to create an outlook. Presently, most forecasts issued to the public are based on statistical forecast systems, which tend to have skill levels comparable to dynamical models and are considerably easier to develop and run. However, dynamical models are developing very rapidly and a new system recently launched by the BOM has comparable accuracy or predictability to long-standing statistical models.

Statistical models rely on long term historical data, meaning they are limited by what has happened in the ~ 50-100 years of recorded climate history. Dynamical models do not rely on historical data and generally forecast the state of the ocean and atmosphere to forecast rainfall and temperature. All have a lead-time and a forecast period. The longer the lead-time and/or the forecast period, the less accurate both forecasts become. The forecasts can be for up to 12 months at a time with three months lead-time.

Statistical/empirical forecasts

Statistical forecast systems are produced from correlations between an observed variable, such as the SOI or the strength of patterns of SSTs in the Pacific and Indian Oceans, and rainfall and temperature over a number of months. The strength of the historical association between the predictor (eg SOI) and the predictand (eg seasonal rainfall) varies from season to season and region to region. Temperature is generally forecast with higher skill than rainfall.

The forecasts are often expressed as probabilities, for example, of rainfall exceeding the median. They are expressed as probabilities because they contain some uncertainty due to random factors which might influence the seasonal outcome. A seasonal forecast is a statement of the leaning of seasonal conditions toward a certain outcome (for example wet or dry), and not a statement of what the season will be (eg. it will be wet). This is not unlike the use of odds in horse wagering, which reflect the likelihood of a certain horse winning a race. So, for example, a keen favourite might be rated as 2-to-1 meaning it has a 66.7% chance of winning. Clearly, in such a race the favourite stands a very good chance of coming first, but this is still not certain, and so it is with seasonal forecasts.

The BOM (Bureau of Meteorology) Seasonal Climate Outlook

This is an outlook for three months, updated monthly. It has a two week lead-time. The BOM forecast is based on correlations of rainfall with patterns of SSTs in the Pacific and Indian Oceans.

Web page: http://www.bom.gov.au/climate/ahead/

The QDPI (Queensland Department of Primary Industries) Seasonal Climate Outlook

This is an outlook for three months. These forecasts are generated from correlations between rainfall and changes in the value of the SOI over two month periods.

Web page:

http://www.longpaddock.qld.gov.au/SeasonalClimateOutlook/OutlookMessage/

Private forecasting services

There are a number of private forecasting services which provide district specific rainfall outlooks for the short and long term. The two most common for southern Australia use statistical methods for forecasting. It is best to a farmer in your region, who have been subscribing to them for a number of seasons, as to what they think of their accuracy for your region.

Dynamical/coupled ocean atmosphere forecast

Coupled ocean atmosphere models combine measurements from both the ocean and atmosphere to produce forecasts. They do not rely on historical data to forecast. They utilise Global Circulation Models, or GCM's.

POAMA

The POAMA system (Predictive Ocean-Atmosphere Model for Australia) looks at the ocean and atmosphere in real-time to produce a 1 to 3 month outlook with up to 8 months lead-time. It predicts SSTs, rainfall, temperature and evaporation.

POAMA was developed in a joint project involving the Bureau of Meteorology Research Centre (BMRC) and CSIRO Marine Research. Web page:

http://www.bom.gov.au/bmrc/ocean/JAFOOS/POAMA/index.htm

CSIRO COCA

COCA (Coupled Oasis CAR-AGCM ACOM) is a global coupled ocean-atmosphere model developed jointly by CSIRO Atmospheric Research and CSIRO Marine Research. It provides 1 to 3 month rainfall outlooks with up to 3 months lead time

CSIRO COCA page:

http://www.dar.csiro.au/climate/coca/html

The Multivariate ENSO Index (MEI)

The MEI is a coupled ocean-atmospheric model that uses the six main observed variables of the Pacific Ocean to monitor ENSO. MEI has been developed mainly for research purposes. Negative values of the MEI represent the cold ENSO phase, La Niña, while positive MEI values represent the warm ENSO phase (El Niño). The output uses rolling historical analogue years, and is available slightly earlier than other models (usually one month lead-time (Wolter and Timlin, 1993).

Web page: http://www.cdc.noaa.gov/~kew/MEI/mei.html

European Centre for Medium Range Weather Forecasting (ECMWF)

Forecasts of SST's in the eastern Pacific are issued up to five months ahead. Seasonal forecasts of rainfall and temperature are generated. It produces a range of forecast options such as average anomalies or probabilities of exceeding median or other values. Lead-times are from one to three months.

Web page: http://www.ecmwf.int/

National Aeronautical and Space Administration (NASA)

Provides one month lead-time forecasts of seasonal rainfall and temperature. They are presented as anomalies on a global map display, which offer little regional interpretation. Future developments will see regional forecasts. There are also predictions of SST's over the Pacific Ocean. Web page: http://nsipp.gsfc.nasa.gov.exptlpreds/exptl_preds_main.html

Summary

As you can see there are a large amount of forecasts available. It depends upon your interest as to how much you monitor them. I monitor them all and summarise them on the Stock Journal weather page, however the most simplest to understand is the BOM site where you can look at both their statistical forecast (the seasonal climate outlook) and monitor POAMA (dynamical).

The future of climate forecasting systems

The limited historical record and future climate change means that it is unlikely that statistical forecast systems will see much further improvement. Therefore dynamical forecast systems are the future. It can be confusing to choose a forecast. Individual studies of each of these forecasts and relevance to a region is done by the SARDI Climate Risk Management Unit. Their aim is to merge forecast tools and services to provide clear forecast messages to their clients. For more information you can purchase the Climate Risk Management Resource Manual, or attend a Climate Risk Management Workshop or enquire about CRIMES (Climate Risk Information Management Email Service). For updated summarised outlook messages for the state see the weather page in the Stock Journal.

Acknowledgements

Thank you to Jim Egan, the Bureau of Meteorology and David Stephens from the Department of Agriculture WA for editing the chapter on Climate Risk Management Forecasts in the newly released version of the Climate Risk Management Resource Manual.

References

Truscott, M.A. and Egan, J.P. (2004) The climate risk management resource manual. SARDI Climate Risk Management Unit.

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Section 12

Section editor: Samantha Doudle

SARDI, Minnipa Agricultural Centre

UNITED GROWER HOLDINGS

Sharing Information

This section is sponsored by GRDC through the Low Rainfall Farming Systems Collaboration project. As part of this project EPFS contracted the services of Jon Lamb Communications to bring together some relevant research from other low rainfall groups for this publication – Mallee Sustainable Farming Inc (Vic, NSW, SA), Central West Farming Systems (NSW), Western Wheat Group (NSW) and Upper North Farming Systems (SA).

Whilst not currently official members of this low rainfall project, our thanks go to our WA friends, Jeremy Lemon and the farmers from the Salmon Gums area for sending across some of their results and participating in so many of our EP events in 2003.

Mallee Sustainable also have work included in the tillage and break crop sections of this book. There are many other topics available in the Farm Talk series (two in this section). Try visiting this website for Mallee Sustainable Farming Farm Talk information sheets: www.msfp.org.au.

Fluid P fertilisers in the Upper North

Research

Searching for answers

Nigel Wilhelm

SARDI, Sustainable Farming Systems, Adelaide

Key Messages

- **Fluid P fertiliser may improve the productivity and profitability of cropping systems in the Orroroo district.**
- **P delivered to wheat on both Orroroo soil types was more effective as a fluid product than a granular one.**
- **Mixes of trace elements with NP fluid fertilisers may be an effective technique for supplying trace elements to broadacre crops.**

Why do the trial?

To assess the performance of fluid P fertiliser on the nutrition and production of wheat on two major soil types of the Orroroo district.

The trials were designed to:

- measure the effect of fluid P fertiliser on grain yield and quality
- measure the effect of zinc (Zn) nutrition on the response of wheat to P fertilisers
- test whether a boron-tolerant durum line would respond to P fertilisers in the same way as a commercial bread wheat variety.

How was it done?

Technical grade MAP (dissolved in water as a fluid NP fertiliser) and DAP (granular) were applied at four rates to Kukri bread wheat and a boron-tolerant durum wheat line, WID 99006.

The fluid fertiliser was applied through the seeder two centimetres below and to the side of each seeding row at an output rate of 104 L/ha in two equal applications; one prior to seeding and the other during the seeding pass. Two passes were necessary because the MAP would not dissolve completely at an output rate of 104 L/ha.

P was applied at nil, low, medium and high for each form: 0, 3, 6 or 9 kg P/ha for the fluid fertiliser and 0, 5, 10 or 20 kg P/ha for the granular.

The P rates were selected on the basis of experience on the West Coast of Eyre Peninsula that suggests fluid P may be more effective than granular.

All treatments received 20 kg/ha of N at seeding regardless of P rate.

If extra N was needed to balance with other treatments it was applied as urea ammonium nitrate (UAN) solution in the fluid treatments and as granular urea in the granular treatments.

Location
Orroroo
Co-operator: Grant Chapman

Rainfall (2002)
Av. Annual: 331 mm
Av. Growing season: 224 mm
2003 total: 168 mm
2003 GSR: 131 mm

Yield
Potential : 0.9 t/ha
Actual: 0.6 t/ha

Soil
Soil type 1 - Grey calcareous sandy loam (grey mallee sand), 19-22 mg P/kg (Colwell), 6 % carbonate, 7.7 pH (CaCl2), 1.3% organic carbon

Paddock History
2001: pasture
2000: pasture
Soil type 2 - Alkaline red mallee soil, 13 mg P/kg (Colwell), c0-1% carbonate, 7.7 pH (CaCl2).
Paddock History
2001: pasture
2000: pasture

Plot size
30 m long and 8 rows wide (22 cm spacings)

Other factors
Total rainfall less than decile 1.
Soil type 2: severe drought stress, too short to harvest.

Zn was applied at a rate of 0.75 kg/ha to all treatments (except the control plots for the zinc-effect work) as a solution of Zn chelate below each seed row in the granular treatments and with the TGMAP solution in the fluid P treatments.

The plots were assessed for establishment, early vegetative growth, nutrition at tillering and grain yield and quality.

What happened?

Fluid P fertiliser was more effective than the granular fertiliser on both soil types.

Fluid P increased early growth of wheat on both soil types because plants were able to get more P into their shoots from the fluid, even when granular P was applied at much higher rates of P per hectare.

The responses to fluid P reduced as the season progressed but were still obvious at both sites at heading.

At maturity, grain yield and quality of wheat was better with fluid P on the grey mallee sand. Plants on the heavy red soil were too small and short to be machine harvested.

The increases in grain yield and quality on the grey mallee sand would have increased the gross margin by about $30/ha compared with the use of granular fertiliser at typical district rates, had the trial results been achieved at paddock scale.

Grey mallee sand

Establishment was higher with fluid fertilisers but was not affected by the rate of fertiliser applied, except that plant numbers were high with a high rate of fluid fertiliser.

Higher rates of P increased wheat growth at tillering, with fluid-applied P resulting in more biomass at lower rates than granular-applied P. The dry weight of shoots of Kukri nearly doubled with 5 kg/ha of P as fluid while the same rate of granular P resulted in an increase of only about 30%. The dry conditions meant there was little P available from the soil and the highest rate of fluid P increased shoot weight to about 250% of the level without P fertiliser.

Fluid P was also a more effective P fertiliser for WID 99006. At the medium rate of application, fluid P increased shoot dry weight of Kukri by 51% compared to granular but in WID 99006 shoot weights were similar for fluid and granular (even though the P rate in the granular fertiliser was twice that in the fluid).

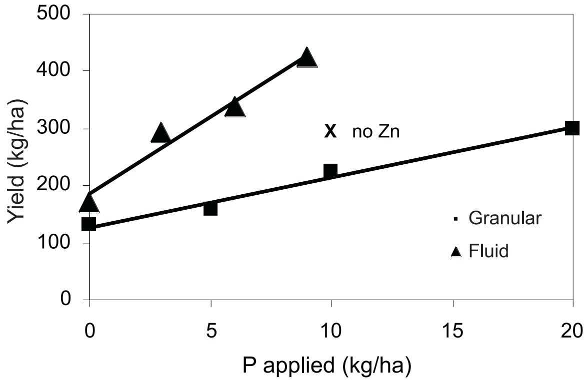

Figure 1: Dry weight of shoots at tillering (kg/ha) of Kukri wheat on grey mallee sand with granular or fluid P fertiliser.

Fluid P increased early growth of wheat (*Figure 1*) and resulted in higher levels of P in the plant, increasing P in shoots by 58 g/ha for each 1 kg/ha of applied P. Granular P increased P content by only 20 g P/ha for each 1 kg P/ha.

In the durum, P content of shoots of WID 99006 were similar with either form of P fertiliser at the medium rate of application, indicating fluid P is twice as effective as granular in this respect.

Fluid fertiliser increased grain yield of both wheats at all rates of application. Kukri yielded nearly 150 kg/ha (30%) more with fluid P than with granular P, at all rates. Grain yield of WID 99006 also improved with fluid P; 6 kg P/ha as fluid resulting in 34 kg/ha (10%) more grain than 10 kg P/ha as granular. Kukri coped with the dry conditions better than the durum wheat, which yielded 130- 230 kg/ha (37-64%) less than Kukri in the same treatments.

Fluid P also improved the quality of wheat grain produced. Grain protein was generally 0.5% higher in plots treated with fluid P than with granular P (*Figure 2B*). All plots had high protein levels, probably due to the dry finish reducing the ability of wheat to load carbohydrate into grain.

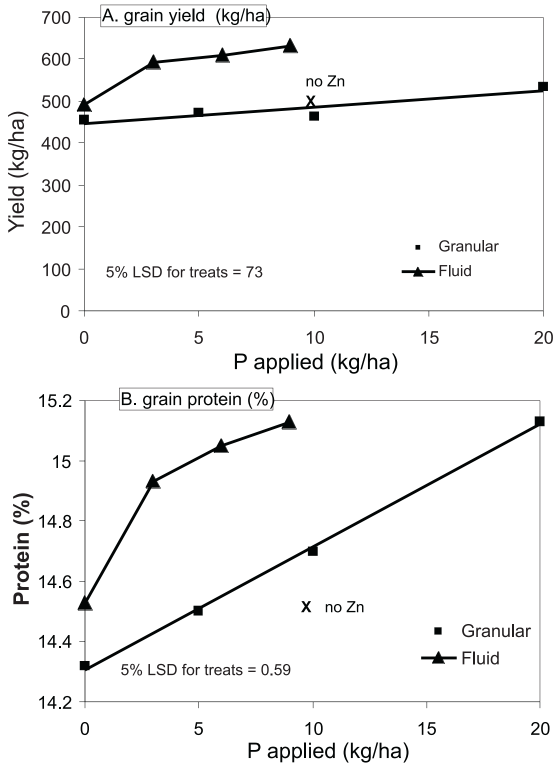

Figure 2: Grain yield (A) and protein (B) of Kukri wheat at maturity on grey mallee soil with granular or fluid P fertiliser.

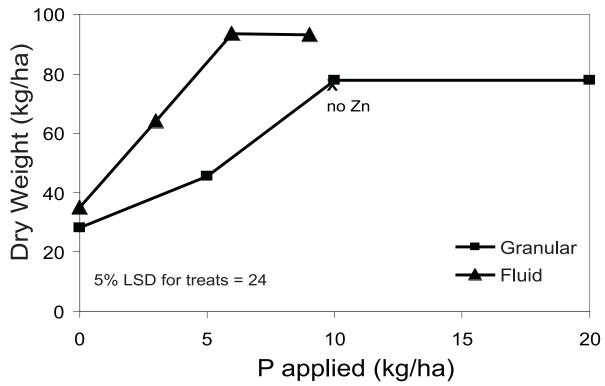

Figure 3: Dry weight of shoots at tillering (kg/ha) of Kukri wheat on red mallee soil with granular or fluid P fertiliser.

Red mallee soil

Long dry spells, especially during late September and in October, reduced vigour and caused severe water stress throughout spring and until maturity.

Despite wheat growth being severely restricted by moisture stress at tillering, access to higher levels of P greatly increased wheat growth at tillering, with fluid-applied P resulting in more biomass at most rates than granular-applied P.

The dry weight of shoots of Kukri more than doubled with 5 kg fluid P/ha (*Figure 3*). Granular P resulted in an increase of only about 60%.

Soil P reserves were very low (13 mg/kg Colwell P) and the dry conditions meant there was a large deficit of P for wheat. The highest rate of fluid P increased shoot weight to more than 250% of the level without P fertiliser.

Fluid P was also more effective in the durum wheat. At the medium rate of application, fluid P increased shoot dry weight of WID 99006 by 63% over the granular fertiliser.

Fluid P resulted in higher levels of P in the plant and increased early growth, improving shoot P levels at a faster rate than granular P. For example, 9 kg P/ha as a fluid increased P content to more than 4.5 times the level with nil P, compared with less than four times the level from 10 kg P/ha as a granular.

At the medium rate of application, shoot P content in WID 99006 plants receiving 6 kg P/ha as fluid P was almost double that in plants receiving 10 kg P/ha as granular.

What does this mean?

P delivered to wheat as a fluid product was more effective than granular product on both soil types. Fluid P increased early growth of wheat in both trials because plants were able to get more P into their shoots from the fluid than from the granular product, even when granular P was applied at much higher rates of P per hectare.

At maturity, grain yield and quality of wheat was better with fluid P on the grey mallee sand. Trials on the red mallee soil – where the plants were too short for machine harvesting - appeared headed for a similar outcome until the moisture cut out.

On the grey mallee sand, fluid P increased wheat yield over the district practice of 10 kg P/ha as granular product by approximately 150 kg/ha; worth about $30/ha based on an on-farm price of approximately $200/tonne.

This gain was achieved with as little as 3 kg P/ha applied as a fluid, currently three times more expensive than granular P, resulting in a net gain of around $30 a hectare.

However, the very dry conditions could have favoured fluid P over granular. The clearest benefits from fluid P on upper Eyre Peninsula have been measured during seasons of below-average rainfall and a similar pattern may apply to the Orroroo district.

Similar trials were also run in 2003; one in the same paddock as the red mallee trial and the other on a red-brown earth at Morchard. Both trials again suffered severely from moisture stress but the crop on the red mallee soil finished off better than that at the Morchard site.

The data has yet to be fully analysed but it is clear that fluid P fertilisers again outperformed granular at the red mallee site. For example, Krichauff wheat yielded 60% (310 kg/ha) higher with 5 kg P/ha supplied as a fluid fertiliser than with 10 kg P/ha supplied as (granular) DAP.

At Morchard, grain yields barely increased with any of the P fertilisers so it was not possible to assess relative efficiencies, although the crops receiving fluids looked better earlier in the season. Yields at Morchard averaged 1 t/ha.

Fluid fertilisers may be superior for supplying trace elements to crops, with Zn levels in shoots at tillering much higher in plants supplied with fluid P than with granular P.

Given that in both sets of treatments Zn was supplied as Zn chelate at quite a low rate (0.75 kg Zn/ha), these results suggest mixes of trace elements with NP fluid fertilisers may be an effective technique for supplying trace elements to broadacre crops.

Acknowledgements

Brenton Byerlee, Soil Management Systems; Trent Scholz and Michael Wurst, Central North-East Farm Assistance Program (CNEFAP).

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Government of South Australia

Sharing Info

The enemy below, subsoil investigations

Survey

Jeremy Lemon

Senior Development Officer, Department of Agriculture WA

Identifying the problem

Location
Closest town: Salmon Gums WA
Cooperator: Seven families involved.
Group: North Mallee Farm Improvement Group

Rainfall
Av. Annual total 300-350 mm
Av. Growing season: 182–228 mm
Actual annual total: see tables
Actual growing season: see tables

Yield
Potential: see tables
Actual: see tables

Paddock History
2001: see tables

Soil
Major soil type description: see tables

Diseases
Depending on variety, leaf and stem rust were prevalent.

Plot size
Sections of paddocks. Most sites were 40m transects to limit the variation of the site.

Other factors
2003 was an above average season with decile 9 rainfall at most sites. Summer rainfall was also above average at most sites.

Key Messages

- **Soil profile testing by farmers in the Salmon Gums area of WA shows the degree of subsoil constraints and effective rooting depth of crops.**
- **Despite severe constraints from pH, salinity and boron, crop yields in 2003 were well above average but few approached the French and Schultz yield potential.**
- **On clay subsoils, soil moisture storage from above average summer rainfall was all accounted for in the top 50cm of the profile.**

Why do the trial?

The investigation aims to identify some of the subsoil constraints in the Salmon Gums area of WA and together with soil moisture profiles relate these to crop performance.

Soils in the Salmon Gums area are similar to soils in mallee areas of SA and Vic with high pH, transient salinity and high boron levels. Investigations in other states have developed some guidelines for estimating yield losses from measured levels of toxicity so that cropping inputs can be matched to the restricted yield potential. Local soils data is needed to be able to correlate interstate recommendations to local conditions. The Potential Yield CALculator or PYCAL has been available for many years but is not commonly used by growers. Soil moisture storage and crop performance need to be calibrated against a farmer friendly yield model to develop confidence in using the model for management decisions.

How was it done?

Members of the North Mallee Farm Improvement Group developed a list of the main soils in their area and each soil's main characteristics. In October 2002, members of the group selected an area of each of these main soils to study over the next season to develop comparative characteristics for each.

Three sample times were chosen,

- Crop maturity 2002 to measure soil moisture profiles as an indication of lower moisture limits after crop and pasture maturity.
- Late April 2003 to measure soil moisture profiles indicating the change of stored soil moisture over the summer period. Soil profile samples were taken at this time for nitrogen, conductivity, pH and boron.
- Crop maturity 2003 to measure soil moisture change over the growing season and compared with previous season.
- Daily rainfall was collected for a nearby site to estimate soil moisture storage using PYCAL for comparisons to the measured change in soil moisture content.
- PYCAL is used to generate potential yields for comparison with actual crop performance in 2003.

Composite samples from three holes close to each other were collected by the growers using a 50 mm hand auger. The sites were marked for the follow up sampling. The profiles were

Table 1: Soil descriptions and chemical summaries and apparent root depth 2003.

Property	Soil Description	Boron *depth at which 15 ppm boron is exceeded*	Salt *depth at which 0.8 dS/m 1:5 soil :water salinity is exceeded*	pH *depth at which pH 8.0 ($CaCl_2$) is exceeded*	Max depth of growing season soil moisture change
R&C Graham	grey loam over clay	30cm, increases to 41ppm @ 90 cm	40cm increases to 1.43	20cm , 8.9 highest	25cm
I&J Guest	10cm sand over clay	only up to 11.8ppm @ 70 cm	50cm increases to 0.99	20cm , 8.8 highest	55cm
T&C Guest	sandy loam over clay	30cm, increases to 28ppm+ @50 cm	30cm increases to 1.26	20cm , 8.8 highest	95cm
G&N Kenney	grey calcareous loam	only 6.2 ppm @ 90 cm	less than 0.46 (at 90 cm)	20cm , 8.5 highest	45cm
R&K Longbottom	grey loam over clay	30cm, increases to 38 ppm @ 90 cm	40cm increases to 1.14	0cm , 9.1 highest	65cm
Longmire Bros	loamy sand to 1m+	only 0.4 ppm in top 1m	less than 0.06 throughout top 1 m	5.7 to 7.0 in top 1m	> 1m
McCrea family	red clay loam over clay	17.8 ppm in top 10 cm, 52 ppm @ 50 cm	0.76 @ surface, 0.9 - 1.0 in rest of top 1m profile	8.5 at surface increasing to 9.0	75cm

Table 2: Soil moisture changes over summer 2002-3.

Property	2002 Crop	Measured change in soil water, Oct 02 to Apr 03 (mm)	PYCAL estimated SSM to April sampling date (mm)	Depth to which 90% of extra soil water stored	Nov 02 to April 03 rainfall (mm)	Decile of summer rainfall
R&C Graham	green manure	19	25	70cm	166	5
I&J Guest	pasture	29	22	50cm	202	9
T&C Guest	wheat	38	48	60cm	249	>9
G&N Kenney	wheat	30	13	na	173	>9
R&K Longbottom	narbon beans	31	29	60cm	163	9
Longmire Bros	lupins	36	27	> 1m	205	9
McCrea family	pasture	60	52	50cm	261	>9

collected in 10cm increments to 1m depth, soil moisture was determined by oven drying 500g samples at 110°C till there was no further reduction in weight, usually 24 to 48 hours. 10cm subsoil increments were combined to make 20cm increments to reduce cost of analyses. Analyses were conducted by CSBP on air-dried samples.

Yield estimates were obtained by the growers rating the test area to the rest of the paddock and protein was determined by collecting grain samples from the header over the test area.

What happened?

Soil profile testing indicated most soils tested had chemical constraints within the profile. Accepted levels of boron, salinity and/or pH were exceeded between10 and 50cm (*Table 1*). McCrea's soil shouldn't grow anything with very high levels of boron and salt near the surface. The deep sand of Longmire's, while not typical of the area, illustrates that soil chemical properties are very different when a deep sandy texture allows water infiltration to depth with associated leaching of soluble salts. Depletion of soil moisture from the profile over the growing season indicates the effective root depth at which soil moisture does not change from sowing to maturity. This varies from 25cm to more than 1m, wheat has an effective root depth from 25 to 75cm on clay subsoils. Barley appears to have an effective root depth of 95cm on the soil investigated compared to an estimated 35 to 50cm under wheat in 2002.

Soil moisture increased over summer by amounts that mostly reflected the PYCAL estimates based on daily rainfall. One site had a large difference that may be due to sample storage. Soil moisture was mostly stored above 60cm, there was little soil water change below this depth even in this very wet summer. This explains why the soluble toxic salts are in the soil profile, wetting fronts rarely move deeper to leach the salts further.

On the T&C Guest site there was less soil moisture down to 90cm under barley in 2003 compared to wheat in 2002. At the same site there was an increase in soil moisture down to 35cm. The increased shallow moisture is due to early sowing on this site and early maturity of barley leading to no crop water use of the late spring rainfall. At the Longbottom site soil water from 20-40cm under the failed Narbon Bean crop was used by the 2003 wheat crop.

The 2003 growing season was well above average at all sites. Seasonal rainfall together with stored soil moisture generated a very high yield potential which was achieved at two sites.

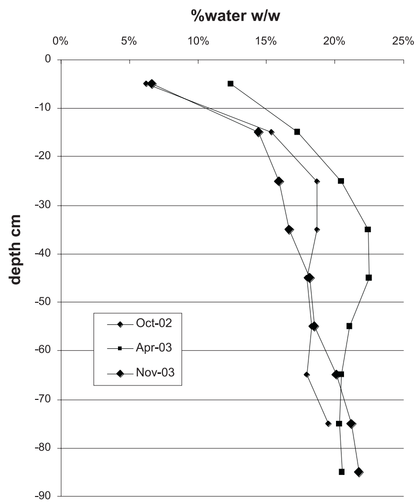

Figure 1: Soil moisture profiles at Longbottom site, 2002-3.

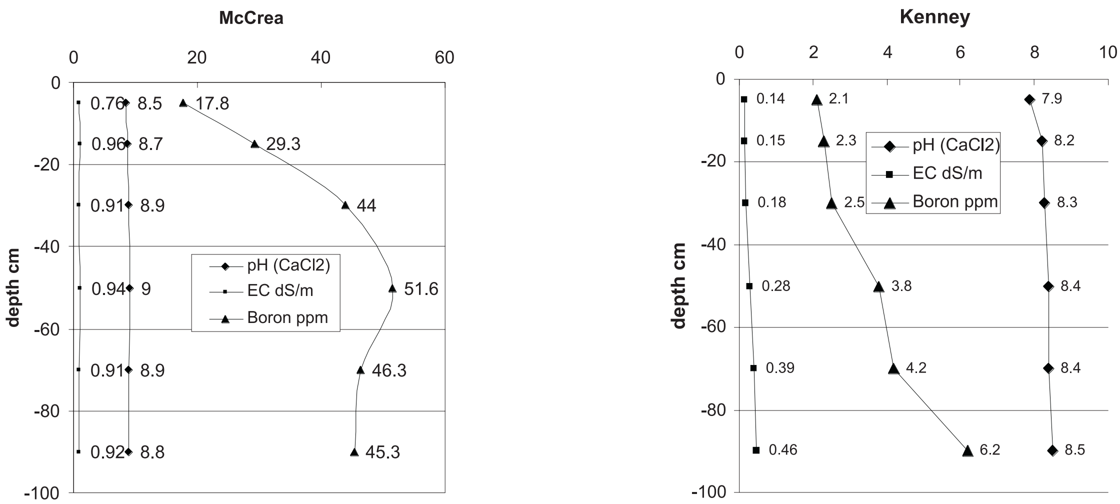

Figure 2: Soil profile properties of contrasting sites.

Table 3: 2003 crop performance.

Property	May to Oct rainfall 2003 (mm)	Winter rainfall decile	Measured change in soil water, April 03 to Nov 03 (mm)	Variety	PYCAL yield potential (t/ha)	Actual yield (t/ha)	Actual protein (%)	Sowing date	Nitrogen applied (kg N/ha)
R&C Graham	304	>9	-12	Carnamah	4.1	3.5	9.5	27-May	5
I&J Guest	245	9	-22	Machete	3.0	3.0	9.3	15-May	19
T&C Guest	314	>9	-28	Schooner	5.0	3.4	9.0	26-Apr	11
G&N Kenney	285	>9	-16	Sunelg	3.8	3.2	11.5	20-May	24
R&K Longbottom	294	9	-33	Mitre	4.1	4.1	9.5	02-Jun	7
Longmire Bros	281	>9	-3	Mitre	4.0	2.1	9.5	25-May	34
McCrea family	292	>9	-98	Carnamah	4.1	2.4	10.5	24-May	14

Lower yields at other sites are due to a range of factors including poor nutrition on deep sand, short season variety in a long season, and probably soil constraints on a couple of sites like McCrea, T&C Guest and Graham.

What does this mean?

Stored soil moisture measured from soil profiles generally matched PYCAL estimates based on daily rainfall. A highly accurate result from intense sampling has limited value due to variation across the paddock and within profiles. The result of simple modelling will give as good a result as intensive sampling and testing with much less effort and cost. Estimating plant available soil moisture in autumn without the reference point of a dry profile under a previous crop can be misleading as in situ chemical and physical conditions will influence Plant Available Water within the profile.

Crop yields can approach potential yields indicated by the PYCAL program in a wet season in mallee environments, even on soils with apparent subsoil constraints. Significantly lower yields usually have some explanation but not exclusively subsoil constraints.

How does this relate to previous information?

The indicators for crop growth limitations need to be assessed in a range of environments and seasons if they are to be used for management decisions.

On some soil profiles tested, the depth of summer soil moisture storage even in this wet summer matches the depth to which cereal crops effectively extracted water during the growing season. The effective root depth did not match the measured soil chemical constraints well.

Will it require further research or a change in direction?

The apparent greater rooting depth of barley compared to wheat should be investigated further to look at water extraction patterns over a sequence of years. This may help explain why barley often has much higher protein than wheat in this area, even more than the difference in moisture basis for infratech testing.

If soil moisture is stored above 50-60cm depth in a decile 9 summer, and chemical constraints occur below this depth, why do we need crop roots to go any deeper? A further area to explore is the vertical movement of soluble salts over a run of seasons to map their movement through time.

Any recommendations or take home messages?

Historic paddock performance can be as good an indicator of potential performance as soil sampling and testing. Variability within paddocks makes sampling a very intensive process. Areas that regularly yield poorly could be investigated for the cause by profile testing when other causes are eliminated.

Acknowledgements

The farming families who participated in the study, listed in the tables, Terina Burnett for assisting with sample preparation and soil water measurements.

Try this yourself now

Methods of applying nitrogen at sowing

Research

Jeremy Lemon

Senior Development Officer, Department of Agriculture WA, Esperance

Key Message

There were small differences between the sources and methods of nitrogen fertiliser strategies tested at sowing. Flexi-N (urea ammonium nitrate) banded resulted in the highest yield, protein and return, urea banded mid-row gave the lowest return. Other treatments such as ammonium sulphate and urea top dressed and Flexi-N applied to the surface and incorporated by sowing were similar, in the middle of the range of results obtained.

Why do the trial?

The trial aimed to compare different sources of nitrogen (N) fertiliser and their application technique to assess if there is any benefit for growers to select one particular N fertiliser system. The costs and time of application influence farmers' choice of technique, especially the cost of equipment required and time taken at sowing to apply additional N.

How was it done?

Wyalkatchem wheat was direct drilled with knife points on 9 June 2003 at 55 kg/ha with 60 kg/ha MAP. The treatments were –

- urea or ammonium sulphate top dressed and incorporate by sowing (IBS),
- urea banded mid-row,
- Flexi-N (42 kg N/100 L) sprayed on the soil surface before sowing or banded below the seed row.

All treatments were sown with a Borgault air-drill except the Flexi-N banded. N fertiliser rates were selected to apply the same rate of 30 kg N/ha to all plots.

The experiment was a randomised block design of three replicates of five treatments sown with farmers' equipment.

Crop establishment, plant nutrient levels, tiller counts and harvest yields and protein were measured.

What happened?

Crop emergence and early tillering was the same for all treatments including with both seeders.

Tissue testing at tillering showed differences in nitrogen uptake between treatments by plant growth and nitrogen concentration. The urea IBS and ammonium sulphate treatments had the lowest uptake and the banded Flexi-N was highest. The top dressed sulphate of ammonia treatment had higher zinc levels suggesting an acidifying effect which would increase the availability of zinc on this neutral soil type over alkaline clay.

At crop maturity, more ryegrass heads were observed in the surface applied treatments compared to either of the banded application methods.

Banded Flexi-N produced the highest yields and urea mid-row banded the lowest (*Table 1*). Grain protein was highest on the banded Flexi-N and lowest on mid-row banded urea reflecting the grain yield result. Returns are based on yields and delivery grade together with grain protein adjustments and differences in cost of the fertilisers and their application. Urea mid–row banded resulted in the lowest return and Flexi-N banded the highest. An application cost was included for the ammonium sulphate treatment only as the product is often top dressed separately. The other fertilisers are generally applied in combination with sowing or spraying operations.

What does this mean?

There were slight differences between the effectiveness of some fertilisers and their application method in this trial. While urea mid row banded performed poorly in this experiment, a similar demonstration in 2000 showed a 10% advantage of urea mid row banded compared to top dressed. This was a drier season (decile 1 growing season on high soil moisture) where losses from shallow incorporation after sowing would have been greater.

Ammonium Sulphate gave a poor return based on a price of $220/t on farm. Many farmers are able to get this cheaper making it a more cost effective source of N (and S). The additional cost of application has been included but it is generally applied well before sowing, saving precious seeding time. Ammonium sulphate also has a cost on neutral to acid soils as it is a very acidifying fertiliser.

Care should be taken in using these results as different machines were used for some of the treatments with possible differences in calibration. The Flexi-N banded treatment was sown with a different seeder from the other plots. The urea treatments are comparable as they were applied with the same seeder. Further comparisons are planned for 2004 to refine the Flexi-N banded application compared to a surface application which can be combined with a pre-sowing herbicide pass.

Location
Closest town: Salmon Gums
Cooperator: Dave Osborne
Group: Salmon Gums Croppers

Rainfall
Avg. Annual total 340 mm
Avg. Growing season: 210 mm
2003 annual total: 444 mm
2003 GSR: 341 mm

Yield
Potential: 4.0 t/ha
Actual: 2.5 – 2.7 t/ha

Paddock History
2002: poor pasture
2001: barley
2000: wheat

Soil
Major soil type description: 15 cm pale sand over yellow clay

Plot size
13 & 15 m x 200 m

Other factors
Well above average, decile 9 seasonal conditions.

Acknowledgements

Andrew Longmire and Rory Graham for bringing their seeder and sprayer to the site, Terina Burnett and Veronica Reck for crop assessments, harvest assistance and grain analysis. GRDC project DAW000012 Protein management.

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Table 1: Results of nitrogen application strategies at sowing on nitrogen uptake, tiller density and grain yield and protein.

Treatment	N uptake (kg/ha) 15/8/03	Tillers (/m^2) 19/9/03	grain yield (t/ha)	grain protein (%)	N in grain (kg/ha)	$ difference from urea spread
Urea spread IBS* @ 65 kg/ha	11.5	519	2.62	10.8	50	
Urea mid-row banded @ 65 kg/ha	12.8	441	2.47	9.9	43	-$67#
Ammonium Sulphate IBS @ 143 kg/ha	11.2	482	2.61	10.2	47	-$21
Flexi-N surface IBS* @ 71 L/ha	12.5	474	2.61	10.5	48	-$13
Flexi-N banded @ 71 L/ha (different seeder)	16.5	518	2.75	10.7	51	$14
LSD (P=0.05)	*0.29*	*ns*	*0.18*	*0.49*		

** IBS; Incorporated by sowing # result based on downgrade to ASW, -$39 if APW 10% is used*

Try this yourself now

WA Northern Wheat Belt "Minimal Rainfall Study Tour"

Michael Bennet

SARDI, Minnipa Agricultural Centre

Key Messages

- **Wide spread use of Flexi-N, (UAN) at seeding and as a foliar source of nitrogen.**
- **Herbicide resistance is a REAL issue which needs serious attention on Eyre Peninsula.**
- **Tramline farming and shielded spraying need not be an expensive exercise.**
- **Farmers funding their own research programs due to downsizing of Ag Department research.**
- **Research favours narrow row spacing as growers continue to go wider.**
- **Salmon Gums is really the "far, far West Coast of the Eyre Peninsula!"**
- **2000 km is a little too far to drive in one day!**

Why do the tour?

Minnipa Agricultural Centre staff and some local farmers were invited to join a group of Esperence/Salmon Gums farmers for a bus tour of the low rainfall areas of the Northern wheat belt in Western Australia. The local Minnipa farming contingent included Julian Post, Ashley Phillips and Matthew Cook. MAC staff included Jon Hancock, Willy Shoobridge, Leigh Davis, Wade Shepperd, Brett McEvoy, Amanda Cook, Michael Bennet and Mark Habner (Rural Solutions SA.) The group wearily travelled from Minnipa through to Northam where they met up with the tour prior to journeying north.

What happened?

The group found Western Australia in good shape for an exceptional season. Good early rainfall and follow up in most districts left the interstate tourists green with envy.

Jeremy Lemon (Dept Agriculture WA) welcomed the interstate visitors joining the tour. Mike Collins led the group through the various trials on display at the Western Australian No-Till Farmers Association (WANTFA) Meckering site. Trials included an omission of key no-till management factors trial, alternative oilseeds herbicide tolerance, lupin row spacings, canola seeding rate and fluid fertiliser trials. A trifluralin alternatives trial also sparked some interest from all attendees.

At the Three Springs Ag. Department the group was briefed by John Borger on the management strategies for the various soils of the Northern wheat belt. An interesting inclusion to farm planning is to increase property size to offset future losses of productive land to salt! This was an interesting approach to the salt predicament, which only seems to be increasing. John also covered the latest in WA climate modelling and seasonal rainfall prediction.

The Mingenew-Irwin group trials at Mingenew included a wheat variety trial, alternative oilseeds and a deep ripping trial. The farmers paddock of Carnamah wheat looked impressive. However, the farmer informed the group that the variety doesn't yield as well as it looks. Linseed, coriander and mustard grew well in the environment. Sale of the end product was seen as the main issue to overcome, however farmers were interested in the prospects of new break crops in the pipeline. Their deep ripping trail included treatments of lime, gypsum and a mix of the both. Responses appeared similar to results seen on the Eyre Peninsula.

The HMAS Sydney Memorial on Mount Misery at Geraldton provided a good vantage point for a view of the town's harbour facilities. The memorial commemorates the tragedy with a dome made up of 645 stainless steel seagulls, one for each life lost. A tour of the port facilities at Geraldton was enjoyed by all. Ships can only partly load at Geraldton due to the depth of the harbour. For this reason, the channel was being dredged down to 13.5 metres. The "Asante" from Cyprus was being loaded in the port which was fascinating and provided a dramatic change from the scenery of green the group had become accustomed to! The ship tour provided a good insight of how their grain is exported.

The Casuarinas – Walkaway TOPCROP group is located south-east of Geraldton. This region of acidic yellow sand is highly productive with average wheat yields in the 3 t/ha range. Herbicide resistance is advanced in this region with annual ryegrass and wild radish showing resistance to most herbicide groups. Radish is reported to have resistance to the chemical groups B, C, F, and I which is very daunting as seed bank exhaustion takes many years. Through the lack of effective control measures, some of the countryside was a carpet of white flowers. Through this development, livestock have an expanded role in rotation planning.

From Geraldton the tour proceeded east to the Ag Dept research site at Mullewa. Peter Newman explained the trials which focussed on crop competition and herbicide resistance risk reduction. Through the trial work, district practice seeding rates for wheat have increased from 50kg/ha to the 70-100 kg/ha mark.

East of Mullewa lies Pindar, which is 250mm annual rainfall country at the eastern extent of the Northern cereal belt. The group visited Mike Kerkman who was in his first season of using GPS-Ag 2 cm autosteer for his seeding operation. He found that through increased accuracy, he was able to plant an extra 300ha with his existing input budget. Seeding and spraying tramlines extend as long as three kilometres in some paddocks! Paul Blackwell introduced the group to his large scale row spacing and fallowing trial. Row spacings of 30cm, 60cm and 30/60cm double skip constitute the treatments. The use of autosteer technology has also allowed "prefurrowing" water harvesting to be investigated.

Long term row spacing research at the Merredin research station favours narrow rows. Comparisons were made between 9 cm, 18 cm, 27 cm and 36 cm row spacings. Each spacing treatment included a stubble retention and stubble burning component. Narrow row spacing and stubble retention consistently topped the yields. Interesting research that bucks the current trend for wider row spacings.

The last official stop on the trip was the Millington property near Burracoppin, east of Merredin. The property has been run as a no-till continuous cropping operation since 1993. The property runs a tramline farming operation which combines a home-made marker arm, with a 'round and 'round operation. The machinery is matched 2:1. Cereals are grown on 37.5 cm row spacing and lupins are grown on 75 cm row spacings. Lupins are economically marginal in the region, however the use of non-selective herbicides through a home made shielded sprayer enabled the input costs of growing lupins to be much lower than conventionally sown crops. The Millington's have found the tramline system to work exceptionally well. Improved accuracy of spraying operations have been the main gain through the system change. It was encouraging for all to see a low cost entry to tramline farming, and how modifying existing machinery can achieve good results.

Prior to driving back to South Australia, some of the group travelled down to Salmon Gums to investigate the country they had heard so much about during the week. The tourists were left amazed at the similarities in soil and vegetation of the alkaline Salmon Gums area to the upper Eyre Peninsula. Growers from this unique WA soil type look to the Eyre Peninsula for research, due to the majority of local WA research catering to acidic soil type country. Of particular appeal on the Longmire property was their fluid fertiliser cart, used at seeding to apply Flexi-N, in the seeding row. This sparked much interest for the visiting farmers and researchers.

What does this mean?

- The trip was an excellent opportunity for farmers and researchers to share information and ideas.
- South Australian farmers and researchers will continue to look to Western Australia for wisdom to deal with the increasing herbicide resistance issue.
- Group tours outside of local areas allow farmers and researchers to "think outside the square" and objectively consider different farming systems.

If you are interested in any particular aspects of the tour, you can contact the author on (08) 8680 6232.

Acknowledgements

Thanks go to Chezley Guest and Jeremy Lemon who organised the tour and invited the Eyre Peninsula group. Appreciation to GRDC for generously supporting the tour. Credit goes to Jon Hancock for coordinating the Minnipa involvement with the tour. Special thanks also go out to the MAC staff and families left behind to carry on while the group were absent!

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Alternate Farming Systems - NSW Research

Research

Rachael Whitworth[1], Michael Pfitzner[2]

NSW Agriculture, Griffith[1], Chairman Griffith[2]

Ed note: this issue comes up for investigation every year for a few groups on EP. Rather than use our limited resources to establish a similar trial we will continue to monitor the progress of this NSW research and hopefully bring you some results in the future after they have had a welcome break from the drought.

Why do the trial?

A trial at Rankin Springs was set up in 1999 to compare the crop and financial performance of different farming systems.

The seven systems in the trial are:

1. Conventional; based on local practice in the Rankins Springs area.
2. Albrecht; focused on achieving a balance of nutrients in the soil.
3. Soil Management Riverina; also focused on achieving a balance of nutrients in the soil.
4. Alroc Mineral Fertilisers; which stresses mineralisation.
5. Nutri-Tech; a biological farming system using methods and inputs designed to enhance the biological activity of the soil.
6. BioAg; a biological farming system using methods and inputs designed to enhance the biological activity of the soil.
7. Organic; being managed as a paddock or farm in conversion to certified organic production.

Due to continuing droughts, yield and economic benefits could not be assessed.

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This article contains information most relevant to the less than 350 mm rainfall mallee farming region

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Mallee Sustainable Farming Inc. SA NSW VIC

Fact Sheet #5
June 2003

Farmtalk is a product of the Mallee Sustainable Farming Inc. Tri-State Research and Extension Team

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Natural Heritage Trust — Helping Communities Helping Australia

CSIRO

University of South Australia

NSW Agriculture

State Government Victoria Department of Primary Industries

Department of Infrastructure, Planning and Natural Resources

RURAL SOLUTIONS SA

Managing Water

in Mallee Farming Systems

Dr. Victor Sadras - Research Scientist, Farming Systems CSIRO

The Issue

In the Mallee we need to identify management practices that maximise returns for every millimetre of available water, e.g. kg of grain per hectare per year or $ per hectare per year.

There are two sources of water for growing crops - **Plant available water stored in the soil at sowing time** and seasonal **rainfall**, which is highly variable and largely unpredictable. The growing season rainfall at Waikerie ranges from about 50 to nearly 350 mm, as shown in Fig. 1. This 7-fold difference between the driest and wettest seasons on record is typical across the Mallee.

What we know

About Plant available water stored in the soil

- After heavy rain, the soil pores fill with water. Once excess water drains, the soil reaches its upper limit (UL) of water holding capacity. The UL is a soil property largely driven by soil texture. Fig. 2 illustrates the increase in UL with depth as clay content increases for a soil at Euston.
- Crops can extract soil water only to a specific point, which is referred to as the lower limit (LL) of water holding capacity. Lower limits are strongly dependent on soil texture, but are also influenced by other factors. Subsoil chemical constraints widespread in the Mallee, such as sodicity or salinity, restrict the ability of crops to extract water, thus increasing the lower limit.
- The maximum amount of plant available water is the water held between the lower and upper limits, shown as the yellow area in Fig. 2. For a typical sandy loam soil in the Mallee with no chemical or physical constraints, the maximum amount of plant available water in a 1-m profile is about 80mm. For the soil in Fig. 2, salinity below 0.6 m prevented the crop from extracting water and so reduced maximum plant available water to 64 mm.

About seasonal rainfall

- The **variation of growing season rainfall** is huge, as illustrated in Fig. 1. The El Niño based forecasts can identify extreme seasons. In some locations, early season rainfall could be an indication of seasonal conditions. The effectiveness of new forecasting tools is being assessed.
- The **timing of rainfall** is critical. There are two key periods in terms of yield response to water availability:
  - The opening of the season - early sowing opportunities favour higher yield potential, provided frost risks are properly managed. Data from the Focus Paddocks indicated an average yield reduction of 17 kg grain per day delay in sowing beyond mid April.
  - The 30 days period bracketing flowering, when grains are set. Crop yield is extremely sensitive to stresses in this period, including water deficit.
- The **fate of rainfall** is variable and important. Rainfall can follow several pathways - direct soil evaporation, runoff, deep drainage, crop transpiration, and weed transpiration.
- **Crop transpiration is the only component of the water budget that is linked to productivity**. All other pathways are unproductive, and some (e.g. deep drainage) are also undesirable for environmental reasons. Management needs to aim to limit water movement via these unproductive pathways and leave more water available for crop transpiration.

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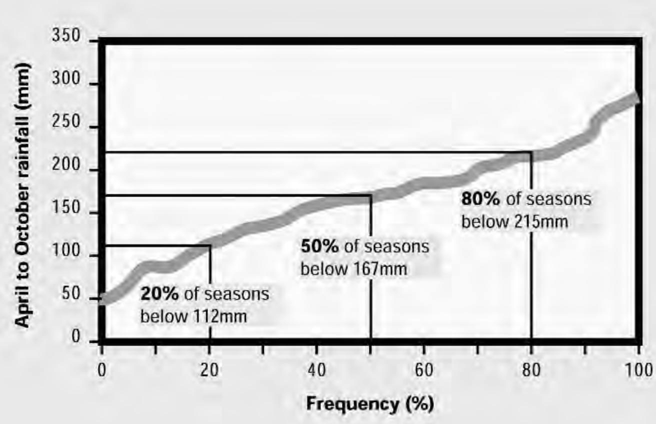

Figure 1. Cumulative frequency distribution of growing season rainfall recorded at Waikerie between 1900 and 2000.

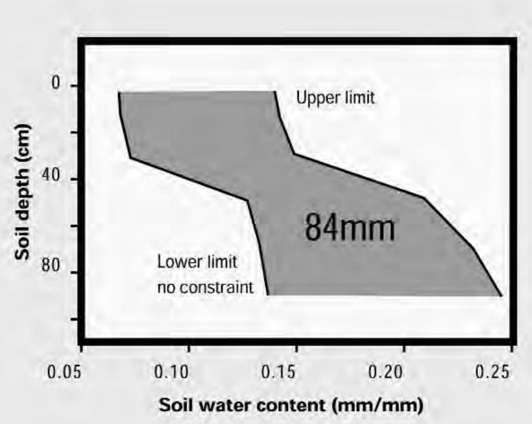

Figure 2. Profile of upper and lower limits of plant available water measured in a sandy loam soil at Euston. The grey area indicates the amount of available water in a full profile.

What you can do

• **Determine the upper and lower limits of water holding capacity for each paddock**. Remember that as for other soil properties, there is spatial variation in both these limits, which needs to be considered when deciding where in the paddock samples have to be taken. Also, the lower and upper limits, like soil texture, are **very stable properties** of the soil. Thus, costs associated with measuring these properties may be offset against the long-term benefit of using this information in managing the paddock.

• **Measure soil water content in the profile around sowing time**. Use measured soil water content and lower limits to work out the amount of water that is available to the crop. Aim to measure soil water content as close as possible to sowing time, as large errors could result from early measurements.

• **Use rain forecasts with caution**. Even though rainfall predictions are far from perfect, they could be used to manage risk and make educated guesses on seasonal conditions. We need to bear in mind that forecasts cannot be evaluated on a singleseason basis; long-term runs are required to determine whether a forecasting method is useful or not in our particular situation.

Where to from here

• **Consult extension officers, who are familiar with the measurement of soil properties,** and could help you in working out sampling procedures and methods to measure the upper and lower limits for your paddocks.

• **Combine your two sources of water to calculate attainable yield.** Following with the example at Waikerie, assuming an average seasonal rainfall of 167 mm, and plant available water in the soil at sowing of 56 mm, gives a total of 223 mm. Using a French and Schultz type approach, target yield may be calculated at around 2.8 t/ha. Determine whether yield calculated with this approach is realistic for your field, and correct if required.

• **Assess input requirements to achieve your target yield.** A user-friendly package has been put together to manage soil water and seasonal rainfall in the calculation of target yield and nitrogen requirements. The package is specifically tailored for the Mallee region, and is freely available on request.

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Mallee Sustainable Farming Website
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farmtalk

This article contains information most relevant to the less than 350 mm rainfall mallee farming region

Sharing, Learning, Doing!

Fact Sheet #10
Feb 2004

Farmtalk is a product of the Mallee Sustainable Farming Inc. Tri-State Research and Extension Team

Summer Weed Control - Options for the Mallee

Vanessa Grieger - Research Consultant, Rural Solutions SA
Graham Fromm - Field Crops Consultant, Rural Solutions SA

The issue

Summer weeds are a constant management issue that confronts farmers in the mallee. In the era of the long fallow, weeds were controlled by cultivation. However, with the shift towards minimum till and no-till, the following questions concerning control options have been raised -

- Should summer weeds be ignored and dealt with at seeding time?

OR

- Should they be controlled during the summer and if so, at what stage?

Dealing with summer weeds in our current farming systems raises even more issues. For example:

- machinery blockages can occur at seeding time if vine weeds such as melons and caltrop are left to grow;
- stock poisoning is a potential concern if Potato weed (Heliotropium europaeum) and Caltrop (Tribulus terrestris) are left to be grazed; and
- stock handling and wool contamination become a problem if Innocent weed (Cenchrus longispinus) is not controlled.

Therefore, if we decide to implement a summer weed management program, what are the best control options?

- Do we revert back to mechanical control and run the high risk of wind erosion? OR
- Do we use some form of chemical control? That raises the issue of what stage of weed growth should be targeted for optimal control to be achieved.

What we know

If summer weeds are not managed over the summer period, then management needs to be performed prior to seeding unless seeding equipment includes the use of coulters. If pre-seeding chemical control is the preferred option, the cost is relatively high because weeds are older, larger, under more stress and thus harder to kill.

Some benefits of controlling summer weeds early include:

- potential increases in soil moisture and nitrogen for the next crop; and
- improved potential yield and grain quality. (The dry conditions of 2002 highlighted these responses.)

Chemical vs Mechanical control

There is **no** difference in crop response between chemical and mechanical weed control. Chemical control is an option, but the timing of control is critical. To obtain maximum benefits weeds need to be controlled early, when they are young and actively growing. An added advantage is that chemical control will also reduce the paddock erosion risk.

What this means

- Summer weeds **can** be successfully controlled, with some added crop benefits including increases in stored moisture and nitrogen levels in the soil profile.
- It is **important** to know your soil profile characteristics and determine whether there are any constraints in the upper horizons of the profile such as compaction or hostile sub soil layers (boron, alkalinity or sodicity). These constraints can limit the capacity of crop roots to take advantage of the extra moisture and nitrogen that has resulted from an effective summer weed management program.

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What can you do

- Implement a summer weed management program as **early** as possible. Weeds will be easier to control and the opportunities for additional in-crop benefits in the following season will be increased.

Figure 1(below) shows the increase in stored soil moisture at the time of seeding and the corresponding responses in yield and protein for an Innocent weed site at Copeville, SA in 2002.

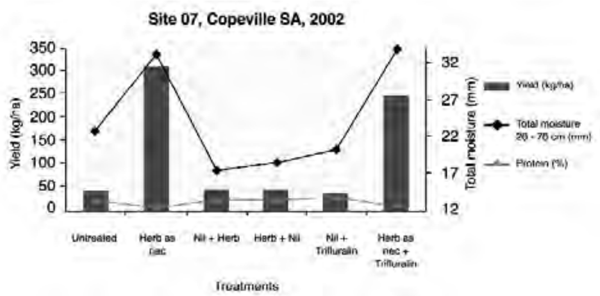

Figure 1. Yield and protein responses to total stored soil moisture (measured at seeding time).

- **Choose a form of control** that will reduce the risk of erosion, such as chemical fallowing or a mechanical fallow that will leave a lot of stubble or dry matter cover.
- **If using herbicides,** be aware of plant growth, previous rainfall events, weather conditions (relative humidity, temperature, delta T, and wind direction) and ground conditions (dust).
- **Be aware** of the responsible use of chemicals, particularly in areas containing sensitive crops.

Where to from here?

- If weeds are controlled over the summer, the next step is to continue the management program over a number of years to prevent seed set. This approach will help reduce the seedbank significantly. **Figure 2 (below)**

Figure 2. Site 07, Copeville, SA. The left plot is the untreated control; the right plot is where innocent weed was controlled for the whole summer.

- Issues on weed control, where there is a high dust presence, needs further research. This is due to the potential reduced efficacy of chemicals when used as a management tool.

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Mallee Sustainable Farming Website
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Searching for answers

Location
Closest town: Edillilie
Cooperator: Edillilie Landcare Group

Rainfall
Av. Annual total:
Av. Growing season: 380 mm
Actual annual total: 516 mm
Actual growing season: 392 mm

Yield
Potential: 5.6 t/ha
Actual: 2 t/ha

Paddock History
2002: Lupins
2001: Barley

Other factors
Waterlogging, particularly in slight depressions

Research

Deep Placed Nutrients at Edillilie, 2003

David Davenport[1], Jeff Braun[1] and Brenton Growden[2]

Rural Solutions SA[1], SARDI, Port Lincoln[2]

Key Messages

- **Waterlogging compromised results in this trial**
- **There was no difference in grain yield between form of fertiliser (fluid or granular), nor to depth of placement (conventional or 17 cm) on a sand over clay soil at Edillilie.**
- **There appeared to be a response to trace elements.**

Why do the trial?

- To compare fluid and granular fertiliser placement at 2 placement depths (conventional and 17 cm) with foliar or soil applied trace elements.
- To establish a new trial in 2003 from which to monitor residual benefits of deep placement of trace elements in future years and if this response varies between fluid and granular fertilisers.

Sand over clay soil types in the Edillilie/Wanilla district are characterised by a bleached A2 sand horizon (at approx 8-10 cm) over sodic clay (at approx 20-50 cm). These bleached layers have low inherent fertility levels and are often subject to waterlogging. Farmers generally consider that there is poor root development in this soil layer and this is thought to be a major factor resulting in the low yields (compared to yield potential). A trial was conducted in 2001 to determine if placing nutrients into this layer would improve yields. Unfortunately difficulties with sowing depth on the deep fertiliser treatments resulted in poor emergence and subsequently no difference between deep and shallow treatments. However, in 2002 a residual effect from trace elements placed below normal seeding depth was observed from this trial (*refer EP Farming Systems 2002 Summary, pg 125*).

How was it done?

Trial Details

Trial Type: 9 treatments x 4 reps (small plot)

Sowing: 11/06/2003, Wyalkatchem wheat @ 100 kg/ha

Fertiliser: All treatments received 20 kg/ha of 18:20 with the seed. In addition, 80 kg/ha of 18:20 was banded at 7 or 17 cm, depending on the treatment for granular treatments and APP + UAN at the same N and P rates were used for fluid treatments.

Trace elements were applied as sulphates. Deep soils applications at sowing: 0.5 kg Cu/ha, 1 kg Zn/ha, 2 kg Mn/ha. Foliar applications at mid-tillering: 0.2 kg Cu/ha, 0.9 kg Zn/ha, 0.9 kg Mn/ha.

Treatments: see Table 1.

What happened?

At early tillering there were visual differences with treatments of applied soil trace elements having better vigour than other treatments although tissue analysis did not indicate any deficiencies. Waterlogging of the site impacted on plots located in slight depressions and had a major impact on yield achieved and site variability. Results are detailed in table 1.

What does this mean?

The trial variability due to waterlogging make interpretation of these results difficult. Despite this variability it would appear that there was no difference between fertiliser type or fertiliser placement depth in this trial. There may have been a response to trace elements. The low yields compared to potential are most likely a result of waterlogging which could also have limited any other treatment responses.

This trial should be monitored in future years to identify if any residual responses to treatments occur.

Acknowledgements

Peter Treloar, Trevor Carter and other members of the Edillilie Landcare Group Committee,

The Million Hectares for the Future program, Ross Britton, Brenton Growden & Terry Blacker SARDI.

Table 1: Grain yield of wheat in Fertiliser Type and Placement Depth Trial, Edillilie, 2003.

Treatment	Yield (t/ha)
*Conventional seeding depth	1.71
*Conventional seeding depth with foliar Cu, Zn, Mn	1.90
*Deep rip (tractor slowed)	1.62
*Deep ripping with granular fertiliser at sowing depth (tractor slowed)	1.83
**Deep ripping with granular fertiliser at depth	1.77
**Deep ripping with fluid fertiliser at depth	1.87
**Deep ripping with granular fertiliser at depth with Cu, Zn, Mn at depth	2.02
**Deep ripping with fluid fertiliser at depth with Cu, Zn, Mn at depth	2.06
**Deep ripping with granular fertiliser at depth with foliar Cu, Zn, Mn	2.06
	LSD (0.05) = 0.3

** Conventional fertiliser placement = 7 cm*
*** Deep fertiliser placement = 17 cm*

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

RURAL SOLUTIONS SA

a Million Hectares for the Future
taking charge of recharge

Top Dressing Cereals with Nitrogen

Research

Catherine Evans

Central West Farming Systems, Condobolin NSW

Searching for answers

Location
Yenda, Merriwagga and Melbergen, south-western NSW

Key Message

- **Late topdressing of nitrogen is economically risky in NSW low-rainfall environments but is an option for farmers in south-western NSW when there is a wet spring.**

Why do the trial?

To identify effective nitrogen management strategies for cereal growers in south-western NSW (between Condobolin and Balranald). This work is part of a "Western Wheat Project" to identify "productive, profitable and sustainable farm practices for low rainfall districts".

The decision whether to top-dress cereal crops or not is often a difficult one to make in drier environments. In a wet spring (August/September) topdressing is a real option for farmers in these regions. However late topdressing of nitrogen is economically risky in low-rainfall environments.

Care also needs to be taken using nitrogen fertilisers in fallow paddocks following pasture or grain legumes as this may negatively affect yield.

How was it done?

Yenda - 1999

Three paddocks of wheat were top-dressed with urea at early tillering and close to flowering to investigate the effectiveness of top dressing wheat crops with contrasting paddock histories.

Merriwagga and Melbergen - 2000

This was an above-average rainfall year with Merriwagga (annual rainfall 325 mm) receiving 473 mm and Melbergen (annual rainfall 400 mm) more than 500mm.

At Merriwagga a Janz wheat crop sown following chickpeas in 1999 was top-dressed by hand at 3 node stage on August 28 with two rates of urea; 50 and 100 kg/ha. 14.4 mm of rain fell the day of topdressing.

At Melbergen a Janz wheat crop sown after pasture in 1999 was top dressed by hand at mid tillering on July 13 with a single rate of 50 kg/ha of urea. Several mm of rain fell the same day and there was another fall six days later.

Rankins Springs - 2001

In this small-plot (1.75 m by 22 m) trial, wheat was sown in soil with good pre-sowing nitrogen and nitrogen applied pre-planting, at the 5-leaf stage and at flowering.

Rankins Springs - 2002

A late, dry start to the 2002 season saw top-dressing carried out on eight sites on landholder's previously-sown paddocks that were already sown without much consideration of soil status.

What happened?

Yenda - 1999

The only treatment to provide an economic return was early application of 50 kg urea/ha at Sylvanham, where nitrogen uptake efficiency was 43% (*Table 2*).

At the other two sites the soil was more fertile and the crops did not benefit from topdressing, which would have reduced profitability.

There was insufficient September rainfall for N top-dressed at flowering to be utilised by the crops at any site.

Merriwagga and Melbergen - 2000

The small responses to top-dressed N reflected the difference in application timing (*Table 2*).

The earlier application at Melbergen produced a slight yield response (0.45 t/ha), for an economic benefit of close to $100/ha. This benefit may have been achieved by pre-drilling the urea, which would have been safer. There was no difference in protein or screenings and the N use efficiency was approximately 40%, close to the expected efficiency.

At Merriwagga the 100 kg/ha of top-dressed N increased the grain protein by 1.5% but also increased the percentage screenings, resulting in an economic loss from the N treatment.

Rankins Springs - 2001

In a very dry year, a dry spell between April and June reduced growth and yield potential and made additional early-season N a negative (*Table 4*). Addition of urea reduced yields. Late application (at anthesis) had least effect. Pre-plant N increased grain protein, late application reduced it.

Screenings were higher with pre-plant N but reduced by applications at the 5-leaf stage and flowering. Applying 100 kg/ha of urea at flowering reduced the level of screenings by almost 40 %.

Rankins Springs - 2002

The continuing drought conditions meant no meaningful results were achieved.

Table 1: Yenda – 1999, paddock details and plant growth stages.

Site	Variety	Paddock History		Plant growth stage when top dressed	
		1997	1998	Tillering 50 kg urea/ha	Flowering 50 & 100 kg urea/ha
Sylvanham	Janz	Barley	Wheat	Z21 (2.8.99)	Booting (15.9.99)
Merelda	Janz	Canola	Fallow	Z27 (2.8.99)	Head emergence (15.9.99)
Bunda Park	Dollarbird		Chickpea	Z23 (2.8.99)	Booting (15.9.99)
				Good moisture	*No immediate follow-up rain*

Table 2: Wheat performance with different nitrogen strategies, Yenda 1999.

	Yield (t/ha)	Protein (%)	Screenings	Economic benefit of topdressing	Water Use Efficiency (WUE)	Nitrogen Use Efficiency (NUE)
Sylvanham						
Tillering 50	1.8	9.1	1.9	$123	9.5	42.5
Flowering 50	1.3	10.0	2.4	$5	6.6	13.0
Flowering 100	1.3	11	2.9	-$6	6.7	11.0
Control	1.2	9.00	3.2		6.4	
	lsd 0.2	lsd 1.0	lsd 2.1			
Merelda						
Tillering 50	3.4	12.6	5.4	- $13	17.7	31
Flowering 50	3.5	11.2	2.7	$1	18.2	3
Flowering 100	3.4	11.5	3.1	-$34	17.8	3
Control	3.4	11.4	4.4		17.7	
	lsd 0.3	lsd 1.1	lsd 0.97			
Bunda Park						
Tillering 50	3.3	17.0	11.7	-$86	17.5	-ve
Flowering 50	3.4	16.2	10.2	-$61	18.0	-ve
Flowering 100	3.5	15.7	8.7	-$42	18.6	-ve
Control	3.5	17.4	8.3		18.5	
	lsd 0.3	lsd 1.1	lsd 0.97		-ve = reduced overall N efficiency	
Assuming urea @ $500/t, spreading @ $10/ha, using AWB Golden Rewards base price at April 2001 of $247/t WUE is the kg grain/ha per mm of rain, NUE is the kg grain/ha per kg applied N/ha						

Table 3: Wheat performance with different nitrogen strategies, Merriwagga & Melbergen, 2000.

Topdressing rate (kg N/ha)	Yield (t/ha)	Protein (%)	Screenings (%)	Economic Benefit (calculated against a yield of 3.05 t/ha)
Merriwagga				
0	3.27	12.9	2.9	$0
50	2.82	12.6	4.1	-$35
100	3.06	14.2	5.3	-$11
Melbergen				
0	2.67	11.7	2.2	$0
50	3.15	11.4	2.1	+$97
Assuming urea @ $500/t, spreading @ $10/ha, using AWB Golden Rewards base price at April 2001 of $247/t				

Table 4: Grain yield and quality, Rankin Springs, 2001

	Yield (t/ha)	Protein (%)	Screenings (%)
Nil urea	1.01	17.1	9.3
50 kg –pre plant	0.65	20.2	13.6
100 kg –pre plant	0.54	21.6	13.4
Nil urea	0.50	21.3	17.7
50 kg - 5 leaf	0.75	19.5	11.5
100 kg – 5 leaf	0.55	20.6	13.2
Nil urea	0.69	20.4	13.3
50 kg –anthesis	0.98	18.9	13.4
100 kg anthesis	0.78	18.6	8.3

Fungicide on Wheat - NSW

Research

Catherine Evans

Central West Farming Systems, Condobolin NSW

Location
Wirrinya
Co-operator: Muffett Family

Rainfall
Av Annual 530 mm
2003 total: 314 mm
2003 GSR: 223 mm

Location
Gunning Gap
Co-operator: Hodges Family

Rainfall
Av Annual: 490 mm
2003 total : 254.2mm
2003 GSR : 181.6mm

Plot size
1.7m x 15m

Key Message

Dry conditions reduced disease and yield potentials.

Why do the trial?

To determine whether or not there are yield and quality benefits from the use of fungicides on wheat.

How was it done?

Four fungicides – Jockey® and Vincit C® seed dressings, Folicur®, and Bumper® - were applied to two wheats - Bowerbird and H45 – planted at trial sites at Wirrinya (sown 8/7/03) and Gunning Gap (sown 4/7/03).

Treatments were Jockey, Folicur applied at joint + flag stage, Vincit C, Folicur applied at flag stage, Bumper, nil fungicide (control).

2003 was the first season of a multi-year trial.

What happened?

There was no significant difference in grain yield between any of the treatments, with the dry season limiting yield potential and fungus disease pressure. It is possible that differences could be observed in a wetter season, particularly at the Gunning Gap site.

At the Wirrinya site, where crown rot was a factor, H45 yielded better than Bowerbird. This was independent of any fungicide treatment and is in line with results from State wide yield trials from 1994 – 2001

The only significant difference ($P \leq 0.05$) recorded was between yield of H45 and Bowerbird at the Wirrinya site.

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Table 1: Yield and quality of wheat with different fungicide treatments at Wirrinya and Gunning Gap, 2003.

		Wirrinya	Gunning Gap				
Variety	**Fungicide Treatement**	**Yield (t/ha)**	**Yield (t/ha)**	**Protein (%)**	**Screenings (%)**	**Test Weight (%)**	**Moisture (%)**
Bowerbird	Control	2.02	0.47	15.93	2.40	77.50	10.60
	Bumper	2.05	0.49	15.83	2.23	76.33	10.67
	Folicur flag	1.93	0.48	15.65	2.15	77.00	10.60
	Folicur joint + flag	1.75	0.51	15.70	2.20	77.17	10.35
	Jockey	1.68	0.50	15.73	2.27	77.67	10.40
	Vincit C	1.81	0.49	15.90	2.80	75.83	10.10
Average		*1.87 a*	*0.46*	*15.79*	*2.35*	*76.69*	*10.44*
H45	Control	1.89	0.47	15.97	2.20	76.00	10.90
	Bumper	2.05	0.48	15.23	2.90	76.50	10.97
	Folicur flag	2.11	0.52	16.07	2.03	76.83	10.83
	Folicur joint + flag	2.17	0.50	16.00	2.60	77.00	10.27
	Jockey	2.01	0.52	15.43	2.40	77.17	10.47
	Vincit C	1.94	0.46	16.17	2.05	76.25	10.43
Average		*2.03 b*	*0.49*	*15.81*	*2.34*	*76.68*	*10.64*
Grand Average		***1.95***	***0.48***	***15.80***	***2.35***	***76.68***	***10.54***

Sharing Info

Notes