Eyre Peninsula Farming Systems Summary 2010

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Viterra is proud to be a major sponsor of the Eyre Peninsula Agricultural Research Foundation (EPARF) and recognises the important role the independent advisory group plays. This includes providing strategic support and planning for the Minnipa Agricultural Centre, actively promoting the needs and benefits of a concentrated research program on the Eyre Peninsula and attracting adequate resources to undertake the programs.

As a company committed to long-term sustainable production, Viterra understands the importance of research and development in the agriculture industry. Viterra supports EPARF's aim to ensure that farmers and agribusiness are an integral part of the planning and implementation of research and extension activities on the Eyre Peninsula.

Viterra continues to invest in local communities and supports a variety of groups, activities and research and development projects, particularly in South Australia. We view our ongoing commitment to research and development as an investment in the sustainability of the Australian grains industry.

EPARF has made a significant contribution to raising the profile of, and raising funds for, research and development projects and activities across the Eyre Peninsula.

Viterra is proud to support EPARF's summary booklet and looks forward to more successful outcomes from EPARF's activities during 2011.

Rob Gordon

Rob Gordon
President South East Asia
Viterra

Foreword

Welcome to the 2010 Eyre Peninsula Farming Systems (EPFS) Summary.

The GRDC is proud to be a long term project partner of the trials, hard work and ingenuity that go into generating the results that are summarised in this book.

Change is occurring at a rapid rate within the Australian grains industry in response to what seems to be increasingly volatile markets and growing conditions. 2010 has been no exception. Crops were planted when grain prices were low and the risk of locusts and mice were front of mind. In much of south eastern Australia after a lot of nitrogen and fungicides were applied, harvest was a frustrating stop/start affair with one of the wettest summers on record and grain being downgraded.

It has been forecast that in the future the number of farms will decline but the increase in production per farm and the adoption of new technology should see grains as a growth industry. Change will no doubt continue and there will be the need to increase the effectiveness of existing operations to reduce costs. In particular it will be necessary to consider better ways of managing risk whilst maximising profit to improve total farm income. This will involve close examination of the key drivers of both profit and risk.

In the past the GRDC has placed a lot of attention on agronomic factors and plant breeding with a concentration on varieties, rates, seeding dates and row spacing type work. While all of this has a place, growers are now seeking greater advice on how they fit the various technologies together to best effect. That "best effect" no longer just means production as it often did in the past – growers see profitability, better targeted inputs and management of risk as the major drivers.

In 2010 the GRDC will be embarking on a new initiative to; more accurately define specific research, development and extension questions; be more responsive to project opportunities that answer identified questions, and improve the communication and awareness of these activities. This will involve working with farming systems projects, agribusiness and private consultants across the country in better understanding their local issues, what is already known, whether the issue is best answered through R, D or E, what value or impact the results are likely to have, how farming practices may change and what further work, if any is required.

The activities that have generated the results highlighted in this book are a collaborative effort with continued support from SARDI, the University of Adelaide, SAGIT, CSIRO, EPARF and growers throughout the Eyre Peninsula.

At the end of the day, farming is complex and the GRDC is working with, and on behalf of, growers to provide the best information, research and technology to ensure our industry is competitive, profitable and sustainable.

I hope you find the articles useful and have a successful 2011!

STEVE THOMAS
Executive Manager, Practices
GRDC

Eyre Peninsula Farming Systems 2010 Summary

Editorial Team

Naomi Scholz	SARDI, Minnipa Agricultural Centre, (MAC)
Amanda Cook	SARDI, MAC
Roy Latta	SARDI, MAC
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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 The Printing Press

March 2011

Front Cover:

(From top to bottom) Dr Annapurna, Dr David Roget and Amanda Cook inspecting Rhizoctonia trials; Ian Richter and Amanda Cook checking sowing in Pratylenchus trials; the view of Yarwondutta Rock from the Minnipa Ag Centre Focus Paddock; Particpants in the 2010 EPARF Day – Crop Growth; NVT trial plots.

Back Cover:

(From top to bottom) Todd Matthews and Trevor Payne at the Central Eyre Sticky Beak Day 2010; Linden Masters and Mark Klante inspecting peas; forage trials in 2010; at the NVT site at the MAC Field Day 2010.

Inside Back Cover:

Photos from various Eyre Peninsula agricultural events in 2010.

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Minnipa Agricultural Centre Update

Hi Everyone,

This year the Eyre Peninsula Farming Systems Summary 2010 is proudly supported by Viterra, Grains Research & Development Corporation (GRDC) through the Eyre Peninsula Farming Systems project (EPFS 3), the GRDC and Caring for our Country funded Eyre Peninsula Grain & Graze project (EPG&G 2), and the South Australian Grains Industry Trust (SAGIT) funded Developing Robust and Lower Risk Farming Systems by Understanding the Impact of Soil Carbon (Rhizoctonia) project. We would like to thank the sponsors for their contribution to Eyre Peninsula (EP) for research, development and extension and enabling us to extend our results to all farm businesses on EP and beyond in other low rainfall areas.

This year's summary features the culmination of the SAGIT funded projects 'Developing robust and lower risk farming systems by understanding the impact of soil carbon' and 'Increasing the understanding of soil carbon and microbial activity on disease suppression of Rhizoctonia' in field trials. This work has been carried out by Amanda Cook over the past 3 years, in addition to Amanda's previous six years of working on Rhizoctonia.

In staff news, Ian Richter has returned to Minnipa Agricultural Centre (MAC) as a Technical Officer and we welcome Jessica Crettenden as the new Grain & Graze Research Officer. The Grain & Graze mixed farming project on EP will further work on grazing cereals, the impact of livestock on soil health (and the value of high input pasture systems vs low input pasture systems) and finding suitable perennial pasture species for EP. With the completion of the No-till project on EP, Michael Bennet and family moved to New Zealand in mid 2010.

In July, 120 farmers, researchers and agronomists attended the 2010 EP Agricultural Research Foundation (EPARF) Day, partly funded by GRDC via the Low Rainfall Collaboration project. The topic of the day was "Cereal Growth Stages - Growing your Profit". Presentations were made by Dr Glenn McDonald (University of Adelaide), Dr Nigel Wilhelm (SARDI), 7 local agronomists, Barry Mudge (Rural Solutions SA), Lyndon May (Syngenta), Hugh Wallwork (SARDI) and Andy Bates (Bates Ag Consulting). A range of plot and pot demonstrations were used to illustrate the growth stages and impacts of management on cereals. A panel session with the key speakers concluded the formal program.

The MAC Annual Field Day was held on 15 September. Approximately 110 farmers, 30 reps, visiting scientists and speakers and staff attended the field day. Participants visited field trials on the MAC farm, and listened to a range of speakers on topics such as sheep genetics, water use efficiency, mice control and barley grass agronomy.

66 women attended the Women's Field Day held at MAC in October 2010. The event was supported by Partners in Grain and Rabobank. Some of the most popular talks were about agronomy and working with banks. Presenters included Amanda Cook focusing on cereal diseases and Cathy Paterson explaining water use efficiency and outlining progress in the EP Farming Systems project.

DATES TO REMEMBER

MAC Annual Field day: Wednesday 14 September 2011

Current funded projects include:

- **Eyre Peninsula Farming Systems 3,** Responsive Farming Systems, GRDC funded, partnership with University of Adelaide, researchers: Cathy Paterson/Roy Latta, CSIRO collaborator: Anthony Whitbread/Therese McBeath
- **Eyre Peninsula Grain & Graze 2,** GRDC/ Caring for our Country funded, partnership with University of Adelaide, researchers: Jessica Crettenden/Roy Latta
- **Developing robust and lower risk farming systems by understanding the impact of soil carbon on Rhizoctonia disease suppression,** SAGIT/EPARF funded, researcher: Amanda Cook
- **Crop Sequencing,** funded by GRDC and Low Rainfall Collaboration, researcher: Roy Latta
- **Profit & Risk Project,** funded by GRDC and Low Rainfall Collaboration, coordinator: Naomi Scholz
- **Australian Farm Groups Demonstrating Adaptive Practices to Minimise the Impact of Climate Change on Farm Viability** Climate adaptation project funded by GRDC and the Australian Government's Climate Change Research Program, researcher: Roy Latta
- **Variety trials** (wheat, barley, canola, peas etc.) **and commercial contract research,** coordinator: Leigh Davis

Thanks for your support at farmer meetings, sticky beak days and field days. Without strong farmer involvement and support, we lose our relevance to you and to the industries that provide a large proportion of the funding to make this work possible. I look forward to seeing you all at farming system events throughout 2011, and all the best for a great season!

Naomi Scholz

Project Manager

EP Farming Systems, EP Grain & Graze

MAC Staff and Roles

Roy Latta	Senior Research Scientist
Nigel Wilhelm	Visiting Senior Research Scientist
Mark Klante	Farm Manager
Dot Brace	Senior Administration Officer
Leala Hoffmann	Administration Officer
Naomi Scholz	Project Manager
Linden Masters	Farming Systems Specialist (EP Farming Systems & EPNRM)
Amanda Cook	Senior Research Officer (Disease Suppression, Rhizoctonia)
Catherine Paterson	Research Officer (EP Farming Systems)
Jessica Crettenden	Research Officer (EP Grain & Graze)
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Wade Shepperd	Agricultural Officer (EP Farming Systems, Rhizoctonia)
Brenton Spriggs	Agricultural Officer (NVT, Contract Research)
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Trent Brace	Agricultural Officer (MAC Farm)

To contact us at the Minnipa Agricultural Centre, please call 8680 5104.

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Eyre Peninsula Agricultural Research Foundation 2010 Report

Peter Kuhlmann, Chairman

Board Members:

Peter Kuhlmann, Matthew Dunn, Dean Wilmott, Simon Guerin, Craig James, Bryan Smith, Geoff Thomas, Andy Bates, Simon Maddocks (SARDI), Glenn McDonald (University of Adelaide), Jordan Wilksch (LEADA), Mark Stanley (EPNRM), Roy Latta (Leader, MAC), Dot Brace (EO).

Role of EPARF

Advise and assist:

- MAC management in strategic decisions like funding opportunities
- Defining research priorities at Project Management meetings
- MAC Farm on major decisions
- Support project applications
- Seek sponsorship and provide a pathway to contribute to positive outcomes for Eyre Peninsula farmers
- Maintain a relationship with our research funders and sponsors
- Utilise our reserve to leverage other funds
- Provide a service to our members

Board Members

There are 6 elected farmer members and each year 2 members are elected for a 3 year term. Craig James and Simon Guerin completed their term and both chose to renominate. EPARF looks forward to their continued involvement.

Membership

188 members.

Sponsors

Thanks to the valuable support of our Sponsors for their vital investment in research in low rainfall agriculture.

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- GPS Ag
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- AWB Seeds
- Letcher & Moroney Chartered Accountants
- Vaderstad
- EP Grain

Finance

EPARF is a foundation and its income is from membership, sponsorship and reimbursements.

Expenditure is administration support and meeting expenses, leveraging, project support and services to members.

2010 EPARF Members' Day

The Cereal Growth Stages – Growing Your Profit workshop held in July attracted 120 attendees. The hands on and interactive activities made the day invaluable for growers to best manage their cereals.

Conference Attendance

Andy Bates attended the Crawford Fund International Conference and Matt Dunn, Peter Kuhlmann and Geoff Thomas attended AIAST Future of Agriculture Research in Australia Conference on behalf of EPARF.

Low Rainfall Farming Systems Collaboration Group

Mildura hosted the annual meeting this year with farmers and researchers from Minnipa, Birchip Cropping Group, Mallee Sustainable Farming, Upper North and Central West Farming Systems groups attending. Bryan Smith attended on behalf of EPARF with staff from MAC.

Ministerial Visit

EPARF board members and senior staff met with Minister Michael O'Brien, Minister of Agriculture for a discussion and a farm tour.

Strategic Planning

EPARF recently supported MAC staff in Strategic Planning. This will form part of the MAC Plans & Profiles document to be reviewed annually.

Thanks

Thanks to the SA Government (through SARDI) for its continued safeguarding of the Minnipa Agricultural Centre. We value the financial support from GRDC and the Federal Government, SAGIT and all of our industry funders and sponsors. Your continued commitment is vital for our farming communities.

Thanks to executive officer Dot Brace and the EPARF board members for their commitment and the support.

Thank you to our EPARF members for your continued support of agricultural research in our dryland environment through attending field days, hosting research sites and contributing ideas. Our membership base is an important factor when we are seeking funding for Eyre Peninsula research. Your membership is important to us.

EPARF Board members in 2010

Eyre Peninsula Agricultural Research Foundation Members 2010

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Adams	Daniel	CUMMINS SA
Adams	Lora	CUMMINS SA
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Freeth	John	KIMBA SA
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May	Debbie	ELLISTON SA	Traeger	Sarah	CLEVE SA
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Sampson	Veronica	WARRAMBOO SA	Woolford	Michael	CLEVE SA
			Zacher	Michael	LOCK SA

Eyre Peninsula Seasonal Summary 2010

Linden Masters[1], Brett Masters[1] and Kieran Wauchope[2]
[1]SARDI and EPNRM, Minnipa Agricultural Centre, [2]Rural Solutions SA, Port Lincoln

OVERVIEW

The 2010 season saw outstanding crop and pasture growth across Eyre Peninsula (EP) with ideal growing conditions throughout winter and spring. Above average rainfall saw some crops suffer waterlogging in parts of the Lower EP. Two good seasons in a row, after a string of poor seasons put pressure on the grain handling system. In 2009 nearly 2.7 million tonnes of grain was produced on EP. Grain delivered on EP in 2010 topped 3 million tonnes. Extra on-farm storage was needed to compliment the extra bunkers put in at Viterra sites at Wudinna and Rudall, and the EP Grain storage site at Taragora. Canola production was in excess of 100,000 tonnes. Due to no exports from Russia, drought in Western Australia and weather damage at harvest in the Eastern states, high prices were offered for delivered grain. Cereal quality became an issue with much of the barley being delivered as feed from malting barley areas. Unseasonal rain during harvest saw some downgrading of cereals and peas were also badly affected. Approximately 25-30% of wheat received was downgraded to GP and some to feed. Many farmers achieved record yields and were rewarded with good prices, feed wheat prices being similar to that for APW in 2009.

WEATHER

Temperatures throughout the season were generally cool to cold which slowed crop and pasture growth considerably and delayed maturity. Scattered frosts were reported in inland areas in July and early August. Warmer temperatures were recorded in October. Whilst crops were not subjected to the hot north winds that can be a problem at flowering, significant rainfall events during November and December resulted in delayed harvest, increased instance of shot grain and reduced test weights and grain quality.

RAINFALL

Growing season rainfall from April-October was above average in all districts, with the Western and Lower EP recording decile 7 rainfall and the Eastern EP recording decile 8 rainfall.

Although there was some heavy rainfall recorded during thunderstorms in March it was not until June that the first widespread opening rain fell. Despite July and August recording below average rainfall an intense low pressure system moved through the region on 4 September, bringing gale force winds and widespread, heavy rainfall to all districts. This significantly boosted soil moisture levels going into spring. The key growing months of September and October recorded well above average rainfall. Continuing rains into November and December caused frustration for farmers at harvest.

CROPS

Plague populations of mice caused significant damage to newly sown crops on Upper EP. This resulted in many growers having to bait and/or re-sow significant areas of crop. Mice numbers had dropped significantly in most areas by September. With high yields and a high stubble load being left after harvest in 2010 we will be watching mouse numbers with bated breath!

Staggered germination of brome grass, barley grass, annual ryegrass and wild oats made controlling weeds in crop extremely difficult which will have considerable implications for weed control next season. A significant number of growers chose to spray out sandy rises that were badly infested with brome grass.

Additional nitrogen was applied to many crops during late July and early August in response to rising grain prices and good soil moisture and rainfall. There were however reports that urea and ammonium nitrate were difficult to source due to this increased demand.

Damp conditions were ideal for the development of foliar fungal disease. Powdery and downy mildew was prevalent in many cereal and pea crops. Stripe rust and to a lesser extent leaf rust was reported in many areas, with stem rust showing up on Eastern EP in the latter half of October as temperatures increased, however they were generally contained to manageable levels with well-timed, preventative fungicide applications. Lower EP growers found that some paddocks were too wet to allow for timely applications of herbicide, fungicide and urea. It is suspected that powdery mildew has contributed to poor grain fill on many of the paddocks.

Grain yields were generally above average, however the wet conditions in November and December meant that grain quality was an issue.

Malting barley was very difficult to achieve and much of the wheat was classified as general purpose or below due to the high percentage of shot grain. These quality downgrades were somewhat offset by increased prices resulting from poor harvest in other states. The year will be remembered by many for the unseasonal rain causing frustration during harvest.

PASTURES

Growing season conditions were ideal for pasture growth with many growers in the upper and western EP stating that the medic pastures were some of the best seen in over 20 years.

Paddock feed was more than adequate for stock requirements in all districts, although some paddocks showed nitrogen deficiency and some sands showed sulphur deficiency. Stock were in excellent condition throughout the 2010 season with record ewe prices and high lamb values adding further value to a good season. Although the amount of hay cut was below average with many growers looking to take advantage of predicted high grain yields and good prices, those that did cut hay reported exceptional yields. Some cereal crops sown for feed had grain harvested from them despite being grazed for many weeks early in the season.

DISTRICT REPORTS

WESTERN EYRE PENINSULA

- Seeding was delayed in many districts due to dry conditions in early May and high mice populations. Growers took advantage of this seeding delay to manage stubbles for mice control and ensure that when they finally began seeding there were few interruptions with most growers finishing by the end of June.
- Heavy rain and high winds in late October caused many barley crops to lodge and pods to split on some pulse crops. Cereals were generally not mature enough to suffer grain damage.
- Canola crops looked good with some dry sowing. Later sown crops showed good early vigour. Significant trials of mustard were sown including paddocks sown for bio-fuel production.
- Despite cool conditions delaying flowering for pulse crops, harvest yields were well above average.
- Mice were recorded in significant numbers from Streaky Bay to Kyancutta. Many growers delayed seeding. Prickle chains and rotary harrows were also used post seeding to level out furrows and try to stop mice from following rows to pick up seed. A number of growers reported having to bait multiple times or re-sow areas of crop. There were some reports of mice targeting the nodes and heads of early sown cereal crops and stripping pods of dry sown canola in some parts of the district.
- Brome grass was a significant issue on sandy soils in the district. Many growers used a chemical fallow on sandy rises to stop seed set. Barley grass plants that escaped control in crop will again pose a real issue next season.
- Summer weeds began to germinate with rains in late October.
- Grain yields were generally higher than average with barley yields reported in excess of 4 t/ha and wheat yields in excess of 3 t/ha. The rain late in the season did cause some damage with shot grain (particularly in susceptible varieties of barley).

EASTERN EYRE PENINSULA

- Temperatures during the growing season were cool with soil moisture levels generally good. Thunderstorms in March saw falls of around 100 mm near Verran and in the Cleve hills. This provided good subsoil moisture coming into the growing season.
- There were a number of frosts reported near Kimba during July and August.
- By October soils contained a high level of subsoil moisture carrying crops through to harvest.
- Many growers sprayed wheat paddocks with fungicide as a preventative spray for rust which provided effective protection resulting in limited infestation. However leaf rust and stem rust proved to be a problem in susceptible varieties and paddocks that were not treated early.
- Growers reported locust hatchings in the Kimba and Franklin Harbour districts in November. This was generally too late to do any damage to this year's grain harvest. However there is some concern that eggs laid during spring may hatch in autumn, causing damage to emerging crops.
- Growers in the Cleve Hills and the Franklin Harbour area have cut significant amounts of hay, with some reports of cereal hay yields in excess of 8 t/ha. Paddocks cut for hay saw significant regrowth.
- Barley grass provided a high level of early feed this season. Many growers spray-topped pasture paddocks to stop barley grass setting seed ahead of cropping the paddock next season.
- Yields around the district were generally well above average. Growers at Cowell reported wheat yields in excess of 2 t/ha with barley yields in excess of 3.5 t/ha reported around Wharminda.
- Grain delivered prior to the rains in mid December was of good quality, however grain quality reduced rapidly following the rain and much of the wheat was graded as feed or general purpose.

LOWER EYRE PENINSULA

- The year started well with early rainfall allowing for weed control. Seeding began after rains in early April but little follow up rainfall in May meant that seeding was halted for about a fortnight before there was enough moisture to begin again.
- Despite the late start for the majority of growers seeding was finished by early June and climatic conditions throughout the year were generally ideal with exception of the wet harvest.
- Due to the variability of starting rainfall there was patchy emergence of many of the earlier sown crops (particularly canola). Snails, slugs, lucerne flea and Red Legged Earth Mite also caused problems with crop emergence.
- Paddock trafficability was an issue for spraying and fertiliser spreading at times due to the high levels of soil moisture.
- Parts of the region suffered from waterlogging, however high yields in the remainder of the paddock meant that paddock yields were average.
- Nitrogen application in response to good rainfall and high subsoil moisture levels saw a high demand on nitrogen supplies.
- Leaf disease including Spot form Net Blotch and Powdery Mildew resulted from continued damp conditions through spring and caused significant damage to both cereal and pulse crops in the region. Early preventative sprays limited the infestation of rust on cereals.
- Diamond back moths (DBM) were evident in crops earlier than normal which caused growers great concern. Intensive monitoring for DBM occurred in September; however cool and wet conditions seemed to prevent numbers from building up significantly. These heavy rainfall events led to some cereal and bean crops lodging.
- Ryegrass, wild oats and brome grass were a consistent problem in crops throughout the season and careful weed management will be required to address these weeds at seeding in 2011. Many growers had planned to crop-top wheat paddocks to stop ryegrass seed set, however cool and moist conditions delayed both weed seed set and crop maturity and made it difficult for growers to time a crop-topping application correctly. Many growers were able to effectively spray-top pasture paddocks to control seed set of ryegrass and barley grass.
- Final yields were well above average with relatively small losses incurred by pests and disease. Some growers reported wheat yields of 6 t/ha at Cummins, Kapinnie, Cockaleechie and Ungarra. Canola reportedly yielded from 1.8 t/ha to 2 t/ha.
- Grain quality was a significant issue with a large amount of shot grain due to the wet harvest conditions. Wheat harvested prior to rains in mid December was achieving APW classification whilst much of the wheat delivered after the rain was downgraded to general purpose or feed. Grain prices were a saving grace for farmers as feed grade wheat was paying a similar price to that of APW in 2009.

MAC Farm Report 2010

Mark Klante
SARDI, Minnipa Agricultural Centre

INFORMATION

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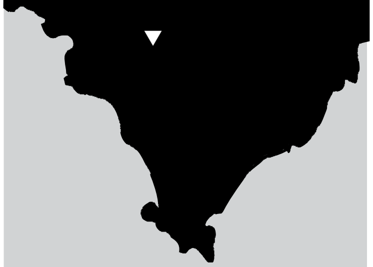


Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 320 mm
Av. GSR: 240 mm
2010 Total: 410 mm
2010 GSR: 345 mm

Key outcomes

- **MAC average wheat yields 3.1 t/ha, barley 3.7 t/ha.**
- **80% of total farm area cropped.**
- **350 breeding ewes producing 118% weaners on 190 hectares.**
- **400 tonnes of quality seed sold to growers.**

Why do the trial?

The performance of the MAC commercial farm is an essential component in the delivery of relevant research, development and extension to the Eyre Peninsula. The effective use of research information and improved technology is an integral part of the role of the MAC farm.

How was it done?

Sowing commenced on 23 May with 10 ha of Angel medic being sown. This was followed by sowing Correll wheat for sheep feed on the 25 May. Following 26 mm of rain on 28 May, seeding commenced on 31 May, finishing on 11 June. The GPS guidance system worked well with inter row sowing into up to 4 t/ha stubbles causing no problems.

The area sown was 865 ha (wheat 640, barley 125, peas 90 and canola 116) with 190 ha of permanent or regenerating pasture.

What happened?

The average farm wheat yield of 3.1 t/ha was comparable to 1991 and 2001 but 20% below the record average yield of 2009. Barley yielded an average 3.7 t/ha. Wheat yields were limited in some paddocks by grass competition made more difficult to control with the relatively late break to the season. 345 mm of May – October rainfall (235 mm of plant available water) achieved a relatively low water use efficiency (WUE) of 13 kg/ha/mm. However due to crop stage of maturity 55 mm in the last 3 days of October may have had limited impact and deleting that from the growing season rainfall figure results in a very acceptable 17 kg/ha/mm WUE.

Table 1 presents a representative sample of grain yields and protein aligned with paddock histories.

What does this mean?

The MAC farm has maintained grain yield productivity/mm of available water of the previous record year of 2009, if the late October rain is not taken into account. If it is taken into account the WUE efficiency slips somewhere close to the district average. The reality is probably somewhere between the 2 points (15 kg/ha/mm).

A similar 80% of total farm area was sown to crops in 2010 with 350 breeding ewes, in a self replacing merino flock, weaning 118% lambs.

400 tonne of seed grain was sold to growers from the 2009 crops, providing quality grain to the industry on Eyre Peninsula.

Acknowledgements

MAC farm staff Brett McEvoy and Trent Brace.

Table 1 Harvest results 2010

Paddock	Paddock History 06-09	Crop 2010	Sowing Date	Yield (t/ha)	Protein (%)
South 1	P W W W	Correll (G)	25 May	Spray topped	
South 1 Scrub	P W W W	Hindmarsh (B)	9 June	3.6	11.6
South 2/8	P W W P	Axe (W)	11 June	3.7	12.1
South 3 S	W W P P	Mace (W)	31 May	3.8	12.2
South 3 N	W Pe P W	Wyalkatchem (W)	3 June	2.2	9.4
South 4	W P W W	Wyalkatchem (W)	3 June	2.6	9.8
South 5	W W W Pe	Espada (W)	1 June	4.1	11.7
South 6 E	P P W W	Hindmarsh (B)	10 June	3.8	11.9
South 6 W	W W P P	Scope (B)	7 June	3.3	13.5
South 9	W B P W	Wyalkatchem (W)	2 June	2.2	8.9
South 10	P W W W	Wyalkatchem (W)	7 May	3.4	9.1
Barn	W W W B	Hindmarsh (B)	9 June	3.9	12.0
North 1	W W W W	Wyalkatchem (W)	4 June	3.1	10.3
North 2	W W W B	Twilight (Pe)	26 May	1.6	
North 2	W W W B	Gunyah (Pe)	26 May	1.8	
North 2	W W W B	Kaspa (Pe)	26 May	1.7	
North 3	W W W O	Kaspa (Pe)	27 May	1.8	
North 4	W W P P	Mace (W)	31 May	4.0	12.1
North 5 N	W W W W	Hindmarsh (B)	7 June	4.1	9.8
North 6 E	W P P W	Wyalkatchem (W)	2 June	2.6	9.3
North 6 W	W C W W	Hindmarsh (B)	7 June	3.5	11.4
North 7/8	W P W W	Mace (W)	10 June	3.0	9.5
North 12	W T W B	Mace (W)	1 June	2.5	8.1
Competition Paddocks		Tarcoola (C)	27 May	0.9	45% Oil

P = pasture, Pe = field pea, W = wheat, B = barley, O = oats, C = canola, T = triticale, G = grazing

Please note:
In 2010, some recordings of rainfall events were missed by the Bureau of Meteorology (BOM) weather station due to technical difficulties:
BOM Total: 326 mm
GSR: 268 mm
Manual recordings @ MAC
Total: 410 mm
GSR: 346 mm

Articles in this book have used Minnipa Agricultural Centre manual rainfall records.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

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, means are compared to see whether any differences 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 observed differences 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.

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

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 *LSD (P=0.05)*	$P \leq 0.05$ *0.33*

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. All three fertiliser treatments also 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 un-replicated trial or demonstration does have a role in agriculture as it enables a farmer to verify research findings on his particular soil type, rainfall and farming system, and we all know that "if I see it on my place, then I'm more likely to adopt it". On-farm trials and demonstrations often serve as a catalyst for new ideas, which then lead to replicated trials to validate these observations.

The bottom line with un-replicated 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, note the following points:

- Choose your test site carefully so that it is uniform and representative - yield maps will help, if available.
- Identify the treatments you wish to investigate and their possible effects. Don't attempt too many treatments.
- Make treatment areas to be compared as large as possible, at least wider than your header.
- Treat and manage these areas similarly in all respects, except for the treatments being compared.
- If possible, place a control strip on both sides and in the middle of your treatment strips, so that if there is a change in conditions you are likely to spot it by comparing the performance of control strips.
- If you can't find an even area, align your treatment strips 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 treatments will be partly on the flat, part on the mid slope and part at the top of the rise. This is much better than running strips across the slope, which may put your control on the sandy soil at the top of the rise and your treatment on the heavy flat, for example. This would make a direct comparison very tricky.
- Record treatment details accurately 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 interpreting the results.
- Yield mapping provides a new and very useful tool for comparing large-scale treatment areas in a paddock.

The "Crop Monitoring Guide" published by Rural Solutions SA and available through PIRSA offices has additional information on conducting on-farm trials.

Trials Sown but not Harvested or Reported 2010

Nitrogen and Sulphur response, Minnipa and Wharminda

Cathy Paterson

Mice damage at Minnipa and brome grass infection at Wharminda resulted in a lack of meaningful results from these trials.

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 un-replicated 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 size	Farmers and Agronomists	Not statistical, trend comparisons
RESEARCH	Yes, usually 4	Generally small plot	Researchers	Statistics
SURVEY	Yes	Various	Various	Statistics or trend comparisons
EXTENSION	N/A	N/A	Agronomists and Researchers	Usually summary of research results
INFORMATION	N/A	N/A	N/A	N/A

Some Useful Conversions

Area

1 ha (hectare) = 10,000 m^2 (square 100 m by 100m)

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

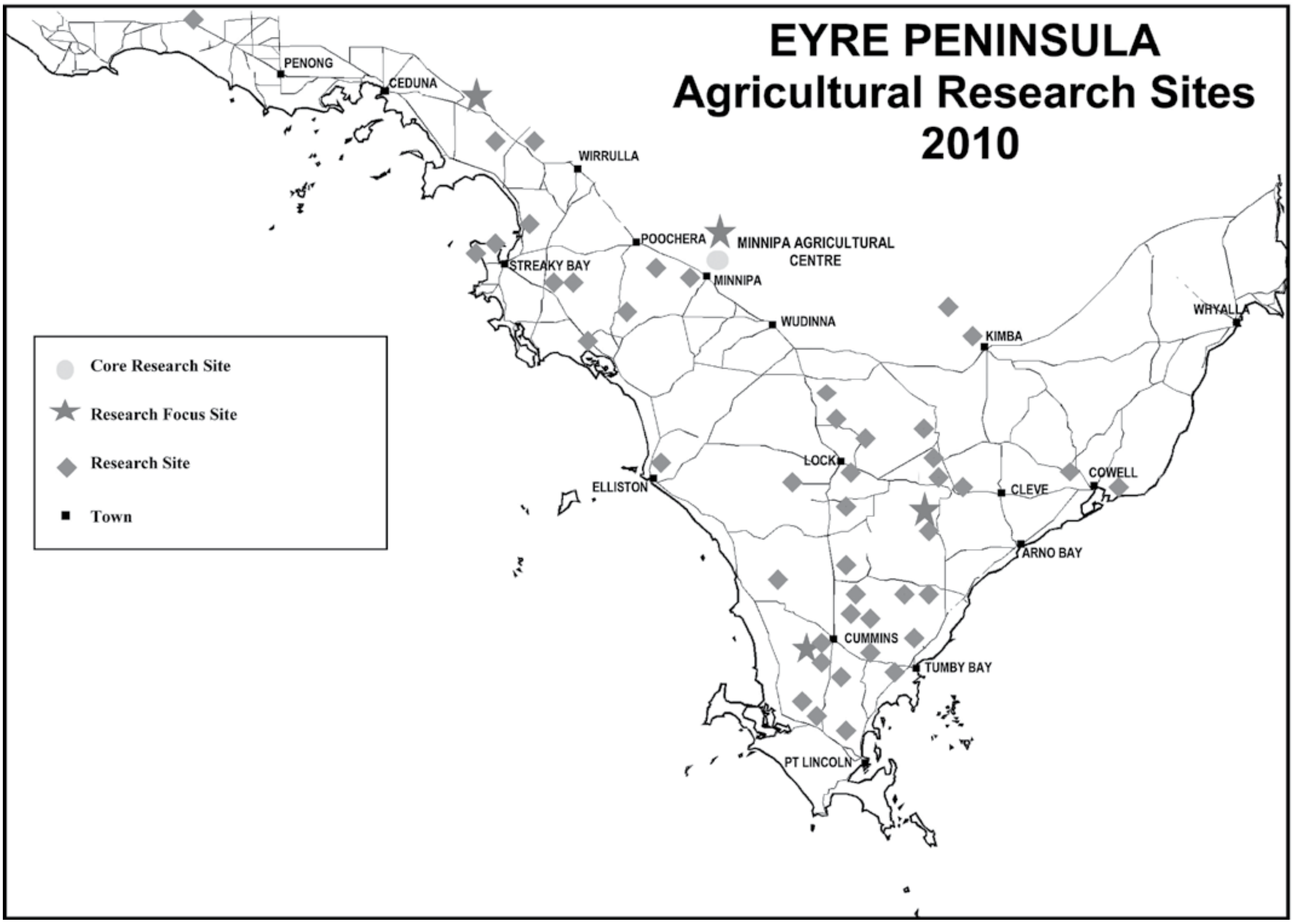
Yield

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

Eyre Peninsula
Agricultural Research Sites 2010



Section 1

Section Editor:
Naomi Scholz
SARDI
Minnipa Agricultural Centre

Cereals

Cereals

The 2010 production figures for Upper Eyre Peninsula were approximately 1.6 million tonnes of wheat, 399,000 t of barley, 28,500 t of oats and 10,300 t of triticale. The Lower Eyre Peninsula production figures were approximately 490,000 t of wheat, 310,000 t of barley, 7,000 t of oats and 2,500 t of triticale.
[PIRSA Crop Production Estimates January 2011]

Triticale variety yield performance

2010 and long term (2001-2010) expressed as % of site average yield and as t/ha

Variety	2010 Yield results (% site av.)			Long term average across sites within region			
				Lower Eyre		Upper Eyre	
	Greenpatch	Minnipa	Streaky Bay	% sites av.	# Trials	% sites av.	# Trials
Berkshire	113	111	98	112	4	109	4
Bogong	126	106	106	122	8	121	7
Canobolas	101	106	107	112	8	112	7
Chopper	106	100	87	103	6	103	6
Endeavour	60	-	-				
Hawkeye	107	101	102	107	10	106	9
Jaywick	100	98	93	106	10	105	9
Rufus	98	95	101	100	8	100	8
Tahara	96	98	106	98	12	103	11
Tickit	95	95	101	99	12	101	11
Tobruk	-	-	-	101	6	105	3
Tuckerbox	87	-	-	92	4		
Yowie	91	89	95				
Yukuri	79	-	-	100	4		
Site av. yield t/ha	**4.25**	**3.97**	**2.32**	**2.88**		**1.98**	
Date Sown	2 Jun	7 Jun	10 Jun				
Soil Type	LS	L	LSCL				
pH (water)	5.6	8.4	8.2				
A-O rain mm	494	345	323				
Stress factors							

Abbreviations

Soil Types: S=sand, C=clay, L=loam

Data source: *SARDI/GRDC & NVT (long term data based on weighted analysis of sites)*

Data analysis by GRDC funded National Statistics Group

Wheat variety yield performance *(2010 and long term, 2004-2010, expressed as t/ha and % of site average yield)*

Variety	Mid and Lower Eyre Peninsula						Upper, Eastern and Western Eyre Peninsula									
	2010 (% site average)			Long Term av. across sites (04-10)			2010 (as % site average)							Long Term av across sites (04-10)		
	Cummins	Rudall	Ungarra	t/ha	as % site av.	# trials	Kimba	Minnipa	Mitchelville	Nunjikompita	Penong	Streaky Bay	Warramboo	t/ha	as % site av.	# trials
AGT Katana	98	113	110	3.11	106	11		103	108	100	101	101	108	1.49	111	22
Axe	96	92	91	3.00	102	20		96	95	93	100	90	97	1.42	106	40
Catalina	91	93	92	2.94	100	14		100	95	91	86	97	98	1.37	102	26
Clearfield Jnz	98	96	102	2.83	97	8		93	94	85	82	82	98	1.21	91	18
Correll	94	100	103	3.04	104	17		93	105	105	94	104	100	1.45	108	33
Derrimut	101	90	106	3.06	104	17	GRASS	93	109	83	80	89	87	1.37	103	33
Espada	98	108	102	3.09	105	14	WEEDS	109	104	106	102	107	104	1.50	112	26
Estoc	100	109	110	3.04	104	8	NO	103	108	106	102	99	106	1.44	108	16
Frame	-	99	99	2.86	98	19	VALID	99	105	100	88	97	95	1.33	99	40
Gladius	96	99	98	3.09	105	17	RESULT	100	107	98	97	96	90	1.48	110	33
Guardian	100	-	98	3.07	105	12		-	-	-	-	-	-	1.44	108	15
RAC1683	96	100	104					97	104	99	99	105	101			
RAC1669	98	92	76					99	100	103	95	98	91			
Lincoln	100	95	101	3.00	103	11		94	100	95	92	92	101	1.43	107	22
Mace	107	108	102	3.17	108	5		109	88	106	112	107	101	1.56	116	11
Magenta	101	103	105	3.04	104	17		100	108	105	100	111	107	1.45	108	33
Peake	97	86	94	3.04	104	17		91	101	83	88	80	90	1.39	104	33
Pugsley	98	109	93	3.06	104	20		99	107	110	98	103	110	1.44	108	40
Scout	104	104	115	3.25	111	5		103	111	98	94	108	100	1.56	117	11
Wyalkatchem	107	102	104	3.10	106	20		100	89	103	110	102	102	1.49	111	40
Yitpi	96	99	103	3.01	103	20		99	109	107	97	111	91	1.43	107	40
Young	100	92	95	3.05	104	20		97	107	96	98	95	109	1.45	108	40
Site av. yield t/ha	6.11	4.67	6.37	2.93	100			4.45	2.9	2.23	1.7	2.52	2.98	1.34	100	
LSD (%)	*4*	*5*	*7*					*5*	*4*	*5*	*6*	*8*	*7*			
Date Sown	31 May	1 June	26 June				19 May	7 June	31 May	5 June	6 June	10 June	1 June			
Soil Type	CL	SL	CSL				LS	L	LS	SL	SL	LSCL	LS			
A-0 Rain (2010)	377	317	325				348	345	311	249	264	323	263			
pH_{water}	8.1	8.5	6.0				7.9	8.4	8.2	8.2	8.5	8.2	8.1			
Site Streses		yls					e,wg			yls	de		yls			

Abbreviations: Soil type: S=sand, L=loam, C=clay, Li=light, M=medium, H=heavy, F=fine.
Site stress factors: de=preanthesis moisture stress, e=emergence(e.g. mice), wg=grassy weeds, yls=yellow leaf spot
Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2000-2010) *Durum varieties trialed separately and not completely valid to compare against bread wheats. Data analysis by GRDC funded National Statistics Group

Barley variety yield performance *2010 and long term, (2004 - 2010) expressed as t/ha and % of site average yield*

Variety	LOWER EYRE PENINSULA					UPPER EYRE PENINSULA							
	2010 (% site average)		Long Term average across sites (2004-2010)			2010 (as % site average)					Long Term average across sites (2004-2010)		
	Cummins	Wanilla	t/ha	as % site av.	# trials	Darke Peak	Elliston	Minnipa	Streaky Bay	Wharminda	t/ha	as % site av.	# trials
Barque	97	88	3.15	102	18	108	94	97	104	92	2.26	108	24
Baudin	89	90	3.08	99	20	92	102	93	107	113	2.09	100	20
Buloke	101	91	3.28	106	20	106	101	97	99	85	2.22	106	24
Capstan	108	98	3.28	106	11	-	-	-	-	-	2.25	107	3
Commander	103	95	3.32	107	20	99	103	104	109	94	2.23	107	24
Finniss	96	84	2.86	92	16	91	91	99	98	81	2.00	95	7
Flagship	91	95	3.11	100	20	101	96	93	102	87	2.15	103	24
Fleet	100	106	3.36	108	20	102	105	98	120	70	2.39	114	24
Gairdner	85	84	3.00	97	18	-	-	-	-	-	2.06	98	12
Hindmarsh	105	104	3.44	111	14	94	105	108	104	87	2.38	114	17
Keel	80	81	3.27	105	20	-	96	118	98	78	2.40	115	23
Maritime	90	87	3.20	103	20	80	90	94	111	108	2.17	104	24
Oxford	115	112	3.42	110	7	109	114	98	107	159	2.16	103	8
Schooner	83	97	2.97	96	20	91	93	87	90	66	2.06	98	24
Sloop	101	92	3.13	101	5	103	94	99	90	83	2.15	103	8
Sloop SA	88	85	3.05	98	20	96	94	94	107	75	2.11	101	24
Vlamingh	104	110	3.16	102	20	108	105	100	99	115	2.11	100	24
Yarra	101	112	3.32	107	20	110	111	99	108	135	2.28	100	24
Site av. yield t/ha	5.39	5				2.66	3.8	4.38	2.9	2.89	2.10		
LSD (P=0.05) as %	*9*	*12*				*10*	*8*	*5*	*14*	*16*			
Date Sown	31 May	26 May				31 May	26 May	7 June	10 June	2 June			
Soil Type	CL	S				CL	S	L	SL	NWS			
A - O Rain mm	377	380				270	409	345	377	341			
pH (water)	8.1	6.7				8.4	8.0	8.4	8.2	6.8			
Site Stress Factors	lr	lr,nn,ns					ns,nn		r,ls,ns	lr,ns,nn			

Abbreviations

Soil type: S = sand, L = loam, C = clay, Li = light, M = medium, H = heavy, F = fine, NW = non wetting, / = separates top soil from sub soil

Site stress factors: ls = late sown, lr = leaf rust, r = rhizoctonia, nn = net form net blotch, ns = spot form net blotch

Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites)

Data analysis by GRDC funded National Statistics Group

Cereals

Oat variety yield performance

2010 and long term (2004-2010) expressed as % of site average yield and as t/ha

	2010 (as % site average)		Long Term average across sites within region (2004-2010) as %			
Region	Lower Eyre	Upper Eyre	Lower Eyre		Upper Eyre	
Variety	Greenpatch	Nunjikompita	% sites av.	# Trials	% sites av.	# Trials
Carrolup	-	-	-	-	100	2
Echidna	-	-	107	5	106	10
Euro	98	112	103	6	100	12
Mitika	98	97	108	6	105	12
Mortlock	-	-	93	4	90	8
Numbat	81	75	-	-	72	6
Possum	97	92	107	6	106	12
Potoroo	86	111	105	6	108	12
Wandering	-	-	-	-	112	2
Yallara	99	100	103	6	101	12
Site av. yield t/ha	4.03	2.10	3.42		1.50	
LSD (P=0.05) as %	*8*	*6*				
Date Sown	2 Jun	5 Jun				
Soil Type	LS	SL				
pH (water)	5.6	8.2				
A-O rain mm	494	249				

Abbreviations

Soil Types: S=sand, C=clay, L=loam, F=fine, K=coarse, M=medium, Li=light, H=heavy, /=divides topsoil from subsoil

Data source: *NVT, GRDC and SARDI Crop Evaluation ans Oat Breeding Programs (long term data based on weighted analysis of sites)*

Data analysis by GRDC funded National Statistics Group

District Wheat and Barley Trials

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RESEARCH DEMO

Cereals

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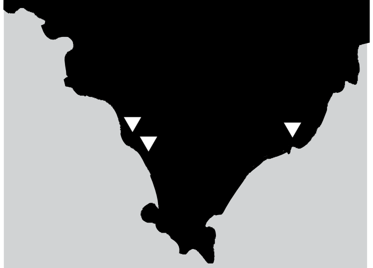

Location: Cowell
Beven & Cindy Siviour
Franklin Harbour Ag Bureau

Rainfall
Av. Annual: 300 mm
Av. GSR: 256 mm
2010 Total: 502 mm
2010 GSR: 343 mm

Yield
Potential: 5.4 t/ha (W)
Actual: 4.8 t/ha (W)

Paddock History
2009: Pasture
2008: Oats
2007: Wheat

Soil Type
Red clay loam

Plot size
18 m x 15 m x 3 reps

Yield Limiting Factors
Stem and Stripe rust

Location: Port Kenny / Mt Cooper
Geoff & Jake Hull
Mt Cooper Ag Bureau

Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2010 Total: 450 mm
2010 GSR: 386 mm

Yield
Potential: 5.5 t/ha (W)
Actual: 4.23 t/ha (W)

Paddock History
2009: Medic Pasture
2008: Medic Pasture
2007: Medic Pasture

Soil Type
Grey loam

Plot size
10 m x 1.5 m x 3 reps

Yield Limiting Factors
Low amount of mice damage

Key messages

- **Guardian and Mace top yielding varieties at Franklin Harbour.**
- **Espada and RAC 1671 top the yields at Mt Cooper.**
- **Hindmarsh barley stands out; yielding 4.76 t/ha at Mt Cooper.**
- **Estoc, Scout and Espada top yielding varieties at Elliston.**

Why do the trial?

These variety demonstrations were identified as priorities by local Agricultural bureaus to compare current varieties to varieties which are not commonly grown in the district, and to compare varieties in soil types and rainfall regions where National Wheat Variety trials are not conducted.

Franklin Harbour District Wheat Trial

How was it done?

13 wheat varieties, replicated three times, were sown by members of the Franklin Harbour Ag Bureau using a plot seeder on loan from Minnipa Agricultural Centre (MAC). The trial was planted on 16 June with 60 kg/ha 18:20 and harvested by the MAC team. It was sprayed with 600 mL/ha Roundup PowerMax® and 30 g/ha Logran® one week prior to sowing.

What happened?

2010 provided an exceptional growing season in the Franklin Harbour area, producing some of the highest yields the district has recorded (Table 1). Guardian and Mace produced both the highest yields and gross income in this trial. The trial area was not sprayed with a fungicide. Stripe rust was found in Carnamah and Wyalkatchem plots, and stem rust was found in the Yitpi plots.

Mt Cooper District Wheat & Barley Trial

How was it done?

15 wheat varieties and 6 barley varieties replicated 3 times was sown on 2 June with 68 kg/ha 19:13:0 and 57 kg/ha urea at seeding. 1L/ha Roundup PowerMax®, 1/Lha Triflur Xtra®, 0.07 L/ha Striker® and 1 L/ha Lorsban® was applied post sowing for weed control and 1 L/ha Bromicide MA® was used to control broad-leaved weeds.

What happened?

The two best performing lines Espada and RAC 1671 produced yields over 4.5 t/ha where the trial averaged 4.2 t/ha (Table 2). These two varieties out-yielded Scout, Guardian, Gladius, Lincoln, Derrimut, Young and Axe. Espada also had the best gross income with $1532/ha. RAC 1671 is 1 of 3 double gene Gladius type Clearfield lines being considered for release by AGT for the 2011 season.

Hindmarsh topped the yields at 4.8 t/ha and gross income of $899/ha, outperforming all other varieties, with an overall trial average of 4 t/ha (Table 3). Commander was the best of the malting varieties, producing 4.3 t/ha. Varieties did not make malting quality due to high protein and low test weights.

Table 1 Grain yield quality and gross income of wheat sown at Franklin Harbour, 2010

Location: Elliston
Nigel & Deb May
Elliston Ag Bureau

Rainfall
Av. Annual: 410 mm
Av. GSR: 340 mm
2010 Total: 528 mm
2010 GSR: 409 mm

Yield
Potential: 6.0 t/ha (W)
Actual: 3.78 t/ha (W)

Paddock History
2008: Grassy pasture
2007: Grassy pasture
2006: Barley

Soil Type
Sand

Plot size
10 m x 1.5 m x 3 reps

Yield Limiting Factors
Brome Grass

Variety	Yield (t/ha)	Test Weight (kg/hL)	Screenings (%)	Protein (%)	Grade	Gross Income* ($/ha)
Guardian	5.39	74.3	0.83	11.2	APW	1,640
Mace	5.35	74.8	1.07	10.2	ASW	1,546
Lincoln	5.14	75.3	0.52	11.3	APW	1,562
Derrimut	5.13	72.0	1.49	10.7	APW	1,559
Wyalkatchem	4.98	74.1	1.26	9.9	ASW	1,439
Correll	4.97	74.8	0.72	10.7	APW	1,511
Catalina	4.92	74.4	0.81	10.5	APW	1,495
Carnamah	4.87	75.2	0.65	10.0	ASW	1,481
Lang	4.72	75.9	1.25	10.7	APW	1,435
Gladius	4.42	74.9	0.70	11.8	H2	1,437
Espada	4.40	74.3	0.96	10.4	ASW	1,272
Yitpi	4.28	73.3	1.15	10.6	GP	1,105
Axe	4.27	73.5	0.70	11.3	GP	1,100
Mean	4.83					
LSD ($P \leq 0.05$)	*0.48*					

**Gross Income is grain yield x price delivered to Cowell 24/12/2010*

Table 2 Grain yield, quality and gross income of wheat sown at Mt Cooper, 2010

Variety	Yield (t/ha)	Screenings (%)	Protein (%)	Test Weight (kg/hL)	Grade	Gross Income* ($/ha)
Espada	4.64	1.8	12.37	75.93	APW	1,532
RAC 1671	4.54	1.8	12.50	75.53	APW	1,362
Correll	4.49	3.0	11.90	75.33	H2	1,482
Estoc	4.48	4.5	12.37	77.87	APW	1,343
Yitpi	4.44	4.8	12.07	76.27	H2	1,464
Wyalkatchem	4.42	2.4	11.33	77.33	APW	1,325
Frame	4.37	2.7	11.97	77.27	APW	1,312
Mace	4.35	2.8	11.60	77.47	H2	1,434
Scout	4.20	2.5	11.20	77.53	APW	1,259
Guardian	4.18	7.6	11.03	76.67	AGP1	1,045
Gladius	4.12	1.6	11.93	75.47	H2	1,358
Lincoln	4.08	4.3	10.87	76.20	APW	1,225
Derrimut	4.06	4.3	11.23	76.33	APW	1,218
Young	3.68	4.2	11.93	75.47	H2	1,213
Axe	3.37	1.2	12.97	71.80	AGP1	843
Mean	4.23					
LSD ($P \leq 0.05$)	*0.32*					

**Gross Income is grain yield x price delivered to Port Lincoln 05/01/2011*

Elliston District Wheat Trial

How was it done?

15 wheat varieties, replicated 3 times were sown on the 26 May with 100 kg/ha 23:16:0 Zn 2.5. Prior to seeding 800 mL/ha of Sprayseed® and 1 L/ha Trifluralin 480® were applied. 50kg/ha of urea was top dressed on 19 July. Bromicide was applied at 1.4 L/ha and Achieve® was applied at 380 g/ha in separate applications in crop to control post emergent weeds.

What happened?

The new variety, Estoc produced the highest yield and gross income, closely followed by Scout and Espada (Table 4). For the ten varieties that have been evaluated at Elliston for three or more years, Correll is the only variety with a slightly higher long term average than Yitpi (Table 5).

Table 3 Grain yield, quality and gross income of barley sown at Mt Cooper, 2010

Variety	Yield (t/ha)	Screenings (%)	Protein (%)	Test Weight (kg/hL)	Grade	Gross Income* ($/ha)
Hindmarsh	4.76	2.2	16.1	61.72	F2	899
Commander	4.30	2.5	15.7	59.42	F3	791
Fleet	4.05	0.9	18.0	54.58	F3	745
Buloke	3.86	1.2	16.6	59.96	F3	710
Flagship	3.63	1.5	16.6	59.46	F3	649
Sloop SA	3.49	2.6	16.9	58.26	F3	642
Mean	4.00					
LSD (P=0.05)	*0.37*					

**Gross Income is grain yield x price delivered to Port Lincoln 5/01/2011*

Table 4 Grain yield quality and gross income of wheat sown at Elliston, 2010

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hL)	Grade	Gross Income* ($/ha)
Estoc	4.26	10.8	4.2	81.6	APW	1,359
Scout	4.12	9.8	6.0	81.0	GP	1,133
Espada	4.10	11.2	4.3	77.6	APW	1,308
Yitpi	4.04	10.0	5.9	79.0	GP	1,111
Guardian	4.02	10.2	7.2	81.4	GP	1,106
Lincoln	3.89	10.7	9.8	77.8	GP	1,070
Correll	3.85	10.7	6.3	76.4	GP	1,059
Frame	3.78	10.4	3.5	79.6	ASW	1,119
RAC 1671	3.70	10.8	5.5	78.2	GP	1,018
Gladius	3.67	11.5	7.1	79.2	GP	1,009
Mace	3.61	10.8	5.7	79.6	GP	993
Wyalkatchem	3.53	11.4	5.4	79.4	GP	971
Derrimut	3.50	10.2	11.4	78.0	Feed	809
Young	3.38	10.7	8.1	80.0	GP	930
Axe	3.30	12.3	5.6	76.8	GP	908
Mean	3.78					
LSD ($P \leq .005$)	*0.44*					

**Gross Income is grain yield x price delivered to Port Lincoln 17/01/2011*

Table 5 Grain yield of wheat varieties in Elliston trials as a % of Yitpi, 2006 - 2010

Variety	2010	2009	2008	2007	2006	Average
Axe	82	58	91	103	120	91
Correll	95	85	85	104	136	101
Derrimut	87	71	100	99		89
Espada	101	76	105			94
Estoc	105					105
Frame	94	88	94	83	95	91
Gladius	91	83	91	112	103	96
Guardian	100	71	87	96	120	95
Lincoln	96	78				87
Mace	89	80				85
RAC 1671	92					92
Scout	102					102
Wyalkatchem	87	78	88	102	115	94
Yitpi	100	100	100	100	100	100
Young	84	61	95	96	111	89
Yitpi (t/ha)	**4.01**	**4.10**	**2.48**	**2.21**	**0.98**	**2.76**

What does this mean?

The recently released varieties Mace, Scout and Estoc all performed well in at least one of the district wheat sites in 2010. All three varieties all have individual qualities that will see them broadly adapted across Eyre Peninsula.

2010 was an exceptional year for grain production at the three sites where these trials were located. The relative performance of the varieties tested may have been very different in a more 'average' season. Decisions to change varieties on the basis of these trials should be made with this in mind.

The varieties tested at Franklin Harbour, Mt Cooper and Elliston were selected to be the best bet options. For more extensive options and details on any variety characteristics visit the National Variety Trials (NVT) Website HYPERLINK "http://www.nvtonline.com.au" www.nvtonline.com.au or refer to the NVT Cereal Performance Tables and the Cereal Variety Disease Guide.

Acknowledgements

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SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Responsive Farming Using Wheat Agronomy

RESEARCH

Roy Latta, Naomi Scholz, Ian Richter
SARDI, Minnipa Agricultural Centre

Cereals

Almost Ready

Location:
Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm

Yield
Potential: 4.7 t/ha (W)
Actual: see article

Paddock History
2009: Wheat
2008: Wheat
2007: Wheat

Soil Type
Sandy loam to Sandy clay loam

Soil Test
Presented

Diseases
Moderate Rhizoctonia

Plot size
9 m x 1.5 m x 4 reps

Yield Limiting Factors
Nil

Resource Efficiency
Energy/Fuel use: standard
Greenhouse gas emmisions (CO_2, NO_2, Methane): standard

Social/Practice
Time (hrs): standard
Clash with other farmers operations: nil
Labour requirements: standard

Economic
Infrastructure/operating inputs: standard
Cost of adoption risk: standard
Market stability risk: standard

Key messages

In 2010 Axe sown 1 July produced a similar grain yield and gross margin to Wyalkatchem sown 11 June. These results continue to show that matching variety selection with sowing date can help to maximise profits.

Why do the trial?

It is critical in a region of low and variable rainfall, that the maturity range within wheat varieties is utilised to adapt to seasonal variability. A series of trials (EPFS Summary 2008 pg. 89 and 2009 pg. 105) have reported that matching wheat variety (maturity) selection to sowing date has achieved grain yield and quality benefits. 2010 is the third year of the study following below and above average rainfall seasons in 2008 and 2009 respectively. The results were also used to validate the Yield Prophet® decision support model.

How was it done?

A plot trial was established on 3 sowing dates (25 May, 11 June and 1 July) on paddock N1 at Minnipa Agricultural Centre. Axe (early maturity) and Wyalkatchem (early to mid season maturity) were sown with 55 kg/ha of DAP at 2 seeding rates (30 and 60 kg/ha) with and without urea (50 kg/ha) applied at Zadocks growth stage 31.The plots were 9 m x 1.5 m with 4 replicates. Plots received pre-emergent glyphosate and trifluralin and post emergent broad-leaf weed control.

Soil samples for chemical analysis were collected on 24 May 2010 and indicated nitrate and ammonium levels in the 0-0.1 m profile at 13 mg/kg, P at 24 mg/kg and soil organic carbon at 0.8%.

Soil moisture contents were taken at each seeding time, at anthesis and again at maturity (post harvest) from 1 treatment of each variety from each sowing time (Axe and Wyalkatchem sown at 60 kg/ha without applied urea). Biomass of each line was sampled at their specific anthesis dates. Plots were harvested and grain samples collected for yield and quality. Dates of measurements are listed with results.

Yield Prophet® simulations were completed at 4 times over the growing period 19 July, 4 and 24 August, and 27 September. Results calculated were restricted to the 3 times of sowing x 2 varieties x 2 seeding rates.

What happened?

The opening seasonal rains commenced on 23 May (totalling 63 mm over 6 days) allowing time of sowing 1 (TOS1) to go ahead on 25 May. TOS2 was sown on 11 June following 10 mm of rain. TOS3 was sown on 1 July following 17 mm rain during the previous week. A total of 69, 34, 27, 66, 68 and 72 mm of rain fell in May, June, July, August, September and October respectively. There was no recorded temperature below 2°C in 2010.

Soil water content at seeding, anthesis (flowering) and harvest for each variety and TOS in the 0-0.4 and 0.4-1 m soil profiles are presented in Table 1.

Time of sowing 1 had more available water at seeding than TOS2 and 3. TOS2 had more water retained at harvest than TOS3 in the 0-0.4 m profile. Wyalkatchem used more water between seeding and anthesis than Axe at TOS1 in the 0-0.4 m profile and in the 0.4-1 m profile at TOS2.

Table 1 Volumetric soil water content (mm) at seeding, anthesis and harvest in resonse to wheat variety and TOS in 0-0.4 and 0.4-1 m soil profile

			0-0.4 m		0.4-1 m	
			Axe	**Wyalkatchem**	**Axe**	**Wyalkatchem**
TOS1	Seeding	25 May	57	57	66	66
	Anthesis	24 September	33		67	
	Anthesis	27 September		26		56
	Harvest	20 September	29	26	47	49
TOS2	Seeding	11 June	28	28	46	46
	Anthesis	7 October	18		55	
	Anthesis	13 October		18		47
	Harvest	20 December	25	28	52	52
TOS3	Seeding	1 July	33	33	45	45
	Anthesis	18 October	24		39	
	Anthesis	21 October		22		39
	Harvest	20 December	23	22	42	45
LSD (P=0.05)			*4.2*		*6.7*	

Table 3 Yield Prophet® grain yield at 50% probability at approximate mid-tillering and anthesis growth stages with measured grain and calculated water use efficiency (kg/mm of plant available water) and gross margins ($/ha) in response to TOS and variety

TOS	**Variety**	**Seeding Rate (kg/ha)**	**N Top Dressed (kgN/ha)**	**Yield Prophet®**		**Grain Yield (t/ha)**	**Water use efficiency (kg/mm**)**	**Gross Margin ($/ha#)**
				Tillering*	**Anthesis***			
				20 July	24 August			
1	Axe	60	0	2.5	3.0	2.8	13	799
1	Axe	60	50			3.3	15	830
1	Axe	30	0	2.5	2.8	3.1	14	930
1	Axe	30	50			2.8	13	799
1	Wyalkatchem	60	0	2.5	3.2	3.4	16	1,011
1	Wyalkatchem	60	50			3.3	15	941
1	Wyalkatchem	30	0	2.5	3.0	2.5	11	525
1	Wyalkatchem	30	50			2.8	13	576
				4 August	27 September			
2	Axe	60	0	0.8	3.2	2.8	17	585
2	Axe	60	50			2.6	15	711
2	Axe	30	0	0.8	3.0	3.2	19	688
2	Axe	30	50			2.7	16	766
2	Wyalkatchem	60	0	0.8	3.1	3.2	19	838
2	Wyalkatchem	60	50			3.6	22	937
2	Wyalkatchem	30	0	0.8	2.9	3.5	21	941
2	Wyalkatchem	30	50			3.5	21	914
				24 August	27 September			
3	Axe	60	0	1.5	3.1	4.2	26	1,139
3	Axe	60	50			3.6	22	925
3	Axe	30	0	1.4	3.1	3.1	19	811
3	Axe	30	50			3.4	21	872
3	Wyalkatchem	60	0	1.5	3.1	3.0	19	794
3	Wyalkatchem	60	50			3.0	18	748
3	Wyalkatchem	30	0	1.4	3.1	3.7	23	990
3	Wyalkatchem	30	50			3.1	19	794

**Decile increased from 5 to 6 over the period 20 July – 24 August and from 6 to 8 over the period 24 August to 27 September.*
***Water use efficiency calculated on rainfall measured between seeding and harvest, taking into account 110 mm of evaporation and changes in soil water content in the 0-1 m soil profile.*
#Gross income is yield x price (with quality adjustments) less seed costs delivered to cash pool on 5 January 2011, Port Lincoln. Grades were adjusted according to screenings and test weight. $350/t used for seed value.

Table 2 Wheat plant numbers (plants/m²), biomass at anthesis (tDM/ha), grain yield (t/ha), protein (%) and test weight (kg/hectolitre) in response to TOS, variety, seeding rate and the addition of top-dressed nitrogen

TOS	Variety	Seeding Rate (kg/ha)	Top Dressed (kgN/ha)	Plant Number (plts/m²)	Biomass at antheisis (tDM/ha)	Grain Yield (t/ha)	Grain protein (%)	Test Weight (kg/hL)
1				54	1.0	3.0	11.8	74.1
2				82	1.1	3.1	11.2	75.5
3				98	0.9	3.4	10.7	76.8
LSD (P=0.05)				*11.0*	*0.13*	*0.19*	*0.27*	*NS*
	Axe			80	0.8	3.1	11.4	75.1
	Wyalkatchem			77	1.2	3.2	11.0	75.9
LSD (P=0.05)				*NS*	*0.10*	*NS*	*0.30*	*NS*
1	Axe			56	0.7	3.0	11.8	74.2
1	Wyalkatchem			52	1.1	3.0	11.8	73.9
2	Axe			86	0.8	2.8	12.0	77.0
2	Wyalkatchem			80	1.4	3.4	10.5	77.0
3	Axe			97	0.9	3.5	10.5	77.0
3	Wyalkatchem			97	1.0	3.2	10.8	77.0
LSD (P=0.05)				*11.8*	*0.10*	*0.25*	*0.18*	*0.62*
Seeding rate x top dressed N		60	0	100	1.0	3.2	11.3	75.6
		60	50	90	1.1	3.2	11.1	75.5
		30	0	64	1.0	3.2	11.3	75.5
		30	50	60	1.0	3.1	11.3	75.3
LSD (P=0.05)				*13.3*	*NS*	*NS*	*NS*	*NS*
1	Axe	60	0	65	0.7	2.8	11.8	74.0
1	Axe	60	50	56	0.7	3.3	11.4	74.2
1	Axe	30	0	47	0.8	3.1	12.0	74.6
1	Axe	30	50	56	0.7	2.8	11.8	74.2
1	Wyalkatchem	60	0	61	1.2	3.4	12.0	74.7
1	Wyalkatchem	60	50	61	1.3	3.3	11.9	74.3
1	Wyalkatchem	30	0	52	1.1	2.5	11.8	73.3
1	Wyalkatchem	30	50	36	1.0	2.8	11.8	73.4
2	Axe	60	0	122	0.7	2.8	12.2	73.3
2	Axe	60	50	91	0.8	2.6	11.8	74.5
2	Axe	30	0	72	0.8	3.2	12.0	73.9
2	Axe	30	50	61	0.9	2.7	12.2	74.3
2	Wyalkatchem	60	0	106	1.5	3.2	10.4	77.5
2	Wyalkatchem	60	50	94	1.5	3.6	10.3	76.9
2	Wyalkatchem	30	0	65	1.3	3.5	10.7	77.4
2	Wyalkatchem	30	50	55	1.5	3.5	10.4	76.4
3	Axe	60	0	119	0.8	4.2	10.4	76.5
3	Axe	60	50	113	0.9	3.6	10.8	77.5
3	Axe	30	0	78	0.9	3.1	10.5	77.3
3	Axe	30	50	75	0.8	3.4	10.3	76.6
3	Wyalkatchem	60	0	125	1.0	3.0	10.9	77.5
3	Wyalkatchem	60	50	124	1.1	3.0	10.6	75.5
3	Wyalkatchem	30	0	72	1.0	3.7	10.8	76.8
3	Wyalkatchem	30	50	76	0.9	3.1	11.0	77.0
LSD (P=0.05)				*15.7*	*0.20*	*0.30*	*0.30*	*1.11*

Plant numbers that established increased at each of the 3 times of sowing and as a result of sowing at 60 kg/ha, compared to 30 kg/ha. Biomass production at anthesis was less at TOS3 than TOS2 and generally higher from Wyalkatchem than Axe. Grain yields were higher at TOS3 than TOS2 and 1, Wyalkatchem produced higher grain yield than Axe at TOS2 and vice versa at TOS3. Grain protein results were closely correlated with grain yields. There was no production or grain quality response to seeding rate or top-dressed nitrogen. Grain screenings were all less than 3% and not reported. Test weights were higher at TOS2 and 3 than TOS1.

Yield Prophet® simulations underestimated grain yield at early tillering based on a decile 5 to 6 scenario but were more accurate at anthesis with decile 8 conditions. Water use efficiency estimates increased with the later time of sowings in response to reduced growing season rainfall. Estimated gross margins reflect quality, yield and variable cost differences with treatments.

What does this mean?

The results were influenced by low numbers of establishing plants at TOS1, this was due to high mouse numbers that at subsequent TOS2 and 3 had an increasing availability of alternative feed sources over the 6 week seeding period. This may have been a factor in the later 1 July TOS3 being the highest yielding, however the above average August-October rainfall was a factor that affected this result. Soil water content results suggest TOS2 may have had a deficit at anthesis.

The two varieties used performed as expected with the early maturing Axe yielding higher from the final time of sowing, compared to Wyalkatchem (early to mid season maturity), which was higher yielding from TOS2. Although pre-seeding measured soil N was quite low there was no response to top-dressed urea. The response to seeding rate was only in plant numbers with no production benefit, or negative, between 60 to 100 plants/m^2.

Gross margins were all quite similar irrespective of TOS or variety but Axe at TOS3 and Wyalkatchem at TOS2 were the leaders.

The results from the above average rainfall season of 2010 do vary somewhat from the previous years studies EPFS Summary 2008 and 2009 “Responsive Farming Using Wheat Agronomy”. The 2010 trials indicated a late sowing benefit with a shorter season variety (Axe) as opposed to the early sowing benefits of previous studies. However low plant numbers established at TOS1 and less available water at the TOS2 anthesis time may have reflected in the grain yields.

These results continue to show that matching variety selection with sowing date can help to maximise profits.

Acknowledgements

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Australian Government Department of Agriculture, Fisheries and Forestry
Ag Excellence Alliance
GRDC Grains Research & Development Corporation
SARDI South Australian Research and Development Institute

Crop Growth Stages - Growing Your Profit EPARF Day

EXTENSION

Naomi Scholz

SARDI, Minnipa Agricultural Centre

Cereals

Key messages

- **Knowing the growth stages of cereals is critical for management practices.**
- **Sowing depth has a big impact on emergence of cereals.**
- **It is very important to use correct fungicide rates.**

On 28 July 2010, 100 farmers converged on the SARDI Minnipa Agricultural Centre to learn about cereal growth stages and how to improve profitability of growing crops. The event was hosted by the Eyre Peninsula Agricultural Research Foundation (EPARF) and was supported by a GRDC funded Low Rainfall Collaboration project.

Dr Glenn McDonald from the University of Adelaide explained how cereals develop from germination through to grain fill, and the stages of the life cycle during which yield potential is determined and is most sensitive to stress.

The Minnipa Agricultural Centre staff had sown wheat and barley plots early and, had examples of different growth stages of cereals for local agronomists to use in hands-on demonstrations. Dissecting wheat plants to see the developing head in Zadoks growth stage 30 -31 was a highlight for many.

Other demonstrations and presentations included:

- **The importance of sowing depth.** Dr Glenn McDonald presented pots of wheat varieties with known varying coleoptile lengths that were sown at different depths (2.5, 5 and 7.5 cm) to demonstrate the impact of sowing depth on emergence.
- **The impact of using incorrect fungicide rates on germination.** Lyndon May (Syngenta) explained that this really made a difference to germination and surprised a lot of people. A fungicide was applied to wheat seed at 0%, 50%, 100% and 150% of recommended rates, this seed was then planted to compare emergence. The emergence vigour was reduced in the 150% of recommended rate of product.
- **Nutrition.** Dr Nigel Wilhelm (SARDI) explained that wheat requires 14 essential elements to grow normally, with most nutrients being provided by soils. (see EPFS Summary 2010, Nutrition).
- **Herbicide timing.** Ken Webber (Nufarm) gave some clear messages regarding growth stages and timing of herbicide applications including:
  - Spraying herbicides prior to Z17 can significantly check plant growth as the crop has difficulty breaking down the herbicide.
  - Stop spraying products with Dicamba at Z24.
  - All spraying should stop after Z37 (flag leaf just visible).
- **Fungicides and pesticides.** Hugh Wallwork (SARDI), provided information about fungicides and pesticides, his key messages included:
  - A lot of fungicide is wasted through poor diagnosis. If spraying is required then protection is more effective than suppression of existing infection.
  - Crops should be monitored regularly and the insect pest identified accurately. Estimate pest density and spray if the density exceeds the economic (or spray) threshold. Monitor the 'Baddies' and 'Goodies'.

Andy Bates (Bates Agricultural Consulting), summarised the day's messages with a list of things we do that may impact on critical yield development stages and can cost or lose us money including:

- Sowing late can mean high temperatures during flowering and grain fill;
- Sowing deep can lead to a lack of early tiller initiation;
- Early insect infestation can result in a lack of early tillers;
- Early application of herbicides can result in stress and poor tillering and minimal spikelet number;
- Late application of herbicides can result in stress and poor pollen formation and low fertile flower number;
- Nutrient deficiencies early in the season can result in poor tillering and low spikelet number;
- Nutrient deficiencies late in the season can result in poor tiller retention and low number of fertile flowers;
- Cereals grazed after Zadoks growth stage 30 can result in yield loss;
- Disease/scalding on early and later leaves can result in yield loss.

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Section Editor:
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Section 2

Break Crops

The 2010 production figures for Upper Eyre Peninsula were 19,000 t of peas, 8,700 t of lupins, 300 t of beans and 5,400 t of canola. Lower Eyre Peninsula produced approximately 12,000 t of peas, 45,000 t of lupins, 17,000 t of beans and 100,000 t of canola.

[PIRSA Crop Production Estimates January 2011]

Field pea variety trial yield performance 2010
(as a % of site mean yield) and Long term (2004-2010) Average across sites (as % of site mean)

	Lower Eyre Peninsula				Upper Eyre Peninsula		
Variety/Line	**2010**		**2004-2010**		**2010**	**2004-2010**	
	Rudall	**Yeelanna**	**% Site mean**	**Trial #**	**Minnipa**	**% Site Mean**	**Trial #**
Kaspa	no result	98	106	19	101	108	9
Parafield		78	103	19	95	104	9
PBA Gunyah		84	108	9	100	107	4
PBA Twilight	High variability in trial	72	105	8	101	107	4
Sturt			108	13	107	109	9
Yarrum		115	110	13	103	110	7
OZP0703		115	111	8	102	110	5
Site mean yield (t/ha)		1.97	1.98		2.90	1.61	
LSD (P=0.05) as %		*19*			*7*		
Date sown	27 May	7 June			31 May		
Soil Type	LS	SCL			SCL		
A-O rainfall (mm)	317	379			345		
pH (water)	6.6	8.1			8.4		
Site stress factors	pe	wl			bs		

Abbreviations
Soil Types: S=sand, C=Clay, L=loam, H=heavy, M=medium, Li=light, F=fine, /=over

Site stress factors: pe = poor establishment, wl = waterlogging, bs = black spot

Data source: *SARDI/GRDC, PBA & NVT (long term data based on weighted analysis of sites.)*

Faba bean variety trial yield performance at Eyre Peninsula sites

2010 and predicted regional performance, expressed as % of site average yield

Variety	Lower Eyre Peninsula 2010	Lower Eyre Peninsula Long term average across sites			Upper Eyre Peninsula 2010	Upper Eyre Peninsula Long term average across sites		
	Cockaleechie (as % site mean)	t/ha	% Site Mean	No. Trials	Rudall (as % site mean)	t/ha	% Site Mean	No. Trials
Doza	116	1.82	90	7	92	-	-	-
Farah	94	1.96	97	10	91	1.03	102	4
Fiesta	96	2.00	99	10	93	0.99	101	4
Fiord	83	1.97	98	9	-	0.93	94	4
Nura	62	1.99	99	10	104	0.98	99	4
Site av. yield (t/ha)	2.25	2.02			2.54	0.99		
LSD (P=0.05) as %	*24*				*17*			
Date sown	27 May				27 May			
Soil Type	SCL				LS			
pH (water)	6.5				6.6			
A-O rain (mm)	407				317			
Site stress factors	cs,wa							

Abbreviations
Soil Types: S=sand, C=clay, L=loam
Site stress factors: cs = chocolate spot, wa=waterlogging, ht=high temperatures during flowering/pod fill, w=weeds

Data source: *SARDI/GRDC, NVT and PBA - Australian Faba Bean Breeding Program.*
2004-2010 MET data analysis by National Statistics Program
More Information: *Andrew Ware (08) 8688 3417 or e-mail andrew.ware@sa.gov.au*

Lupin variety trial yield performance at Eyre Peninsula sites

2010 and predicted regional performance, expressed as % of site yield

Variety	Lower Eyre Peninsula 2010 (as % site mean)		Lower Eyre Peninsula Long term average across sites			Upper Eyre Peninsula 2010 (as % site mean)	Upper Eyre Peninsula Long term average across sites		
	Wanilla	Ungarra	t/ha	% of Site Mean	No. Trials	Tooligie	t/ha	% of Site Mean	No. Trials
Coromup	84	81	1.91	105	11	87	2.05	100	4
Jenabillup	116	106	2.03	112	9	107	2.17	106	3
Jindalee	72	93	1.68	92	12	84	1.92	94	4
Mandelup	94	99	1.99	109	12	102	2.13	104	4
Wonga	86	98	1.82	100	11	98	2.03	99	4
Site av. yield (t/ha)	2.13	2.33	1.88			3.38	2.05		
LSD (P=0.05) as %	*16*	*10*				*15*			
Date sown	18 May	26 May				25 May			
Soil Type	S	S				S			
pH (water)	6.3	5.6				6.5			
Apr-Oct rain (mm)	380	325				314			
Site stress factors									

Abbreviations
Soil types: S=sand
Site stress factors: Nil

Data source: *SARDI/GRDC & NVT 2004 - 2010 MET data analysis by National Statistics Program*
More Information: *Andrew Ware (08) 8688 3417 or e-mail andrew.ware@sa.gov.au*

Desi & Kabuli chickpea variety trial yield performance 2010

(as % of site mean) and Long term (2000-2009) Average Across Sites (as % of site mean)*

Variety	LOWER EYRE PENINSULA			
	2010		2000-2009*	
	Cockaleechie	Rudall	% Site mean	Trial #
Desi trials	NO VALID RESULT WATER LOGGING & WEEDS	NO VALID RESULT POOR ESTABLISHMENT		
Genesis 509			99	8
Genesis 079#			112	3
Genesis 090#			101	8
Howzat			108	8
PBA HatTrick			99	4
PBA Slasher			112	5
Sonali			104	7
Site mean yield (t/ha)			1.55	
LSD (P=0.05) as %				
Kabuli trials	NO VALID RESULT WATER LOGGING & WEEDS			
Almaz			95	6
Genesis 079#			129	7
Genesis 090#			114	8
Genesis 114			94	6
Genesis 115				
Nafice			88	5
Site mean yield (t/ha)			1.28	
LSD (P=0.05) as %				
Date sown	27 May	27 May		
Soil Type	CLS	LS		
A-O rain (mm)	407	317		
pH (water)	6.5	6.6		
Site stress factors	wl, w, ct	pe, ct		

 # Small kabuli type

***Soil type:** S=sand, C=clay, L=loam, H=heavy, M=medium, Li=light, /=over*

***Site stress factors:** W = weed competition, ct = low temperatures during flowering, pe = poor establishment, wl = waterlogging*

Data source: SARDI/GRDC, PBA & NVT (long term data based on weighted analysis of sites and courtesy National Statistics Program).

***Long term yields incorporating 2010 data not available at time of publishing.**

Lentil variety trial yield performance 2010

(as % of site mean yield) and Long term (2004-2010) Average accross sites (as a % os site mean)

Variety	LOWER EYRE PENINSULA			
	2010		2004 - 2010	
	Rudall	Yeelanna	% site mean	Trial #
Aldinga	NO VALID RESULT - HIGH VARAIBILITY IN TRIAL	NO VALID RESULT - HIGH VARAIBILITY IN TRIAL	-	-
Boomer			100	7
Nipper			95	9
Northfield			86	9
Nugget			96	9
PBA Blitz			102	5
PBA Bounty			99	9
PBA Flash			104	9
PBA Jumbo			104	6
CIPAL702			95	3
Site mean yield (t/ha)				
LSD (P=0.05) as %				
Date sown	27 May	7 June		
Soil Type	LS	SCL		
A-0 rainfall (mm)	317	379		
pH (H_20)	6.6	8.1		
Site stress factors	pe	wl,w		

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

***Site stress factors:** w = weed competition, wl = temporary waterlogging, phwd = preharvest weather damage, pe = poor establishment*

Data source: SARDI/GRDC, PBA & NVT (long term data based on weighted analysis of sites)

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Early canola 2010 summary

Entry	2010, % site mean		Long term 2004-2010	
	Tooligie	Lameroo	Upper Eyre Peninsula	
	%	%	t/ha	# trials
Conventional				
AV Garnet	125	129	1.51	3
CB Agamax	105	117		
Hyola 433	120	122		
Hyola 50	117	108	1.48	4
Oasis CL	75	68		
Sahara CL	70	59		
Tarcoola	94	102	1.25	4
Site Mean (t/ha)	**1.50**	**1.11**	**1.17**	
LSD (P=0.05) as %	*9*	*8*		
Triazine tolerant				
ATR - Cobbler	100	110	1.38	3
ATR - Snapper	110	107		
ATR - Stingray	119	110		
CB Jardee HT		105		
CB Junee HT	114			
CB Mallee HT	83	98		
CB Scaddan	93	88	1.33	3
CB Tanami	86	105	1.30	3
CB Telfer	88	108	1.22	3
CB Tumby HT		95		
Fighter TT	103	85		
Tawriffic TT	105	97	1.39	3
Crusher TT				
Hyola 444 TT		93		
Hyola 555 TT				
Site Mean (t/ha)	**1.48**	**1.18**	**1.42**	
LSD (P=0.05) as %	*9*	*8*		
Date sown	26 May	13 May		
Soil Type	SL	L		
A-O Rain (mm)	304	231		
pH (water)	8.4	8		

Abbreviations

Soil Types: S=sand, C=clay, L=loam, H=heavy, M=medium, Li=light, F=fine,

Data source: *NVT & SARDI / GRDC (long term data based on weighted analysis of sites, 2004 - 2010)*

Data analysis by GRDC funded National Statistics Group

Mid season canola summary 2010

Entry	2010 % site mean		Long term 2004-2010	
	Mt Hope	Yeelanna	Lower Eyre Peninsula	
Conventional	%	%	t/ha	# trials
AV - Garnet	98	No difference between varieties	2.01	10
CB Agamax	98			
Hyola 433	106		1.98	4
Hyola 50	109		2.02	10
Victory V3001	82			
Site Mean (t/ha)	**2.86**	**2.88**	**1.55**	
LSD (P=0.05) as %	*9*	*ns*		
Clearfield				
Hyola 571 CL	105	103	1.86	6
Hyola 575 CL	106	105		
Hyola 676 CL	100	96		
Pioneer 44Y84	107	97	1.85	6
Pioneer 45Y82	97	98	1.81	4
Pioneer 46Y78	100	98	1.79	8
Pioneer 46Y83	113	106	1.90	4
Site Mean (t/ha)	**2.67**	**2.67**	**1.62**	
LSD (P=0.05) as %	*6*	*8*		
Triazine Tolerant				
ATR Cobbler	97	97	1.56	8
ATR Snapper	93	105		
ATR Stingray	121	113		
CB Argyle	78	99	1.52	8
CB Jardee HT	107	105	1.69	5
CB Junee HT		107		
CB Mallee HT	78	93	1.59	3
CB Scaddan	100	89	1.50	6
CB Tanami	58	84	1.39	4
CB Telfer	87	94	1.39	4
CB Tumby HT	98	96	1.60	4
Crusher TT	122	114		
Fighter TT	114	98		
Hyola 555 TT	125	112		
Hyola 751 TT	124	101		
Monola 603 TT	97	96		
Monola 704 TT	87	94		
Monola 76 TT	87	98	1.54	6
Monola 77 TT	90	95	1.55	6
Tawriffic TT	92	103	1.59	8
Thumper TT	156	114		
Hurricane TT			1.57	4
Site mean (t/ha)	**2.00**	**2.52**	**1.63**	
LSD (P=0.05) as (%)	*11*	*8*		
Date sown	1 May	30 Apr		
Soil Type	SL	CL		
A-O Rain (2010)	440	379		
pHwater	5.5	8.2		
Site stresses	bl			
Blackleg	37, 56	10, 21		

Soil types: S=sand, C=clay, L=loam, H=heavy, M=medium, Li=light, F=fine,
Site stress factors: lo=lodging, bl=blackleg, f=frost, h=hail, htg=high temperature at grain fill, wa=waterlogging, md = mouse damage
Blackleg data: Polygenic variety: Tawriffic TT Sylestris variety: Surpass 501 TT
% average blackleg infection

Data source: *NVT & SARDI / GRDC (long term data based on weighted analysis of sites, 2004 - 2010)*

Data analysis by GRDC funded National Statistics Group

Canola and Juncea Canola for Low Rainfall Areas in 2011

Trent Potter
SARDI, Struan

RESEARCH

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 2.7 t/ha (C)
Actual: 2.3 t/ha 45Y77 Canola
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Red calcareous sandy loam
Plot size
10 m x 1.48 m x 3 reps
Yield Limiting Factors
Nitrogen

What did fantastic yields in 2009, followed by a late break in 2010 do to canola? There was not much of a problem due to the good rainfall and extremely mild spring conditions, both conditions that give canola a great chance to perform.

Variety selection

The choice of the most suitable canola variety for any situation will often follow a consideration of maturity, herbicide tolerance, blackleg resistance and early vigour, together with relative yield and oil content. In relation to some of these issues the following points can be made:

- The weed species expected may dictate the need for a herbicide tolerant production system (e.g. triazine tolerant or Clearfield). Remember that a triazine tolerant variety will incur a yield and oil penalty when grown in situations where they are not warranted.
- Varietal blackleg resistance and/or fungicide use should be considered, particularly when rotations are close, although blackleg is less of a factor in low rainfall systems.

The following are early or early-mid flowering varieties that may be suitable for lower rainfall areas.

New varieties for 2010-2011

A number of new early or early-mid maturity varieties will be marketed for 2011 sowings. Information about new varieties has been provided by the seed companies as in most cases, entries have only come into NVT trials in 2010.

Conventional varieties

Hyola 433 Mid-early maturing conventional hybrid. High yielding. High oil and good protein content. Medium height. Suited from low to medium rainfall regions including irrigation zones. Blackleg resistance rating is R-MR. Tested in NVT trials 2005 and 2009. Bred and marketed by Pacific Seeds.

CB Agamax New Release 2011. Early-mid maturing hybrid. Canola Breeders indicate excellent yield in low to medium rainfall, excellent early vigour and good oil content. Anticipated to have MR resistance rating (to be classified 2010). Tested in NVT trials in 2010 for the first time. Marketed by Canola Breeders. To be released in 2011.

SARDI515M A juncea variety for biodiesel feedstock production. It is a conventional type that is suited to areas with rainfall below 350 mm. Tested as SARDI515M, it is early flowering. Excellent pod shatter resistance allows for direct heading. Blackleg resistance rating is R (P). First tested in NVT 2010. Released in 2010. Bred by SARDI based on material bred by Vic DPI/Viterra in association with GRDC. Marketed in a closed loop by Smorgon Fuels.

Triazine tolerant (TT) varieties

CB™ Telfer Very early season for low rainfall areas. CBWA indicate high oil. Blackleg resistance rating is MS-S. Tested in SA NVT trials in 2008. Bred and marketed by Canola Breeders. An End Point Royalty (EPR) applies.

CB™ Scaddan Medium season for medium to high rainfall areas. Blackleg resistance rating is MR-MS. Tested in SA NVT trials in 2008. Bred and marketed by Canola Breeders. An End Point Royalty (EPR) applies.

CB™ Tanami Early maturing. Targeted for low rainfall areas. Moderate oil and protein content. Blackleg resistance rating MS-S. Released in NSW in 2007. Tested in NVT trials 2006-2009. Bred and marketed by Canola Breeders. An EPR applies.

CB Jardee HT™ Mid season TT hybrid canola. CBWA indicate excellent early vigour. Blackleg resistance rating is MR. Good early vigour and good oil content. Tested in SA NVT trials in 2008 at a few sites only, in trials in 2009 and 2010. Bred and marketed by Canola Breeders.

CB Mallee HT™ Early season TT hybrid canola. Blackleg resistance rating is MR (P). Good early vigour and good oil content. Tested in SA NVT trials in 2009 and 2010 as CHYB157. Bred and marketed by Canola Breeders.

CB Tumby HT™ Early-mid season TT hybrid canola. Blackleg resistance rating is MR (P). Good early vigour and good oil content. Tested in SA NVT trials in 2009 and 2010 as CHYB125. Bred and marketed by Canola Breeders.

CB Junee HT™ (Trialled as CHYB-127). New Release 2011. Early maturing TT hybrid. Canola Breeders indicate excellent yield, good early vigour and good oil content. Anticipated to have MR blackleg resistance rating (to be classified 2010). Tested in NVT trials in 2010 for the first time. Bred and marketed by Canola Breeders. To be released in 2011.

Hyola 555TT (tested as T2522) Mid-early maturing TT Hybrid. (TT version of Hyola 433) Pacific Seeds indicate excellent yield, excellent oil and high protein content. Ideally fits medium-low right through to high rainfall areas. This Hybrid exhibits good TT Hybrid vigour, medium plant height and excellent standability. Anticipated blackleg resistance rating R-MR. Tested in NVT trials in 2010. Bred and marketed by Pacific Seeds. To be released in 2011.

Hyola 444TT (tested as T98002) Early maturing TT Hybrid. Pacific Seeds indicate excellent yield, excellent oil and high protein content. Medium-short plant height. Ideally fits low to medium-high rainfall areas and exhibits good TT Hybrid vigour and good standability. Anticipated blackleg resistance rating R-MR. Tested in NVT trials in 2010. Bred and marketed by Pacific Seeds. To be released in 2011.

Fighter TT (tested as T2181) Early to mid-early maturing double haploid OP TT variety. Pacific Seeds indicate good yield with moderate oil and very high protein content. Medium-short height. Ideally fits medium-low to medium-high rainfall areas, exhibits reasonable vigour and excellent standability. Blackleg resistance rating MR. Currently being tested in NVT trials in 2010. Bred and marketed by Pacific Seeds. To be released in 2011.

ATR-Snapper (tested as NT0049) Early-mid maturing. Medium-short height. High oil and protein content. Anticipated to have good blackleg resistance. Bred by Canola Alliance. Marketed by Nuseed Pty Ltd. To be released in 2011.

ATR-Stingray (tested as NT0045) Early maturing. Short height. High oil and protein content. Anticipated blackleg resistance rating MR. Bred by AgSeed Research and DPI Victoria. Marketed by Nuseed Pty Ltd. To be released in 2011.

CLEARFIELD® *(imidazolinone tolerant) varieties*

43C80 (coded NS6108BI). Early maturing variety. Pioneer indicate good early vigour, good yield and moderate oil content. Blackleg rating MS (provisional). Suited to low rainfall areas and potentially as a late sowing option in medium-high rainfall areas. Tested in SA NVT trials in 2008. Limited seed quantities in 2009. Bred and marketed by Pioneer Hi-Bred.

Table 1 Oil content (%) of canola sown at 5 sites in 2009

Entry	Tooligie (%)	Keith (%)	Lameroo (%)	Minlaton (%)	Spalding (%)	Mean (%)
AV Garnet	48.5	46.7	38.6	45.5	48.1	45.5
Hyola 433	47.3	46.8	37.4	45.4	47.7	44.9
Tarcoola	48.8	45.1	37.6	45.1	47.9	44.9
Pioneer 44C79	48.1	43.0	40.3	44.5	48.2	44.8
Pioneer 43C80	49.1	44.5	36.9	44.9	47.9	44.7
Tawriffic TT	47.7	44.8	38.5	44.6	47.0	44.5
Hyola 50	45.0	45.3	37.9	45.4	47.4	44.2
Hurricane TT	47.1	44.4	38.2	44.3	46.3	44.1
CB Telfer	47.6	42.0	38.8	43.6	47.3	43.9
ATR Cobbler	46.6	42.8	37.3	43.2	47.5	43.5
Bravo TT	46.4	43.4	38.4	43.5	45.5	43.4
Rottnest TTC	45.7	41.7	37.7	42.4	45.4	42.6
CB Tanami	44.9	42.2	37.2	42.4	44.8	42.3
CB Jardee HT	45.2	41.2	37.6	42.2	45.1	42.2
CB Tumby HT	45.2	40.0	37.6	42.0	44.7	41.9
Lightening TT	45.2	41.1	35.0	44.1	43.3	41.8
CB Scaddan	44.6	40.6	36.3	42.5	44.0	41.6
Oasis CL	46.9	42.8	40.4		46.6	
Sahara CL	43.8	38.7	39.2		43.3	

Table 2 Grain yield of conventional canola at Tooligie 2010 NVT trials

Entry	Yield (t/ha)	% site mean
Sahara CL	1.05	70
Oasis CL	1.13	75
Tarcoola	1.42	95
CB Agamax	1.58	105
Hyola50	1.76	117
Hyola433	1.81	121
AVGarnet	1.88	125
Site Mean	1.5	
CV%	5.8	
LSD (P=0.05)	*0.14*	

45Y82 (tested as 06N785I). Pioneer Hi-Bred indicate provisional blackleg rating likely to be R-MR. 45Y82 is an early-mid hybrid Clearfield variety with shorter stem and good standability. Included in NVT trials in 2009.

Hyola 571CL (tested as K9209). Early-mid maturing hybrid with similar maturity to 45Y77. Pacific Seeds indicate excellent early vigour, with good oil and yield potential. Blackleg resistance R (provisional). Tested in SA NVT trials in 2008. Bred and marketed by Pacific Seeds.

Hyola 575CL (tested as K9317). Mid-early season hybrid. Pacific Seeds indicate high grain yield and oil content about 1% more than Hyola571CL. Medium plant height. Blackleg rating suggested to be R (Pacific Seeds data). Tested in SA NVT trials in 2010. Bred and marketed by Pacific Seeds. To be released in 2011.

44Y84 (CL) Early/early-mid season hybrid. Pioneer Hi-Bred indicate provisional blackleg rating likely to be R-MR. Included in NVT trials in 2010. Bred and marketed by Pioneer Hi-Bred. To be released in 2011.

CLEARFIELD® *(imidazolinone tolerant) Juncea canola*

Oasis CL (tested as - J05Z-8920) First herbicide tolerant low-rainfall juncea canola variety in Australia. Suited to areas with rainfall below 350mm. Blackleg resistance rating is R. Excellent pod shatter resistance allows for direct heading. Seed quality as good as or slightly better than Dune. Bred by DPI Vic/Viterra in association with GRDC. Marketed by Viterra.

Grain quality

Grain quality data from trials conducted in 2009 are presented in Table 1. Many of the newer varieties have improved oil content over older varieties, but consider oil content amongst the other factors when choosing a new canola variety

Grain yield of canola and juncea canola varieties is shown in Tables 2 and 3. With the wet, mild conditions, the early mid varieties performed best at Tooligie. Juncea canola varieties performed poorer than canola in the conventional trial. Several new TT canola varieties to be released in 2011 performed very well. More data on these varieties in drier years will assist to determine how consistent these varieties are likely to be.

JUNCEA CANOLA FOR LOW RAINFALL ENVIRONMENTS

The only juncea canola variety to be available in south eastern Australia for 2011 will be OasisCL which has major changes to both the oil and meal quality from traditional table mustard. The variety was bred by DPI Victoria and Viterra, in Canada, and partly funded by the GRDC.

Juncea canola has a number of advantages over traditional canola in low rainfall areas, including faster ground covering ability, better heat and drought tolerance and shatter tolerance - thus it does not need windrowing (saving around $25/ha).

Future breeding priorities include further development of herbicide tolerant varieties with high yield, improved quality, good blackleg resistance and good adaptation. The first triazine tolerant advanced breeding lines were in multi-locations trials in 2009 and were tested on Eyre Peninsula, with first cultivars hopefully available in 2012. Hybrids and other herbicide tolerances are also currently being developed and will continue to be selected in low rainfall systems across Australia. One mustard of interest in these trials is SARDI515M which is being grown for biodiesel feedstock production. Good progress has been made with the development of the first TT juncea cultivars, with XCEED TT canola lines planned to be entered for the first time in 2011 NVT trials. More data will be available on XCEED TT canola's relative performance compared to napus canola in 2012.

Juncea canola lines tend to yield the same or more than traditional canola in situations where canola yields are equal to or less than 1.5 t/ha.

Table 3 Grain yield of TT canola at Tooligie 2010

Entry	Yield (t/ha)	% site mean
CB Mallee	1.23	83
CB Tanami	1.27	86
CB Telfer	1.29	87
CB Scaddan	1.38	93
ATR-Cobbler	1.48	100
FighterTT	1.52	103
TawrifficTT	1.55	105
ATR-Snapper	1.62	109
CB Junee	1.68	114
ATR-Stingray	1.76	119
Site Mean	1.48	
CV%	5.6	
LSD (P=0.05)	*0.13*	

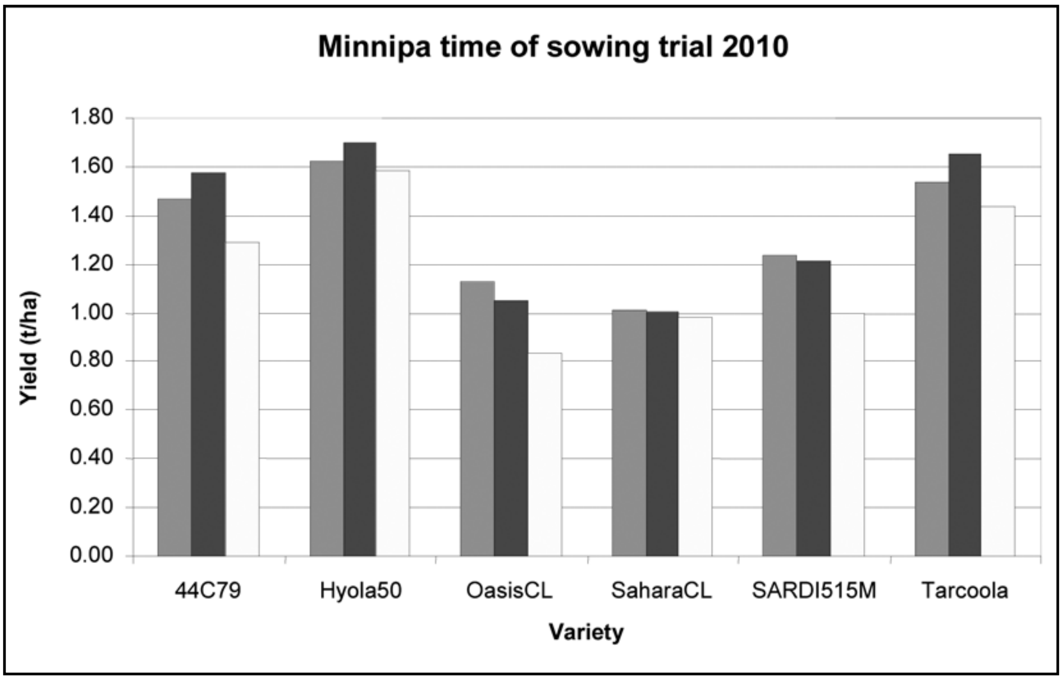


Figure 1 Effect of sowing date on canola and juncea at Minnipa in 2010, TOS1 - 27 May, TOS2 - 11 June, TOS3 - 24 June

Table 4 Yield of canola and Juncea canola with varying N rates, Minnipa and Lameroo 2010

	Minnipa		Lameroo	
Treatment	**t/ha**	**% site mean**	**t/ha**	**% site mean**
44C79 0 kg/ha N	0.57	61	1.03	124
44C79 30 kg/ha N	1.19	127	1.09	131
44C79 60 kg/ha N	1.47	156	1.09	131
44C79 90 kg/ha N	1.59	169	0.99	120
Oasis CL 0 kg/ha N	0.42	45	0.73	88
Oasis CL 30 kg/ha N	0.85	90	0.70	84
Oasis CL 60 kg/ha N	0.95	101	0.72	87
Oasis CL 90 kg/ha N	1.21	129	0.68	82
Sahara CL 0 kg/ha N	0.39	42	0.76	92
Sahara CL 30 kg/ha N	0.76	81	0.75	91
Sahara CL 60 kg/ha N	0.97	103	0.67	81
Sahara CL 90 kg/ha N	0.93	99	0.75	90
Site Mean	0.94		0.89	
CV %	9.35		13.85	
LSD (P=0.05)	*0.10*		*NS*	

Table 5 Yield of canola and Juncea canola with varying sowing rates, Minnipa and Lameroo 2010

Treatment	Minnipa		Lameroo	
	t/ha	% site mean	t/ha	% site mean
Oasis CL 1 kg/ha	0.64	94	0.74	91
Oasis CL 2 kg/ha	0.74	108	0.84	103
Oasis CL 4 kg/ha	0.67	99	0.88	108
Oasis CL 6 kg/ha	0.67	98	0.75	92
Oasis CL 8 kg/ha	0.74	108	0.81	99
Sahara CL 1 kg/ha	0.66	97	0.80	97
Sahara CL 2 kg/ha	0.65	96	0.87	106
Sahara CL 4 kg/ha	0.68	100	0.87	106
Sahara CL 6 kg/ha	0.66	97	0.82	101
Sahara CL 8 kg/ha	0.71	104	0.80	98
Site Mean	0.683		0.82	
CV %	12.14		13.35	
LSD (P=0.05)	*NS*		*0.13*	

With the mild spring in 2010, canola varieties tended to produce higher grain yields than juncea. Generally, grain yield reduced with later sowing but to a much lesser degree in 2010 compared to other years. As in 2009, SARDI515M produced higher yields than the juncea canola varieties OasisCL and SaharaCL.

Sowing rates and nitrogen rates have been tested for canola and juncea canola (Tables 4 and 5). Trials at Walpeup in Victoria, with older juncea lines, suggested that juncea had a lower need for nitrogen than canola. While the nitrogen rate trial at Lameroo showed no response to applied nitrogen in canola or juncea in 2010, the trial at Minnipa produced a yield increase for both species. However, the yield increase ranged from 1.02 t/ha for the canola variety 44C79 to 0.79 and 0.54 t/ha for OasisCL and SaharaCL respectively.

In 2010, sowing rate had little or no effect on grain yield at Minnipa or Lameroo. This may be due to the mild conditions as we have seen yield increases of up to 3 kg/ha for juncea in previous years. In general we recommend using a sowing rate of about 3-4 kg/ha for juncea canola due to the small seed size and the possible drying conditions of the seed bed in low rainfall areas.

Acknowledgements

Thank you to the Minnipa and Struan staff who manage the canola and juncea trials.

SARDI

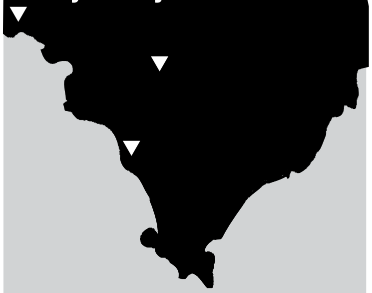
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Break Crop Performance at Mount Cooper, Minnipa and Penong

DEMO

Leigh Davis and Brenton Spriggs
SARDI, Minnipa Agricultural Centre

Try this yourself now



Location: Port Kenny/Mt Cooper
Geoff & Jake Hull
Mt Cooper Ag Bureau
Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2010 Total: 450 mm
2010 GSR: 386 mm
Yield
Potential: 4.1 t/ha (C)
Actual: 2.5 t/ha
Paddock History
2009: Medic Pasture
2008: Medic Pasture
2007: Medic Pasture
Soil Type
Grey loam
Plot size
10 m x 1.5 m x 3 reps
Yield Limiting Factors
Low amount of mice damage

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 250 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 2.7 t/ha (C)
Actual: 1.5 t/ha
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Sandy Clay loam
Plot size
10 m x 1.5 m x 3 reps
Yield Limiting Factors
Low amount of mice damage

Key messages

- **Two Clearfield varieties, Pioneer 44Y84 and Pioneer 45Y82, exceeded 2.5 t/ha at Mt Cooper.**
- **There were no stand-out varieties in the Triazine Tolerant (TT) and Conventional canola varieties at both Minnipa and Mt Cooper.**
- **Juncea canola and Biodiesel canola produced lower yields than in the past compared to traditional napus canola due to above average rainfall year.**
- **No significant difference between the newly released pea lines at Mount Cooper.**
- **Break crops were successfully grown at Penong in 2010.**

Why do the demonstrations?

There is limited ongoing released canola variety yield data available for low rainfall areas such as Minnipa and none for the Mt Cooper area. These trials compare current released varieties at two locations on Eyre Peninsula. A demonstration was also sown at Penong to compare best bet break crops.

How was it done?

Current best bet canola varieties of 7 TT, 5 Clearfield, 2 Clearfield Juncea and 6 conventional lines were tested at Minnipa and Mt Cooper. There were 7 pea varieties tested at Mt Cooper and the seed was not inoculated. The replicated trials at Mt Cooper were sown on 1 June with 68 kg/ha 19:13:0 and 60 kg/ha of urea pre-drilled. The trial had a follow up of 60 kg/ha of urea broadcast at stem elongation. Trials received 1 L/ha Round up Power Max®, 0.07 L/ha Striker® and 1 L/ha Triflur Xtra® at seeding and 0.35 L/ha Select® + 1 L/100 L Hasten® for grass control. Triazine and Clearfield chemicals were not applied to the specific technologies, they were treated as conventionals. Grain yield was measured.

The same lines were tested at Minnipa Agricultural Centre (MAC) but sown on 26 May with 68 kg/ha 19:13:0 and 58 kg/ha urea at seeding. The trials had 97 kg/ha application of sulphate of ammonia to help out with sulphur deficiency and boost nitrogen levels. Minnipa canola site received 1 L/ha Roundup PowerMax®, 1 L/ha Triflur Xtra®, 0.07 L/ha Striker® & 1 L/ha Lorsban® (for Cut-worm control) at seeding. Then 800 g/ha simazine was applied to the TT lines post sowing, pre-emergence and 0.35 L/ha Intervix® + 0.1% BS1000® (wetter) was applied to the Clearfield lines 6 weeks after sowing and 0.3L/ha Select® + 1 L/100 L Hasten® was used for grass control.

Some canola varieties and 1 pea variety (Kaspa) were sown at Penong on 3 June with 66 kg/ha DAP and 57 kg/ha urea. The canola site received 1 L/ha Roundup Power Max®, 1 L/ha Triflur Xtra®, 0.07 L/ha Striker® & 1 L/ha Lorsban® at seeding. Then 0.8 L/ha atrazine was applied to the TT lines and 0.35 L/ha Intervix® + 0.1% BS1000® (wetter) was applied to the Clearfield lines both on 6 August. 0.3 L/ha Select® + 1 L/100 L Hasten® was used for grass control also on 6 August.

What happened?

Mt Cooper had a slow and late start to the year with rainfall, but well and truly made up for it throughout the rest of the year receiving 386 mm for the growing season.

Location: Penong
Bill & Trevor Oats
Charra Ag Bureau
Rainfall
Av. Annual: 310 mm
Av. GSR: 220 mm
2010 Total: 333 mm
2010 GSR: 264 mm
Yield
Potential: 2.3 t/ha (Canola)
Actual: 0.65 t/ha (AV - Garnet)
Paddock History
2009: Pasture
2008: Pasture
2007: Wheat
Soil Type
Sandy clay loam
Plot size
30 m x 1.5 m x 3 reps
Yield Limiting Factors
Some mice damage,
15% to 20% shattering

Minnipa also had a late start but received well above growing season rainfall of 346 mm. Nitrogen was a key for good yields in 2010.

Mt Cooper Peas

Peas struggled for early vigour and growth throughout the year. Not inoculating at seeding along with a poor pulse history causing low rhizobia for nodulation may have been the reason for the poor growth. The trial still averaged 1.2 t/ha with PBA Gunyah and PBA Twilight producing the best gross incomes with $371/ha and $333/ha respectively (Table 1).

Mt Cooper Canola

Canola yields at Mt Cooper were exceptional considering how late the start of the season was with the trials averaging 2.1 t/ha for TT, 2.1 t/ha for Clearfield and 2.4 t/ha for conventional canola lines. The best gross income for TT varieties was Tornado TT and ATR Cobbler both with $1368/ha. For Clearfield varieties the best was Pioneer 44Y84 with $1530/ha and the best of the conventional varieties was Hyola 433 filler with $1490/ha (Table 2).

The two lines Pioneer 44Y84 and Pioneer 45Y82 broke the 2.5 t/ha mark in the Clearfield trial and along with Hyola 571 CL out-yielded Pioneer 43C80, Pioneer 44C79, Oasis CL and Sahara CL. The two Juncea lines Oasis CL and Sahara CL were out-yielded by napus canola but this can happen in high yielding years like 2010. Generally Junceas yield similar to standard canola in years producing less than 1.2 t/ha, but do not suffer as much in drought years. Junceas have other benefits over standard canolas like extra height, good straw strength and lodging resistance, good black leg resistance and direct heading at harvest time with good shattering resistance. Markets for Juncea are being developed through Viterra.

Minnipa Agricultural Centre Canola

Canola yields at MAC did not meet their full potential. The trials were placed in a sandy paddock coming off a 3 t/ha wheat crop the year before which used a large amount of nitrogen. Despite the 58 kg/ha of urea and 97 kg/ha of sulphate of ammonia, the trials could have used around another 50 to 100 kg/ha urea.

TT varieties averaged 1.3 t/ha, Clearfield varieties averaged 1.2 t/ha and the conventional varieties averaged 1.2 t/ha (Table 2).

Penong Break Crops

This trial was established to see if canola can successfully be grown in low rainfall areas such as Penong. Evading mice and the distance from Minnipa were some of the hurdles faced when establishing the trial. With a few mouse bait spreading trips for the NVT site as well and good early rains, canola and pea lines germinated well. The site was visited once more before harvest for weed control. At harvest the canola had some shattering around 15% to 20%, which is not unusual considering the amount of rain and wind this season.

Canola can be successfully grown in the lower rainfall zones (Table 3). If the trial was harvested before shattering occurred expected yields would have been around 0.7 to 0.85 t/ha.

The pea plots did not perform as well as they could have due to management issues. The peas were not inoculated causing poor nodulation and growth. Mice also caused some damage and the trial was harvested without crop lifters, resulting in some shattering.

What does this mean?

Choose canola that suits your farming system. Utilise the technologies in Clearfield and TT canola varieties. Canola is a great break crop and in some years can be very profitable in low rainfall areas. Browse the NVT web site, www.nvtonline.com.au for varietal characteristics, yield and quality data.

Acknowledgements

Thanks to Geoff, Jake and Leroy Hull and Bill and Trevor Oats for help with the trials and use of their land. Thanks to Amanda Cook for doing the stats.

Table 1 Pea yields and gross income at Mount Cooper, 2010

Variety	Mt Cooper 2010		
Field Peas	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**
PBA Gunyah	1.53	242	371
PBA Twilight	1.38	242	333
Kaspa	1.32	242	318
Yarrum	1.28	242	310
Morgan	1.21	242	292
Parafield	0.90	242	219
OZP0703	0.86	242	207
Mean	1.21		
LSD (P=0.05)	*0.40*		

**Gross Income is grain yield x price delivered to Viterra Pt Lincoln using daily cash price on 5/1/2011*

Table 2 Canola yields and gross income at Mount Cooper and Minnipa, 2010

Variety/Line	Minnipa 2010			Mt Cooper 2010			
Triazine Tolerant	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Average (t/ha)**
CB Mallee	1.36	598	810	2.14	598	1,281	1.75
Tornado TT	1.36	598	810	2.29	598	1,368	1.82
CB Tanami	1.31	598	786	2.09	598	1,247	1.70
Tawriffic TT	1.30	598	779	2.19	598	1,311	1.75
ATR Cobbler	1.29	598	774	2.29	598	1,368	1.79
Hurricane TT	1.29	598	773	2.09	598	1,247	1.69
CB Tanami filler	1.27	598	757	2.11	598	1,262	1.69
CB Telfer	1.22	598	729	1.89	598	1,130	1.55
CB Telfer filler	1.21	598	721	1.92	598	1,151	1.56
Mean	1.29			2.11			1.70
LSD (P=0.05)	*0.12*			*0.22*			
Clearfield	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Average (t/ha)**
Hyola 571 CL	1.53	598	917	2.45	598	1,463	1.99
Pioneer 44Y84	1.49	598	891	2.56	598	1,530	2.02
Pioneer 45Y82	1.49	598	888	2.55	598	1,525	2.02
Pioneer 44C79	1.28	598	765	1.90	598	1,136	1.59
Pioneer 43C80	1.20	598	718	2.07	598	1,239	1.64
Pioneer 43C80 Filler	1.13	598	675	2.00	598	1,197	1.57
Oasis CL (Juncea)	0.88	598	526	1.75	598	1,048	1.32
Sahara CL (Juncea)	0.85	598	511	1.52	598	911	1.19
Oasis CL Filler	0.79	598	473	1.78	598	1,066	1.29
Mean	1.18			2.07			1.62
LSD (P=0.05)	*0.24*			*0.12*			
Conventional	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Yield (t/ha)**	**$/t**	**Gross Income ($/ha)**	**Average (t/ha)**
Hyola 50	1.27	598	759	2.42	598	1,447	1.84
AV Garnet	1.22	598	731	2.44	598	1,461	1.83
Hyola 433	1.21	598	721	2.47	598	1,474	1.84
Hyola 433 Filler	1.14	598	682	2.49	598	1,490	1.82
Hyola 433 Filler	1.12	598	672				1.12
Tarcoma	1.08	598	643	2.27	598	1,359	1.67
SARDI 515M				2.00	598	1,197	2.00
Mean	1.17			2.35			1.73
LSD (P=0.05)	*0.16*			*0.23*			

**Gross Income is grain yield x price (assuming 42% oil based) delivered to Viterra Pt Lincoln using daily cash price on 5/1/2011*

Table 3 Break crop yields and gross income at Penong, 2010

Variety	Type	Yield (t/ha)	Price ($)	Gross Income ($/ha)
Kaspa	Pea	0.31	242	$76
Kaspa	Pea	0.48	242	$116
AV - Garnet	Conventional	0.65	598	$392
Hyola 50	Conventional	0.53	598	$318
Tarcoola	Conventional	0.45	598	$268
44Y84	Clearfield	0.61	598	$362
43C80	Clearfield	0.50	598	$297
Oasis	Clearfield	0.27	598	$159
Hurricane	TT	0.55	598	$327
Tawriffic	TT	0.53	598	$315
Cobbler	TT	0.50	598	$301
Tanami	TT	0.46	598	$273
Telfer	TT	0.42	598	$250
Sahara	Juncea	0.38	598	$227
Oasis	Juncea	0.34	598	$206

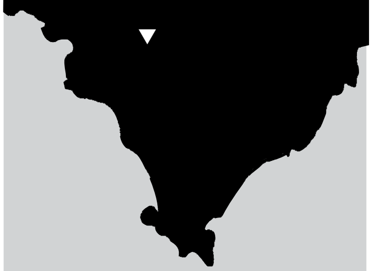
**Gross Income is grain yield x price (assuming 42% base oil for Canola) delivered to Viterra Pt Lincoln using daily cash price on 5/1/2011*

Selection of Canola Lines for Low Rainfall Environments in South Eastern Australia

RESEARCH

Geoff Thomas
Low Rainfall Collaboration Project, Adelaide

Searching for answers



Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 2.7 t/ha (C)
Actual: 2.3 t/ha 45Y77 canola
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Red calcareous sandy loam
Plot size
10 m x 1.48 m x 3 reps
Plot size
Nitrogen

Key messages

- **Mustard outperformed by canola in high production situations.**
- **Some early generation material flowered much earlier than current commercial varieties but they struggled to out-yield them in 2010.**

Background

The development of a profitable break crop in a low rainfall cereal growing areas is essential for sustainable and profitable systems. Until now, canola, peas and lupins have been the most promising options, with canola having several valuable characteristics (e.g. herbicide tolerance, high value grain and well anchored stubble). It is relatively free of disease in low rainfall areas and is able to utilise high nitrogen levels following legume-based pastures. This is useful in low rainfall rotations.

Following discussion with the new canola breeding companies (Nuseed, Pioneer, Pacific Seeds and Canola Breeders Western Australia Pty Ltd), GRDC has supported a small program for early lines to be selected in the districts located around Minnipa (SA), Walpeup (Vic), and Condobolin (NSW). The second year of trials has now been completed, even though Pioneer will have material available only for this coming season.

In 2010, well over one hundred lines were trialled at each of the three locations. These included triazine tolerant (TT), imidazolinone tolerant (IT), Round up Ready (RR) (except in SA because of the GM Moratorium) and conventional lines, all of which were grown with their respective registered herbicides applied. The various lines were assessed for early vigour, height, standability, time to flowering, and yield. Other characteristics which may be of commercial significance (e.g. sensitivity to herbicides) were also noted. Grain analysis included commercial tests such as oil content and protein. However, even more so than in 2009, seasonal conditions did not lend themselves to evaluating lines under low rainfall stresses.

Results

All three sites had very high production levels for low rainfall locations with site average grain yields above 1.5 t/ha (above 2 t/ha at Condobolin). Condobolin and Walpeup were the wettest, receiving an annual rainfall about 50% above the long term average. Substantial rainfall pre-January also contributed to the water supply of the 2010 crops. At Minnipa, annual rainfall was above average and the critical months of August, September and October were about twice the average.

Unlike many commercial crops, these trials escaped most of the traumas facing growers this year (such as mice and locusts at establishment, waterlogging and damaging rains at maturity) even though yields at Minnipa and Walpeup were perhaps not as good as seemed likely at flowering. Plots at Minnipa and Walpeup were largely undamaged prior to harvest, while at Condobolin some losses occurred due to persisting wet conditions leading up to and after maturity.

All three trials were seeded promptly after the break in each location but were not especially early on the calendar by local standards (29 April at Condobolin, 3 May at Walpeup and 26 May at Minnipa). However, the wet and prolonged season in all three districts meant that there was little penalty for the later sowing.

Due to the very mild temperatures in spring and prolonged moisture in the profile at all sites, it was not possible to evaluate lines in 2010 for their performance under drought and high temperature stress. However, the most desirable lines for low rainfall conditions will not only have to "tough it out" in drought years but also be able to do well in the better rainfall years. The 2010 season allowed us to assess them on that basis.

In 2009, a number of entries were identified as promising for low rainfall environments. Mustards performed well compared with canola under the drought conditions at Condobolin. H6693, H6698, H6756, CBWALR07, CBWALR08 CBWALR11, CBWALR15 and CBWALR20 topped yields at Condobolin and also performed well at Minnipa. They also had no major grain quality weaknesses.

Just as occurred in 2009 at Minnipa (a high yielding site), the mustard lines in 2010 could not match the performance of their canola cousins under good growing conditions. The mustard lines included current commercial releases. The yield gap between mustards and canola in high yielding situations has been substantial, e.g. over 1 t/ha difference at Condobolin. So far, this seems to be a feature of current mustard material: it performs strongly under tough conditions but really struggles to exploit good seasons.

More often than not, the early generation material being tested in this project struggled to outperform current commercial varieties. This is not surprising given that the early generation material was specifically selected for very low rainfall situations whereas the commercial varieties must have more general adaptability.

Of the lines which performed well at both sites in 2009 (H6693, H6698, H6756, CBWALR07, CBWALR08 CBWALR11, CBWALR15 and CBWALR20), only H6693 was carried forward into 2010 trials and it was only just into the top half of the conventional block.

Time to reach 50% flowering occurred over a 3-6 week window, depending on the site. Some lines flowered as much as one week earlier than the earliest commercial varieties.

Lines were blocked according to their herbicide tolerance at each site. As a result, direct comparisons between these groups could not be made. However, RR lines appeared to reach similar yields to conventional and IT at the two sites at which they were tested, while the TT continued to carry some yield penalty.

The Future

Despite the less than ideal seasons for testing low rainfall material, this project continues to show that there is real potential for some of the new material to do better than current commercial varieties in these locations, increasing the prospects of a more profitable and reliable break crop.

The trials will continue in 2011 with all four breeding companies submitting material for the three sites at Minnipa, Walpeup and Condobolin.

Acknowledgments

This project was funded by GRDC. Thankyou to the management teams at Minnipa, Walpeup and Condobolin for maintaining and monitoring the trials.

LOW RAINFALL COLLABORATION GROUP

GRDC Grains Research & Development Corporation

Field Pea Varieties and Agronomy for Low Rainfall Regions

Michael Lines[1], Larn McMurray[1], Tony Leonforte[2] and Leigh Davis[3]
[1]SARDI, Clare [2]DPI Victoria, Horsham [3]SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 3.2 t/ha
Actual: 2.9 t/ha
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
2006: Wheat
Soil Type
Red calcareous sandy clay loam
Diseases
Blackspot - low to moderate infection
Plot size
10 m x 1.5 m x 3 reps
Yield limiting factors
Blackspot (low)
Odd heat event during flower/pod fill

Key messages

- **New field pea varieties PBA Gunyah and PBA Twilight performed similarly to Kaspa and Parafield under extremely favourable conditions in 2010 at Minnipa, and given their yield advantages over these varieties in drier seasons, will be better adapted varieties for this region.**
- **Grain yield of PBA Stage 3 field peas averaged 2.9 t/ha at Minnipa in 2010 due to the wet and long growing season, which generally favoured later flowering pea varieties.**
- **Most advanced breeding lines showed no difference in yield to Kaspa (2.93t/ha) due to the favourable conditions.**
- **Though blackspot was present in 2010, it was not as extensive as in 2009 and had little impact on yield. This will have contributed to the 27% higher yield achieved in 2010 compared with 2009.**
- **Agronomy trials showed no significant effect of sowing date or stubble management treatments in 2010. This is likely due to the long growing season, and lack of disease. However early sowing is still recommended for low rainfall regions providing frost, weeds and blackspot risks are considered.**

Why do the trial?

The aims of this work are to facilitate the expansion of field peas into lower rainfall areas of southern Australia through the development of new cultivars and identification of agronomic methods to improve yield and yield reliability, and to provide an economically viable break crop option in areas where pulses are not presently grown. These areas are generally characterized by variable soil types and low rainfall.

Pulse Breeding Australia (PBA) field peas is committed to increasing adaptation of pulse crops in the medium and low rainfall areas of Australia, of which Minnipa is a key part of the program. Selection criteria for these environments include resistance to blackspot, shattering, lodging, tolerance to soil boron and soil salinity, and appropriate flowering/maturity time. PBA also has a germplasm enhancement (pre-breeding) program that focuses on identifying and incorporating genes with tolerance to frost, water use efficiency, transient drought and heat at flowering/podding into adapted varieties.

The agronomic management trials aim to identify best management practices in new pea varieties to maximise field pea yield, and is part of the GRDC funded southern region pulse agronomic project. A sowing date trial was set up to compare and identify optimum sowing times of 6 pea varieties to maximise grain yield and minimise impacts of disease. A secondary trial was also set up to determine whether field peas could benefit from sowing into standing stubble compared to slashed stubble in low rainfall areas. This project also provides information back to PBA on the appropriate flowering and podding times required in field peas for optimum performance in low rainfall environments.

How was it done?

A replicated Stage 3 pea breeding trial containing 6 commercial entries and 59 advanced breeding lines was sown into good soil moisture levels on the 31 May at Minnipa. An agronomic pea time of sowing trial with 4 varieties (Kaspa, Parafield, PBA Gunyah and PBA Twilight) and 2 advanced breeding lines (OZP0703 and OZP0903) was sown on the 27 May (early) and 11 June (mid) also at Minnipa.

A stubble management trial was also sown on the 9 June at Minnipa, comprising sowing into standing stubble (wheat stubble 30 cm high) and slashed stubble. Varieties in this trial included 4 commercial varieties (Kaspa, Parafield, PBA Gunyah and PBA Twilight) and 2 advanced breeding lines (OZP0703 and OZP0819). All sowing dates were 3-4 weeks later than in previous years due to the later break to the season.

All trials were sown with 66 kg/ha of 18:20 and a spray mix comprising 700 mL/ha paraquat, 800 mL/ha trifluralin and 1 L/ha chlorpyrifos. Pre-emergent chemical applications included metribuzin @ 160 g/ha and 1 L/ha glyphosate with 80 mL/ha oxyfluorfen. Clethodim® @ 350 mL/ha with 1% Hasten® was applied post emergent for grass weed control. Insect sprays were applied as required. Scores for establishment, early vigour, disease, flowering, maturity, lodging, shattering and selection potential were recorded during the year and grain yields were measured at harvest.

What happened?

As in 2009, very high growing season rainfall was recorded at Minnipa in 2010. However this did not cause such a severe infection of blackspot disease as was observed in 2009, most likely due to the later sowing date in 2010. This low level of blackspot together with lower levels of powdery mildew in 2010 resulted in a 27% higher yield than in the previous year. Yields were also not limited by moisture stress, and vegetative growth and yield potential was high. Later flowering and maturing lines were able to capitalise on the long and favourable growing season, and generally performed equal or better than earlier maturing lines. Several high temperature events during spring may have led to some flower and pod abortion.

Stage 3 PBA breeding trial

The grain yield of the PBA Stage 3 trial averaged 2.9 t/ha in 2010 (Table 1). There was very little variation in yield between the vast majority of lines and yield of Kaspa was the same as the site mean. Of the other 64 lines in this trial, only 12 lines yielded lower than Kaspa, and 7 higher. All commercial cultivars performed similarly to the site mean.

The highest yielding line from the 2009 trial, the late and short flowering OZP1001, was again one of the standouts, yielding 10% above Kaspa. The advanced breeding line 02H016P-03HO2004-06TGVP001, an early-mid flowering Kaspa/Yarrum cross, was the highest yielding entry in the trial, yielding 12% higher than Kaspa in this trial. This line, as well as 04H069P-05HO2014 and 04H049P-05HO2003 (improved boron tolerance) yielded well in both this trial and also at a state level, and will be further evaluated across more sites and seasons.

Sowing date agronomy trial

Yield of early sown peas was not affected by disease in 2010, and the soft finish to the season did not penalise yield of later sown peas. Consequently, there was no yield difference between sowing dates in this trial. This is a very different result to that found from previous experiments at Minnipa where a yield penalty of 26 kg/day occurred as sowing was delayed. Significant variety differences were apparent (Table 2). OZP0903 yielded higher than all other varieties (3.3 t/ha), and 13% higher than Kaspa. OZP0903, Kaspa and OZP0703 all yielded higher than Parafield. 2010 releases PBA Gunyah and PBA Twilight performed similarly to Kaspa, along with the bacterial blight resistant OZP0703, an anticipated 2011 release.

Stubble management agronomy trial

As for the sowing date trial, there was no significant treatment interaction with stubble management. This is likely because the long and wet season favoured vegetative growth and biomass was high, and consequently any improvements in crop standability, ease of harvest or disease which might have been observed in a drier season were not apparent in 2010. However there were differences in yield between varieties (Table 2). OZP0819, a tall, white field pea, yielded highest (3.3 t/ha), averaging 17% higher yield than Kaspa, a result not found in the PBA breeding trial. As for the sowing date trial, PBA Gunyah, PBA Twilight and OZP0703 all performed similarly to Kaspa (2.8 t/ha). Parafield yielded lower than all lines except PBA Twilight.

Table 2 Grain yields of six varieties in sowing date and stubble management trials at Minnipa, 2010

Sowing date trial							
Line	**Kaspa**	**Parafield**	**PBA Gunyah**	**PBA Twilight**	**OP0703**	**OZP0819**	***LSD (P>0.05)***
Yield (t/ha)	2.90	2.61	2.78	2.75	2.88	3.29	*0.25*

Stubble management trials							
Line	**Kaspa**	**Parafield**	**PBA Gunyah**	**PBA Twilight**	**OP0703**	**OZP0819**	***LSD (P>0.05)***
Yield (t/ha)	2.78	2.46	2.84	2.69	2.78	3.27	*0.25*

Table 1 Grain Yield, flowering date and number of flowering days of selected field pea lines in the 2010 Minnipa Stage 3A PBA trial

Variety	Start Flower	Flower Days	Grain Yield % Kaspa	
			Minnipa	Mean 5 sites SA
Kaspa	13 Sept	25	2.93 t/ha	2.97 t/ha
Parafield	4 Sept	40	94	91
PBA Gunyah	9 Sept	30	99	95
PBA Twilight	3 Sept	35	100	94
Sturt	31 Aug	39	106	100
Yarrum	23 Sept	15	102	101
OZP0606	9 Sept	27	103	99
OZP0703	31 Aug	37	101	66
OZP0801	9 Sept	28	105	100
OZP0803	1 Sept	37	104	103
OZP0804	11 Sept	29	97	104
OZP0805	9 Sept	31	98	101
OZP0808	9 Sept	27	110	107
OZP0809	17 Sept	21	101	104
OZP0815	2 Sept	40	104	101
OZP0819	2 Sept	38	102	103
OZP0901	24 Aug	45	100	100
OZP0903	1 Sept	35	101	107
OZP0904	1 Sept	38	106	106
OZP0905	12 Sept	24	104	102
OZP01001	12 Sept	24	108	110
OZP01002	13 Sept	32	105	109
OZP01003	21 Sept	19	103	107
OZP01004	21 Sept	15	108	108
02H016P-03HO2004-06TGVP001	14 Sept	21	112	112
04H069P-05HO2014	14 Sept	26	107	104
04H049P-05HO2003	14 Sept	25	108	101
Site Mean Yield (t/ha)			2.90	2.92
CV %			3.83	5.34
LSD (P>0.05)			*6.8*	

What does this mean?

Favourable conditions and minimal yield limiting factors such as disease resulted in little differences between lines included in the Stage 3 field pea breeding trial. Since soil moisture was not limiting, and a soft finish to the season was observed, agronomic management trials at Minnipa in 2010 showed no differences between sowing dates or stubble management treatments under these conditions. However early sowing and stubble retention is still generally recommended in low rainfall regions provided that optimal management of blackspot, frost and weed risks are considered. These trials will be continued with the new varieties to validate practices under lower rainfall conditions.

While Kaspa still remains an option for low rainfall environments due to its combination of improved standability, shattering resistance, early vigour, grain yield potential, and round dun seed type, growers should consider the benefits of the 2010 pea releases PBA Gunyah and PBA Twilight. These lines yielded similarly to Kaspa in 2010, a season which favoured later maturing types like Kaspa, and have the same plant and seed type benefits of Kaspa which are favoured for their milling quality and harvestability over Parafield. These earlier maturing "Kaspa types" also maximise yield reliability across seasons in favourable years (e.g. 2009-10) or short seasons (e.g. 2006-08). This makes these varieties an optimum choice for lower rainfall environments such as Minnipa, especially in years where early sowing cannot be practiced or where spring conditions are not favourable for later flowering varieties. The bacterial blight resistant line OZP0703 is expected to become available for 2012 sowings, and displays a combination of broad adaptation, high yield potential and a favourable disease resistance profile. While Parafield did not yield significantly lower than most other varieties in the breeding trial, it did perform lower than Kaspa and some other lines in the agronomy trials. This is likely to be because Parafield is not as well suited to wetter seasons such as 2010 due to its high amount of vegetative growth and proneness to lodging, causing shading of neighbouring plants and issues at harvest.

Acknowledgements

Thanks to Brenton Spriggs for managing the trials.

Improving Yield and Reliability of Field Peas Under Water Deficit

EXTENSION

Lachlan Lake[1], Victor Sadras[1] Larn McMurray[1], Michael Lines[1], Glenn McDonald[2], Jeff Paull[2] and Leigh Davis[1]

[1] South Australian Research and Development Institute, [2] University of Adelaide

Try this yourself now

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 250 mm
2010 Total: 410 mm
2010 GSR: 346 mm

Yield
Potential: 3.2 t/ha (Pulses)
Actual: 2.5 t/ha

Paddock History
2009: Wheat
2008: Wheat
2007: Wheat

Soil Type
Sandy clay loam

Plot size
5 m x 1.5 m x 3 reps

Yield Limiting Factors
Late moisture stress at filling

Key messages

- **This three year research project aims to increase the yield and reliability of field pea under water deficit and is a major pre-breeding target of Pulse Breeding Australia.**
- **Key traits being monitored include phenology, canopy and yield traits and the adaptive value of these traits will be explored.**
- **The trade-offs between adaptation to stress and yield in good environments will be investigated.**
- **Improving the reliability of yield of field pea in water limiting environments will help to provide a robust break crop option for growers in low rainfall regions.**
- **Preliminary results only from the first season of experiments are presented with more detailed trait data currently being analysed, with two more years from different seasons to follow.**
- **Correlations between yield and canopy traits such as greenness have been identified.**

Why do the trials?

Grain legumes are generally more sensitive to periods of drought than cereals and consequently their yield is more variable with production concentrated in the medium and high rainfall areas. By increasing the yield and reliability of field peas under water deficit we can increase their reliability and improve their value in dryland farming systems.

Background

Pulse crops provide a cereal disease break, weed management options, nitrogen benefit and alternative marketing opportunities. Field pea is the major pulse crop grown across southern Australia and is currently grown over 300,000 ha in Australia. Field pea production in recent seasons has been displaced in the higher rainfall areas by higher value crops such as lentil and chickpea and increased sowing area is occurring in the lower rainfall areas where it is considered the most reliable break crop option. Pulse Breeding Australia Field Peas aims to improve the reliability and adaptation of field peas in medium and low rainfall areas of Australia. These regions are dominated by large areas prone to periods of moisture stress and water deficit; hence a major breeding priority of the program is drought tolerance.

Currently PBA has no effective way of breeding for drought tolerance and relies on selecting varieties that perform well in breeding trials such as the one conducted annually at Minnipa. This method has made some improvements through varieties such as PBA Gunyah and PBA Twilight, however progress has been slow and the traits responsible for improved yield in these varieties are not well understood. Improvement of yield under stress can be achieved by direct selection for yield, or targeting adaptive traits, or a combination of both. In this project, we will focus on secondary adaptive traits – their value, how to measure them and how to implement them into the breeding program.

How was it done?

30 field pea accessions were sown – representing a range of flowering times, duration, maturity timings, pod number, pod size, leaf type and other plant characteristics.

Accessions sown in 2010 across 4 different sites that differed in average rainfall.

Minnipa (1 June), Mallala (8 and 22 June), Roseworthy (8 June) and Turretfield (15 June). These sites were chosen for their rainfall gradient with Minnipa being at the dry end of the scale and Turretfield the wettest. We also had two times of sowing at Mallala to increase the effects of terminal moisture stress.

Sowing density of 50 plants/m^2 (seed treated with PPT and Apron®).

80 kg/ha MAP was applied with seed.

Herbicide was a post-sowing pre-emergent application of metribuzin and then a group A grass spray pre flowering.

Insecticides applied were endosulphan at sowing, Karate® at flowering and fortnightly until the completion of pod fill.

Fungicides applied were chlorothalonil fortnightly 6-8 weeks after sowing in line with rain fronts.

Measurements taken

Plant development – timing of first and last flower, beginning of seed fill and pod set

Canopy traits – temperature, chlorophyll content, density, NDVI

Yield and yield components – harvest index, pods per plant, seed per plant, seed per pod

Senteck moisture probe was employed to measure soil moisture content in selected varieties. This is aimed at characterising the water balance of the different environments.

What happened?

Yield was affected, as expected, by location, variety and variety x location interaction, although the location effect was smaller than predicted due to the favourable season at all sites.

The differences between the environments are shown in Table 1.

The differences in performance of field pea varieties in different environments are illustrated in Figure 2.

We are currently analysing the results from the plant and yield component measurements to identify links between consistently high yielding varieties and plant and crop traits.

Table 1 Mean, minimum and maximum yield (kg/ha) of field peas in 2010

Environment	Mean	Standard Error	Minimum	Maximum
Mallala early sowing	3009	32.6	1641	3911
Mallala late sowing	3014	29.7	1759	3816
Minnipa	2501	26.3	1204	4232
Roseworthy	2763	34.8	1765	3985
Turretfield	3039	39.8	1439	4125
Accross all environments	2876	16.5	1204	4232

What does this mean?

By measuring the phenology, canopy traits and yield of field peas in a broad range of environments we aim to determine which common adaptive traits enhance crop's ability to produce reliable yield in dry environments whilst maintaining yield in good environments.

Once identified, these traits could be utilised by PBA field peas for enhanced pea varieties.

Once practical phenotyping techniques are established and tested, they can potentially be applied to other major Australian pulse species.

Acknowledgments

Many thanks GRDC for funding this project, Roy Latta for coordinating the trial at Minnipa, Leigh Davis and Sue Budarick, Minnipa Agricultural Centre team, for managing and sampling the Minnipa trial, the SARDI New Variety Agronomy team at Clare for management of Turretfield, Mallala and Roseworthy trials, Paul Blacket for allowing us use of his land for the Mallala trials and Tony Leonforte DPI Victoria for providing us with seed and advice on germplasm.

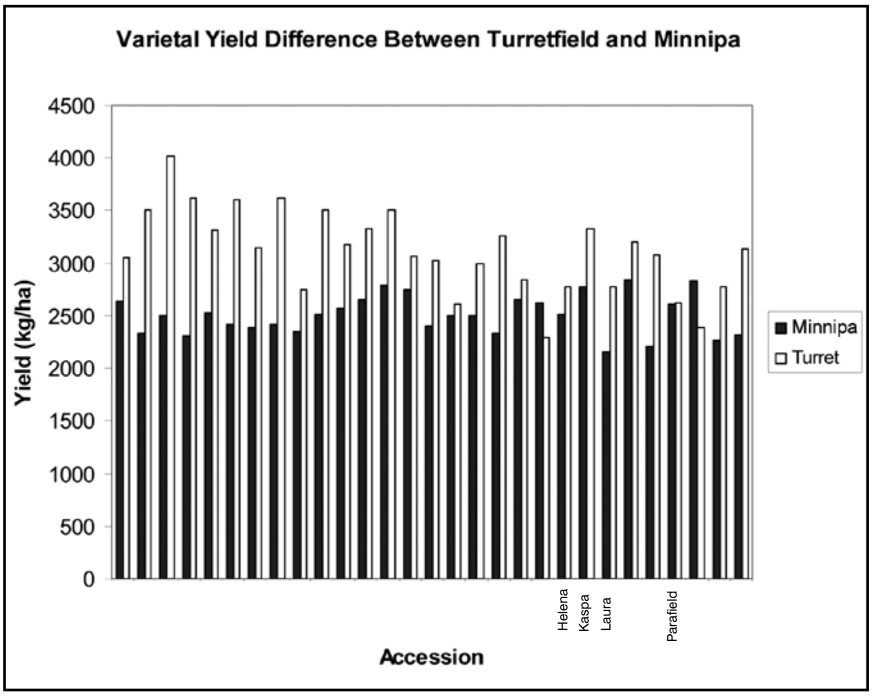


Figure 2 Difference in varietal yield between environments

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Understanding the Benefits of Break Crops

EXTENSION

Charlton Jeisman
Rural Solutions SA, Jamestown

Searching for answers

Location: Upper North
Nurom, SA
Brendon Johns
Upper North Farming Systems

Rainfall
Av. Annual: 377 mm
Av. GSR: 236 mm
2010 Total: 413 mm
2010 GSR: 290 mm

Yield
Potential: 3.93 t/ha (w)
Actual: 2.82 t/ha (w)

Paddock History
2009: Barley
2008: Wheat
2007: Peas

Soil Type
Sandy clay loam

Plot size
15 x 6.5 m x 3 reps

Yield Limiting Factors
Stripe rust (late in season), nitrogen in cereals and juncea

Water Use
Water use efficiency: 9.7kg/ha/mm

Key messages

- **Stored soil moisture at depth is valuable for subsequent crops.**
- **Fallow stored more moisture below 60 cm than all other treatments.**
- **Vetch, wheat and juncea extracted more moisture from the soil than other treatments.**
- **Peas, lentils, oaten hay and medic crops leave behind residual soil moisture after harvest (below 60 cm).**

Why do the trial?

This is the first year of research to investigate the impacts that different break crops have on the following wheat crop, in terms of available soil moisture, nitrogen, root disease break and benefits from weed control.

Background

Break crops are grown for different reasons such as nitrogen fixing benefits (if a legume), a disease break and importantly to allow good weed control of grassy weeds. Break crops are not always profitable (especially in low rainfall regions) but are an important part of rotations to avoid reliance on certain herbicides and reduce the probability of root diseases.

It is often thought that break crops leave behind residual moisture after harvest (at depth) which might benefit the following year's crop, particularly on lighter soil types. This is due to the generally shallower rooting depth of break crops and the inability of some break crops to extract as much moisture as cereals.

How was it done?

A two-year trial was set up to test the above theory. This involved sowing different break crops in the first year (2010) and will involve sowing the whole trial area to wheat in 2011. The break crops that were chosen are representative of crops grown in the Nurom/Crystal Brook region, while wheat and fallow treatments were included as a comparison.

All treatments were sown on 7 May with juncea (a Clearfield mustard line) and medic sown very shallow. 25 mm of rain received 18 days after sowing resulted in good germination and establishment. All treatments (except medic) received 75 kg/ha DAP while cereals and juncea received an additional 65 kg/ha urea at seeding. Medic plots were sown in two passes (to better represent a regenerating pasture) with half seed and fertiliser rate each time. Medic plots received a total of 38 kg/ha DAP. Wheat plots received 100 kg/ha urea on 8 August due to the crop's potential and low starting nitrogen levels. Plots were sown side by side in one long block, made up of three replicates, while each plot was made up of three seeder passes to allow for plot sampling later in the season.

Mice damage to chickpea plots meant they required re-sowing. This occurred on 6 July (much later than optimal) however it provided a crop for comparison instead of empty plots. Dry matter cuts were taken from all treatments on 30 September to compare growth and production and oats were cut for hay (slashed) at the same time. All plots were harvested on 18 November except for chickpeas (harvested 13 December). Soil sampling occurred after harvest on 17 December taken on the centre plot of each treatment in each rep. Samples were taken to a depth of 100 cm and were analysed for moisture content.

All herbicides were applied at seeding except for Select/Targa/Hasten mix and RoundUp @ 1.2 L/ha which were applied on 7 August. Refer to table 1 for more information.

Table 1 Herbicides and rates used for each break crop treatment

	Treatment	Le-Mat 50 mL/ha	RoundUp PowerMax 1 L/ha	Trifluralin 1 L/ha	Metribuzin 900 125 mL/ha	Logran 30 g/ha	Select (400 mL/ha) Targa (400 mL/ha) + Hasten
1	Fallow	x	✔ (1.2 L/ha)	x	x	x	x
2	Kaspa peas	✔	✔	✔	✔	x	✔
3	Flash lentils	✔	✔	✔	✔	x	✔
4	Wintaroo oats (Hay)	✔	✔	x	x	x	x
5	Mace wheat	✔	✔	✔	x	✔	x
6	Morava vetch	✔	✔	✔	✔	x	✔
7	Genesis 079 chickpeas	✔	✔	✔	✔	x	✔
8	Oasis juncea	✔	✔	✔	x	x	✔
9	Angel medic	✔	✔	✔	x	x	✔

Break Crops

What happened?

Dry matter production

Dry matter cuts were taken to compare crop production at a suitable point during the season (30 September). By this point, the late-sown chickpeas had produced only 1 t/ha dry matter compared to lentils/vetch/medic which had produced between 4 - 4.8 t/ha (Figure 1). Peas/ wheat/ juncea had produced around 6.5 t/ha with oaten hay at 9 t/ha. The dry matter produced gave an indication of water use by plants to this point in the season, although this is unlikely a true reflection of the true potential of chickpeas due to delayed sowing.

Soil analysis

Soil samples were analysed both in increments of 20 cm depths as well as total moisture in the profile (0-100 cm) and again as total moisture below 60 cm (60-100 cm). There was no difference in soil moisture between treatments in the 0-20 cm zone due to rain at harvest. 20-40 cm and 40-60 cm depths showed fallow having more moisture compared with all other treatments. 60-80 cm showed fallow had more moisture than chickpeas and oaten hay which had more moisture than juncea (there was no difference between all other treatments). 80-100 cm depth showed fallow with the most moisture followed by chickpeas, then vetch and wheat (there was no difference between all other treatments).

When analysed for total moisture content below 60 cm (60-100 cm) (Figure. 2) the fallow contained the most water, then the late sown Chickpea. The wheat, juncea and vetch had less soil water in the profile (Table 2 indicates that trend).

As vetch and juncea are both break crops, this suggests these crops have the same ability to extract moisture below 60 cm as wheat (as indicated by Figure 2).

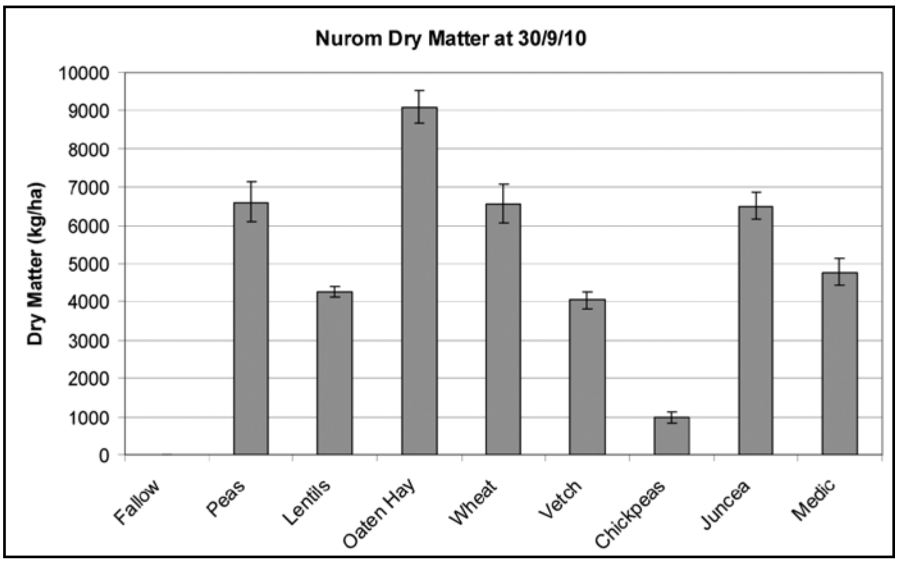


Figure 1 Dry matter production for different break crops to end September 2010

Chickpeas extracted the least amount of moisture (apart from fallow) of all crops however chickpeas' late start combined with the favourable winter and spring meant the crop did not have to actively search for moisture during the season and therefore rooting depth was not as deep. The delayed sowing meant the crop was disadvantaged and is therefore not a fair comparison in this analysis.

Peas, lentils, oaten hay and medic treatments contained equal moisture after harvest, although this was a higher amount compared with wheat, vetch and juncea. Therefore, since these break crops extracted less moisture than wheat, vetch and juncea, either of these crop types is likely to benefit from residual moisture (below 60 cm) if sown the following season.

Oaten hay was cut at the end of September which meant it immediately stopped extracting moisture whereas the other crops (e.g. wheat) kept drawing moisture which contributed to grain yield. The growing season was slightly longer than normal for this site in 2010 which meant treatments were able to extract moisture for longer compared with an average season.

What does this mean?

The soil moisture in the 60-100 cm soil depth is the main area of interest as this zone highlighted the main differences between break crops. As break crops generally have a shallower rooting depth or a higher wilting point than cereals, they are likely to leave residual moisture behind (at depth) after harvest. If a cereal crop follows certain break crops, this residual moisture might become a benefit, particularly in a season with a dry finish.

The analysis is specific to these crop types, planting dates and soil type. If the trial was repeated on a different soil, the outcome would likely be different as each soil type has different constraints. For example a heavier clay loam soil can hold more moisture than a sandier soil; however the clay loam has a higher wilting point (crop lower limit) than sandier profiles. This means that more moisture can be present in a clay loam soil but is not always available to plant roots.

As the sandy clay loam soil type at this site has not been fully characterised as part of APSIM (crop production simulation model), we do not know what the drained upper limit or the crop lower limit is. This means we cannot (at this stage) determine exactly how much of the moisture remaining in the profile (below 60 cm) is actually available to plant roots.

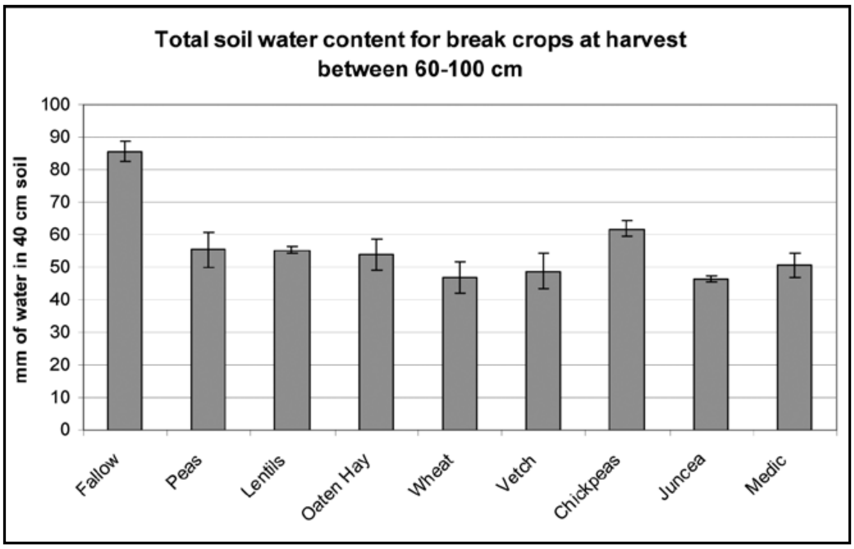


Figure 2 Soil water content for different break crops after harvest (sampled on 17 December 2010)

The Upper North Farming Systems will soil sample the trial site again (hopefully beyond 100 cm) to determine moisture content prior to sowing the whole trial area to wheat in 2011. A full characterisation of the site will identify the crop lower limit in order to determine where moisture extraction by crops ceases due to soil constraints. This will also enable comparison of actual crop production with modelled production.

Therefore this trial suggests that residual soil moisture remains after harvest below 60 cm after growing peas, lentils, oaten hay and medic crops compared with growing wheat, vetch or juncea (canola). This means that in a season with a dry finish, a wheat, vetch or juncea crop could benefit from soil moisture stored at depth (on this soil type) if following a pea, lentil, oaten hay or medic crop.

Acknowledgements

Brendon Johns (Nurom farmer); Larn McMurray (seed distribution, SARDI); Craig John (Juncea oilseed, Viterra); Ben Hook (fertiliser distribution, Mid North Ag, Crystal Brook); Barry Mudge (paddock activities).

Product acknowledgement

Le-Mat – registered trademark of Bayer

RoundUp Powermax – registered trademark of Nufarm

Logran – registered trademark of Syngenta Crop Protection Pty Ltd

Select – registered trademark of Arysta LifeScience Corporation

Targa – registered trademark of Sipcam Pacific Australia Pty. Ltd.

Hasten – registered trademark of Victorian Chemical Co Pty Ltd

UNFS Upper North Farming Systems

GRDC Grains Research & Development Corporation

Growing Chickpeas on Eastern Eyre Peninsula

INFORMATION EXTENSION

Paul and Jo Turner
Cleve

Searching for answers

Location: Cleve
Nurom, SA
Paul and Jo Turner
Rainfall
Av. Annual: 380 mm
Av. GSR: 300 mm
2010 Total: 650 mm
2010 GSR: 430 mm
Yield
Average: 1 t/ha Genesis 090 Kabuli Chickpeas
Paddock History
2009: Wyalkatchem wheat
2008: Grass free pasture
2007: Chebec barley
Soil Type
Red clay loam
Yield Limiting Factors
Late grass and Pratylenchus

Key messages

- **Chickpeas will suffer far more from being too cold and to some degree too wet than they ever will from being too hot and too dry.**
- **Chickpeas don't like high levels of boron, but will handle some.**
- **Chickpeas have some Pratylenchus tolerance but low resistance. Do a Predicta-B® test for Pratylenchus. If levels are high, you will need to find an alternative paddock.**
- **Chickpeas don't like competition from weeds. Use the herbicide Balance® post sowing pre-emergent. If you don't have broad leaf weeds under control before chickpea emergence there are few herbicide options. Grass weed control is quite easy as for normal pulses, such as Targa® or Select®.**

What did you do and why did you do it?

I grew Genesis 090 small Kabuli chickpeas for the sixth season. In our area field peas are difficult to reap and don't provide enough ground cover for my soils. I liked chickpeas as a break crop because they were easy reaping as they stand up and the pods are high on the plant. Our climate is good for growing chickpeas as we are less prone to frosts and our temperature is suitable. Lupin growth is limited in our area due to too much free lime in the soil and it is too dry for beans.

How did you do it?

Variety: Genesis 090

Inoculant: Group N

Pickle: Thiraflo® (for Ascochyta)

Sowing Rate: 80-100 kg/ha

Sowing Date: My ideal time is late May/early June. Be careful you don't run the flowering time into the cold. Needs to be 15°C or above.

Fertiliser: 60-100 kg/ha DAP or MAP

Herbicides:

First knockdown: 1-1.5 L/ha glyphosate, 80-100 mL Striker® (avoid Ester)

Second knockdown: (if applicable) 800 ml Gramoxone® or Sprayseed®, 1-1.2 L/ha trifluralin, 450 mL diuron

Post seeding pre-emergent: 70 g/ha Balance®, 100 mL dimethoate, 100 mL Fastac®

With Balance® - If sandier can get down to 50 g/ha, and if heavier clay can get up to 100 g/ha. Rule of thumb: more clay = more buffer from chemical damage.

6-8 weeks later: 100 mL dimethoate, 250 mL Fastac®, rate of either Targa® (350 mL/ha) or Select® (400 mL/ha)

At podding: 1.5 kg/ha Mancozeb® (for Ascochyta) – Genesis 090 has resistance on the stems and leaves but not on the pods. With good management (e.g. good pickle, hygiene final pod spray) ascochyta may not be an issue, 350 mL Fastac® for bud worm. Possible second grass herbicide for late rye grass and wild oats.

Chickpeas are not a cover crop. In cold of winter growth rate is very slow. Chick peas are good at exhausting the season's soil moisture.

What happened?

In 2010, the chickpeas yielded 1.9 t/ha. An improved yield may have been achieved with greater management, predominantly a second grass herbicide application. The heavy red clay suffered waterlogging and chickpeas suffered accordingly both from rye grass and Pratylenchus.

What does this mean?

Chickpeas are a high value crop that has good returns with the average being $500 - $1000/t.

Chickpeas allow the use of different chemical groups for weed resistance issues and the ability to control grasses.

Chickpeas have good nitrogen fixation for the following crop.

Post harvest there is good ground cover remaining and the paddock can be grazed to make use of chickpea grain lost during harvest.

Don't sow too early to avoid flowering in the cold weather. Establish Pratylenchus levels and get broad leaf weed control before emergence.

In my experience chickpeas have provided good margins, are easy to grow and easy to reap. 2006, 07 and 08 were tough years but chickpeas proved to be robust and comparable to wheat.

Researcher Comments

Chickpeas will provide a good break crop option when grown on the correct soil types, but do prefer longer growing seasons and/or soils with plant available moisture at depth.

Chickpeas have low tolerance but some resistance to Pratylenchus species which may affect wheat in the following season. Newer varieties have better resistance levels (Genesis 090 - MR rating) than older varieties.

The addition of simazine to Balance® gives a broader weed control spectrum but rates must be adjusted for soil types, use lower rates on lighter and sandier soil types. Chickpeas allow the use of different chemical groups compared to field peas, beans, lentils and lupins for weed resistance issues.

Daily mean temperature (average of daily max and daily min) needs to be 15°C or above for effective fertilisation.

The desi chickpea variety PBA Slasher is now widely available and provides a higher yielding alternative option to Genesis 090. Desi markets in Australia are established due to high and regular eastern state production, but prices average around the $350/t mark. Genesis 090 has attracted a price but markets are not yet well established and on farm storage may be required in some seasons. Harvested grain needs to be of high quality as it is aimed at the food market.

Acknowledgements

I would like to thank and acknowledge Larn McMurray (SARDI), Craig James (Agronomist) and Elders Cleve Agronomist Staff for all their help and pointers.

New Strand Medics for the Eyre Peninsula and Murray Mallee - Early Results

RESEARCH

Jake Howie, Ross Ballard and David Peck
SARDI, Waite

Searching for answers

Location: Minnipa Ag Centre
Roy Latta / Ian Richter
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Actual: > 6t/ha (rising plate meter est 28/9/10)
Paddock History
2009: Wheat
2008: Wheat
2007: Cereal
Soil Type
Calcareous sandy loam, pH 8.5
Plot size
6 m x 1.6 m x 3 reps
Yield Limiting Factors
None apparent
Environment impacts
Soil Health
Disease levels: None detected
Chemical use: flumetsulam, quizalofop-p-ethyl

Location: Arthurton
Neville & Ashleigh Rowe
Rainfall
Av. Annual: 375 mm
Av. GSR: 275 mm
2010 Total: 477 mm
2010 GSR: 359 mm
Yield
Actual: > 6t/ha (estimated by rising plate meter)
Paddock History
2009: Canola
2008: Lathyrus
2007: Durum wheat
Soil Type
Clay loam, pH 8.2
Soil test
Colwell P - 68 ppm, organic carbon - 3.4%
Diseases
P. neglectus (RLN)
Yield Limiting Factors
Naturalised burr medic. RLN

Key messages

- **New powdery mildew resistant hybrids have performed very well agronomically at three sites in SA (despite absence of significant powdery mildew infection this year).**
- **The insecticide/nematicide aldicarb, increased medic dry matter at Arthurton by 15%.**
- **Lines with putative tolerance to root lesion nematodes showed reduced root damage but overall were not as productive as the powdery mildew resistant hybrids.**

Why do the trial?

The broad aim of this SAGIT funded project is to assess the potential of a range of multi-trait breeders' lines for commercial development.

More specifically we want to:

- evaluate in the field for the first time, the agronomic performance of 27 strand medic hybrids possessing various combinations of new traits including SU tolerance, larger seed size, nematode tolerance, improved nitrogen fixation capacity and powdery mildew resistance;
- determine the benefit that Pratylenchus neglectus root lesion nematode (RLN) tolerance has on medic production and measure the change in nematode populations after growing these medic lines.

How was it done?

Trial sites were selected in three target zones; Eyre Peninsula (Minnipa), Yorke Peninsula (Arthurton) and the Murray Mallee (Karoonda) (Table 1). The Arthurton site, which was dry sown, was specifically selected for its high level of RLN (30/g soil) and nematicide treatments (plus/minus) were applied in an attempt to quantify RLN field tolerance. The 27 strand medic hybrid entries plus a range of cultivar controls were assessed for dry matter production, maturity, and pod and seed yield. At Arthurton initial RLN numbers were also quantified and root damage assessments made for selected genotypes. Seedling regeneration will be monitored to gain valuable hardseed breakdown data and additional agronomic performance data.

What happened?

Plant establishment at Arthurton and Minnipa was very good, helped by good rain shortly after sowing. At these two sites, spring dry matter production of many lines was excellent and exceeded 5 t/ha in many cases. At Karoonda the establishment was staggered with at least 4 distinct germination events as a result of patches of non-wetting sand failing to wet up sufficiently given the many small rainfall events. In June and July there were 28 rain days recorded by the on-site NRM weather station for a total of only 49 mm rainfall. Notwithstanding this, with a good spring finish the final production of the best lines at Karoonda was also very good (> 5 t/ha).

It is only early days for this project with seed yields still being processed and final nematode populations to be assessed. However the main finding so far this year has been the excellent dry matter production at all sites of a small set of powdery mildew (PM) resistant hybrids which also have SU tolerance, aphid resistance and large seeds. They had superior early vigour and have outperformed Herald and Angel by 20% for winter and spring dry matter growth (Figure 1), even in the absence of any significant powdery mildew infection this year.

Table 1 Herbicides and rates used for each break crop treatment

Site	Sowing Date	Sowing Rate (kg/ha)	Plot Size (m)	Reps	Entries	Nematicide applied (+/-)
Arthurton	21/5/2010	10	3 x 1.2	4	36	yes
Minnipa	31/5/2010	10	6 x 1.6	3	33	no
Karoonda	1/6/2010	10	4 x 1.2	3	32	

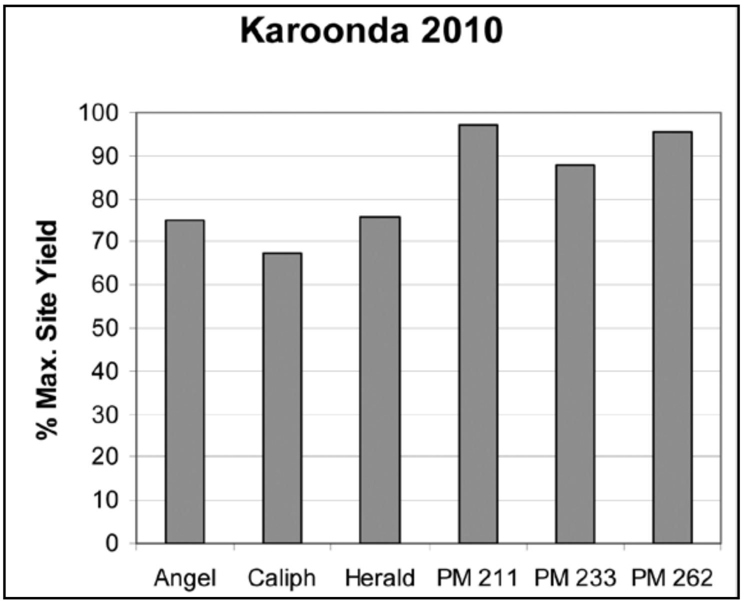


Figure 1 Winter-spring dry matter production (average of % maximum site yield over three assessments) at Karoonda of cultivar controls and selected powdery mildrew resistant lines (PM).

Another observation from the Karoonda site was that plants were poorly nodulated and reinforces a number of similar anecdotal reports of poor nodulation of medics growing on some Mallee soil types (eg non-wetting sandy rises, low organic matter). Nodulation of the regenerating plots will be monitored in 2011.

At Arthurton (high RLN site), positive growth responses to the nematicide aldicarb (applied at sowing) were frequently measured in the field (on average 15%). However, because there was no change in nematode number shortly after sowing, only small reductions in visual root damage and the responses to nematicide were generally consistent across the medic lines, it is likely the effect of the nematicide extended beyond nematode control. Impacts on other soil flora and nutrient availability are often reported where nematicides are used. Nematicide effects aside, the medic line RH-1 (nematode tolerant parent) and Z-2365 (bred line) showed significantly reduced root damage compared to the variety Herald, indicating that a useful level of nematode tolerance has been incorporated into some of the bred lines. But overall the RLN tolerant hybrids were less productive than the powdery mildew hybrids that produced exceptional growth. In the longer term it may be possible to cross the nematode tolerance trait into the highly productive powdery mildew lines.

What does this mean?

Seed yield data (pending) will be important to supplement the dry matter assessments but we are encouraged so far by the consistently good performance of a small group of material sharing the same genetic background. This material has never been evaluated in the field before but has done well at three field sites with quite different soil and seasonal characteristics (EP, YP & MM). The lines are derived from a cross made with a line originally selected for powdery mildew resistance and Angel strand medic. Although powdery mildew (PM) was not a factor in this year's trials, genetic gains in early vigour and adaptation to sandy soils may have resulted from the larger seeded PM parent. Further selections have be made on this material to stabilise traits and if the level of agronomic improvement can be confirmed at additional 'sites x years' there are good prospects for a commercial release as a result of this project.

In additional work, final RLN numbers are being assessed at Arthurton to measure what effect the different medics have had on their population. A second site has also been set up at Arthurton in collaboration with Dr Alan McKay, where nematode levels were manipulated in 2010. This will be used to further assess the nematode tolerance of the best lines.

Subject to the final analyses of the 2010 data, a shortlisted selection of the best lines will be re-sown at additional sites.

Acknowledgements

We gratefully acknowledge the funding by South Australian Grains Industry Trust; technical assistance from Jeff Hill, Barbara Morgan, John Heap and Ian Richter, SARDI; and collaborators, Roy Latta (Minnipa), Neville Rowe (Arthurton) and Peter & Hannah Loller (Karoonda).

SARDI

SAGIT

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Profitable Broadleaf Crop Sequencing in South Eastern Australia

RESEARCH

Nigel Wilhelm[1] and Michael Moodie[2]

[1] SARDI, Waite Institute, [2] Mallee Sustainable Farming Inc, Mildura Vic

Break Crops

Why do the project?

In low rainfall regions of south-eastern Australia, farmers have increasingly adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to yield and price fluctuations. Broad-leaf crops make up only a very small proportion of the total area of sown crops. There is a need for non-cereal crop and pasture options to provide profitable rotational crops, disease breaks and weed control opportunities for cereal production. The current alternative to cereals is pastures, and poorly managed grass dominant pastures can be havens for cereal pests and disease and may have a negative impact on subsequent cereal yields and quality.

This project will develop an improved understanding and implementation of management practices for Brassica, pulse crops, pastures and other options to reduce the risk of crop failure and improve whole farm profitability in low rainfall south-east Australia.

How will it be done?

This is a collaborative project between five farming systems (FS) groups (Eyre Peninsula, Upper North, Mallee Sustainable Farming, BCG and Central West). Over-arching guidance and support will be provided by the Low Rainfall Collaboration Project (LRCP).

This project incorporates 4 approaches which when combined to develop a package will provide industry confidence in broad-leaf crops as components of risk minimisation cropping strategies:

- An opportunistic combination of crops, cereals, canola, pulses and pastures, and crop sequences, based on soil and seasonal variables.
- Integrating grain legume or oilseed varieties better suited to dry climates into crop sequences.
- Growing crop or pasture mixtures such as a legume and an oilseed may increase benefits to subsequent cereals over that expected of component species, through enhanced nitrogen availability from the legume and enhanced root disease control by the oilseed. In addition, mixtures could have higher combined yields than component crops through more efficient partitioning of resources through space and time.
- Multipurpose use of broad-leaf crops as grain, hay or forage based on seasonal and enterprise requirements.

Issues restricting the more widespread use of non-cereal phases will be identified in each region from the evaluation processes which each group is currently developing. These issues will be integrated across the project by a management group consisting of representatives from each FS group and major projects in the area.

Five small plot experiments will be conducted at locations and environments to be decided by each management group to investigate not only a wide range of break crop and pasture types but also differing management options. The sites will be on long term wheat paddocks and central to each experiment will be a break phase of 2 years followed by 2 years of cereal.

A design has been developed which will allow the rigorous comparison of up to 44 individual break sequences (unique combinations of break type and management options over 2 consecutive years) analysed spatially with a continuous cereal as a monitoring check.

Commercial paddocks which are already addressing a problem from a continuous cereal phase with a 2 year break will also be monitored in each FS region.

Agronomic outcomes from this project will be examined for their economic and risk impacts through existing activities of each group.

Extension of project outcomes will be achieved via the existing activities, networks and infrastructure of the 6 FS groups partnering in this proposal. The project management group will ensure scientific outcomes are reported to the industry. A guide for improved decision making for the implementation and management of break phases in low rainfall south-eastern Australia will be developed and promoted to the regional communities as part of this project.

What will it mean?

The outcome from this project will be more reliable and more productive low rainfall farming systems through the increased use of less risky broad leaved break phases.

This will be achieved through the promotion of the following outputs from the proposal in low rainfall regions of south eastern Australia

1. More reliable management strategies for the production of broad leaved phases.
2. Identification of more reliable break phase options.
3. Guidelines to identify trigger points for when, for how long and which break phases to use for improved farming systems outcomes.
4. Reliable estimation of risks with break phases as well as their total impacts on following cereal crops.

Acknowledgements

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GRDC Grains Research & Development Corporation

Section 3

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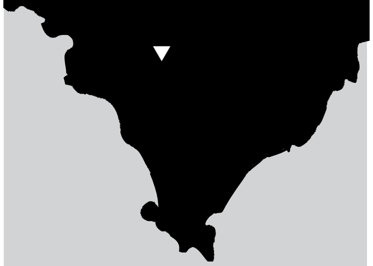
Disease

The Impact of Soil Mineral Nitrogen on Disease Suppression

Amanda Cook, Nigel Wilhelm, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers



Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 236 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 5.1 t/ha (B)
Actual: 4.3 - 6.0 t/ha
Paddock History
2010: Wheat
2009: Wheat
2008: Barley
2007: Triticale
Soil
Red sandy loam
Plot size
40 m x 4 reps
Environmental Impacts
Soil Health
Disease levels: See article
Soil Nutrients: High phosphorus, low nitrogen system
Tillage type: Direct drill, stubble retained for 27 years
Economic
Cost of adoption risk: No livestock in system, higher risk cropping

Key messages

- **It appears that once disease suppression is achieved in low rainfall farming systems of upper EP and inoculum levels are low, it is quite robust and will be maintained despite systems with substantially different amounts of mineral N.**
- **Fallow, Medic/Fallow and Peas all lowered rhizoctonia inoculum levels in 2010, and Fallow and Peas lowered levels in 2009.**
- **Continuous cereals produced the highest inoculum levels but all levels were low at this site.**
- **Even high mineral N (118 kg N/ha) in the top 60 cm (measured in April after spraytopped medic) did not increase Rhizoctonia patches in 2010.**
- **Trichoderma fungus and the beneficial PEM microbes are present in the MAC N12 system.**

Why do the trial?

Rhizoctonia solani (AG-8) is a major disease in our cereal based farming systems. This research is the final year of a SAGIT funded project which aims to understand the impact of soil carbon and nitrogen cycling on disease suppression. Disease suppression is a result of activity of some particular soil microbial populations reducing the impact of the disease on plant root systems. A better understanding of disease suppression offers hope for reducing the impact of this disease.

The development of biological disease suppression in a dry land cereal system was first observed in a rotation trial at Avon, in the lower north of SA. Rhizoctonia caused poor plant growth in 46% of the trial area in 1983, but this declined to negligible levels by 1990. The Avon soil is an alkaline calcareous sandy loam, pH (H_2O) 8.2, organic carbon of 1.6%, total N 0.15%, $CaCO_3$ 8% (Roget, 1995). Mineral nitrogen in the soil over summer is believed to be a 'switch' which turns disease suppressive activity on or off (Roget and Gupta, 2006) with suppressive activity being reduced with increasing mineral N in the surface soil.

Paddock N12 is located on Minnipa Agricultural Centre (MAC) and has been continuously cropped for 27 years and shows a level of disease suppression in both pot bioassays and in the field, although not as great as Avon. This trial in MAC N12 was designed to test whether typical rotation or nitrogen fertiliser options for upper EP can 'switch' suppression off.

How was it done?

The trial was established in 2008 in MAC N12 to determine the relationships between soil mineral nitrogen, microbial populations and disease suppression. The treatments aimed to increase soil mineral nitrogen and these were then monitored for disease suppression. The treatments in 2008 and 2009 included two nitrogen fertilisers (urea at 60 kg/ha and sulphate of ammonia at 120 kg/ha [split applications]), peas, medic (with and without grass control or mown to simulate grazing), fallow (no carbon or N input into the system) and wheat. In 2009 two ammonium sulphate plots were accidently spraytopped at booting, giving an extra treatment.

In the 2010, all treatments were sown with Hindmarsh barley @ 60 kg/ha on 31 May. A pre-seeding application of 1 L/ha Roundup®, 1 L/ha Treflan® and 80 mL/ha of Hammer® was followed mid season by 400 g/ha Achieve® and 300 mL/ha of Lontrel®.

Soils were collected in March to measure soil mineral nitrogen and root disease inoculum levels (measured by the PredictaB® root disease testing service). Plant roots were scored for Rhizoctonia disease and number of crown roots on 21 July at 7 weeks post seeding. Early dry matter, grain yield, quality and biomass at maturity was measured.

What happened?

Rhizoctonia inoculum levels in March were low, but still sufficient to cause disease symptoms in a barley crop in a non-suppressive paddock. The lowest levels of Rhizoctonia inoculum were following Fallow, Medic/Fallow (medic in 2008 followed by fallow in 2009) and Peas (Table 1). In 2009, Fallow and Pea treatments also lowered Rhizoctonia inoculum levels. It appears that grass free medic options had lower Rhizoctonia inoculum than cereals. There was very little grass in the Medic grass treatments in this paddock. These results indicate rotation may affect Rhizoctonia inoculum more than previously thought.

Barley did not develop typical bare patches in 2010 and relatively low levels of disease scores on the seminal roots are consistent with this low level of disease severity. A root disease score of 2.5 is normally required for patches to develop within a crop.

By seven weeks after seeding an average of 3.5 crown roots had developed, but this was also dependent on soil mineral nitrogen as the higher nitrogen systems were more advanced both in root growth and early dry matter. The PredictaB® test is also able to measure beneficial microbes. These microbes were first isolated from the Avon soil, and have been shown to be linked to disease suppression. The PredictaB® results showed the Trichoderma fungus (which attacks Rhizoctonia) and PEM microbes are present in the MAC N12 system, data not shown.

Disease

Table 1 PredictaB® levels in March and Rhizoctonia disease scoring on barley at tillering for MAC N12, 2010

Treatment (2008/2009)	R solani AG8 (pgDNA/g soil) (level in 2009)	Early Dry Matter (g/plant)	Average Rhizoctonia Score on Seminal Roots (0-5)	Infected Crown Roots	Number Crown Roots	Infection Crown Roots (%)
Amm Sulphate	107 (34)	0.23	0.9	0.9	3.4	25
Amm Sulphate + spraytop booting	173	0.34	0.5	0.9	3.9	24
Wheat Control 1	80 (0)	0.25	0.9	0.7	3.1	23
Wheat Control 2	107	0.26	0.9	0.3	2.7	14
Fallow	0 (2)	0.40	0.3	0.2	3.9	4
Fallow/Wheat	40	0.22	0.8	0.4	2.6	14
Medic/Fallow	2	0.37	0.4	0.2	4.0	5
Medic Grass	13	0.35	0.6	0.5	3.7	13
Medic Mow	63	0.39	0.8	1.0	4.2	23
Medic Spraytop	24 (23)	0.36	0.7	0.4	3.8	10
Medic/Wheat	54	0.23	0.6	0.5	2.9	17
Peas	8 (4)	0.46	0.5	0.3	3.8	8
Urea	99 (31)	0.27	1.2	0.7	3.2	20
Wheat spraytop booting	73	0.34	1.3	1.2	3.7	31
LSD (P=0.05)	*48*	*0.08*	*0.3*	*0.6*	*0.7*	*33*

Table 2 Soil phosphorus and nitrogen, MAC N12 2010

Treatment	Colwell Phosphorus (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	10-60 cm	0-60 cm
2008 (initial)	*63*	*23*	*234*	*257*
Amm Sulphate	44	19	46	64
Amm Sulphate + spraytop booting	52	56	37	93
Wheat Control 1	41	23	43	66
Wheat Control 2	*	19	35	53
Fallow	47	29	45	74
Fallow/Wheat	44	17	39	56
Medic fallow	48	28	55	83
Medic Grass	40	45	69	115
Medic Mow	43	45	53	98
Medic Spraytop	40	50	68	118
Medic/Wheat	54	20	34	54
Peas	47	26	63	89
Urea	46	19	34	52
Wheat spraytop booting	57	40	56	96
LSD (P=0.05)	*44*	*15*	*16*	*31*

Crop growth in MAC N12 is not limited by phosphorus as Colwell P levels are considered greater than adequate for mallee soils. However, despite high mineral N reserves at the start of the trial (Table 2) barley growth and quality in 2010 were limited by N (Table 3). Medic, peas and added N fertiliser treatments had higher yields and protein but also higher screenings than the cereals without extra N. Mineral N reserves which would normally be considered sufficient for typical upper EP crops were inadequate for the very high yields achieved in 2010, following the good season of 2009.

Table 3 Dry matter, yields and grain quality from MAC N12 Increasing N Trial, 2010

Treatment oversown with Hindmarsh barley @ 60 kg/ha	Dry Matter at Harvest (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Amm Sulphate	11.5	5.1	7.6	8.8
Amm Sulphate spraytop booting	13.7	5.9	8.1	11.3
Wheat Control 1	8.6	4.3	7.2	5.5
Wheat Control 2	*	4.4	7.7	6.5
Fallow	11.4	5.6	9.3	21.0
Fallow/Wheat	8.0	4.5	7.5	6.7
Medic Fallow	15.4	5.9	9.1	19.7
Medic Grass	14.9	5.9	9.1	19.7
Medic Mow	14.4	5.8	9.0	16.8
Medic spraytop	15.4	5.8	9.7	23.3
Medic/Wheat	9.6	4.6	7.3	7.9
Peas	15.2	6.0	8.8	18.1
Urea	11.2	5.4	8.0	14.1
Wheat spraytop booting	11.5	6.0	7.7	6.0
LSD (P=0.05)	*3.3*	*0.4*	*0.5*	*7.5*

What does this mean?

Previous Rhizoctonia research has indicated there was very little rotational control of Rhizoctonia disease, but the use of Predicta B® (RDTS) to measure DNA inoculum levels in recent research, has shown canola has the ability to lower Rhizoctonia inoculum levels. The results from this trial indicate rotation may be linked to Rhizoctonia inoculum levels more than previously thought, as the Fallow, Medic/Fallow and Peas all lowered Rhizoctonia inoculum levels in 2010, and Fallow and Peas lowered levels in 2009. It appears the grass free medic systems have Rhizoctonia inoculum levels higher than fallow and break crops, but lower than the cereal systems. This rotational effect on inoculum level will need further research and clarification through the new crop sequencing project.

MAC N12 is a low nitrogen system with grain yields and quality influenced by nitrogen levels in 2009 and 2010, and the medic and added nitrogen systems yielding highest. The highest nitrogen levels achieved by spraytopped medic did not increase Rhizoctonia patches in barley in this system. The soil tests show N12 is unlikely to be limited by phosphorus with the soil having low calcium carbonate and hence a lower phosphorus buffering index. Soil characteristics like high calcium carbonate and high phosphorus fixation may limit the ability of both the plant to cope with Rhizoctonia disease infection and the development of suppression within the microbial population.

MAC N12 has been shown in bioassays to have a level of suppression which is almost as high as that achieved in the Avon soil. The beneficial microbes which are linked to disease suppression in the Avon soil, Trichoderma fungus and PEM microbes are present in the MAC N12 system. In N12 the low Rhizoctonia inoculum levels and lack of disease symptoms are due to the disease suppressive abilities of the microbial populations present in this paddock. The disease suppressive ability of MAC N12 appears non-responsive to increased mineral N in soil, and it is a relatively low N system, so once suppression is achieved in low rainfall farming systems it should be robust.

Acknowledgements

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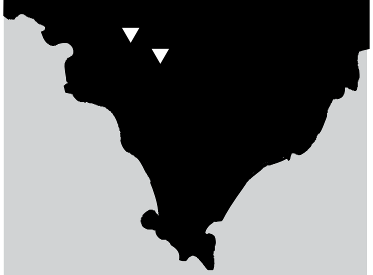
Investigating the Impact of Carbon Inputs on Disease Suppression

Amanda Cook, Nigel Wilhelm, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

Searching for answers



Location: Poochera
I & J Gosling

Rainfall
Av. Annual: 324 mm
Av. GSR: 245 mm
2010 Total: 326 mm
2010 GSR: 279 mm

Yield
Potential: 3.7 t/ha (W)
Actual: 3.1 t/ha

Paddock History
2010: Wheat
2009: Pasture/trial treatments
2008: Wheat/trial treatments
2007: Oats

Soil
Grey calcareous loam

Plot size
40 m x 4 reps

Yield Limiting Factors
Late seeding due to initial trial having mice damage

Location: Minnipa
B and K Heddle

Rainfall
Av. Annual: 325 mm
Av. GSR: 236 mm
2010 Total: 411 mm
2010 GSR: 346 mm

Yield
Potential: 5.1 t/ha (B)
Actual: 2.5 t/ha

Paddock History
2010: Medic Canola Hay
2009: Wheat
2008: Wheat
2007: Medic

Soil
Brown calcareous sandy loam

Plot size
40 m x 4 reps

Yield Limiting Factors
Late seeding due to initial trial having mice damage

Key messages

- **Canola in rotation reduced Rhizoctonia inoculum levels and increased following cereal yields.**
- **Fluid fertiliser increased plant dry matter and yield on highly calcareous grey soils.**
- **A barley/vetch brown manure increased soil mineral nitrogen and this appears to have exacerbated Rhizoctonia disease symptoms on a following barley crop.**
- **Added carbon (10 t/ha/yr) has increased microbial respiration and microbial nitrogen.**

Why do the trial?

This research aims to understand the impact of soil carbon and nitrogen cycling on disease suppression. If we understand suppression more thoroughly, then we will be in a stronger position to manipulate it for improved control of rhizoctonia in cereal crops. This article reports on activities in the final year of a SAGIT funded project.

Trials were established on two highly calcareous soils to see if disease suppression can be stimulated by increasing carbon inputs into farming systems under local conditions. The dynamics of disease suppression to Rhizoctonia are not fully understood but increased microbial activity, especially of certain specific microbes that compete with Rhizoctonia is an important factor. Vibrant microbial populations need rich supplies of carbon (as a food source) for normal functions and for growth in the soil.

How was it done?

Identical trials were established on a grey calcareous soil at Poochera and a red calcareous soil at Minnipa, to vary carbon input into soil with different crops and management practices. Treatments in 2008 and 2009 were:

- extra cereal stubble added as chaff (5 or 10 t/ha).
- wheat, barley or canola at high seeding rates with fluid fertiliser (to encourage high dry matter production).
- wheat (Wyalkatchem @ 60 kg/ha with DAP @ 60 kg/ha) as a control.

Fluid fertiliser was APP and UAN at the same nutrient rate as granular (12 kg P/ha and 10 kg N/ha). A barley/vetch mixture was included as a brown manure treatment sprayed out at late tillering. Zinc was drilled below the seed on all treatments as a fluid at 1 kg Zn/ha.

Chopped oaten chaff was added to the soil surface a month before seeding for appropriate treatments. Both trials were sown with Hindmarsh barley @ 60 kg/ha with DAP @ 60 kg/ha in 2010; on 4 June under ideal conditions at Minnipa and on 7 June at Poochera into reasonable moisture. Both trials had 1 L/ha Roundup®, 1 L/ha Treflan® and 80 mL/ha of Hammer® pre sowing. Severe mice damage occurred to both trials so they were both resown on 28 June; the Minnipa trial was also harrowed post seeding to further reduce mice damage.

What happened?

The trial sites were chosen for severe Rhizoctonia and low productivity in cereal crops to try to improve production levels. Soil pH down the profile is similar for both soils but the Minnipa site has higher boron at a depth of 20-40 cm compared to Poochera.

Organic carbon levels at the sites are typical for the upper EP; being relatively low in the surface profile and decreasing with depth. In 2008 the Poochera site had a much higher level of nitrate-N throughout the profile (total of nearly 400 kg N/ha compared to Minnipa at 180 kg N/ha). Soil Colwell P levels were only moderate for the highly calcareous soils at Minnipa and Poochera (47 P and 50 P (mg/kg) respectively). These sites have high calcium carbonate (free lime) throughout the profile (see EPFS Summary 2008, p126).

At both sites PredictaB® (RDTS) results at the beginning of 2010 showed high inoculum and high risk of Rhizoctonia in all treatments except where canola had been grown in the previous season (Table 1 & 2). At the Minnipa site the barley/vetch brown manure treatment (sprayed out at booting in 2009) had greater Rhizoctonia root damage and more patches (Table 2). There were some patches in the same treatment at Poochera but not as strongly developed, which is reflected in the lower Rhizoctonia root score (Table 1). The mineral N level in the 0-10 cm zone in the barley/vetch treatment was highest.

Table 1 PredictaB® levels, Rhizoctonia disease scoring, and soil data for Poochera, 2010

Treatment	R Solani AG8 (pgDNA/g soil)	Average Seminal Root Rhizoctonia Score (0-5)	Colwell Phosphorus (mg/kg)		Microbial Biomass N (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	0-10 cm	10-60 cm	0-10 cm	0-10 cm	10-60 cm	0-60 cm
Barley DM*	345	0.8	22	5	3.4	25	72	97
Barley & Vetch	173	1.3	20	6	3.0	46	89	134
Control Wheat	236	1.1	22	6	2.3	24	134	157
Canola*	11	0.3	34	6	3.5	27	86	114
Wheat DM*	210	1.2	27	6	3.2	28	158	186
Stubble 5 t	213	1.1	27	6	5.4	41	61	102
Stubble 10 t	236	1.2	31	8	6.7	35	63	97
LSD (P=0.05)	*119*	*0.3*	*8*	*NS*	*NS*	*13*	*NS*	*NS*

**Fluid fertiliser system*

Table 2 PredictaB® levels, Rhizoctonia disease scoring, and soil data for Minnipa, 2010

Treatment	R Solani AG8 (pgDNA/g soil)	Average Seminal Root Rhizoctonia Score (0-5)	Colwell Phosphorus (mg/kg)		Microbial Biomass N (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	0-10 cm	10-60 cm	0-10 cm	0-10 cm	10-60 cm	0-60 cm
Barley DM*	270	1.2	43	5	7.0	15	74	89
Barley & Vetch	431	2.3	38	8	7.0	62	83	145
Control Wheat	189	1.4	34	5	7.2	18	59	77
Canola*	6	0.3	30	7	5.4	35	58	93
Wheat DM*	327	1.4	35	5	7.1	21	63	84
Stubble 5 t	217	1.4	35	7	7.3	24	43	67
Stubble 10 t	232	1.2	38	7	10.0	20	46	66
LSD (P=0.05)	*133*	*0.3*	*NS*	*2*	*2.5*	*9*	*13*	*16*

**Fluid fertiliser system*

The Colwell phosphorus levels are considered adequate for Poochera and Minnipa, with 18 mg/kg being in the adequate zone for mallee soils. Both trials are showing an increase in microbial nitrogen with the 10 t/ha/yr of added stubble treatment (Tables 1 & 2).

Fluid fertiliser increased early and late plant dry matter at both sites, with barley on canola having the greatest dry matter and grain yield. There was greater production potential at Poochera (Table 3) which resulted in higher screenings compared to the Minnipa site (Table 4).

The greatest amount of added carbon to the system has been through the added 10 t/ha treatments with an accumulated total of 47 t/ha at Poochera and 45 t/ha at Minnipa. The barley fluid fertiliser system has produced the greatest amount of dry matter, in two exceptional seasons.

Table 3 Dry matter and yield results of Hindmarsh barley at Poochera, 2010

Treatment 2008/2009	Early Dry Matter (g/plant)	Dry Matter at pre-harvest 2010 (t/ha)	Total Dry Matter accumulated 2008,09,10 (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	0.10	5.7	13.1	2.9	9.8	51
Barley & Vetch	0.07	5.2	7.8	2.5	10.0	29
Control Wheat	0.07	4.9	10.5	2.3	9.6	37
Canola*	0.13	6.6	13.9	3.1	9.8	79
Wheat DM*	0.09	5.4	11.7	2.9	9.7	43
Stubble 5 t	0.06	5.4 (+5)	26.5	2.1	9.6	34
Stubble 10 t	0.07	5.7 (+10)	47.7	2.7	9.7	29
LSD (P=0.05)	*0.02*	*0.5*	*2.3*	*0.2*	*0.2*	*16*

**Fluid fertiliser treatments and these treatments accidentally received double fertiliser rates in 2008*

Table 4 Dry matter and yield results from Hindmarsh barley at Minnipa, 2010

Treatment 2008/2009	Early Dry Matter (g/plant)	Dry Matter at harvest 2010 (t/ha)	Total Dry Matter accumulated 2008, 09, 10 (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	0.09	5.6	12.2	1.7	9.9	13.7
Barley & Vetch	0.06	5.0	7.9	1.5	10.1	8.0
Control wheat	0.06	4.9	10.5	1.5	10.2	4.4
Canola*	0.11	6.2	11.6	2.5	9.8	12.0
Wheat DM*	0.09	5.3	11.5	1.8	10.0	8.1
Stubble 5 t	0.07	4.8 (+5)	25.3	1.7	10.0	5.0
Stubble 10 t	0.07	4.8 (+10)	45.5	1.7	10.1	5.7
LSD (P=0.05)	*0.03*	*0.7*	*2.1*	*0.1*	*NS*	*NS*

**Fluid fertiliser treatments*

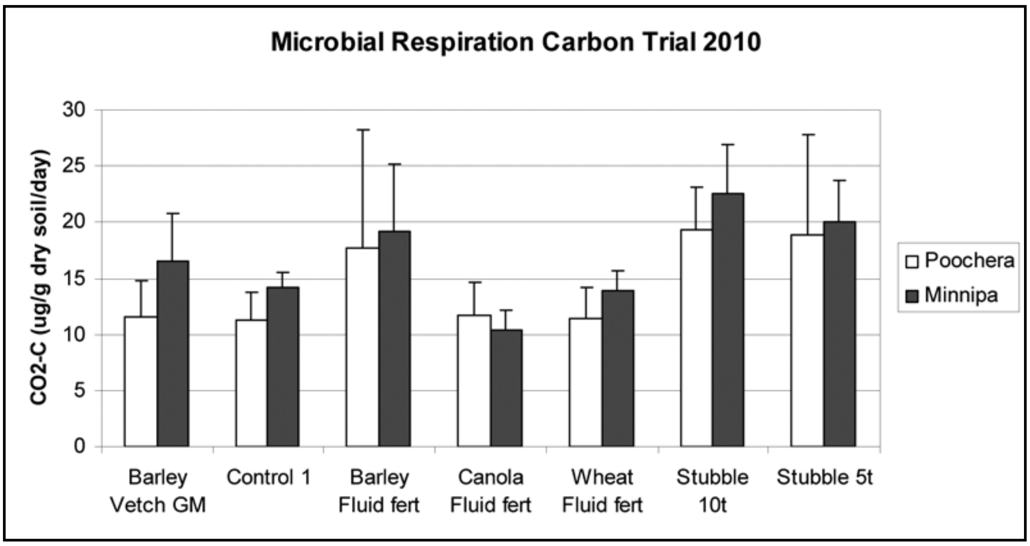


Figure 1** **Microbial Respiration (CO_2-C (ug/g dry soil/day) at Poochera and Minnipa sites, 2010

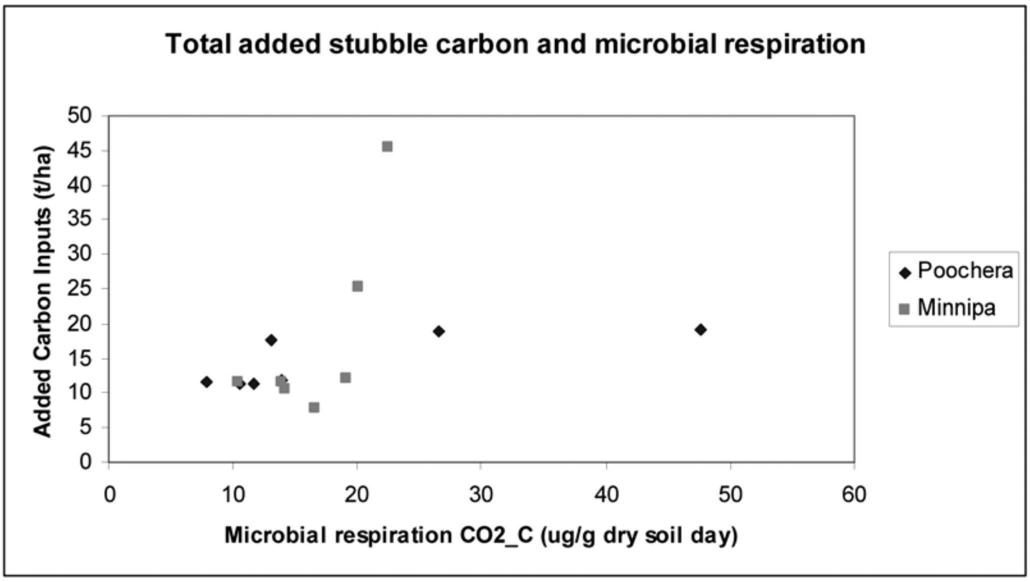


Figure 2 Added carbon inputs (t/ha) and Microbial Respiration (CO_2-C (ug/g dry soil/day) at Poochera and Minnipa sites, 2010

Microbial respiration is a measure of the potential activity of the microbial population, estimated under controlled conditions in the lab (Figure 1). Both sites show similar trends with the added carbon treatments having the highest microbial activity.

Figure 2 shows the total amount of added carbon against microbial activity, the Minnipa site shows a greater response of the microbial population to the added carbon than the Poochera site. The lower response at Poochera may indicate some other factor is limiting the population and its ability to utilise the carbon resource available.

What does this mean?

Canola has again shown the ability to reduce Rhizoctonia disease inoculum, which has resulted in an increase in yield in following barley crops at both sites this season. The fluid fertiliser system also continues to increase yield and dry matter production at both these sites.

The brown manure barley vetch treatment showed an increase in soil mineral nitrogen and increased Rhizoctonia disease incidence especially at the Minnipa site. This interaction requires further research to see if nitrogen will exacerbate Rhizoctonia disease symptoms in suppressive paddocks with high inoculum levels.

This season has shown a response by the microbial population to the added carbon with an increase in microbial respiration and microbial nitrogen but at this stage the treatments show no development of disease suppression or decreased Rhizoctonia disease patches. However it is hoped these trials will continue to be monitored so that any future developments will be detected.

Acknowledgements

Thank you to SAGIT for funding this project. Thanks to Goslings and Heddles for allowing us to have trials on their property. Thank you to Penny Day for soil testing, also Alex Watts and Jake Pecina for casual work.

Disease

Better Prediction and Management of Rhizoctonia Disease in Cereals

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[1]SARDI, Minnipa Agricultural Centre, [2]CSIRO Waite, [3]SARDI, Waite, [4]Private Consultant

Searching for answers

Location: Streaky Bay
J Williams & B Goosay
Streaky Bay Ag Bureau

Rainfall
Av. Annual: 340 mm
Av. GSR: 274 mm
2010 Total: 358 mm
2010 GSR: 294 mm

Yield
Potential: 3.7 t/ha (W), 2.8 t/ha (C), 10.8 t/ha (Pasture)
Actual: 2.3 t/ha (W), 0.9 t/ha (C)

Paddock history
2007: Barley
2006: Wheat
2005: Pasture

Soil
Highly calcareous grey loamy sand

Plot size
60 m x 1.48 m

Other factors
Mice damage meant cereal plots were resown.

Key messages

- **Inoculum can change dramatically throughout the year.**
    - Inoculum build-up continues throughout crop growth until maturity.
    - Rain post maturity of a crop causes a decline in inoculum.
    - Major rainfall events over summer can substantially reduce inoculum.
    - Long dry periods over summer can allow inoculum build up.
- **Inoculum is concentrated near the surface of field soils (top 5 cm).**
- **Cereals are the key host for rapid build-up of *Rhizoctonia solani* AG8 inoculum.**
    - Inoculum after canola and other non-cereal break crops is lower than before these crops.
    - Break crops have similar impacts on inoculum as fallow.
    - Lower inoculum levels after break crops are maintained through to the end of the following summer.
    - Crop impacts on inoculum only last for one year, e.g. one year of wheat will take low levels following canola to high and vice versa.
- **Soil microbial assessments have been strongly associated with changes in Rhizoctonia infection, especially seasonal and site differences.**
- **The importance of Rhizoctonia infection on crown roots in modern cropping systems may have been underestimated.**

Why do the trial?

Rhizoctonia continues to be an important but complex disease in the southern agricultural region, especially on upper Eyre Peninsula. This is the final year of a national project funded by GRDC to improve long term control of Rhizoctonia by increasing the understanding of the interactions between disease inoculum and natural soil suppressive activity and to improve the prediction and management of disease.

How was it done?

A trial was established at Streaky Bay in 2008. Rhizoctonia disease and inoculum levels are being compared between three different tillage systems; conventional cultivation (5 May - wide sweeps; 26 May - narrow points), strategic cultivation (26 May - narrow points), no-till and with several rotations. The trial was sown again on 7 June 2010 into reasonable moisture but mice damage resulted in the cereal plots being sprayed out and resown on 29 June. These plots were also harrowed to remove the furrows and make it harder for mice to find the grain.

Correll wheat was sown in 2010 at 70 kg/ha with DAP @ 60 kg/ha and urea @ 35 kg/ha. Cobbler canola was sown @ 5 kg/ha with MAP @ 150 kg/ha, and urea @ 70 kg/ha was broadcast shortly after germination. Herald medic was sown @ 2.5 kg/ha ha with MAP at 35 kg/ha. Both the canola and medic had excellent establishment in 2010. The trial area received 1.5 L/ha of Roundup®, 1 L/ha of Treflan® and 80 mL/ha Hammer® pre seeding; 0.9 L/ha of Lorsban® post sowing and 500 mL/ha of Astound® and 400 g/ha of Achieve® later in the season. The canola plots also received 1.5 L/ha of atrazine and 200 mL/ha of Lontrel®.

Sampling included soil characterisation, soil moisture, pathogen DNA levels, root disease infection, dry matter, microbial activity, soil microbial populations and grain yield.

What happened?

In 2010 the highest grain yield occurred after pasture despite Rhizoctonia inoculum at seeding being lower after fallow, canola and pasture. This indicates nitrogen may have been a limiting factor in 2010, rather than just the impact of disease on grain yield (Figure 1).

Crop rotation impacts on Rhizoctonia inoculum levels showed similar patterns for the 2009 and 2010 seasons. Rhizoctonia inoculum levels were lowest immediately after canola, medic pasture and fallow, and the highest following cereal.

This lowered inoculum level was found to be only a one year effect. For example, inoculum levels following wheat after rotation crops returned to original levels (Figure 1).

Tillage impacts on Rhizoctonia showed similar patterns for the 2009 and 2010 seasons, with no till and strategic cultivation having the highest levels and conventional cultivation the lowest (Figure 2).

The amount of Rhizoctonia inoculum at seeding was correlated with amount of disease in the following wheat crop although the overall seminal roots disease levels were lower in 2010 (root score average 1.7) compared to 2009 (root score average 3.0). Seminal roots may escape some of the disease by rapidly growing through warm soil early in the season, while crown roots will develop in cold soils with re-established rhizoctonia hyphal networks in place. The role of crown roots infection in modern cropping systems may be underestimated and may not result in classic bare patches early in the crop but may cause more damage later. Crown root infection was lower in 2010 compared to 2009 (Figure 3).

In 2009 disease patch incidence in crop was negatively correlated with grain yield. A yield loss of 0.25 t/ha occurred with every 10% increase in area of patch incidence (Figure 4).

Other research from this project (data not presented) has shown that soil microbial activities have been strongly associated with changes in Rhizoctonia infection, especially with seasonal and site differences.

Catabolic diversity (of the microbial population present) and suppression potential in pot assays can be used as tools to identify activity which affects disease expression, and catabolic diversity correlates well with pot suppressiveness. Fungal diversity has also been shown to be influenced by management more than bacterial diversity.

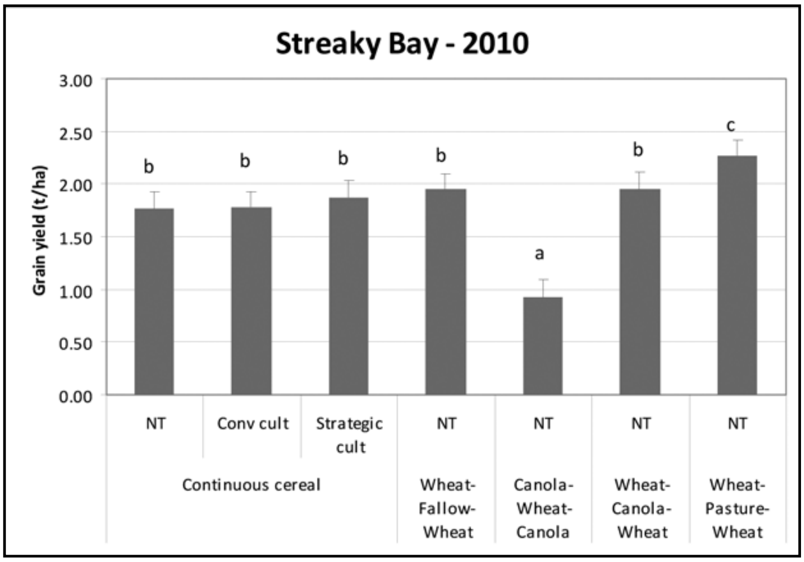


Figure 1 The effect of crop rotation and cultivation on grain yield, Streaky Bay 2010

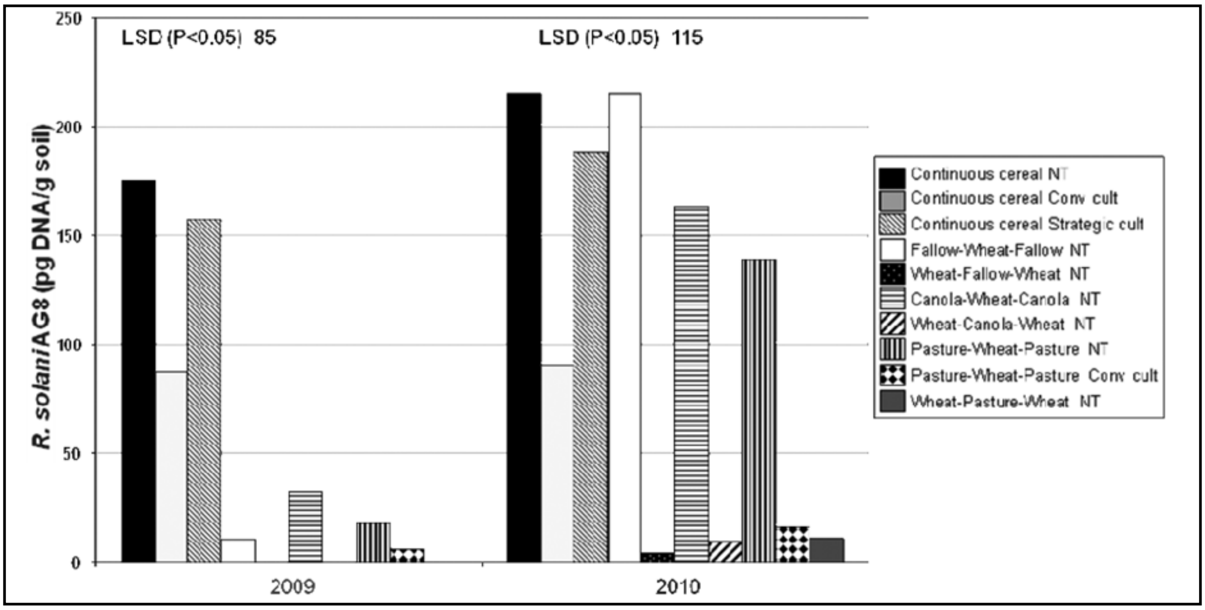


Figure 2 The effect of crop rotation on Rhizoctonia solani AG8 inoculation level in soil (pg DNA/g soil), 2009 and 2010

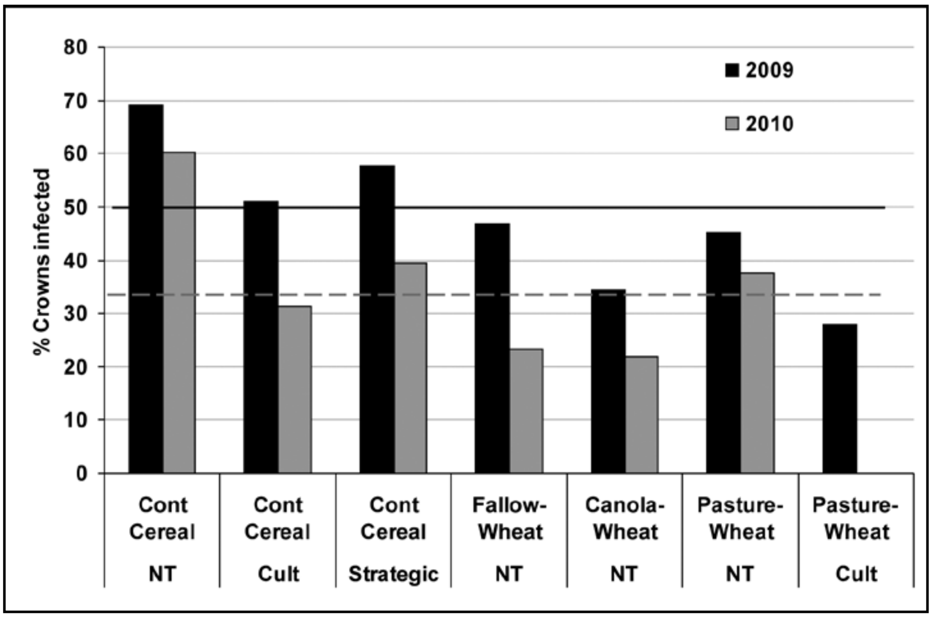


Figure 3 Incidence of Rhizoctonia crown root infection in 2009 and 2010. Average disease levels are indicated by solid (2009) and dashed (2010) lines.

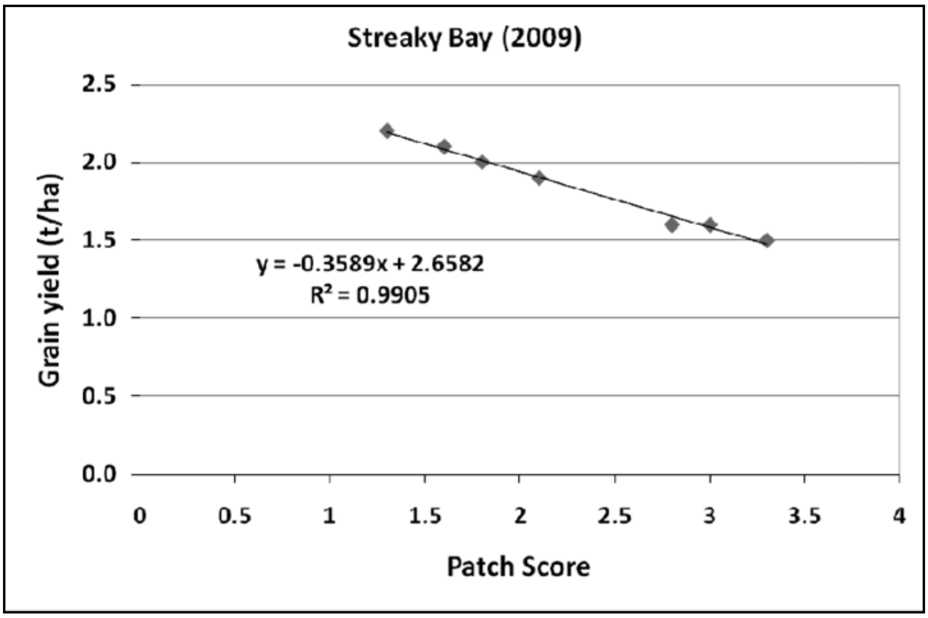


Figure 4 The impact of Rhizoctonia patch incidence on grain yield in 2009

What does this mean?

- Cereals are the key host involved in the rapid build-up of *Rhizoctonia solani* AG8 inoculum. Canola and other non-cereal break crops can lower inoculum similar to a fallow. Lower inoculum levels after break crops and fallow are maintained throughout the following summer. However these crop impacts last for one year only, e.g. one year of wheat will take low levels following canola to high and vice versa.
- Changes in the Rhizoctonia inoculum, both in-crop and during the non-crop period, are far more dynamic than previously believed. Rhizoctonia inoculum build-up continues through to maturity in a crop especially in the 0-5 cm zone. Long dry periods over summer can allow inoculum build up.
- Rain post maturity of a crop causes a decline in inoculum, and major rainfall events over summer can substantially reduce inoculum.
- The role of Rhizoctonia crown root infection in modern cropping systems may be underestimated.

Acknowledgements

Thank you to GRDC for funding this project. Thanks to the Williams and Goosay families for allowing us to have trials on their property. Our special appreciation to Nigel Wilhelm for reviewing the manuscript.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

CSIRO

SAGIT

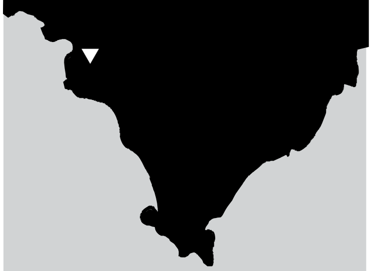
Long Term Disease Suppression Trial at Streaky Bay

Amanda Cook, Nigel Wilhelm, Wade Shepperd and Ian Richter

SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers



Location: Streaky Bay
K, D and K Williams
Streaky Bay Ag Bureau

Rainfall
Av. Annual: 298 mm
Av. GSR: 243 mm
2010 Total: 453 mm
2010 GSR: 377 mm

Yield
Potential: 5.7 t/ha (W)
Actual: 2.74 - 4.9 t/ha

Paddock History
See Table 1

Soil
Highly calcareous grey loamy sand

Plot size
60 m x 1.48 m

Other factors
Disease
Rhizoctonia

Livestock
Trial has not been grazed since established in 2004

Economic
Cost of adoption risk: No income from livestock enterprise

Key messages

- **Changing rotation and nutrition have changed the microbial population activity and diversity but not developed disease suppression after seven years.**
- **One year of wheat in 2009 resulted in high Rhizoctonia inoculum regardless of previous rotation or fertiliser histories.**
- **Take-all has increased in the continuous cereal district practice treatment to severe levels; higher nutrition treatments give the plants the ability to cope better with these increased disease levels.**
- **The high input systems have continually yielded higher than the other systems, but inputs of N have not matched production levels completely so soil reserves of mineral N are now lower in these treatments.**
- **In good seasons the high input treatments have shown that district practice performance is severely limited by inadequate nutrition.**

Why do the trial?

This long term trial was established at Streaky Bay in 2004 to determine if disease suppression against rhizoctonia is achievable in an upper EP environment on a grey highly calcareous soil using different rotations and cropping inputs. It is also being used to assess whether soil microbial populations can be influenced by rotation and fertiliser inputs in this environment.

How was it done?

This trial was established in 2004 with the fertiliser treatments and rotations listed in Table 1. In the 2010 season all treatments were sown with Hindmarsh barley at 60 kg/ha on 7 June with different fertiliser treatments. The trial received 1.5 L/ha each of Roundup® and Sprayseed® pre-seeding, and 400 g/ha Achieve® (for ryegrass and barley grass control), 300 mL/ha Lontrel® and 300 mL/ha Fastac® during the season.

Soil (0-10 cm) was collected in April for PredictaB® (Root Disease Testing) and soil mineral N and Colwell P measurements.

Plants were collected at 7 weeks to score plant roots for Rhizoctonia and measure early dry matter of shoots. Late dry matter cuts were taken before harvest, and grain yield and quality were assessed.

What happened?

This trial was sown 2 weeks after the break in the season to allow a grass weed germination and although it was within a pasture paddock it established well (regular baiting was used to prevent mice damage). All treatments were sown to wheat in 2009 and PredictaB® Rhizoctonia levels were all within the high risk category in April 2010 (Table 2).

The PredictaB® test can now also measure beneficial microbes, Trichoderma fungus (which attacks Rhizoctonia) and PEM microbes isolated from the Avon soil which are linked to disease suppression. The test detected PEM microbes in most plots, but only detected one plot with Trichoderma.

Take-all inoculum level was a medium risk in the Intensive Cereal District Practice rotation only and Take-all symptoms did develop in that treatment later in the season.

The soil mineral nitrogen levels were similar in the 0-10 cm zone, however there were differences deeper in the profile, with brassica break high input system being the lowest and the district practice being the greatest. The high input systems show an increase in soil Colwell P compared to the other fertiliser systems.

Table 1 Rotations and treatments used in the Long Term Disease Suppression trial, 2004 - 2010

Rotation	Fertiliser each season (kg/ha)	Crops/pastures and seeding rates (/ha)						
		2004	2005	2006	2007	2008	2009	2010
District practice	14 P and 16 N applied as DAP	Excalibur wheat @ 55 kg	Keel barley @ 60 kg	Angel medic @ 5 kg	Clearfield stiletto wheat @ 60 kg	Herald medic @ 5 kg	Wyalkatch-em wheat @ 60 kg	Hindmarsh barley @ 60 kg
Intensive Cereal - district practice inputs	16 P applied as MAP	Excalibur wheat @ 55 kg	Keel barley @ 60 kg	Tickit triticale @ 60 kg	Clearfield stiletto wheat @ 60 kg	Clearfield janz wheat @ 60 kg	Wyalkatch-em wheat @ 60 kg	Hindmarsh barley @ 60kg
Intensive Cereal - high inputs as fluids	20 P applied as APP, 18 N as UAN and TE (Zn, Mn, Cu)	Excalibur wheat @ 55 kg	Keel barley @ 60 kg	Tickit triticale @ 60 kg	Clearfield stiletto wheat @ 60 kg	Clearfield janz wheat @ 60 kg	Wyalkatch-em wheat @ 60 kg	Hindmarsh barley @ 60kg
Brassica break - district practice inputs	16 P applied as MAP	Rivette canola @ 5 kg	Keel barley @ 60 kg	Stubby canola @ 5 kg	Clearfield stiletto wheat @ 60 kg	44C73 Canola @ 5 kg	Wyalkatch-em wheat @ 60 kg	Hindmarsh barley @ 60kg
Brassica break - high inputs as fluids	20 P applied as APP, 18 N as UAN and TE (Zn, Mn, Cu)	Rivette canola @ 5 kg	Keel barley @ 60 kg	Stubby canola @ 5 kg	Clearfield stiletto wheat @ 60 kg	44C73 canola @ 5 kg	Wyalkatch-em wheat @ 60 kg	Hindmarsh barley @ 60 kg

Table 2 Disease and soil data collected from the Long Term Disease Suppression trial, 2010

Rotation	Rhizo RDT level (pg DNA/g soil)	Rhizo Infection of Seminal roots (0-5 score)	Rhizo Infection of Crown roots (%)	Take - all RDT level (pg DNA g/soil)	Soil NO_3 (kg N/ha)		Phoshorus Colwell (mg/kg)
					0-10 cm	10-60 cm	0-10 cm
District Practice	378	1.0	16	2	16	156	50
Intensive Cereal District Practice Inputs	474	0.7	16	45	16	96	44
Intensive Cereal High Inputs	466	1.1	14	8	16	91	98
Brassica Break District Practice Inputs	300	0.4	6	2	14	74	55
Brassica Break High Inputs	219	0.6	13	2	13	108	86
LSD (P=0.05)	*NS*	*0.5*	*NS*	*16*	*NS*	*49*	*28*

Both high input systems yielded higher than the other treatments in 2010. The high input systems also had the greatest level of screenings, along with the intensive cereal district practice treatment. This may have been due to the high level of Take-all in the intensive cereal treatment. Higher mineral nitrogen in the soil under the district practice treatment resulted in slightly higher protein levels.

Table 3 Hindmarsh barley yield and quality data collected from the Long Term Disease Suppression trial, 2010

Rotation	2010 Yield (t/ha)	Late DM (t/ha)	Protein (%)	Screenings (%)	Test wt (g/hL)
District Practice	3.0	5.3	9.5	23	350
Intensive Cereal District Practice Inputs	3.1	5.6	9.4	34	349
Intensive Cereal High Inputs	4.0	6.9	9.3	37	352
Brassica Break District Practice Inputs	3.2	5.3	9.4	18	353
Brassica Break High Inputs	3.9	6.6	9.3	28	352
LSD(P=0.05)	*0.3*	*0.9*	*0.1*	*6*	*NS*

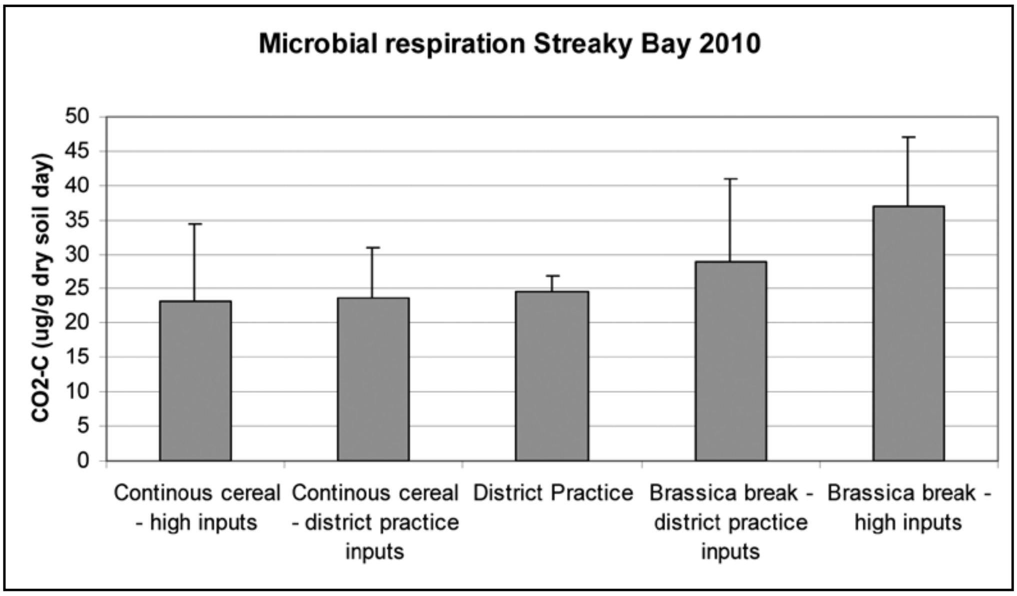


***Figure 1** MIcrobial respiration of treatments in the Long Term Disease Suppression trial, 2010*

Microbial respiration measures the amount of CO_2 produced by the microbial population under ideal laboratory conditions and reflects the size and activity of the resident population. The greatest level of activity was under systems which included brassicas in the rotation (Figure 1). In 2009 both of the high input systems had the greatest microbial respiration.

What does this mean?

The Rhizoctonia inoculum level was high in all treatments after the cereal crop last season, which follows previous research that the lower Rhizoctonia inoculum level after canola is a one year effect.

The Take-all levels were medium in the continuous cereal district practice treatment indicating the higher nutrition treatments gives the plants the ability to cope better with increased disease levels.

The high input systems have continually yielded higher than the other systems, and the higher Colwell P levels and lower mineral N levels are a reflection of increased production from these systems. Again in a good season the district practice treatment has shown potential yield is limited in these seasons by lower nutrition.

The microbial respiration this season and catabolic diversity measurements of 2009, show changing rotation and nutrition have changed the microbial population activity and diversity. The Avon soil developed disease suppression in seven years, however given the limitations with phosphorus nutrition, high calcium carbonate, low clay content and low initial organic carbon we would expect it to take longer to develop suppression. The presence of some Trichoderma is a positive sign. Hopefully this trial will continue to be monitored in the future.

Acknowledgements

Thank you to SAGIT for funding this project. Thanks to Agrichem for suppling some fluid fertiliser products used in the trial. Thanks to the Williams family for allowing us to have trials on their property. Thanks to Penny day (Uni of Adelaide & EPFS Project) for measuring microbial respiration, mineral N and Colwell P.

Cereal Variety Disease Guide 2011

Hugh Wallwork and Pamela Zwer
SARDI, Waite

Summary of 2010 season

The cool wet and humid conditions experienced across most of SA during the growing season favoured higher than normal levels of yellow leaf spot and powdery mildew in wheat and scald in barley. The net form of net blotch was much less damaging than expected and this is thought to be due to later sowing in some areas, cooler conditions and effective management of early sown crops with fungicides. Stem and leaf rust in wheat and oats became widespread after several quiet years and this poses a threat for crops in 2011 should volunteers allow carryover of infection to autumn. At the end of the season white grains were observed and caused downgrading of some wheat, particularly on the Eastern Eyre Peninsula and Upper North regions. The white grain was caused by a fungus, *Botryosphaeria zeae,* previously not recorded in south-eastern Australia. This new pathogen which is favoured by wet conditions can also infect barley and survives on wheat and barley stubbles.

Stripe rust

Stripe rust developed later than normal and was mostly well controlled with early application of fungicides. The most common strain identified was the WA "Jackie" strain (134E16A+J+) although the WA Yr17 strain (134E16A+17+) was also widespread and common. Another new strain the "Tobruk" strain was also identified from samples collected from Mambray Creek, Crystal Brook, Paskeville and Wolseley. This strain is more virulent on Tobruk triticale but is otherwise not thought to be different from the Jackie strain.

Stem rust

Stem rust was observed on volunteers at Jabuk in the Mallee and at Kapinnie on the Eyre Peninsula in autumn but wide dispersal of stem rust in spring is thought to have originated from a very early sown crop of Kite wheat at Baroota in the Mid North. Kite was released with the stem rust resistance gene Sr26 which is effective against all strains of stem rust. After 44 years of growing Kite at Baroota it appears that the Sr26 gene, which has a yield reducing effect, has been selected out of the seed rendering these particular crops of "Kite" susceptible to stem rust. Similar selection along with seed mixing has led to nearby crops of Blade, also released with Sr26, similarly susceptible to stem rust. The stem rust spread widely through the Mid North and Mallee and also to the eastern part of the Eyre Peninsula during late September and October. Cool weather would have slowed development of the epidemic especially in varieties with at least partial resistance. Many crops, mainly Yitpi, were sprayed and little crop damage was reported.

Leaf rust

Leaf rust was observed on the Eyre and Yorke Peninsulas from August onwards. Although somewhat cool, the conditions were more favourable for leaf rust than stem rust and had susceptible varieties been grown then a significant epidemic is likely to have occurred. Because almost all crops grown in SA are now at least only moderately susceptible (MS) the development of leaf rust was effectively suppressed. Growers are therefore encouraged to maintain this level of resistance and avoid adopting varieties more susceptible than Gladius and Yitpi.

Yellow leaf spot

The higher than usual levels of stubbles from 2009 and late rain in that year led to increased inoculum of yellow leaf spot in wheat stubbles and increased infection in 2010. The wet winter and spring will have also helped to increase the levels of infection and it is to be expected that even higher levels of yellow leaf spot infection will be observed in 2011. Pink blotches can be seen on many mature wheat stems where they have been exposed to high moisture levels. This is one sign of the yellow leaf spot fungus colonising stubbles. Growers should therefore take particular care to select more resistant varieties if they plan to sow wheat into wheat stubbles in 2011.

Powdery mildew

Powdery mildew developed more severely on Wyalkatchem crops on the Eyre Peninsula than previously observed. Some Gladius crops were also affected but not as severely. The late damp conditions caused severe head infection and led to widespread use of fungicides on the Lower Eyre Peninsula in particular. Given the ideal conditions for powdery mildew, the fact that barley mostly escaped infection despite large areas sown to susceptible varieties demonstrates the effectiveness of seed treatments when almost all crops are treated. Where a few crops are not treated these provide a breeding ground for the fungus and can lead to severe epidemics when the effects of seed treatments have worn off. Continuing widespread use of seed treatments will also greatly reduce the risk of fungicide resistance emerging as has happened in Europe and Western Australia.

Net form net blotch

Seedlings of early sown crops on the western and south-eastern coasts of the Eyre Peninsula were infected early with NFNB and fungicide spraying began at the tillering stage and repeated up to 3 times to keep crops protected, particularly Maritime. Less infection occurred where crops were sown later and the cool winter and spring conditions appear to have effectively suppressed the disease. Virulence on Keel and Maritime were widespread whilst virulence on Fleet, observed in one paddock in 2009, was not evident in 2010.

Leaf yellowing and death in wheat and oats

"Frame yellows" which is not a disease but is often confused for one was particularly noticeable in many crops of Yitpi, Correll and Axe during August. The yellows symptoms are more prevalent in wet winters and the cause remains elusive. In October a similar but different yellows condition became apparent in Gladius crops. Again no cause is known.

Another different but widespread yellowing and death of wheat leaves occurred in the Keith-Bordertown region and into Victoria during October. The symptoms were observed in all wheat varieties and were similar to barley yellow dwarf virus (BYDV) but this is not thought to be the cause owing to a lack of aphids and negative antibody tests.

Oats

Stem and leaf rust of oats became common and widespread after a few years of low recordings. A strain of oat stem rust not previously observed in South Australia and virulent on a resistance gene *Pga* caused severe infection and significant damage in many Mitika oat crops in the South-East and in western Victoria. Mitika and Yallara are now rated as S to stem rust but will be more resistant in other areas of SA until this strain reaches these areas. Glider and Tungoo are also thought to carry *Pga* and so may also be more susceptible where this strain occurs although no data on the resistance of these varieties to the new strain is available.

Red leather leaf, a fungal disease caused by *Spermospora avenae*, has become more common in recent years, particularly in the South-East, and was favoured by the wet spring in 2010. General leaf death was observed in many crops in the South-East and although red leather leaf and BYDV may have had a role, other unknown causes are also likely to have been involved.

Explanation for Resistance Classification

- R The disease will not multiply or cause any damage on this variety. This rating is only used where the variety also has seedling resistance.
- MR The disease may be visible and multiply but no significant economic losses will occur. This rating signifies strong adult plant resistance.
- MS The disease may cause damage but this is unlikely to be more than around 15% except in very severe situations.
- S The disease can be severe on this variety and losses of 15-50% can occur.
- VS Where a disease is a problem this variety should not be grown. Losses greater than 50% are possible and the variety may create significant problems to other growers.

This classification based on yield loss is only a general guide and is less applicable for the minor diseases such as common root rot, or for the leaf diseases in lower rainfall areas, where losses are rarely severe.

Other information

This article supplements other information available including the SARDI Sowing Guide 2011 and Crop Watch newsletters. Cereal Leaf and Stem Diseases and Cereal Root and Crown Diseases books (2000 editions) are also available from Ground Cover Direct or from Hugh Wallwork in SARDI.

Disease identification

A diagnostic service is available to farmers and industry for diseased plant specimens.

Samples of all leaf and aerial plant parts should be kept free of moisture and wrapped in paper not a plastic bag. Roots should be dug up carefully, preserving as much of the root system as possible and preferably kept damp. Samples should be sent to the following address:

SARDI Diagnostic Centre
Plant Research Centre
Hartley Grove
Urrbrae SA 5064

Further information contact:
hugh.wallwork@sa.gov.au

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Wheat	Rust			CCN		*Septoria tritici* blotch	Yellow leaf spot	Powdery mildew	Root lesion nematodes			Common root rot	Flag smut	Black point	Quality in SA
	Stem	Stripe #	Leaf	Resistance	Tolerance				*P. neglectus* Resistance	*P. thornei* Resistance	Crown rot				
AGT Katana	MS	MR-MS	MS	MS	-	MS	MS	MR-MS	S	S	S	MS	S	MS-S	Speciality
Axe	MS	R-MR	MR	S	-	S-VS	S	MR	MS	MS	S	MS-S	S	MS-S	AH
Barham	MR	#MS-S	MR-MS	MS	-	MS-S	MS-S	S	MR	MS	S	MS-S	MR-MS	MS	Soft
Bolac	MR	R-MR	MS	S	-	MS	MS-S	-	-	-	S	-	R-MR	MR-MS	AH
Bowie	S	#S	MS	MR-MS	MT	MS	S	S-VS	MR	MS	S	S	-	MR-MS	Soft
Brennan	MS	R-MR	R-MR	-	-	-	-	-	-	-	-	-	-	MS-S	Feed
Catalina	R-MR	MS	R-MR	R	-	MS	MS-S	MS-S	MS	MS	S	MR-MS	R-MR	S	AH
Chara	MR-MS	MS-S	MR-MS	R	MI	MS	MS-S	-	MS-S	MR-MS	S	S	MR	MS	AH
Correll	MR-MS	MR-MS	MS-S	MR	-	MR-MS	S-VS	MR-MS	S	MS	S	MS	R	MR-MS	AH
Derrimut	MR	#MS-S^	R	R	-	MS-S	S	MS	S	MS-S	S	S	R	S	AH
Espada	R-MR	#MR-MS	R	MS	-	S	MS	MS-S	MS	MS-S	S	MS-S	MR-MS	MS-S	APW
Estoc	MR	MR-MS	MR-MS	MR	-	S	S	MS	S-VS	MS	S	MS	MR-MS	MR-MS	APW
Frame	MS	MS	MS-S	MR	MT	MR-MS	S-VS	MS	MS-S	S	S	S	MR	MS	APW
Gladius	MR^	#MR-MS	MS	MS	-	MS-S	MS	S	MS-S	MS-S	S	MS	R-MR	MR	AH
Guardian	R-MR	MS	MS	R	-	MS-S	S	MR-MS	MS-S	MS	S	MS	S	S	APW
CLF Janz	R-MR	MS-S	MR-MS	S	I	MR-MS	MS-S	MS	MS-S	S	S	MS-S	R	S	AH
Kukri	MR-MS	MR-MS^	MS x	S	I	MR-MS	MS	-	S	MS	MS	S	MS	MS	AH
Lincoln	MR	R	MR	S	-	S	MS	-	S	S	S	MS	R-MR	-	AH
Mace	MR-MS^	#S-VS	R	MR-MS	-	MR-MS	MR-MS	MS-S	MR-MS	-	S	MS-S	S	MS	AH
Mackellar	MR	R-MR	S	-	-	-	-	-	-	-	-	-	-	MS-S	Red Feed
Magenta	R-MR	MS	MR-MS	MS-S	-	MR-MS	MR-MS	MR-MS	MS	S	S	S-VS	S-VS	S	ASW
Peake	MR-MS^	MR-MS^	R^	R	-	S	S	MS	S	MS	S	S	MR-MS	MS-S	AH
Preston	S-VS	R	R	S	-	MR	MS-S	-	S	MR-MS	S	MS	S-VS	MR-MS	APW (prelim)
Pugsley	S	#S^	MS	MS	MI	MS	S	MS-S	S	-	S	MS	MR	MS	APW
SQP Revenue	R	R	R	-	-	MR	MS	R	MS	MS	-	S-VS	S	MS	Feed
Scout	MR	MS	R	R	-	MS	S-VS	MS-S	MS	MS-S	S	-	R-MR	S	APW
Sentinel	R-MR	R-MR	R	S	-	MS-S	MR-MS	R	S	MS	MS-S	S	MS-S	MR-MS	ASW
Wyalkatchem	MS	S ε	R	S	MI	MR	MR-MS	S-VS	MR-MS	-	S	S	S-VS	MS	APW
Yitpi	S	MR-MS	MS	MR	MT	MR-MS	S-VS	MR-MS	MS-S	-	S	MS	MR	MS	AH
RAC1669R	R-MS	MR-MS	-	MR	-	MS-S	MS-S	MS-S	-	-	S	-	-	-	-
RAC1671R	R-MR	MS	-	MS	-	MS-S	MS-S	S	-	-	S	-	-	-	-
RAC1683	R-MR	MR-MS	MS-S	MS	-	S	S	S	-	-	S	-	-	-	-

- The wheat stripe rust ratings are for the WA Yr17. Varieties with a # have the Yr17 (VPM) seedling resistance and so will be resistant to the WA Jackie strain

^ - Some susceptible plants in mix   ε - Wyalkatchem shows stronger stripe rust resistance at higher temperatures

x - kukri and treat have a resistance gene (Lr13) which is not effective to a leaf rust (Mackellar) strain found in NSW

Durum	Rust			CCN		*Septoria tritici* blotch	Yellow leaf spot	Powdery mildew	Root lesion nematodes *P. neglectus*	Root lesion nematodes *P. thornei*	Crown rot	Common root rot	Flag smut	Black point ‡	Quality in SA
	Stem	Strips #	Leaf	Resistance	Tolerance				Resistance	Resistance					
Caparoi	R-MR	MR	R	-	-	R-MR	MR	-	-	-	VS	MS	R	S	Durum
Hyperno	R	MR	R	MS	-	R-MR	MS-S	-	MR-MS	-	VS	MR-MS	R	MS-S	Durum
Kalka	R-MR	MR	R-MR	MS	MT	MR-MS	MR	-	MR-MS	R	VS	MS	R-MR	S	Durum
Saintly	R-MR	MR	MR-MS	MS	-	MR-MS	MR	-	MR-MS	-	VS	MS	R	MS-S	Durum
Tamaroi	R-MR	MR	R-MR	MS	-	S	MR	-	MR-MS	R	VS	MS	R	MS	Durum
Tjilkuri	MR-MS	MR	MR	-	-	MR-MS	MS	-	-	-	S-VS	MS	R	S	Durum

Triticale															
Bogong	R	MS	R	-	-	R	-	-	-	-	-	-	-	-	Triticale
Chopper	R	MR	R	R	MR	R	-	-	-	-	-	-	-	-	Triticale
Hawkeye	R-MR	MR ^	R	R	-	R	-	-	-	-	-	-	-	-	Triticale
Jaywick	R-MR	MR ^	R	R	-	R	-	-	-	-	-	-	-	-	Triticale
Rufus	R-MR	MR-MS	R	R	T	R	-	-	R-MR	R-MR	-	-	-	-	Triticale
Tahara	R-MR	MS	R	R	T	R	R	-	R-MR	R	S	MS	R	-	Triticale
Treat	R	MR	MRx	MS	T	R	R	-	MR-MS	-	S	MS	R	-	Triticale

The stripe rust ratings for the tritcales is for the WA 'Jackie' strain common in SA in 2009 and 2010

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible
T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, - = uncertain

‡ Tolerance levels are lower for durum receivals.
Black point is not a disease but a response to certain humid conditions.

Barley	Leaf Rust*	Net form net blotch	Spot form net blotch	Scald	CCN Resistance	Powdery mildew	Barley grass stripe rust	Covered smut	Common root rot	Root lesion nematodes *P. neglectus*	Root lesion nematodes *P. thornei*	Black point
Barque	MS-S-VS	MS-S	R-MR	S-VS	R	MR	MR	MS-S	S	R-MR	MR	S
Buloke	MS-S-VS	MR	MS	MS	S	MR	R	MR	MS	-	-	MS-S
Commander	MR-MS-S	MS	MS	S	R	MR	R	R	S	-	-	S-VS
Finniss	MR-MR-MS	MS	MS-S	R#	R	VS	-	S-VS	S-VS	-	-	S
Flagship	MR-MS-S-VS	MR	MR-MS	MS	R	MR-MS	MR	MR-MS	S	MS	MR-MS	S
Fleet	MR-MS-S	MR	R-MR	MR-MS	R	MR-MS	MR	MR	MS-S	-	-	MS-S
Gairdner	MS-S	MR-MS	S	R#	S	MR	R	-	MS-S	MR	MR-MS	MR-MS
Henley	R	MR	S	S-VS	-	-	-	MR	MS	-	-	MS-S
Hindmarsh	MS-S	MR	S	R#	R	MS	R	MR-MS	S	-	-	-
Keel	VS	MS	R-MR	MS	R	MR-MS	MS	R	S	MR	MR	S-VS
Maritime	MS-S	VS	MR-MS	MS-S	R	S	S	MS	S	MR	-	S
Oxford	R	MR	MS-S	MS#	S	R	-	MR-MS	-	-	-	MR
Schooner	S-VS	MR	MS	MS-S	S	S	R	MR	S	MR-MS	R	MS-S
Scope	MS-S-VS	MR	MS	MS-S	S	MR	R	MR-MS	MS	-	-	S
Sloop SA	S-VS	MR	S-VS	S	R	S	R	R	S	MS	R	MS-S
Vlamingh	MS-S-VS	MR	MS	MR-MS	S	VS	-	R	S	-	-	S
Yarra	R	MS	MS	S-VS	R	S	R	MS	S-VS	-	-	S-VS
WI4262	VS	MR	MR	R#	R	-	MR	MS	S	-	-	MS-S

* Due to multiple strains of leaf rust, the table provides a range of reactions that may be observed. Different ratings are separated by a -
# These varieties may be more susceptible in some regions with different strains.
R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible
T = tolerant, - = uncertain

Oats	Rust		CCN		Stem nematode		Bacterial blight	Red leather leaf	BYDV	*Septoria avenae*	*P. neglectus* Resistance
	Stem	Leaf	Resistance	Tolerance	Resistance	Tolerance					
Brusher	MS-S	MS	R	MI	MS	I	MR-MS	MS	MS	MS	MR-MS
Echidna	S	S	S	I	MS	MT	S	MS	MS	S	MR
Euro	VS	S	R	I	S	I	MS	MS	S	MS	MR
Glider	φ MR-MS	R	MS	I	R	T	R	R	S-MR#	MR	-
Kangaroo	MR-MS	MS	R	MI	S	MI	MR-MS	MR-MS	S-MR#	MR-MS	-
Marloo	S	S	R	MT	MS	MI	S	VS	MR-MS	S	-
Mitika	φ MR-S	MR-MS	VS	I	S	I	MR	S	MS-S	S	-
Mulgara	MS	MR	R	MT	R	MT	MR	MS	MS	MS	-
Numbat	MS	R	S	I	S	I	S	MS	S	MR	MR
Potoroo	S	S	R	T	S	MI	S	VS	MS	S	MR
Possum	MS-S	MS	VS	I	S	I	S	S	S	MS	MR
Quoll	MS-S	MR	S	I	R	MT	MS	MS	MS	MR	MR-MS
Swan	VS	S	MR	I	S	I	S	S	MS	MS	MR-MS
Tammar	MR	MR	MR	MT	R	T	MR	R	MS	MR	-
Tungoo	φ MS	R	R	MT	R	T	MR	R	MR-MS	MR	-
Wallaroo	S	S	R	MT	MS	MI	S	MS	MS	S	MR
Wintaroo	S	S	R	MT	R	MT	MR-MS	MR-MS	MR-MS	MR-MS	MR-MS
Yallara	φ MS-S	R	R	I	S	I	MR-MS	MS	MS	MS	-

Key to symbols used
φ – See text on oats
# These varieties may be more susceptible in some regions with different strains
R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible
T = tolerant, I - Intolerant, MI - moderately intolerant, - = uncertain

Section 4

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Farming Systems

Eyre Peninsula Farming Systems 3 Project – Responsive Farming Systems

A five year (2008-2013) GRDC funded project 'Eyre Peninsula Farming Systems 3 – Responsive Farming Systems' is aiming to assist farmers to understand what their land is capable of producing under a range of conditions and how to tailor inputs to get the most profitable outcomes.

On upper Eyre Peninsula (EP) farmers have always had to cope with a wide range of seasons, including runs of several years with below average growing season rainfall. One of the main factors affecting farm viability and profitability in these difficult seasons has been risk created by a mismatch of inputs and production. Looking forward, farmers will continue to face several challenges including a predicted increase in season variability, higher input costs, managing grain price volatility, and changing agronomic factors. Increasingly farmers need to understand exactly what their land is capable of producing under a range of conditions and how to tailor inputs or alter management to run low risk and flexible systems – 'responsive farming systems'.

Three **"focus sites"** have been established across upper EP on 3 major soil types;

- Minnipa (Minnipa Agricultural Centre), red sandy loam
- Mudamuckla (Mudabie), grey calcareous loamy sand
- Wharminda, siliceous sand over sodic clay

Collective groups of farmers, researchers and consultants set goals and make decisions about the management of these sites. Field days are then held to showcase the innovative ideas and hold discussions with farmers.

At these sites we are combining the latest soil and plant science with new machinery technology and ideas from local discussion groups. The sites have been EM38 mapped, yield mapped and variable rate technology is used for sowing and fertiliser applications. We are ground truthing modelling tools APSIM and Yield Prophet® to see if these programs will be a benefit in making better farming decisions as the year progresses.

The following series of articles are from trials undertaken in 2010 on the three focus sites:

- Responsive Farming Using Variable Rate Sowing at Minnipa
- Responsive Farming for Soil Type at Mudamuckla
- Responsive Farming for Soil Type at Wharminda
- Farming to Soil Potential on the Upper Eyre Peninsula: How Accurate was In-season Yield Prediction in 2010?
- Crop Production Using Replacement P Rates
- Measuring the Effect of Residual P
- Nitrogen Management on Upper Eyre Peninsula
- Wheat Variety Response to P on Grey Calcareous Soil

GRDC Grains Research & Development Corporation
THE UNIVERSITY OF ADELAIDE AUSTRALIA
CSIRO
EPARF Eyre Peninsula Agricultural Research Foundation Inc.
SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Responsive Farming Using Variable Rate Sowing at Minnipa

Cathy Paterson, Roy Latta, Nigel Wilhelm, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 4.7 t/ha (W)
Actual: 4.1 t/ha (medium zone - standard input)
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Sandy loam to sandy clay loam
Plot size
Paddock trial, sowing widths 9 m
Yield Limiting Factors
Rhizoctonia
Mice damage
Yellow leaf spot
Environmental Impacts
Soil Health
Soil Nutrients: Needs to be monitored
Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, NO_2, methane): Standard
Social/Practice
Time (hrs): Standard
Clash with other farming operations: Standard
Labour requirements: Standard
Economic
Infrastructure/operating inputs: VRT technology
Cost of adoption risk:
Low if improving returns

Key message

- **After two good seasons a variable rate approach is as profitable as a low input blanket approach and more profitable than a standard blanket approach.**

Why do the trial?

It is important that low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. Paddock North 1 (N1) at Minnipa Agricultural Centre, one of three focus paddocks in the current farming systems project, is being used to evaluate variable rate technology using low, standard and high seed and fertiliser inputs on 3 soil types of poor, medium and good production potential. Yield Prophet® decision support simulations are being used to make decisions relating to in-crop fertiliser inputs. This also provides a comparative measure between physical crop measurements (water use, grain yield etc.) and model simulations to help validate the model outputs for our environment.

Variable rate technology (VRT) offers farmers the ability to adjust sowing and fertiliser rates during the seeding process, allowing the opportunity to change inputs according to the production capability of different paddock zones or soil types. One basis for developing the variable rate strategy has been previous research investigating crop canopy size effects on crop growth and yield on different soil types. For example this research has shown that in a poor season, like 2006, grain yield increased with smaller canopies on heavy/shallow soil types (EPFS Summary 2006 p 91-92). This means that a lower seeding rate, with less fertiliser was more profitable on the shallow constrained soils in a paddock as opposed to a paddock wide blanket fertiliser and seeding rate.

To further evaluate variable rate sowing as a tool to improve profitability in low rainfall upper EP farming systems, this broad acre trial began in 2008 and has continued through to 2010.

How was it done?

Paddock N1, at Minnipa Agricultural Centre, was segregated into 3 zones in 2008 using a combination of yield, EM38 and elevation maps to produce 3 distinct production zones (good, medium and poor). Soil chemical analysis was carried out on the soils within these zones to document the extent of any chemical constraints. In 2010 seed and fertiliser rates for each zone were maintained at similar levels to 2009 (Table 1). Low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder row strips across the paddock with Wyalkatchem wheat on 4 June, in the same positions as those treatments in 2008. Due to the high mice numbers the paddock was prickle chained in an attempt to reduce mice collecting seed. Foliar N (UAN@10 units of N/ha) was applied on 17 August at growth stage 31 to the high input treatment. This was in line with Yield Prophet® growth stage 31 outputs as to the N requirement to achieve optimum grain yield. The paddock received standard weed management across all zones.

Table 1 Sowing and mid season seed and fertiliser rates in paddock N1 at Minnipa, 2010

Paddock Zone	Paddock Area (%)	Input strategy	Seed Rate (kg/ha)	DAP (kg/ha)	Foliar N (kg/ha of N)
Good	55	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0
Medium	20	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0
Poor	25	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0

Measurements collected were soil chemical analysis, plant establishment, early tillering, anthesis and maturity dry matter, grain yield and quality and soil water content at seeding and harvest. Calculations of gross margins and the YieldProphet® projections are also presented.

What happened?

Pre-seeding Colwell P levels tended to be lower in the good zone as compared to the other zones. Within each zone P levels were similar irrespective of the 2008 and 2009 P treatments (10, 5 and nil kg) P rates applied to the same sites in 2008 and 2009. There was more total mineral N measured in the medium zone than the good or poor zones (Table 2). The 2008 analysis of the depth to chemical plant root constraints is shown in Table 2.

The anticipated plant density based on seeding rate was 120 plants/m^2 for the low input and 150 for the standard and high input treatments. However, due to mice damage and the prickle chaining to protect sown seed from mice there was only 60-70% of the anticipated plant density established (Table 3). The low input treatment had lower plant numbers in all zones than the high and standard treatments, as a result of the lower seeding rate.

The lower seeding rate reduced the biomass production of the low input system. The medium zone with standard inputs produced more biomass than the good zone at all sampling times. The poor zone produced less than the medium zone at the anthesis and maturity sampling times. This biomass production reflected the higher nitrogen figures measured in the medium zone.

Soil water contents measured at sowing showed the medium and poor zones had greater volumetric soil water content in the 0-40 cm soil profile (more than 20 mm compared to 13 mm in the good zone). The anthesis biomass was similar for the 3 high input treatments, but the poor zone had less biomass at harvest. This may be due to the shallow soil profile and possible soil water deficit in late September, through October (late dough stage). However 55 mm of rain in late October masked any measurable difference in plant available water between treatments.

Table 2 Soil characterisations for zones in paddock N1, Minnipa 2010

Zone	Colwell P 0-10 cm (mg/kg)			Total Mineral N 0-60 cm (kg/ha)			*Depth to soil $CaCO_3$ > 25% (cm)	* Depth to B > 15 mg/kg (cm)	* Depth to Cl > 1000 mg/kg (cm)
	High	Standard	Low	High	Standard	Low			
Good	32	34	29	124	117	108	60	100	80
Medium	38	37	37	215	220	186	40	60	60
Poor	39	38	37	93	88	65	20	80	40

** 2008 Data*

Table 3 Plant establishment, biomass at tillering, anthesis and maturity from the 3 paddock zones for each 2010 input strategy

Zones	Inputs	Establishment (plants/m²)	Dry matter (t/ha)		
			Early Tillering	Anthesis	Maturity
Good	High	106	0.7	6.7	7.1
	Standard	109	0.7	5.5	6.9
	Low	74	0.4	4.3	6.7
Medium	High	129	1.1	7.2	7.5
	Standard	106	1.0	6.5	7.8
	Low	76	0.6	4.4	6.2
Poor	High	109	1.1	6.8	5.9
	Standard	124	1.1	5.3	5.7
	Low	81	0.5	4.3	5.9
LSD (P=0.05)		*11*	*0.1*	*0.8*	*0.5*
Good		97	0.6	5.5	6.9
Medium		104	0.9	6.0	7.1
Poor		105	0.9	5.4	5.7
LSD (P=0.05)		*NS*	*0.1*	*0.6*	*0.4*
	High	115	1.0	6.8	6.8
	Standard	113	1.0	5.8	6.8
	Low	77	0.5	4.3	6.3
LSD (P=0.05)		*7*	*0.1*	*0.4*	*0.4*

Farming Systems

Table 4 Grain yield, harvest index, grain quality and gross income from the 3 paddock zones with low, standard and high inputs

Zones	Inputs	Grain Yield (t/ha)	Protein (%)	Test Wt (kg/hL)	Gross Margin[1] ($/ha)
Good	High	3.9	10.1	74.9	959
	Standard	3.7	10.2	74.7	939
	Low	3.3	10.0	74.1	892
Medium	High	3.9	11.3	72.2	889
	Standard	4.1	10.8	73.3	973
	Low	3.8	10.5	74.3	999
Poor	High	2.9	10.7	72.3	639
	Standard	2.7	10.0	72.5	623
	Low	2.7	10.5	72.9	656
LSD (P=0.05)		*0.8*	*0.7*	*NS*	
Good		3.7	10.1	74.9	
Medium		3.9	10.8	73.3	
Poor		2.7	10.4	72.6	
LSD (P=0.05)		*0.8*	*0.5*	*NS*	
	High	3.6	10.7	73.1	
	Standard	3.5	10.5	73.5	
	Low	3.2	10.2	74.2	
LSD (P=0.05)		*0.2*	*0.4*	*NS*	

[1] Gross margin is yield x price less seed and fertiliser costs delivered to cash pool on 2 December 2010, Pt Lincoln. $350/t used for seed value

The poor zone produced lower grain yields than the good and medium zones irrespective of treatment (Table 4). Grain protein levels from the medium zone were similar or higher than from the good and poor zones. The test weights of the good zone were all above 74 kg/hL, but lower for the poor and medium zones. Screenings were less than 2% irrespective of treatments. Gross margins were obviously correlated with yield, but with adjustment for test weights less than 74 kg/hL.

Yield Prophet® reports were run for the 3 soil zones on 2 dates over the growing season, 4 August (early tillering) and 27 September (anthesis) (Table 5). The estimated biomass was similar or higher than the actual biomass produced and the predicted grain yield was similar or lower (10% probability) than the harvested yields for all zones.

The treatments applied to VRT combinations used for gross margin analysis are outlined in Table 6. The 'Go for gold!' aim is to increase overall profitability by reducing inputs on areas with poorer yield potential and increasing on high potential areas. The VRT 'Hold the gold!' treatment keeps inputs at standard (good zones) and low (medium and poor zones), an approach to reduce risk. These two VRT combinations were then compared to the gross income of a standard blanket treatment if the different treatments had been applied to the whole paddock (Table 6) taking into consideration the percentage of each zone within the paddock as outlined in Table 1.

Both VRT approaches were more profitable in 2010 than if any of the input strategies had been applied across the whole paddock. After 2 consecutive good growing seasons the low input approach maintains a similar profit level to the variable rate treatments (Figure 1).

Table 5 Yield Prophet® biomass and grain yield projections (from 90 – 10% probability) at tillering and anthesis, rainfall decile ranking and measured biomass and grain yields on the 3 soil zones in 2010

Date	Zone	Biomass projections (t/ha)	Measured biomass (t/ha)	Grain yield projections (t/ha)	Measured grain yield (t/ha)	Decile ranking
4 August (tillering)	Good	1.4	0.6	0.5 - 3.5	3.7	5
	Medium	1.4	0.9	0.5 - 3.5	3.7	
	Poor	1.2	0.9	0.5 - 2.2	2.7	
27 September (anthesis)	Good	6.0	5.5	3.0 - 3.8	3.7	8
	Medium	7.4	6.0	2.5 - 3.8	3.9	
	Poor	5.0	5.4	1.6 - 2.1	2.7	

Table 6 Treatments applied to VRT gross income analysis for N1, Minnipa 2010

Paddock Zone	VRT - Go for Gold!	VRT - Hold for gold!	High input blanket approach	Standard input blanket approach	Low input blanket approach
Good	High	Standard	High	Standard	Low
Medium	Standard	Low	High	Standard	Low
Poor	Low	Low	High	Standard	Low
2010 Gross margin ($/ha)	903	885	864	865	877
Accumulated gross income (compared to standard input treatment) ($/61ha paddock)	2365	2405	-3991	0	2440

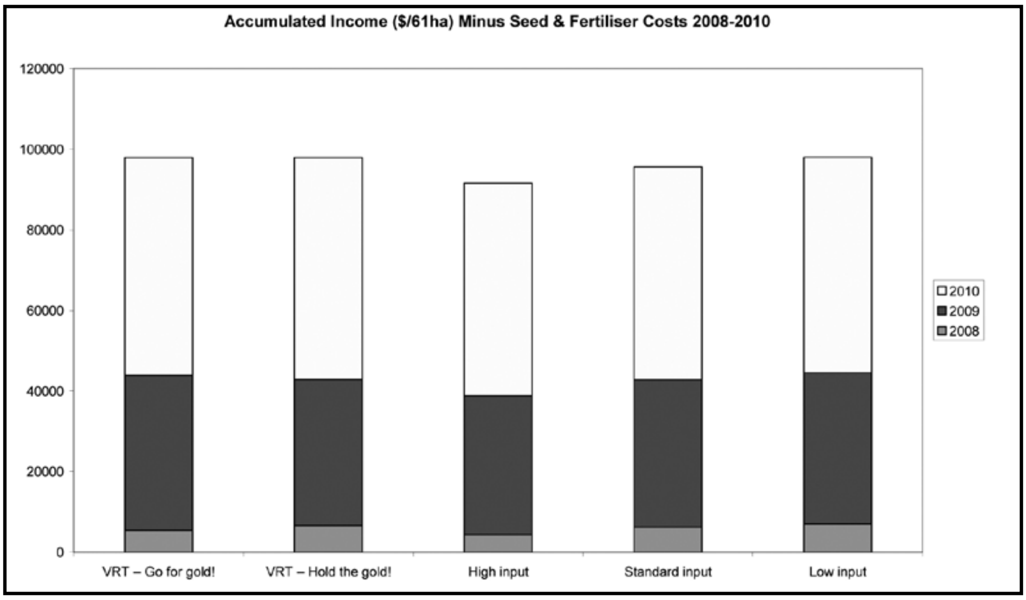

Figure 1 Comparison of accumulated income minus seed and fertiliser costs of different sowing regime vs. VRT rates across the whole 61 ha paddock.

What does this mean?

In 2010, the second consecutive above average growing seasons, the VRT 'Go for gold!' approach was the most profitable. The previous 2 years a low input approach was the most profitable due to low yields in 2008 (EPFS 2008 pp 77-80), in 2009 there were high levels of available soil nutrients due to the run of 3 poor seasons (EPFS 2009 pp 87-90) and thus only low levels of nutrition required to obtain yields. The conservative VRT approach -'Hold the gold!' is as profitable as the 'Go for gold!' approach, but carries a much lower level of risk due to the reduced input costs.

The Yield Prophet® projections under-predicted the grain yields in all zones and gave too wide a range of yields to be of value in terms of crop response to additional N early in the season. As the season progressed the range of yields narrowed, and may have been of some use if a decision about the application of a rust spray later in the season was required.

The impact of these treatments will be monitored in this paddock for at least the next 2 years to track the long term impact of changing inputs, how the different zones respond to different treatments in different seasons, and how the overall economics stack up.

Acknowledgements

Special thanks to Brett McEvoy, Mark Klante and Trent Brace for their assistance sowing and managing the trial. Also thanks to Leigh Davis for his help at harvest and to Jake Pecina for his technical assistance with the trial.

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SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT

Responsive Farming for Soil Type at Mudamuckla

Cathy Paterson, Roy Latta, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location: Mudamuckla
Muddy/Nunji/Wirrulla Ag Bureau

Rainfall
Av. Annual: 291 mm
Av. GSR: 219 mm
2010 Total: 347 mm
2010 GSR: 275 mm

Yield
Potential: 2.5 t/ha (C)
Actual: 1.1 t/ha (C - Medium Zone 8 kg/ha P)

Paddock History
2009: Wheat
2008: Wheat
2007: Self sown barley

Soil test
Outlined in article

Diseases
Rhizoctonia

Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, NO_2, methane): Standard

Social/Practice
Time (hrs): Standard
Clash with other farming operations: Standard
Labour requirements: Standard

Economic
Infrastructure/operating inputs: VRT technology
Cost of adoption risk: Low if improving returns

Key messages

- **4 kg/ha of P as a blanket application increased grain yields and gross margins over nil P in all 3 soil zones, however applying a variable rate to the medium soil zone of 8 kg P/ha improved gross margins over the 4 kg/ha rate.**

Why do the trial?

It is important that our low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. At Mudamuckla, one of three focus paddocks in the current farming systems project, the emphasis is on managing risk through tailoring inputs to the different production zones potential by using variable rate technology. Yield Prophet® is also being evaluated as a decision making tool by matching nutrition to plant available water with modelling of climatic conditions.

Changing inputs according to the production capability of different paddock zones or soil types may provide an opportunity to improve gross margins for the whole paddock.

How was it done?

Paddock 8 at Mudamuckla was segregated into zones of good, medium and poor production zones in 2009 using 5 years of yield maps and an elevation map (EPFS 2009 pp 97-103).

The paddock was sown to canola after the opening rain on 26 May as a break crop to control grassy weeds. Fertiliser application strips were applied at 0, 4 and 8 kg P/ha (as phosphoric acid) over 4 permanent sampling points in each of the good, medium and poor zones identified in 2009.

Incorrect adjustment of the seed roller covers for small seeds resulted in the strips having canola sown on one half only of each machine pass at double the intended seeding rate. The result was bands of mostly canola and bands of volunteer medic and wild turnip. Targa® was used to control the grasses across the paddock, however no broad leaf weed control was attempted to protect the volunteer medic and maintain groundcover.

All crop measurements were taken in strips of 43C80 canola sown at 3 kg/ha (double the planned rate of 1.5 kg/ha), no nitrogen was applied. Measurements collected included soil chemical analysis, plant establishment, dry matter at anthesis, soil water measurements (sowing and harvest) and grain yield.

What happened?

Colwell P soil measurements were high and had increased in all zones from 2009. The high total mineral N also showed an increase from 2009, these levels are due to a history of good medic based pasture and fertiliser applications exceeding production requirements. *Rhizoctonia solani* AG8 inoculum levels constituted a high infection risk on the good zone at seeding, a medium to high risk on the medium zone and a low risk on the poor zone. From soil analysis done at harvest disease risk levels had increased in the medium and poor zones. The poor zone, which represents 15% of the paddock, has toxic levels of boron at 40 cm and chloride at a depth of 20 cm which will restrict productivity, except in wet years when frequent rainfall events may leach some of the hostile elements deeper into the soil profile.

The medium and good zones do not have constraints that will severely restrict root growth until 70 cm (EPFS 2009 pp 97-104), these zones represent 45% and 40% of the paddock respectively.

There were less plants established on the good zone compared to the medium and poor zones. There were generally less canola plants established, less biomass at anthesis and lower grain yields with no applied P. Water use efficiency variations between treatments of less than 1 to up to 7 kg/ha/mm of available water (160 mm) was much less than a potential 12 – 14 kg/ha/mm given the plant available water. Gross margins were negative at nil P on all soil zones.

Yield Prophet® reports were run for the 3 soil zones on 4 dates over the growing season, 5 August, 24 August (poor and good zone only), 27 September and 27 October (Table 3). The narrow range of yields between projections with available N and N unlimited indicate that N is not a yield limiting factor. In this paddock there was no indication of a nitrogen deficiency in the yield projections and plant available water was in the positive until 27 October on the medium zone, which was rectified with 48 mm over the period 29 - 31 October.

The VRT combinations are the same as those applied to the Minnipa focus paddock and are outlined in Table 4. These VRT combinations were then compared to the potential gross margins if the different input rates had been applied to the whole paddock (Table 5) taking into account the percentage that the different production zones represent. A high input blanket approach gave the best gross margin in 2010, with a low input and the 'Hold the Gold!' approach resulting in a significantly lower gross margin than the medium input blanket approach.

Farming Systems

Table 1 Colwell P, total mineral N and Rhizoctonia infection risk measured pre-seeding and post harvest on the 3 (good, medium and poor) zones at the Mudamuckla focus paddock in 2010

	Colwell P (mg/kg) 0-10 cm		**Total Mineral N (kg/ha) 0-60 cm**		*Rhizoctonia solani* **AG8**	
	2009	**2010**	**2009**	**2010**	**pre-seeding**	**post harvest**
Good	38.5	43	142	168	High	High
Medium	42.7	44	158	273	Medium	High
Poor	43.2	50	231	272	Low	Medium-Low

Table 2 Plant establishment, biomass at tillering, anthesis and maturity and harvest index from the 3 paddock zones

Zone	**P applied (kg/P/ha)**	**Establishment (plants/m²)**	**DM at anthesis (t/ha)**	**Grain Yield (t/ha)**	**WUE (kg/ha/mm)**	**Gross Margin[1] ($/ha)**
Good	Standard	50	1.2	0.5	3.1	
Medium	Low	59	1.6	0.6	3.8	
Poor	Standard	59	1.4	0.6	3.8	
LSD (P=0.05)		*8.2*	*0.3*	*NS*		
	0	51	1.1	0.2	1.3	-28
	4	59	1.4	0.6	3.8	215
	8	59	1.8	0.9	5.6	398
LSD (P=0.05)		*NS*	*0.4*	*0.2*		
Good	0	42	0.7	0.1	0.6	-69
	4	59	1.5	0.6	3.8	225
	8	50	1.5	0.8	5.0	337
Medium	0	48	1.3	0.2	1.3	-8
	4	63	1.5	0.6	3.8	225
	8	66	2.0	1.1	6.9	520
Poor	0	62	1.2	0.2	1.3	-8
	4	54	1.3	0.7	4.4	286
	8	62	1.9	0.8	5.0	337
Within soil type LSD (P=0.05)		***14.3***	***0.5***	***0.2***		
Zone x Rate LSD (P=0.05)		***16.4***	***0.6***	***0.3***		

** Gross margin is yield x price less seed, fertiliser and variable costs delivered to cash pool Port Lincoln 20 January 2011*

Table 3 Yield Prophet® yield projections, decile at the time of simulation and estimated plant available water at 4 dates on 3 soil zones over the 2010 growing season

Date	Zone	Yield range (t/ha) with available N	Yield range (t/ha) with unlimited N	Decile ranking	PAW (mm)
5 August	Good	0.5 - 2.2	0.2 - 3.0	7	39
	Medium	0.3 - 2.2			20
	Poor	0.2 - 1.3	0.2 - 1.3		46
24 August	Good	0.7 - 2.2	0.7 - 2.8	6	27
	Medium	na	na		na
	Poor	0.3 - 1.5	0.5 - 1.5		37
27 September	Good	1.7 - 2.1	1.8 - 2.2	7	14
	Medium	1.5 - 2.1	1.6 - 2.1		1
	Poor	1.0 - 1.5	1.1 - 1.6		29
27 October	Good	1.7	1.8	6	1
	Medium	1.5	1.6		-6
	Poor	1.1	1.2		14

Table 4 Treatments applied (kg P/ha as phosphoric acid) to VRT gross income analysis for Mudamuckla 2010, sown with canola at 3 kg/ha (double planned rate of 1.5 kg/ha)

Paddock Zone	VRT - Go for gold!	kg P/ha	VRT - Hold the gold!	kg P/ha
Good	High	8	Standard	4
Medium	Standard	4	Low	0
Poor	Low	0	Low	0

Table 5 Comparison of the gross income of different sowing regimes vs. VRT combinations across the whole 200 ha paddock

Treatment	Gross Margin[1] ($/ha)	Gross Margin compared to standard input treatment ($/200 ha paddock)
VRT - Go for gold!	235	109
VRT - Hold the gold!	85	-29,895
High input	419	36,976
Standard input	235	0
Low input	-33	-53,419

What does this mean?

The 2010 growing season was above average for rainfall, with canola yields only reaching 1.1 t/ha indicating there were significant constraints. Weed competition was an issue due to the lack of broad leaf weed control to maintain groundcover on unsown strips (50% of paddock). *Rhizoctonia solani* AG8 was at high levels on the medium to good zones which may have reduced yield. Canola is known to be a poor host for *Rhizoctonia solani* AG8, however in situations when there are extremely high levels of inoculant it can be attacked by this disease (pers comm, Alan McKay). The disease levels in this paddock will be reassessed before seeding to assess if there has been any change over summer.

Yield Prophet® was not accurate at predicting the yields in the medium and good zones. At this stage it has not been well calibrated for canola in low rainfall cropping areas (pers comm, Tim McClelland).

In 2010 there was a benefit in grain yield in the high P rates on the medium zone, compared to the poor zone, but not on the good zone. The reason for this is unclear, an unidentified soil constraint may have had an impact on canola production in the good zone. This is partly suggested from the comparative good and medium zone anthesis biomass figures, where the good zone production is similar or less than the medium zone.

The effects of rotation choice and the different treatments on the different zones, as well as the overall economic impact of the different approaches will be monitored for the next 2 years.

Acknowledgements

Thanks to Peter Kuhlmann for the opportunity to use this paddock as part of EPFS 3 and Andre Eylward for sowing the paddock and all their help during the year.

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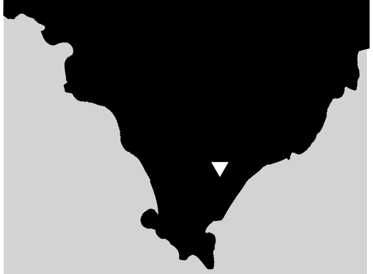
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Responsive Farming for Soil Type at Wharminda

Cathy Paterson, Linden Masters, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

Searching for answers



Location: Wharminda
Ed Hunt
Wharminda/Arno Bay Ag Bureau

Rainfall
Av. Annual: 322 mm
Av. GSR: 222 mm
2010 Total: 479 mm
2010 GSR: 349 mm

Yield
Potential: 5.7 t/ha (B)
Actual: 3.4 t/ha (poor zone - high input B)

Paddock History
2009: Wheat
2008: Wheat
2007: Wheat

Diseases
Rhizoctonia

Yield limiting factors
Brome, barley and rye grass competition

Key messages

- **In an above average season a high input system was the "best bet".**
- **Variable rate had reduced production but at a lower risk.**

Why do the trial?

It is important that low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. At Wharminda the focus is on managing risk through variable rate technology (VRT) using different inputs over variable soil types. We are also testing the use of Yield Prophet® to match plant available water (PAW) and nutrition with modelling of climatic conditions, knowing that we can have unpredictable finishes to seasons.

The Wharminda soil was chosen as a focus site for the Eyre Peninsula Farming Systems 3 Project (EPFS 3) as the non-wetting sands represent approximately 455,000 ha on EP. These sands present farmers with unique challenges; non-wetting sands that "wet up" slowly and unevenly at the beginning of the growing season which can result in uneven germination and increasing the likelihood of wind erosion. There are also a range of factors common on EP preventing crops from reaching their yield potential including insufficient nutrition, disease, weed competition, delayed sowing dates and restricted access to soil water due to chemical constraints.

Changing inputs according to the production capability of different paddock zones or soil types provides an opportunity to improve profitability for the whole paddock.

How was it done?

A paddock at Ed Hunt's property, Wharminda, was selected and zoned according to soil type - deep sand over clay (poor) representing 20% of the paddock, shallow sand over clay (medium) representing 50% of the paddock and loam (good) representing 30% of the paddock. Soil samples were taken at 4 permanent sampling points for chemical analysis (Table 1).

The paddock was sown with Fleet barley @ 65 kg/ha on 1 June 2010. Three fertiliser treatments of Low 0, Standard 8 and High 16 kg P/ha were applied to the paddock in alternating strips across the paddock. The paddock received standard weed management across all zones.

The measurements taken during the growing season were plant establishment, dry matter at early tillering, anthesis and maturity, soil water content at sowing and harvest, and grain yield and quality. A basic economic analysis was performed to compare a blanket approach of the different fertiliser treatments to tailoring the inputs to match the zone potential using variable rates of fertiliser.

What happened?

Soil chemical analysis prior to seeding showed that mineral N levels were low in all zones, despite a history of good medic based pastures (Table 1). All zones have adequate P levels for this soil type (above 13 mg/kg). Boron, chloride and conductivity are in a restrictive range at 20-40 cm in the medium zone and there are no chemical restraints in the good and poor zones at 0-60 cm.

The was no difference across the zones in terms of plant establishment (data not presented), however the amount of dry matter production was higher in the good zone at early tillering compared to the medium and poor zones (Table 2). In the good zone the medium and high input treatments produced greater early dry matter. There was a yield response to the high input treatment in the good zone, but no response to fertiliser in terms of grain quality.

Table 1 Soil chemical analysis for Wharminda 2010

Zone	Colwell P (mg/kg) 0-10 cm		Total Mineral N (kg/ha) 0-60 cm	
	2009	2010	2009	2010
Good	24	32	149	78
Medium	22	23	82	66
Poor	34	26	125	52

Table 2 Dry matter production, grain yield and grain quality from the 3 paddock zones, 2010

Zones	Inputs	Dry Matter Early Tillering (t/ha)	Dry Matter Anthesis (t/ha)	Grain Yield (t/ha)	Test Weight (kg/hL)	Protein (%)	Gross Margin[1] ($/ha)
Good	High	1.2	4.0	3.4	62.2	10.1	532
	Standard	1.2	3.3	3.1	63.3	9.8	520
	Low	1.1	3.2	3.0	62.5	9.8	395
Medium	High	1.2	3.5	2.7	62.0	9.5	400
	Standard	1.4	3.9	2.3	62.3	9.7	365
	Low	1.1	3.2	2.4	61.3	10.0	414
Poor	High	1.5	4.3	3.4	62.6	10.2	549
	Standard	1.7	4.4	2.5	62.8	9.3	404
	Low	1.1	3.3	2.3	62.9	9.9	532
LSD ($P \leq 0.05$)		*0.2*	*1.4*	*0.9*	*NS*	*NS*	
Good		1.4	4.0	2.7	62.7	9.8	
Medium		1.2	3.5	2.5	61.9	9.7	
Poor		1.1	3.5	3.1	62.8	9.9	
LSD ($P \leq 0.05$)		*0.1*	*0.8*	*0.5*	*NS*	*NS*	
	High	1.3	3.9	3.2	62.3	9.9	
	Standard	1.4	3.9	2.7	62.8	9.6	
	Low	1.1	3.2	2.5	62.2	9.9	
LSD ($P \leq 0.05$)		*0.1*	*0.8*	*0.5*	*NS*	*NS*	

[1] Gross income is of yield x price (with quality adjustments) less seed, fertiliser, chemical and operating costs delivered margin cash pool at 4 January, Pt Lincoln 2011. $150/t used for seed value.

Table 3 Yield Prophet® yield projections at 50% probability with available nutrients, current decile and estimated plant available water at 4 dates on 3 soil zones over the 2010 growing season

Date	Zone	Predicted Yield (t/ha)	Decile ranking	PAW (mm)
10 September	Good	1.0	7	16
	Medium	1.9		27
	Poor	2.1		30
27 September	Good	2.5	9	65
	Medium	3.5		84
	Poor	2.1		51

Yield Prophet® reports were run for the 3 soil zones on 2 dates over the growing season, 10 September and 27 September (Table 3). Projections indicated that the crop in all zones was under moderate N stress by 10 September. The PAW of the 3 zones was calculated by using a combination of the water holding capacity of the different soil types combined with any chemical constraints. The crop did not experience water stress due to good growing season rainfall.

The aim of the variable rate treatments used for the economic analysis was to increase overall profitability by reducing the inputs on the poorer areas of the paddock and increasing inputs in the higher potential areas. This approach keeps the high input on the good zone, standard input on the medium zone and low input on the poor zone. In 2010 the high input blanket approach was the most profitable (Table 4), with the variable rate approach being the next most profitable. The gross margin with a low input blanket approach was slightly more profitable than the standard input.

Table 4 Comparison of the gross income of different sowing regimes vs. variable rates across the whole 60 ha paddock

Treatment	Gross Margin[1] ($/ha)	Gross Margin ($/60 ha) compared to medium input treatment
High Input	425	3,796
Standard Input	363	0
Low Input	385	1,415
Variable Input	407	2,712

What does this mean?

2010 was a decile 9 growing season rainfall at Wharminda, resulting in above average yields across all zones despite the low levels of available N.

Yield Prophet® was run for the first time at the Wharminda Focus Paddock site; the projections underestimated the yields for all zones. This model has not been calibrated for non-wetting sands such as those at Wharminda at this time (pers comm. Anthony Whitbread) and over the next few seasons work will continue on improving the accuracy.

The high input blanket approach was the most profitable in 2010 as this treatment maximised the yields in all zones but at the greatest risk at the start of the season. In contrast to this the low input blanket approach minimised cost and yield. In an above average year such as 2010 some production is forgone by using a variable rate approach, although it may be a good risk management tool in average or below years as the input costs are reduced.

It is intended that these management strategies will be applied to these paddock strips for the next few seasons to track the long term impact of changing inputs, how the different zones respond to different treatments in different seasons, and how the overall economics perform.

Acknowledgements

Thanks to the Hunt family for the opportunity to use this paddock as part of EPFS 3. Thanks also to Sue Budarick for her technical help during the year.

Farming Systems

Better Defining Yield Potential for the Upper Eyre Peninsula

RESEARCH

Anthony Whitbread[1], Linden Masters[2], and Cathy Paterson[2]

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Key messages

- **On zones where wheat growth is not constrained the French and Schultz method gives a realistic potential yield estimate based on growing season rainfall (GSR) and a soil water evaporation term of 110 mm.**
- **Where soil water evaporation is higher because of sub soil constraints and other factors that affect the growth of wheat, the soil water evaporation term must be adjusted.**
- **Zoning your paddocks into areas of performance and soil testing these areas separately for soil nutrients can improve decisions on where to apply nutrients for the best return.**
- **Fertiliser application rates at sowing should be strategic i.e. based on the yield potential of the zone and soil test results (e.g. a sowing application of DAP or MAP on a soil with high yield potential should be supplemented with topdressing applications of N if seasonal conditions are good).**

Why do the trial?

The Eyre Peninsula environment is one of the most challenging regions of the world to farm profitably and sustainably, particularly in the last decade. Despite these challenges, many farmers show that it is possible to do so with modern technology, sound business skills and an understanding of the environment. The responsive farming systems approach adopted by the latest GRDC EP Farming Systems 3 project aims to build resilience into EP farms by understanding the interactions between soil potential, climate and management. Critical to this is establishing realistic yield potential targets. The most commonly used method used has been that established by French and Schultz (1984) and more recently using the APSIM soil-crop models. The potential yield calculation is a simple and widely used method for predicting potential grain yield. The loss term of 110 mm commonly used to account for soil water evaporation, runoff and drainage (the latter two typically low in upper EP environments) frequently overestimates soil evaporation, but may even underestimate them on constrained soils. This paper suggests more realistic loss terms based on deciles and soil types for 3 sites across the EP.

How it was done?

The majority of research activities in the current EP water use efficiency initiative are taking place at focus paddocks located at Mudamuckla, Minnipa and Wharminda. At each site the use of EM38 survey, yield maps and soil testing have been used to create zones representing good, medium and poor performing areas of each paddock. Representative soils within these zones have been characterised for plant available water capacity (PAWC) by determining the drained upper limit (DUL) and the crop lower limit (CLL), as well as chemical analysis for plant available nutrients (e.g. mineral N, Colwell P, S, exchangeable cations) and chemical constraints such as pH, boron and chloride.

Three approaches were used to estimate how much yield Yitpi wheat should have achieved in these three environments in each of the last hundred years, assuming current management approaches, paddock conditions and no nutrient deficiencies.

Method of potential yield estimate

APSIM: Using the APSIM crop model and long term weather records sourced from nearby meteorological stations, wheat growth was simulated for the period 1910 to 2009 using modern varieties and management and assuming no nutrient constraints. The effects of rainfall, evaporation, drainage and water extraction by the crops were all calculated by the model. Wheat (cv. Yitpi) was sown between 25 April and 30 June and sowing within this period was triggered by the first rainfall event of 10 mm or more over 5 days. Cumulative growing season rainfall and soil evaporation was for the April to October period of each year.

French and Schultz (1984): This method was based on the collection of data described in French and Schultz (1984) to define a linear boundary function describing grain yield per unit of water use (i.e. 20 kg grain/ha.mm for wheat grain, or transpiration efficiency). A loss term, or the x-intercept of this line, accounting for soil evaporation in the original papers was 110 mm, although it was noted to range from 30-170 mm depending on soil type and rainfall pattern. Accounting for soil moisture at sowing and harvest to better estimate how much moisture in addition to GSR the crop has access to, was also recommended. The equation is therefore:

Yield = (water use − soil evaporation) x transpiration efficiency

French and Schultz (EP2010): Assuming that transpiration efficiency is constant, soil evaporation is the only term available to adjust water use. APSIM was used to calculate April to October in-crop soil evaporation for all seasons from 1910 to 2009 at a range of sites and soils. Runoff and drainage was also calculated but was found to be negligible in the majority of seasons and therefore ignored. This paper presents the soil evaporation terms that could be used to replace the standard figure normally used in the FS calculation (see equation above and Table 2).

Comparison of potential yield methods vs observed data for MAC

An evaluation of the 3 methods was undertaken using long term farm records from MAC to establish the average grain yield of all paddocks that were sown to wheat for the seasons between 1972 and 2007. This includes paddocks that have been in long term cereal or other rotations as well as paddocks coming out of pasture rotation. No management information about variety, planting date, fertiliser or stage of rotation was available. Potential Yield for each season was then calculated by:

1. as reported by Whitbread and Hancock (2008) APSIM was also used to simulate the growth of wheat for zones represented by loam and shallow heavy loam soils that were characterised at MAC. The average farm yield was then calculated assuming that 2/3 of the area grown to wheat was located on the zones represented by loams and 1/3 represented by shallow heavy loam zones;
2. based on GSR and ignoring soil moisture that may have been stored in the soil profile at sowing and harvest, potential yield was calculated using the French and Schultz (1984) method with a 110 mm soil evaporation term; and
3. based on GSR and ignoring soil moisture that may have been stored in the soil profile at sowing and harvest, potential yield was calculated using the French and Schultz (EP2010) method with APSIM used to calculated soil evaporation for each season and soil. An average yield for the 2 zones was calculated as for the APSIM method.

What happened?

The 3 methods used to calculate potential yield for each zone of the focus site are presented in Table 1. In the French and Shultz (1984) method, the soil water loss term remains as 110 mm for all sites, seasons and soils resulting in average growing season rainfall defining yield potential. In the French and Shultz (EP2010) method, soil evaporation increases with growing season rainfall and is also influenced by the soil type of the zone (Table 2). The zones with the least constrained soils, namely sand, loam and deep sand found at Mudamuckla, Minnipa and Wharminda respectively, have the lowest soil evaporation terms and consequently the highest potential yield estimates. These are lower than those estimated by French and Shultz (1984) and APSIM for the same zones. Soil evaporation increases on the less favourable soils, therefore reducing the water available for transpiration and consequently the potential yield (Table 2).

The real yields measured at MAC reached a maximum of about 2.9 t/ha with 287 mm April to October rainfall (data not shown) presumably due to constraints such as N limitation. Predictions of grain yield based on the French and Schultz (1984) approach are considerably higher in most seasons, particularly in the higher yield or higher rainfall seasons. A regression of the predicted against observed yields (Figure 1) was a poor fit of the data. Predictions of grain yield using APSIM more closely match the measured data for April to October rainfall up to 300 mm, but in seasons where rainfall exceeds this amount, APSIM also predicts higher yield than achieved. A regression of the predicted against observed yields was a similarly poor fit (Figure 1). The French and Schultz (EP2010) method closely matched the APSIM predictions.

Table 1 Potential wheat grain yield (average of 1910 to 2009) calculated using the standard French and Schultz (1984) method with water loss term of 110 mm, a modified French and Schultz (EP2010) using a water loss term calculated for each season and soil by APSIM and the APSIM N-unlimited potential yield.

	Soil type-zone	F&S (1984) (t/ha)	F&S (EP2010) (t/ha)	APSIM (t/ha)
Mudamuckla	Sand	2.1	1.9	1.9
	Grey loam	2.1	1.0	0.8
	Shallow heavy loam	2.1	1.2	1.1
Minnipa	Loam	2.5	1.8	2.4
	Shallow loam	2.5	1.7	2.1
	Shallow heavy loam	2.5	1.5	1.1
Wharminda	Deep sand	2.5	2.1	2.9
	Shallow sand	2.5	1.7	2.0
	Shallow loam	2.5	1.3	1.0

What does this mean?

- On zones where wheat growth is not seriously constrained by factors such as shallow rooting depth, the French and Schultz (1984) method results in realistic potential yield estimates based on GSR and a soil water evaporation term of 110mm. Where soil water evaporation is likely to be higher because of sub soil constraints and other factors that affect the growth of wheat, the soil water evaporation term must be adjusted.
- Table 2 presents soil evaporation terms for all deciles and soil types and is based on APSIM simulations for the seasons between 1910 and 2009.
- Zoning your paddocks into areas of like performance and soil testing these areas separately for soil nutrients can inform decisions on where to apply nutrients for the best return.
- Fertiliser application rates at sowing should be strategic i.e. based on the yield potential of the zone and soil test results. For example a typical sowing application of DAP or MAP on a soil with high yield potential should be supplemented with topdressing applications of N if seasonal conditions are good. In regions like Wharminda, multiple small applications of N could be most efficiently used.

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Acknowledgements

The MAC crew are thanked for their expert technical support. The support of the participating farmers at the focus sites, Marko Klante, Peter Kuhlmann and Ed Hunt is gratefully acknowledged.

***Table 2** Look-up table for cumulative soil evaporation (mm) from April to October for deciles as calculated by APSIM based on 100 year unlimited-N simulations at each site and soil type of the focus sites.*

Decile	Mudamuckla			Minnipa			Wharminda		
	Sand	Grey loam	Shallow grey loam	Loam	Shallow loam	Shallow heavy loam	Deep sand	Shallow sand	Shallow loam
1	96	132	126	133	144	152	118	140	156
2	103	142	135	139	149	158	122	144	162
3	108	149	142	142	152	162	125	147	167
4	112	157	149	146	155	166	129	150	173
5	117	165	155	149	157	169	132	153	176
6	120	169	159	152	160	172	136	156	182
7	124	175	164	156	163	176	142	161	190
8	127	180	169	162	168	182	145	164	195
9	133	190	178	169	174	190	150	168	201
10	158	228	213	182	186	204	169	185	229

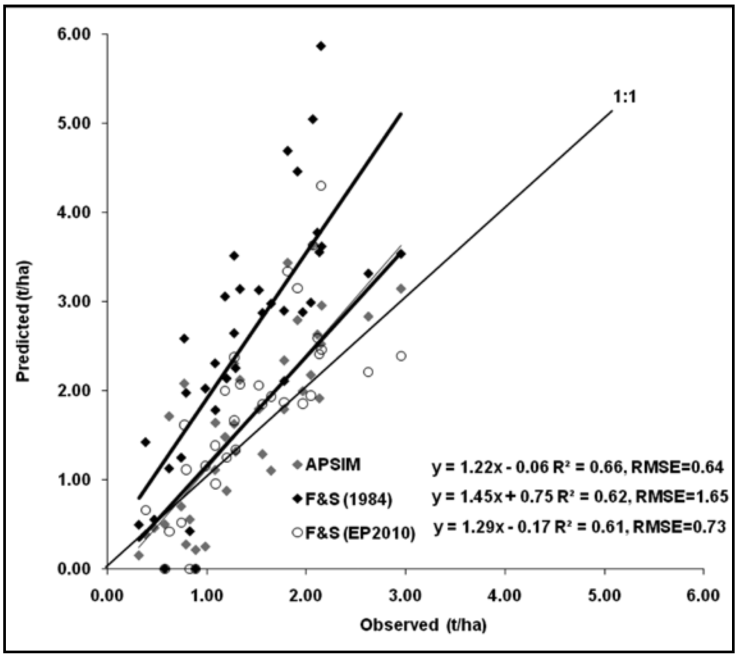

***Figure 1** Comparison of observed average wheat yield (t/ha) at MAC for seasons between 1972 and 2006 with potential yield estimates calculated using French and Schultz (1984), French and Schultz (EP2010) and APSIM.*

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CSIRO

GRDC Grains Research & Development Corporation

The 10% Challenge

Linden Masters and Naomi Scholz
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RESEARCH

Farming Systems

Early in 2010, local 'think tanks' were set up to support the three focus sites at Minnipa, Wharminda and Mudamuckla as part of the GRDC funded Eyre Peninsula Farming Systems 3 (EPFS 3) project. The think tanks, or discussion groups, consisted of 10 farmers, a consultant and local retail agronomists. Many of the farmers involved were considered to be successful in their area. The groups were posed the following questions;

- How do you increase your crop water use efficiency?
- How do you maximise profit?
- How can you find more leisure time?

The groups were also challenged to identify things that they could change in order to increase water use efficiency, profit and leisure time by 10%, which we referred to overall as the '10% Challenge'.

The aim of the 10% Challenge was to identify the important drivers in local farming operations and from this information to find rules of thumb that would help others to implement and maintain a robust flexible farming system. These discussion groups also have input into the management of the focus sites, so that the research remains relevant, moves from white peg trials to paddock demonstrations, then on to a farm scale and adoption across the district.

Increasing water use efficiency by 10%

In a nutshell, water use efficiency is about increasing production from the amount of rain we get. The following list describes what the think tank members considered important drivers for increasing water use efficiency (WUE):

- Timing of all operations. Timing and timeliness including the efficiency of the program; matching capacity, quality of gear, labour.
- Strategic planning and decision making are essential, but need to be adaptive. Have plans A, B and C as the season develops.
- Good agronomic understanding and knowledge of the farming system allows; appropriate sequence of crops and pastures, adapted crop/variety choice, timing of nutrition (including N and management of foliar and root diseases), understanding of soil type variability.
- Having a good base nutrition for all seasons – general good fertility.
- Weed control including grass free medics, removing summer weeds (allowing some water and nutrition conservation) and consequently improved timeliness of sowing.
- WUE is improved by press wheels, stubble retention, minimum/zero tillage.
- Access to capital dictates ability to use 'best practice', thus WUE is constrained by capital.
- Need flexibility for different; soil types, seed burdens, constraints.
- Match areas on the farm, e.g. high risk areas with low risk strategies, matching risks to constraints; soil type, weeds, rainfall patterns.

Increasing profit by 10%

Profit can be described as the portion of income remaining after all costs are accounted for. Increasing profit can be achieved by reducing costs, or maintaining costs while increasing income, or a combination of both. The following list describes what the think tank members thought were important factors in increasing the profitability of farming:

- Work smarter, not harder, put a value on your time.
- Be organised so you are not pressured to make a quick decision.
- Knowing where your skills/strengths are e.g. grain marketing is a new skill required – keep it simple if it is not a strength.
- Outsourcing expertise where possible e.g. mechanics, grain marketing, crutching.
- Keep the system manageable so you have capacity to achieve.
- Going back to basics – wheat and medic and conservative machinery decisions (labour vs. capital).
- Don't chase fads, have a very stable, basic system.
- Actively chasing chemical/fertiliser, 8 – 10 months pre-season.
- Quarterly wheat payments to spread income and improve cashflow.
- Changed over to air seeders – wider rows, less rates, put out liquid trace elements; crops looked more even.
- Fenced off hills and revegetated. Made land a lot more usable and increased grazing days. Mobile electric fencing transformed grazing package and enabled increase in stock numbers.
- Other things happening in the district: delving, spreading sand on poor/magnesia patches. Deep banding trace elements and P under seed (especially grey soils).

- Know and understand your cost of production (or have good intuition).
- Seize opportunities (have the capital backing to be able to take opportunities as they arise).
- Sowing cereals dry (depending on soil type and paddocks set up).
- Sow early for grazing with a grain option if not needed for feed.
- Having different blocks (geographically) and soil types to spread risk.
- Gut feel and luck. Avoid making the 'clanger' decisions, learn from mistakes. Confidence.
- Efficient sheep yards (saves time and labour).
- More land, another worker, frees up time.
- Too much emphasis on livestock being risk reducers – the livestock enterprise must be profitable to reduce risk.
- Make change a process, not an event.
- Know when to stop spending.

Increasing leisure time by 10%

Many laughed at the suggestion of increasing leisure time, but after some thought, there was concern amongst the groups regarding the lack of time farmers have for family, community or oneself. It is an important issue that is often overlooked in our discussions about new practices. The following comments are things people did or aspired to:

- Buy a new sprayer (bigger, better, more efficient).
- Get a working man "A Nitro (self-propelled boom spray) can't fix a gate".
- Good planning, preparation and coordination, work towards a goal.
- Plan a proper holiday every 2 years or have shorter breaks more often (gives the whole family something to look forward to and plan as a family).
- Management and monitoring of new farming systems takes more time (e.g. break crops) so take this into consideration when planning the year ahead.
- Putting trace elements down the tube and soil applied herbicides by seeder.
- Insurance/planning ahead for contingencies e.g. treat some seed so you don't have to spray all areas at the same time.
- Sowing one variety only.
- Block farming.
- New sheep yards, get a good dog, laneways, breed easy care sheep, jet before there's a problem, be timely with livestock operations.
- Auto steer (stress saver) good for night spraying, opens spraying window.

From the 10% challenge came a feast of ideas, usually with one or two key focus points considered valuable to the farming operation, with farmers agreeing with or discussing other ideas as they were shared within the groups. The information arising from these sessions has been presented at farmer meetings for local groups to discuss in relation to their own farming systems. Further development and extension of this work and 'rules of thumb' will be investigated with the discussion groups and delivered at local farmer meetings.

Planning and understanding their farming system and business situation were high on the farmers' lists. The three areas covered are not exclusive to each other but all need to be in balance. Production, finance and people resources all need addressing for a long term sustainable farming business.

Annual Medic-Wheat Rotation at MAC

Roy Latta
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DEMO

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Paddock History
2009: Medic self-regenerating pasture
Soil Type
Red sandy loam
Plot size
Broadcare demonstrations (40 ha)
Yield limiting factors
Nil
Environmental Impacts
Soil Health
Soil structure: more even grazing
Compaction risk: low
Social/Practice
Time (hrs): sowing pre normal seeding
Clash with other farming operations: standard management
Labour requirements: minimal, check sheep and spraying grass and insect pests
Ecomomic
Cost of adoption risk: low

Key messages

- **The study has shown benefits from the medic as a break crop and a high quality forage source.**
- **There was no wheat quality loss in 2010 as a result of high soil N from 2009 medic production.**

Why do the demonstration?

Medic pastures are known to be an important part of low input, low risk sustainable mixed farming on upper EP. They provide high quality animal forage, and a weed, pest and disease break for following cereal crops and clean, green nitrogen. However the above average rainfall and high production from annual medic pastures over wide areas of Eyre Peninsula in 2009 and 2010 has resulted in some concern of increased “haying off” in subsequent cereals in average or lower rainfall years due to excessive soil nitrogen.

The aim of this demonstration was to assess the performance of annual medics in a pasture – wheat rotation over the 2009 and 2010 seasons. The biomass produced over the 2009 growing season and the retention of the pasture residue over the summer period was reported in EPFS Summary 2009, pg 167. In 2010 the impact of the pasture on the cereal phase was measured.

How was it done?

Paddock North 4 (area 40 ha) on Minnipa Agricultural Centre had a regenerating medic pasture in 2009 (see EPFS Summary 2009, pg 167). In 2010 Mace wheat was sown at 65 kg/ha on 31 May with 45 kg/ha of DAP (9 units of N, 8 units of P), there was no further fertiliser applied.

The same 4 sites from within the 40 ha commercial paddock were used throughout the 2009 and 2010 demonstration. In 2010 measurements collected from the 4 sites were; soil analyses from the 0-10 and 10-60 cm profiles (25 May), plant density and anthesis biomass (18 September), harvest biomass (16 November) and grain yield, protein, screenings and test weight.

What happened?

More than 5t DM/ha of medic biomass was produced in this paddock in 2009; a decile 9+ year. With the mineralisation of N from the 2009 medic and with the nitrogen applied as fertiliser there was 170 kg/ha of crop available N. In the decile 8+ 2010 year the paddock produced 3.8 t/ha of grain with a 44% harvest index. Protein content was measured at 11.4% resulting in an APW1 classification (Table 1).

What does this mean?

The benefits of an annual medic dominant pasture are well documented and through this demonstration have supported medic as a;

- High quality animal forage – in 2010 ewe hoggets stocked at 10 DSE/ha on a medic dominant pasture gained 3.5 kg/head over a 2 week period in a controlled experiment at MAC.
- An excellent break crop to control grass weeds and soil borne cereal root diseases – the 3.8 t/ha 2010 wheat yield followed a grass free medic in 2009. The crop received only low levels of P and N at seeding, was weed-free despite no pre or post emergent weed control and had no obvious disease issues.

There was no indication of haying off as a result of the 2009 pasture/ nitrogen production, in fact on 3 of the 4 sampled sites the protein content was less than expected in response to the calculated N levels available. The fourth site (3) had the highest protein and screenings percentages, which suggests a lack of plant available water during seed maturation. Reasons may include that site having the highest established plant density and decile 5 conditions at anthesis. However, most likely is paddock variability and the site selected was an outlier.

Table 1 Soil, wheat plant density, biomass and grain yield, protein, screenings and test weight from 4 sites in N4 on MAC in 2010

		1	2	3	4	Mean
Soil Analysis	N mg/kg 0-10 cm	44	36	35	31	37
	N mg/kg 10-60 cm	31	17	10	16	19
Plant density	plants/m^2	165	135	170	163	158
Anthesis biomass	t DM/ha	5.5	4.8	5.1	6.3	5.4
Harvest biomass	t DM/ha	9.8	6.8	8.4	96	8.7
Grain yield	t/ha	4	3.6	3.6	4	3.8
Grain protein	%	11	10.8	13	10.6	11.4
Grain screenings	%	2.1	1.8	8.5	2	13.2
Grain test weight	kg/hL	65.8	79.4	72	79.6	74.2

Table 2 Grain yield (t/ha), protein (%), screenings (%) and gross margin summary from sampled sites in North 4 and whole of South 7 and North 1 paddocks at Minnipa Agricultural Centre, 2010

	North 4	South 5	North 1
Rotation	Medic - Wheat	Field Pea - Wheat	3 years Wheat
Area (ha)	37	34	70
Yield (t/ha)	3.8	4.2	2.8
Protein (%)	11.4	11.6	10.3
Screenings (%)	3.6	1	2.1
Variable cost of growing wheat/ha (%.ha)*	112	112	112
Wheat value ($/ha)**	1,140	1,386	750
Gross margin ($/ha)	1,028	1,274	638

**Wheat costs based on 2010 Farm Gross Margin Guide.*
***Wheat value was calculated by using Viterra Port Lincoln nett contract prices on 5 January 2011 for APW1 (N4), H2 (S7) and ASW1 (N1) classification.*

The commercial results from the paddocks show relatively comparable performance from the annual medic-wheat and field pea-wheat rotations. The wheat-wheat rotation produced a lower yield and protein as would be expected.

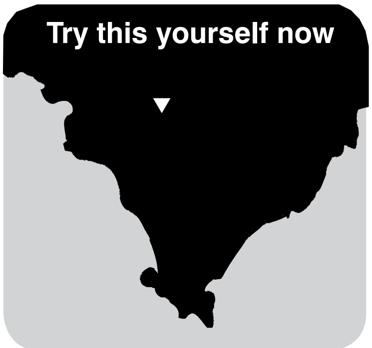
Acknowledgements

Thanks to Brett McEvoy for harvesting the selected paddock sites.

Minnipa Farming Systems Competition - A Review of Soil Health after 10 years

Roy Latta
SARDI, Minnipa Agricultural Centre

INFORMATION



Key messages

- **A comparison of 2001 and 2010 soil analysis suggests that organic carbon levels may have declined over the 9 year competition, irrespective of the rotation utilised and production achieved.**
- **However to suggest that there is a continuing long term decline in soil health in the face of improved "sustainable" farming techniques is premature.**
- **The competition ceased in its current form in 2010 with all paddocks sown to an oilseed (canola or juncea).**

Why do the trial?

The Farming Systems Competition was commenced in 2000 to compare the impact of four different management strategies on production, profitability and sustainability at the Minnipa Agricultural Centre.

The trial continued until 2009 comparing the production of four independent farming systems imposed by four management groups, these being; local farmers, farm consultants, research staff and the current district practice, each group being responsible for one paddock.

While comparative production and profitability were measured annually (EPFS Summary 2009, pg 120) soil health and sustainability have not been previously reported.

How was it done?

The field crop or pasture sown on each of the four 3 ha plots were determined annually based on rotation, market forces, seasonal forecasts, land condition and the personal preferences of the four management groups.

Each trial plot had a chemical fallow treatment imposed in 2000. Over the 9 year study the number of years of each crop type varied from 8 to 3 years of wheat and 3 to 1 years of pasture, each plot had 1 year of hay production. The annual pasture phases, dominated by annual *Medicago* sp., were grazed for short periods, based on available feed on offer and the maintenance of adequate groundcover to avoid wind erosion. Crop residues were also grazed, to remove spilled grain and weeds, but with consideration to maintaining adequate ground cover. Crop sowing rates varied based on the preferences of the individual management groups as did the disease and weed management strategies. Total units of phosphorus and nitrogen applied to each trial plot over the 9 year period are presented in Table 1.

Organic carbon (%) from the 0–0.1 and 0.1–0.6 m soil profiles taken at 4 random points from within each of the 4 trial plots were estimated at the commencement (2001) and at the completion (2010) of the trial. The comparative fertiliser inputs were recorded along with the total grain yields from the 3 ha plots. Annual and growing season rainfall was also recorded.

What happened?

The long term average growing season and annual rainfall at Minnipa is 240 and 330 mm respectively. The period 2001 to 2009 included 3 years of deciles 1, 2 or 3 (2006, 2007 and 2008), 5 years of deciles 4, 5 or 6 (2001 to 2005) and 1 year of decile 9 (2009).

The 4 farming systems imposed a range of crop types, rotational structures and fertiliser inputs over the course of the study. All systems included wheat, pasture and had a hay crop in the rotation. The total amount of grain removed from each system varied from 5.2 to 12.4 t/ha with the lower grain producing systems having pasture with grazing imposed or hay cut and removed in 2009 (decile 9 year).

Table 1 Nine year adaptive farming systems annual rotations and grain yield (t/ha) with total nitrogen and phosphorus inputs (kg/ha)

Year	Local farmers Annual crop - (t/ha)	Consultants Annual crop - (t/ha)	Researchers Annual crop - (t/ha)	District Practice Annual crop - (t/ha)
2001	Wheat - 2.7	Wheat - 2.8	Hay	Wheat - 2.8
2002	Wheat - 1.5	Wheat - 1.3	Barley - 1.4	Pasture
2003	Wheat - 1.2	Wheat - 1	Canola - 0.5	Wheat - 0.9
2004	Wheat - 1	Barley - 1.4	Wheat - 1.3	Wheat - 0.8
2005	Pasture	Peas - 1.6	Wheat - 2	Pasture
2006	Wheat - 0.7	Wheat - 0.8	Pasture	Wheat - 0.6
2007	Wheat - 0.9	Wheat - 1.2	Pasture	Wheat - 0.5
2008	Hay	Pasture	Wheat - 0.5	Hay
2009	Wheat - 4.4	Hay	Pasture	Wheat - 4.6
Total grain	12.4	8.5	5.2	10.4
Units of N	84	109	61	52
Units of P	53	72	48	8

Table 2 Soil organic carbon (%) in the 0-0.1 and 0.1-0.6 m soil profiles in April 2001 and 2010

Treatment	Year	Local farmers	Consultants	Researchers	District Practice
Organic carbon 0 - 0.1m	2001 2010	1.1 1	1.1 0.9	1.1 0.8	1.1 0.8
Organic carbon 0.1 - 0.6m	2001 2010	0.5 0.4	0.5 0.5	0.4 0.4	0.5 0.5

Soil organic carbon percentages were the same across all farming systems in 2010. However there was a soil organic carbon decline (LSD P=0.05) between the 2001 and the 2010 means of the 4 systems in the 0-0.1 m measured profile depth. This decline was not repeated in the 0.1-0.6 m soil profile.

What does this mean?

The study has suggested that current farming systems incorporating no-till/minimum till crop establishment, recommended crop nutrition inputs, sound weed and disease control and grazing management may have resulted in a decline in soil organic carbon over the 9 year course of the study. Irrespective of the rotation, from a conservative 3 year wheat-wheat-pasture to a 5 year wheat-wheat-wheat-wheat-pasture rotation, the decline trend was consistent.

Coventry et al (1998) reported that in a continuously cropped paddock (1984 -1995) at the Minnipa Agricultural Centre soil organic carbon increased (0.7 to 1%). Recent measurements from that same paddock (2005-2008) with ongoing continuous cropping indicate a further increase in soil organic carbon to 1.2% (A Cook pers. comm.). In a 2002 survey of 12 upper Eyre Peninsula commercial farm paddocks Cordon (2003) reported soil organic carbon levels less than 0.7% in response to continuous cropping and more than 1.4% following extended periods of annual pasture. However between the outliers there were a number of intensive cropping systems that had a measured soil organic carbon of more than 1%.

To accept the results of this study as opposed to the previous reports (Cordon, 2003; Coventry et al., 1998) may require consideration of the impact of 3 years of exceptionally low production (2006, 2007 and 2008) along with the period of near to average rainfall and production (2001-2005). To suggest that there is a continuing long term decline in soil health in the face of improved “sustainable” farming techniques is premature but there is a need to validate these outcomes on a broader regional scale.

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Row Direction Trial

Amanda Cook, Jon Hancock, Wade Shepperd and Ian Richter
SARDI, Minnipa Agriculture Centre

RESEARCH

Try this yourself now

Location
Minnipa Ag Centre

Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm

Yield
Potential: 3.2 t/ha (P)
Actual: 2.4 - 5 t/ha

Soil
Red sandy loam

Key messages

- **In low rainfall seasons, (2005-08), north-south sowing increased grain yield by an average of 8.4% compared to east-west.**
- **Narrow row spacing with retained stubble also showed increased grain yield.**
- **In 2009 (decile 9+ season) there was a 0.24 t/ha yield advantage in wheat with sowing east-west.**
- **In 2010 (decile 8-9 season) with Kaspa peas, row direction at sowing had no effect on grain yield.**
- **Ultimately direction of sowing will depend mostly on paddock shape and direction of sand hills.**

Why do the trial?

This is the final year of a trial which has been running at Minnipa since 2005 to investigate the effects of row direction, row spacing and stubble cover on grain yield and quality. In 2010 the trial was sown to Kaspa peas at a row spacing of 23 cm.

How was it done?

The trial at Minnipa Agricultural Centre has been sown with identical treatments in the same locations from 2005 to 2008. The trial had three treatments in those initial years; sowing direction (north-south vs east-west), row spacing (18, 23 and 30 cm) and stubble cover (retained vs burnt). In 2009 the treatments were over-sown with 50 kg/ha of Clearfield Janz all on 18 cm row spacing with only the row direction treatment maintained. In 2010 the paddock was in pasture so the trial was sown on 26 May with the row direction treatment maintained with Kaspa peas @ 100 kg/ha with 50 kg/ha of 18:20 on 23 cm row spacing. Grain yield was measured.

What happened?

In 2010 grain yields were similar irrespective of direction of sowing and averaged 2.38 t/ha. The previous treatments of stubble cover being burnt or retained (from 2005-08) also had no effect on pea yields in 2010.

What does this mean?

In low rainfall seasons, north-south sowing resulted in yields an average of 8.4% higher than with east-west sowing. Narrow row spacing with retained stubble also showed increased grain yield.

However, in 2009 (decile 9+ season) there was a 0.24 t/ha yield advantage of sowing east-west. In 2010, a decile 8-9 season with Kaspa peas, the row direction of sowing had no effect on grain yield.

In low rainfall seasons the north south sowing direction may decrease soil evaporation and other research shows this is the preferred direction of sowing. In seasons when soil moisture is not as limiting other factors such as increased light interception may impact on plant growth, final yield and grain quality. The growth habit of the crop will also affect the impact of sowing direction.

The results from this trial show north-south sowing is an advantage in low rainfall seasons however direction of sowing will largely depend on paddock shape and direction of sand hills for best efficiencies.

Table 1 Effect of row direction on grain yield (t/ha) at Minnipa, 2005 - 2008

Year	Row direction		Yield Advantage of Sowing N - S	
	N - S	E - W	(kg/ha)	(%)
2005	1.50	1.43	71	5.0
2006	0.31	0.25	64	25.7
2007	1.26	1.16	99	8.6
2008	0.91	0.84	71	8.5
2005 - 2008	0.99a	0.92b	76	8.3
LSD (P=0.05) (2005 - 2008)	*0.06*			

Table 2 Effect of row direction on wheat grain yield (t/ha) at Minnipa, 2009

Year	Row direction		Yield Advantage of Sowing N - S	
	N - S	E - W	(kg/ha)	(%)
2009*	2.99	3.23	- 240	- 7.4
LSD (P=0.05)	*0.13*			

** sown at 18cm row spacing*

Table 3 Effect of row direction on Kaspa peas yield (t/ha) at Minnipa, 2010

Year	Row direction	
	N - S	E - W
2010*	2.41	2.34
LSD (P=0.05)	*NS*	

** sown at 23cm row spacing*

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Stubble Management Demonstration

Mark Klante and Linden Masters
SARDI, Minnipa Agricultural Centre

DEMO

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 4.7 t/ha (W)
Actual: 2.95 t/ha
Paddock History
2009: Wheat Yitpi
2008: Wheat Clearfield
2007: Pasture
Soil Type
Red loam

Key messages

- **Different methods of stubble handling had little impact on yield.**
- **Early soil testing allowed good decision making for crop nutrition and budgeting.**
- **Soil biota were more active in the in-row root zone, as opposed to the mid row zone.**

Table 1 Surface stubble biomass, 16 March 2010

Treatment	Biomass (t/ha)
Standing Stubble	3.6
Offset	2.7
Slashed	2.7
Rolled	2.3
Burned	0.0

Why do the demo?

Following a Farm Management meeting at Minnipa Agricultural Centre (MAC), it was decided that a demonstration paddock on stubble management would be implemented due to many farmers across upper EP facing large stubble loads for the 2010 growing season. The impact of different stubble management techniques on soil biota activity and nutrition demands would be monitored using the same fertiliser applications in crop and by comparing yields. In subsequent years the effect of different treatments will be monitored.

How was it done?

The South 4 (S4) paddock was chosen for the demonstration site as in 2009 it grew a 3.4 t/ha crop of Yitpi wheat with standing stubble left about 50 cm high. Treatments included; using a stone roller, slashing, off-set discing, burning and inter-row sowing into standing stubble. These practices were expected to be used by farmers in 2010 due to the previous season's high stubble loads and high mice activity. The demonstrations were approximately 4 ha each, with 4 ha of standing stubble left as a comparison between each demonstration.

An expected high demand for nitrogen from stubble incorporation, and mining of nutrition from last season's 3.4 t/ha crop made a pre-seeding deep N soil test an essential decision support tool. The soil N results (Table 2) lead to the application of 40 kg/ha of 18:20 and 40 kg/ha of urea applied at time of sowing across all treatments.

Stubble management treatments were applied during the period 10-15 March when soil was dry and conditions hot. Soil samples from between the crop rows were tested for nitrogen and soil biota on 2 November with the wheat crop at dough stage.

Wyalkatchem wheat was sown on 3 June at 65 kg/ha with 40 kg/ha 18:20 and 40 kg/ha of urea below the seed. A knockdown of 800 ml GlyphosateCT®, 300 ml Ester 680, 100 ml Striker® and 125 ml Li 700® per ha was used, no other weed control was required.

What happened?

Comments on the success of stubble management operations:

- Roller didn't smash up stubble as much as we thought. Maybe it wasn't hot enough on the day and the roller could have been a bit heavier.
- A good burn resulted in total removal of all stubble (and a couple of scorched trees on the fenceline).
- Off set disc did not incorporate all stubble.

Surface stubble biomass was measured after treatments (Table 1).

Table 2 S4 paddock soil test results

Soil depth (cm)	Ammonium N (mg/kg)	Nitrate N (mg/kg)	Organic Carbon (%)	Colwell P Phosphorus (mg/kg)	Conductivity (dS/m)	Boron (mg/kg)	pH ($CaCl_2$)
0 - 10	2	10	1.1	28	0.171	1.9	7.7
10 - 60	1	10	0.6	6	0.534	12.1	8.0

Table 3 Crop establishment, 29 July, 2010

Treatment	Plants/m^2 GS 22
Offset	83
Slashed	88
Rolled	86
Burned	79
*Standing average	99

** Standing stubble next to burnt area 42 plants/m^2*

Table 4 Soil and microbial N and microbial C levels (0-10 cm) in response to burning stubble and following subsequent growing season (0-10 cm)

	Sample date	Nitrate (mg/kg)	Ammonium (mg/kg)	Microbial N (ugN/g)	Microbial C (ugC/g)
Before burning	4 March	13.66	1.39	8.50	46.95
After burning	12 April	11.17	1.67	9.80	54.63
At senescence	2 November	4.61	0.51	79.01	436.66

The soil test results (Table 2) indicate good phosphorus, nitrogen and organic carbon levels. The available nitrogen in 10-60 cm is limited by increasing boron levels. High stubble loading may require the application of extra nitrogen.

The wheat crop looked healthy and had a low weed count, except for some mouse damage at establishment, especially in standing stubble next to burnt section (Table 3).

Soil microbial N and C levels showed no decline in response to burning stubble with a subsequent increase over the growing season (Table 4). Nitrogen levels declined over growing season.

Soil samples were tested for nitrogen and soil biota on 2 November with the wheat crop at dough stage. Samples were taken in close proximity to the plant rows plus a comparison made between near-row in-row and mid-row samples (Table 5). There were high levels of soil microbial activity measured and also some mineral N still available. Microbial activity was similar across all treatments although there was an increase in in-row microbial N and C compared to mid-row. There were some trend differences in nitrate and ammonia component (rolled stubble had less nitrate, more ammonia than alternatives).

Table 5 Soil N and biota tests at crop maturity, 2 November 2010

ID #	Sample Name	Nitrate (mg/kg)	Ammonia (mg/kg)	Microbial N (ugN/g dry soil)	Microbial C (ugN/g dry soil)
1	Rolled	3.7	1.3	65.3	361
2a	Standing	5.2	0.7	-	-
2b	Standing	5.5	0.1	-	-
3	Slashed	4.9	0.5	68.1	376
4	Standing	4.4	0.6	68.3	377
5	Disced	5.0	0.3	74.0	409
6	Standing	4.0	0.4	78.9	436
7	Burnt	4.6	0.5	79.0	437
10	Standing ave	4.6	0.6	61.2	338
Comparison between near row, in row and mid row samples in standing stubble treatment					
2	Standing near-row	5.5	0.7	61.2	338
8	Standing in-row	4.2	0.4	72.9	403
9	Standing mid-row	2.9	0.5	57.6	318

Table 6 Harvest results S4 stubble demonstration

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)
Rolled	3.0	9.7	0.7
*Standing	2.8	9.9	2.0
Slashed	2.5	9.4	1.6
Off-set	2.7	9.8	1.5
Burnt	2.9	9.4	0.7

average of 3 plots

Grain yields (Table 6) did not vary greatly between stubble handling approaches except the slashing may have had less yield. Seeding into standing stubble resulted in a higher screening percentage. Rolled and burnt operations had low screenings, burning and slashing protein figures were lower than the other 3 treatments. Standing stubble next to the burnt ground recovered from low plant numbers due to mice damage to record a comparable yield.

What does this mean?

The fertiliser recommendation provided adequate nutrition for the 3 t/ha crop despite the wheat on wheat rotation. In-season response of adding additional nitrogen was not taken to boost protein in a decile 7-8 season.

Providing adequate nutrition up front saw little impact on yields with different stubble treatments. This was a different result in many paddocks across upper Eyre Peninsula where different stubble treatment practices produced a great variation in yields. Burning in many cases was used as a last option to get through stubbles and expose mice and gave the best result only if adequate N was included. Soil testing gave a guide on crop inputs that matched future crop requirements.

Monitoring next season will be of interest to see if there are any long term effects of the different treatments in nutritional requirements and yield.

Acknowledgements

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Section 5

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Nutrition

Crop Production Using Replacement P Rates

Cathy Paterson, Wade Shepperd and Ian Richter
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RESEARCH

Searching for answers

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 4.7 t/ha (W)
Actual: 4.4 t/ha (20kg/ha P - good zone) (W)
Paddock History
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Plot size
1.4 x 9 m
Yield Limiting Factors
Nil
Water Use
Runoff potential: Low
Resource Efficency
Energy/fuel use: Standard
Greenhouse gas emmisions (CO_2, NO_2, methane): Cropping and livestock
Social/Practice
Time (hrs): No extra
Clash with other farming operations: Standard practice
Economic
Infrastructure/operating inputs: High input system has higher input costs
Cost of adoption risk: Medium

Key messages

- **A replacement P strategy produced similar yields to 10 and 20 kg/ha P rates in 2010.**
- **The trial indicated an economic benefit in increasing P rates up to 20 kg/ha on a deep sandy loam in 2010.**

Why do the trial?

Adequate levels of P are essential to achieve optimum crop yield. However there is an opportunity to minimise the cost of the P applications by adjusting the amount of P applied based on P soil reserves, seasonal and known soil based limitations.

Historically, recommended P rates have exceeded plant requirements, taking into account P requirements for regular annual medic pasture phases in the rotation. This has resulted in high levels of P in the soil. However recently a change in rotation practices where cereals may be grown continuously for a number of years combined with a string of poor seasons and increasing fertiliser prices has resulted in farmers reassessing the amount of fertiliser they use, and if they can utilise the P reserves in the soil strategically in high production seasons, where crop usage of 3 kg of P/ha/t of grain may surpass applications of applied P.

The aim of this ongoing study is to monitor crop production and economic outcomes from applying P at nil, replacement, average and twice average rates on both a deep sandy loam and a shallow constrained soil.

How was it done?

Two replicated trials were established in Paddock North 1 (N1) on Minnipa Agricultural Centre (MAC) in 2009; one on a deep red sandy loam (good zone) that has been P responsive and a second on a shallow, heavy soil (poor zone) that has been non-responsive to P. In 2009, pre-seeding Colwell P levels were 25 and 35 mg/kg on the deep and shallow soil respectively.

There are 4 treatments which are repeated each year on the same plots (Table 1). P is applied as DAP banded at seeding with N balanced with urea to give a total 18 kg N/ha on all treatments. In 2010, both trials were sown with Wyalkatchem wheat at 60 kg/ha on 3 June.

Table 1 shows 2009 yields, P rates and DAP and urea rates applied to each treatment. Measurements during 2010 included plant establishment, dry matter at end of tillering, grain yield and quality (Table 2).

What happened?

Soil tests taken before seeding in 2010 indicated that the Colwell P levels at both trial sites had increased to levels greater than 35 mg/kg (good zone - deep sandy loam) and greater than 50 mg/kg (poor zone – shallow, heavy soil).

Table 1 *2009 wheat yields, phosphorus, DAP and urea (kg/ha) applied in 2010*

Good zone: Deep, light soil (moderate Colwell P levels in 2009)	**Yield 2009 (t/ha)**	**P applied in 2010 (kg/ha)**	**DAP applied in 2010 (kg/ha)**	**Urea applied in 2010 (kg/ha)**
0	3.9	0	0	40
Replacement P	4.2	13.3	66	18
10	4.4	10	50	25
20	4.6	20	100	0
Poor zone: Shallow, heavy soil (high Colwell P levels in 2009)				
0	2.9	0	0	40
Replacement P	2.8	8.4	42	27
10	2.8	10	50	25
20	3.1	20	100	0

Table 2 *Wheat performance in P replacement trial, 2010*

kg/ha P applied	**Early DM (kg/ha)**	**Yield 2010 (t/ha)**	**Test Weight (kg/hL)**	**Protein (%)**	**Screenings (%)**	**Gross Income[1] ($/ha)**
Good zone (moderate Colwell P in 2009)						
0	291	3.9	79.7	9.8	2.3	966
Replacement P	532	4.3	79.8	10.0	2.4	1,078
10	393	4.0	79.5	10.1	2.5	1,007
20	560	4.4	79.8	10.1	2.4	1,085
LSD (P=0.05)	*133*	*0.4*	*NS*	*0.2*	*NS*	
Poor zone (high Colwell P in 2009)						
0	347	3.5	81.4	10.5	2.5	859
Replacement P	410	3.9	78.3	10.3	3.1	982
10	476	3.7	79.4	10.2	2.8	927
20	526	3.9	79.0	10.4	2.3	951
LSD (P=0.05)	*89*	*0.3*	*NS*	*NS*	*NS*	

It is not clear if this is caused by P mineralisation after an exceptional growing season in 2009 or an example of the inaccuracy of the Colwell P test for calcareous soils.

In 2010 there was a response in early dry matter, grain yield and protein to P rates above 10 kg/ha in the good zone compared to the nil P treatment. The nil P treatment had less dry matter than P applied at 10 kg/ha in the poor zone, and generally less grain yield than all P treatments. Protein levels were similar across all treatments. Test weights were greater than 78 g/hL and screenings were 3.1% or less for all treatments.

A basic gross income analysis on all treatments shows that P increased the gross income in 2010 compared to the nil P strategy. The highest gross income in the good zone was produced by the 20 kg/ha P treatment. The replacement P strategy returned the highest gross income in the poor zone.

What does this mean?

At this early stage of the trial a replacement P fertiliser strategy appears to be a sound risk management tool (see EPFS Summary 2009 pp 162-163 to determine P replacement strategy). Both the poor zone and the good zone showed no production loss in 2009 when a replacement rate of P was applied compared to the average (10 kg/ha) and twice average (20 kg/ha) treatments, and there was a yield increase in 2010 compared to the nil P treatment. This yield increase provided a 10% increase in gross income in the good zone and a 12% increase in the poor zone.

The trial will continue over the next 2 seasons with appropriate soil analysis carried out to measure any changes in soil P and if there is any impact of differing P regimes on crop performance. The results from this trial will undergo a financial assessment to evaluate the merits of each system in subsequent years.

Acknowledgements

Thanks to Roy Latta and Nigel Wilhelm for advice on this trial during the year. Also thanks to Sue Budarick, Alex Watts and Jake Pecina for their technical assistance during the year and to Linden Masters for his help harvesting the trial.

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Measuring the Effect of Residual P

Cathy Paterson, Roy Latta, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2009 Total: 417 mm
2009 GSR: 330 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 4.7 t/ha (W)
Actual: 2.8 t/ha
Paddock History
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Red sandy loam
Plot size
1.4 m x 12 m

Key messages

- **A site with high phosphorus (P) reserves needed no applied P fertiliser in 2010 to produce a 2.5 t/ha wheat yield.**

Why do the trial?

While we know soil reserves of phosphorus (P) are an important source of P for crops, we do not have a good understanding of how long soil P reserves last or how applied fertilisers contribute to soil reserves.

In order to assess the P response from current and residual fertiliser applications, a 4 year replicated trial was established at MAC with the changes in soil P measured annually as Colwell P, and the comparative crop performances monitored.

How was it done?

A 4 year replicated trial was established in Paddock South 1, Minnipa Agricultural Centre in 2009. The trial aims to measure comparative wheat yields in response to different rates and strategies of P applications over time. Table 1 shows the P application rates on each of the 10 treatments over the 4 years of the study. Deep banded DAP is used as the P supply with the N balanced using urea to give a total at 18 kg N/ha. The trial was sown on 10 June with Wyalkatchem wheat at 60 kg/ha.

Dry matter production was sampled on 9 September (end of tillering). Grain yield and grain quality were measured at maturity. All plots received standard weed management.

What happened?

Colwell P assessments taken before seeding showed a range in P levels (34-53 mg/kg), but with no relationship between 2009 applied P and 2010 measured levels. This was an increase from the 2009 pre-seeding site measure of 27 mg/kg Colwell P. There was a dry matter response where 10 and 20 kg/ha of P was applied; however this did not result in a yield increase. None of the P treatments affected grain quality with test weight more than 80 kg/hL and screenings less than 2.2%. The low protein levels are indicative of a season such as 2010.

Table 1 Phosphorus (kg/ha) applied over the 4 year duration of the project, 2009 - 2012

4 YEAR PLAN	Year 1	Year 2	Year 3	Year 4
Treatment	**2009**	**2010**	**2011**	**2012**
1	20	20	20	20
2	0	0	0	0
3	10	0	0	0
4	5	10	0	0
5	5	5	10	0
6	5	5	5	10
7	5	0	0	0
8	5	5	0	0
9	5	5	5	0
10	5	5	5	5

Table 2 Dry matter (DM), wheat yield and quality in response to applied P rates in 2009 and 2010

2009 P (kg/ha) Treatment	2010 P (kg/ha) Treatment	DM 9 Sept (t/ha)	Grain Yield (t/ha)	Test Wt (kg/hL)	Screenings (%)	Protein (%)
20	**20**	2.1	2.8	81.5	1.7	9.0
0	**0**	1.4	2.7	80.4	2.1	9.4
10	**0**	1.3	2.7	81.5	2.2	9.2
5	**10**	1.7	2.8	81.3	1.9	9.0
5	**5**	1.8	2.8	81.1	1.6	9.0
5	**5**	1.5	2.7	80.8	2.0	9.0
5	**0**	1.4	2.7	79.6	2.1	9.1
5	**5**	1.5	2.6	80.7	2.1	9.1
5	**5**	1.6	2.7	79.5	2.2	9.2
5	**5**	1.7	2.7	80.9	2.0	9.3
LSD (P=0.05)		*0.4*	*NS*	*NS*	*NS*	*NS*

What does this mean?

Despite the increase in dry matter in response to 20 kg of P (40 kg over 2 years), compared to the nil and several of the 5 kg/ha treatments, this did not equate to a gain in grain yield. This would indicate that the variance measured in the pre-seeding Colwell P tests was adequate to produce a 2-3 t/ha crop. Similar results were found last year in this trial (EPFS 2009 pg 156-157) and in trials done by Sean Mason (EPFS 2009 pg 150-153). Alternatively there may be a constraining issue in this soil type or other nutrient deficiency as yet unidentified resulting in a water use efficiency figure around 60% of optimum.

Soil analysis will continue over the next 2 seasons to continue measuring any changes in soil P and if there is any impact of differing P regimes on crop performance. The results from this trial will undergo a financial assessment to evaluate the merits of each system in subsequent years.

Acknowledgements

We gratefully acknowledge the help of Sue Budarick, Alex Watts and Jack Pecina for their technical assistance during the year.

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Phosphorus Use In Wet and Dry Soil Conditions

RESEARCH

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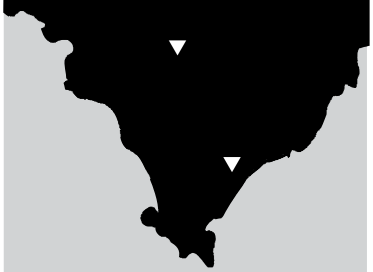
Searching for answers



Location:
Langhorne Creek, McAnaney Family, sand over calcrete
Karoonda, Loller Family, deep sand and sand over clay
Halidon, Schober Family, deep sand over clay
Wanbi, Obst Family, loamy sand over calcrete
Minnipa, MAC, alkaline sandy loam
Wharminda, Hunt Family, sand over clay
Plot size
10 cm diameter open bottom core planted within a 3 x 4 m area with 4 reps.

Key message

- **The amount of applied phosphorus (P) fertiliser that was used by the crop plant increased with increasing simulated rainfall.**
- **The amount of P fertiliser used was not directly related to whether the soil was deficient or sufficient in P, but the growth response was.**
- **The use of subsoil P increased with the addition of P fertiliser, suggesting that the P fertiliser stimulated root growth into the subsoil.**

Why do the trial?

Phosphorus fertiliser efficiency varies across sites and seasons. Soil fertility and seasonal soil moisture conditions both influence this fertiliser efficiency. The efficiency of fertiliser use by the target crop has rarely been quantified directly and is often assumed to be 15-25% (McLaughlin et al. 1988). In larger scale field trials fertiliser efficiency can be measured using indirect methods where a control of no P is compared with plus P treatments, but this measurement is susceptible to interference from other factors (disease, soil type change etc.) and lack of response does not mean that the fertiliser did not contribute P to the crop.

Seasonal conditions also influence the relationship between fertiliser and topsoil and subsoil P uptake by crops. Our hypothesis was that under dry conditions a plant might push more roots into the subsoil and access nutrients from deeper in the profile, due to the inaccessibility of nutrients in the dry topsoil. To test this we measured topsoil and subsoil contribution to plant P uptake in response to wet and dry conditions at 3 of the 7 sites (choosing sites that actually had subsoils to extract nutrients from!).

How was it done?

We had 7 experiments in the field under rain-out shelters where we directly measured the uptake of P fertiliser (using radioisotope) under wet (decile 7-8) and dry (decile 2-3) in-season conditions. Our 7 experiments were at Karoonda (2 soil types), Wanbi, Halidon, Langhorne Creek, Wharminda and Minnipa. These soil types ranged from neutral to alkaline pH and P deficient (Langhorne Creek and Wanbi) to sufficient (Karoonda, Halidon, Wharminda and Minnipa) soil test (CDGT-P) values (Table 1).

Table 1 Soil test results

Site	Langhorne Creek	Karoonda (Deep sand)	Karoonda (Sand/ clay)	Halidon	Wanbi	Minnipa	Wharminda
pH (H_2O) topsoil (0-10 cm)	7.5	6.6	6.5	6.9	8.8	8.6	6.8
pH (H_2O) subsoil (15-50 cm)	7.7 - rock	7.1 - 7.1	7.0 - 9.0	7.6 - 8.8	8.8 - rock	8.8 - 8.8	8.8 - rock
Carbonate (%)	<0.2	<0.2	<0.2	<0.2	6.1	1.6	<0.2
Colwell P* (mg/kg)	52	26	29	54	28	41	35
CDGT - P* (µg/L)	58	206	241	75	30	91	114

** Critical value for colwell P is 15 - 20 mg/kg for light textured soils while for CDGT - P it is 60 (µg/L)*

We added P fertiliser containing a radioactive tracer that gives the fertiliser a unique 'fingerprint' so that we can track the uptake of fertiliser into the plant. The P fertiliser was added at 15 kg P/ha as phosphoric acid. Liquid fertiliser was used because it is difficult to manufacture consistent and comparable radioactive fertiliser granules. There was a control of no P fertiliser for comparison and all treatments received 20 kg N/ha as urea and 2.5 kg Zn/ha as zinc sulphate at sowing. The Mallee sites received 50 kg N/ha at Zadoks growth stage 30 (late tillering).

The plants were sown into soil at 50% of field capacity (ideal sowing moisture). We then watered the plants to simulate decile 2-3 vs. decile 7-8 conditions to represent wet sowing-dry growth phase and wet sowing-wet growth phase scenarios. It was quite difficult at times to achieve the decile 2-3 growing conditions due to the prevalence of good subsoil moisture reserves in 2010.

Wheat (cv. Axe) plants were grown until Zadoks 47 (head in the boot) and harvested by hand so that we could measure dry weight, P content and fertiliser content using radioactivity. We recognise that there is a difference in P use efficiency in different cultivars of wheat. We selected the cultivar Axe because it has a short growing season and due to the decay of radioactivity limiting the length of experiment to 3 months, we wanted a variety that would be near completion of the P uptake phase of the growth cycle (root uptake of P tends to be limited from flowering onwards).

To measure the contribution of topsoil and subsoil residual P to plant nutrition at 3 of the sites (Karoonda deep sand, Halidon and Minnipa) we had to devise a more complicated methodology. In this experiment we labelled the fertiliser with one isotope and then used another isotope of P to fingerprint (label) the topsoil. We used a physical barrier to prevent roots growing into subsoils in some treatments and were therefore able to determine the use of subsoil P by difference. This experiment also used the simulated decile 2-3 and decile 7-8 rainfall applications.

What happened?

Plant Response to Phosphorus

At Wanbi, Langhorne Creek and Wharminda, the addition of P increased shoot dry weight, while at Wanbi decile 7-8 also increased shoot dry weight compared with decile 2-3 (Table 2). At the Karoonda sand over clay and Halidon there was a negative growth response to P addition (reason unknown) while at Minnipa site there was no response to P fertiliser addition. At all three sites there was no difference between the simulated low and high rainfall treatments (Table 2). We think this is because the roots were able to readily access subsoil moisture and so the topsoil watering treatments did not affect shoot growth. By contrast, on the Karoonda deep sand there was no response to added P but we did see increased shoot dry weight in the wet treatment.

Fertiliser Efficiency

'Fertiliser efficiency' is the percentage of the P fertiliser added that was used by the crop plant. The fertiliser efficiency was higher in the decile 7-8 treatment in all soils except the Karoonda sand over clay and the Wharminda soils (Table 3). The Wharminda result is surprising as this soil recorded a shoot response to both the extra rainfall of decile 7-8 and P addition. The fertiliser efficiency was in the order of 3-30% of P added. At P application rates of 10-20 kg P/ha this equates to 0.3-6 kg P/ha being used in the year the fertiliser is applied. This remaining (unused) fertiliser will also have residual value in subsequent seasons (depending on climate and soil conditions).

Topsoil vs. Subsoil P uptake

Although none of the three sites (Karoonda deep sand, Halidon and Minnipa) showed a dry weight response to the addition of P fertiliser, the P fertiliser still made a significant contribution to total plant P uptake in the order of 7-10% of total plant P at Minnipa and up to 43-44% of total plant P at Halidon (Table 4). The contribution of subsoil P to plant P nutrition was increased by adding P fertiliser (Table 4). The very low contribution of the subsoil to crop P uptake at Minnipa may be related to the high subsoil pH (pH 8.8 cv. pH 7.1-7.6 for Karoonda and Halidon, Table 1), which can both inhibit the availability of P and indicate the presence of other subsoil constraints such as boron and sodicity (which is currently being tested for).

Table 2 Plant dry weight t/ha in response to P fertiliser and applied rainfall

Site	Langhorne Creek		Karoonda (Deep sand)		Karoonda (Sand over clay)		Halidon		Wanbi		Minnipa		Wharminda	
	Decile		Decile		Decile		Decile		Decile		Decile		Decile	
	2 - 3	7 - 8	2 - 3	7 - 8	2 - 3	7 - 8	2 -3	7 - 8	2 - 3	7 - 8	2 - 3	7 - 8	2 - 3	7 - 8
0P	2.7	2.1	1.9	3.5	5.4	5.0	1.2	2.2	1.0	1.6	7.3	6.7	2.0	3.7
+P	3.4	4.5	2.4	3.7	4.2	4.2	1.0	0.9	1.9	3.5	7.1	6.8	3.2	4.6
LSD (P<0.05)	*Fert (1.1)*		*Water (0.4)*		*Fert (0.7)*		*Fert, water (0.7)*		*Fertxwater (0.5)*		*No effects*		*Fert (0.7)*	

Nutrition

Table 3 Fertiliser efficiency (%) under decile 2 - 3 vs. decile 7 - 8

Site	Langhorne Creek	Karoonda (deep sand)	Karoonda (sand/ clay)	Halidon	Wanbi	Minnipa	Wharminda
Decile 2 - 3 Fertiliser Efficiency	25.0	7.6	22.7	5.7	8.9	2.6	22.8
Decile 7 - 8 Fertiliser Efficiency	33.5	15.5	22.1	18.6	16.9	10.4	24.2

Statistics: Site x Water treatment (P<0.05, LSD 6.0)

Table 4 Plant phosphorus that came from fertiliser, topsoil and subsoil (%) for decile 2-3 vs. decile 7-8

Site	Karoonda (Deep Sand)		Halidon		Minnipa	
Watering	Decile 2 - 3	Decile 7 - 8	Decile 2 - 3	Decile 7 - 8	Decile 2 - 3	Decile 7 - 8
	Plus P fertiliser					
Fertiliser P (%)	15.1	18.5	44.2	43.4	6.8	10.2
Topsoil P (%)	29.0	27.5	29.0	50.0	89.4	71.3
Subsoil P (%)	48.0	53.2	19.0	7.0	6.7	18.3
	No P fertiliser					
Topsoil P (%)	75.5	79.5	97.2	84.8	95.0	86.4
Subsoil P (%)	24.5	20.6	3.7	15.2	5.0	13.6

Statistics: Site x Water x P Source (fertiliser/topsoil/subsoil) (P<0.05, LSD 11.9)

What does this mean?

The addition of P fertiliser to a P deficient soil will increase shoot biomass. The CDGT-P soil test was able to reliably predict which soils were P deficient. In general the amount of P fertiliser added that was used by the crop plant was greater for decile 7-8 compared with decile 2-3 simulated rainfall. The fertiliser efficiency ranged from 3-30% and was different for different soils, but a more P deficient soil did not necessarily have a higher P fertiliser efficiency. The importance of subsoil P to crop plant P uptake increased with the addition of P fertiliser, suggesting that the fertiliser P is important for root vigour enabling the crop plant to then access subsoil nutrients.

Acknowledgements

Funding for this work was from South Australian Grains Industry Trust and Australian Research Council (LP0882492). Thanks to MAC and the Hunt family for providing land and watering for EP sites and to the Loller, Obst and Schober families for providing land for Mallee sites. Thanks to Bill Davoren, Anthony Whitbread, Rick Llewllyn, Glenn McDonald and Bill Bovill for collaboration in the Mallee. We gratefully acknowledge Colin Rivers and Caroline Johnston for technical support, Sean Mason for DGT analyses and Erik Smolders and Yibing Ma for discussions of the topsoil-subsoil experimental design.

Wheat Variety Response to P on Grey Calcareous Soil

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DEMO RESEARCH

Searching for Answers

Location:
Mudamuckla
Rainfall
Av. Annual: 290 mm
Av. GSR: 216 mm
2010 Total: 347 mm
2010 GSR: 275 mm
Yield
Potential: 3.3 t/ha (W)
Actual: 2.4 t/ha (Mace - 4 units P/ha)
Paddock History
2009: Canola and medic feed
2008: Barley - Maritime 0.88 t/ha
2007: Barley - Barque 0.30 t/ha
Paddock History (replicated trial)
2009: Wheat
Soil Type
Grey calcareous sandy loam
Soil Test
Colwell P, Mineral N
Plot Size
9 m x 4 reps
Yield Limiting Factors
Mice damage early in the season

Key messages

- **There was no yield response to increased P rates in any variety tested suggesting that adequate available soil P masked any purported difference in P use efficiency between varieties.**
- **However, there was a trend in that the grain yield of the variety Axe increased in response to higher levels of P in both the replicated and broad acre studies.**

Why do the trial?

Previous research has shown that there is considerable variation in the efficiency of phosphorus use among varieties of wheat (EPFS Summary 2009 pp 37-38). A replicated trial and a paddock sized demonstration was designed to compare P efficiency of commonly grown varieties (plus a few new ones) on the upper EP to provide farmers with better knowledge of their current varieties, or select new varieties that may better utilise applied P in a grey calcareous soil. The paddock sized evaluation was seeking to clarify the most appropriate fertiliser strategy for different zones in the paddock and the relationship with different varieties.

How was it done?

A replicated trial was established at Mudamuckla on 2 June on a grey calcareous sandy loam. Seven varieties of wheat were grown at 3 rates of phosphoric acid (0, 4 and 8 kg P/ha) with all varieties sown at a calculated density of 150 seeds/m^2. Measurements taken during the year included; soil chemical analysis, plant establishment, grain yield and quality. All plots received standard weed management.

In a neighbouring paddock, four wheat varieties, (Axe, Gladius, Mace and Yitpi) were sown with up to 6 treatments 4, 6, 8, 10 and 12 kg P/ha (phosphoric acid delivered as fluid) plus nil P. Strips were sown the length of the paddock using the different phosphorus rates and wheat varieties. All strips were harvested with a commercial header using a yield monitor to record wheat yields. This repeated a 2009 evaluation (EPFS summary 2009; Mudamuckla Focus Paddock, p 93).

What happened?

Soil tests taken before seeding from the replicated trial indicated that the Colwell P level at the trial site was 43 mg/kg and the mineral N levels were 155 kg/ha (0-60 cm). There was mice damage at emergence resulting in some established plant differences between treatments, all treatments were less than the planned 150 plants/m^2 (Table 1). There was no grain yield response to applied P within any variety. Protein contents, test weights and screenings were also similar within each variety.

What does this mean?

The Colwell P levels, 43 mg/kg, measured before seeding suggest that there may have been sufficient available P in the soil for the 2010 growing season. No statistically significant response to applied rates of P in grain production in any of the varieties would support this suggestion. The paddock this trial was in has an excellent P history, which may be compounded by a string of below average production years where the inputs exceed the nutrients exported in the grain.

Table 1 Wheat establishment, grain yield and quality, gross income (GI) calculations in response to variety and P rate in the 2010 replicated trial

Variety	P rate (kg/ha)	Establishment (plants/m²)	Yield (t/ha)	Test Weight (kg/hL)	Protein (%)	Screenings (%)	Pay Grade	GI ($/ha)
Axe	0	128	1.8	78.4	11.1	2.6	APW1	524
	4	113	1.7	79.4	11.1	2.3	APW1	457
	8	117	2.0	79.2	10.7	2.2	APW1	555
Gladius	0	114	2.2	78.6	11.0	2.1	APW1	638
	4	102	2.1	78.4	11.0	2.4	APW1	585
	8	108	2.2	78.7	11.1	1.9	APW1	596
Lincoln	0	133	1.9	77.5	9.4	4.5	ASW1	473
	4	123	2.0	75.7	9.1	5.7	AGP1	458
	8	125	2.0	78.2	9.5	4.5	ASW1	471
Mace	0	133	2.3	77.2	9.9	2.8	ASW1	590
	4	101	2.4	78.8	9.9	3.0	ASW1	611
	8	126	2.1	78.0	10.3	2.0	ASW1	511
Scout	0	132	1.7	79.6	10.1	2.5	ASW1	435
	4	87	1.8	79.0	10.2	3.5	ASW1	438
	8	107	1.7	79.2	10.0	3.2	ASW1	394
Wyalkatchem	0	101	2.2	77.0	10.0	2.3	ASW1	559
	4	131	2.1	76.9	9.6	1.8	ASW1	530
	8	121	2.3	78.4	9.8	1.6	ASW1	565
Yitpi	0	110	2.0	79.7	11.5	4.2	H2	631
	4	129	2.0	78.9	11.5	3.0	H2	603
	8	127	2.1	79.1	11.5	3.7	H2	624
LSD (P=0.05)		*29*	*0.3*	*1.8*	*0.7*	*1.0*		

Table 2 Grain yields, gross margin, extra income and return on investment from the P applied in the 2010 broad acre evaluation

Variety	P applied (kg/ha)	Yield (t/ha)	Gross margin ($/ha)	Extra $ from P* ($/ha)	Return on P investment (%)
Axe	0	1.9	485		
	4	2.1	529	59	279
	8	2.4	589	135	333
Gladius	0	2.3	598		
	4	2.3	583	1	-94
	6	2.4	598	24	4
	8	2.2	542	25	-179
	10	2.3	571	13	-67
	12	2.5	597	46	-1
Mace	0	2.3	600		
	4	2.0	605	21	32
	6	2.4	611	34	47
	8	2.5	629	60	92
Yitpi	0	2.1	524		
	4	2.2	548	40	156
	8	2.3	564	71	129

*Income was based on $300/t for the grain with variable costs from a calculated on Mudabie farm figure of $92/ha + $4 for every unit of P applied. * Extra total income from applying P as compared to nil P (yield x $300)*

However, in both the replicated trial and the broad acre evaluation there was a trend from the wheat variety Axe to respond to increased levels of P application. This replicates the 2009 broad acre study where there was also a suggestion of an Axe response to increasing P rates. The 2009 response was not repeated with Gladius in 2010 with no suggestion of increased yield from increased P application rates (0, 4, 6, 8, 10 and 12 kg/ha).

It must be remembered that seeding was relatively early in May 2009 and in 2010 the growing season was longer than usual, both situations that would not benefit the comparative yield of the early maturing Axe above the other early-mid season to mid season varieties in the study. The 8 kg of applied P allowed the Axe to achieve a similar yield to other varieties irrespective of their applied P rate. Indications were that all other varieties with longer growing seasons in an above rainfall season with a soft finish, were able to meet required P demands from the soil P reserves.

Peter Kuhlmann, Mudabie Pty Ltd

General notes on broad acre study

- The rainfall was adequate up until late September with the 48 mm of rain in the last 3 days of October too late for the earlier maturing Axe and Mace.
- Protein levels were low due to seasonal conditions and the high yields and all varieties were APW quality.
- All varieties yielded more under higher fertiliser rates. With exceptional yields and high prices, putting on high rates of fertiliser was a great investment (Table 2).
- As in 2009, Axe was the most responsive variety with 8 units increasing yields by 0.44 t/ha giving a return on investment of 333% (gain from fertiliser less cost of fertiliser then divided by the cost of the fertiliser). Mace, Yitpi and Gladius had similar yield responses to phosphorus despite a couple of aberrations in the Gladius yields.
- When comparing varieties at 4 units of P (normal practice) yields were Axe 2.12 t/ha (97% of Yitpi); Gladius 2.3 t/ha (105%); Mace 2.38 t/ha (109%) and Yitpi 2.19 t/ha (100%).
- The good zones (usually sandier soil on hills) were still the best yielding parts of the paddock unless limited by nitrogen deficiency, grass or root disease. The wet season reduced the variation across the paddock by improving yields on the average and poor zones as the lower water holding capacity of the soils was not so limiting in 2010. The poor zones were still the lowest yielding areas of the paddock.
- Using a P replacement strategy, replacing the phosphorus removed by the grain in this paddock in 2010 (3 kg P/t of wheat) will require 7 units of phosphorus next year which is above the normal rate.

Acknowledgements

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Nutrition

SARDI

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Explanation and use of the Phosphorus Buffering Index (PBI)

RESEARCH

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Key messages

- **The PBI measurement is useful to include in soil testing programs.**
- **At the moment PBI is required to help improve the interpretation of Colwell phosphorus (P) results.**
- **The PBI is being evaluated for use in conjunction with soil tests to predict the rate of P fertiliser required to maximise yields.**

Why do the article?

This article aims to describe the potential uses of the PBI measurement. Soil testing companies are now including the PBI measurement in their programs on the back of work from Moody (2007) that indicated PBI can improve the interpretation of Colwell P values. Improving the Colwell P measurement is important to the EP region due to the known poor performance of using Colwell P values alone to interpret the amount of available P in calcareous soils. Recent work (Mason et al. 2010, Bates and Mason EPFS 2009, pg 150) has reviewed how much the PBI improves Colwell P interpretation and how PBI can be beneficial for use in precision agriculture.

The following article will summarise results relevant to the EP and recent developments with PBI methodology.

How was it done?

PBI methodology

The PBI measurement provides an indication of the ability of a particular soil to fix P when it is applied. It is a single point measurement, using only one application rate of P and is used as a quick alternative to the production of P sorption curves using a range of P application rates to determine the Phosphorus Buffering Capacity (PBC) of a soil. The PBI method has been highly correlated with the PBC measurement (Burkitt et al. 2002).

An addition of 100 mg/L P in solution is added in a 1 to 10 ratio, which equates to an addition of 1000 mg P/kg to the soil. The soil solution is equilibrated overnight and a sub-sample is measured for P concentration. The PBI is simply a measure of the difference between the amount of P added and the amount of P remaining in solution, which gives the amount of P sorbed.

Interpreting Colwell P from PBI measurement

The theory behind combining PBI with Colwell P to help its interpretation is discussed by Moody (2007). In summary the principle can be best described by placing the forms of soil P in pools,
1) P in soil solution (Intensity – P that is most available for plant uptake),
2) Sorbed P (Quantity – P that will become available for plant uptake with dilution of the intensity pool and
3) Unavailable P (fixed P – not available for plant uptake).
For a low PBI soil the proportion of P between pools favours the soil solution (pool 1) relative to a high PBI soil where the supply from pool 2 to 1 is smaller. Therefore to provide the same amount of available P (pool 1) the higher PBI soil will need a larger pool 2 – Quantity (Figure 1). The Colwell P method is said to include a measure of the amount of sorbed P (pool 2) so the higher the PBI measurement, the higher the critical Colwell P value needs to be to supply the same amount of available P from pool 2 to 1. Moody (2007) established a relationship between PBI and the critical Colwell P values from previous replicated P response trials (Figure 2).

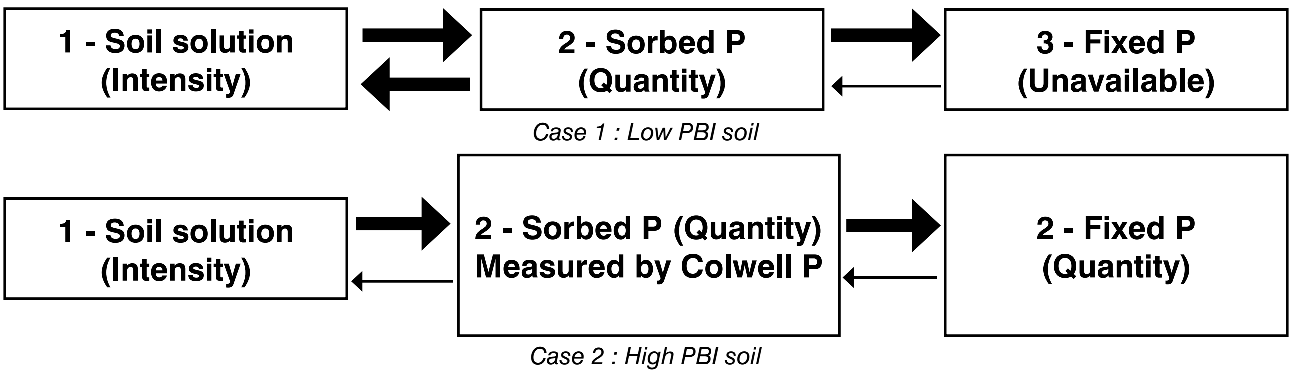

Figure 1 Illustrated theory why the critical Colwell P value should increase with increasing PBI

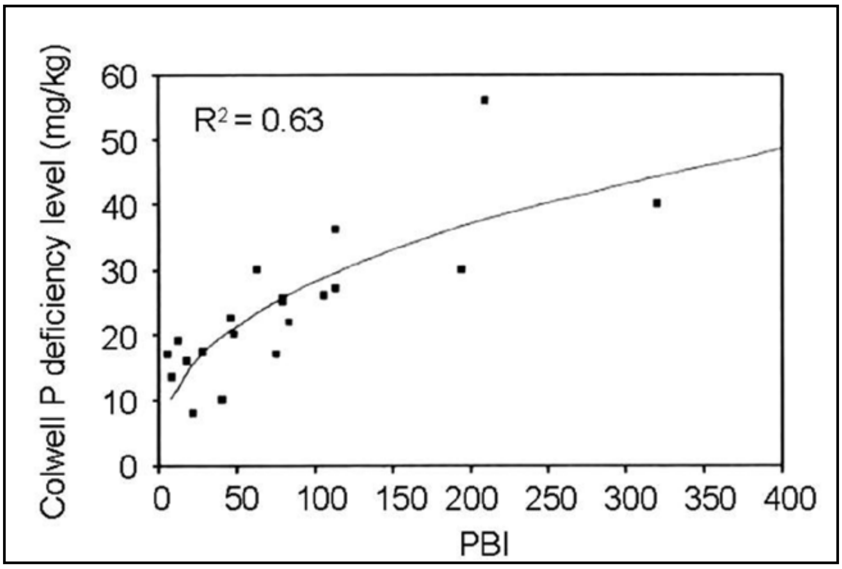

Figure 2 Relationship of PBI with the critical Colwell P value determined from P response trials for wheat, Moody 2007.

Using Figure 2, the Critical Colwell P (CCP – point of adequate P) of a particular soil type can be calculated from a PBI measurement. This creates a CCP value according to soil PBI.

A comparison of the CCP with the actual Colwell P value obtained could determine if a grain response to P is expected using the example in Table 1.The accuracy of this method was tested against the most recent database of replicated P response trials collated across Australia.

Table 1 Comparison of how the PBI value is used to correct the same Colwell P value. *Critical Colwell P is calculated from the relationship in Figure 2.

Site	Colwell P mg/kg	PBI	Critical Colwell P* (mg/kg)	Colwell P - Critical Colwell P	Response to P
1	30	200	37	-7	Yes
2	30	50	21	9	No

What happened?

Typical PBI values obtained on EP by region

The range of PBI values found on EP can vary greatly (Table 2) with the main soil property controlling the P buffering in this region being the calcium carbonate (CaC^{O}3) content. Also included in Table 2 is the success of the Colwell + PBI method for each trial performed from 2007-09.

How successful is the Colwell + PBI method?

From the database of replicated P response field trials for wheat (32 different sites, 46 experiments (2006-10)) the Colwell P plus PBI method correctly predicted the response for 30 of the 46 different data points (65%). This was a significant improvement on using Colwell P results alone where no possible prediction could be used due to the lack of relationship between Colwell P and plant response. For comparison the latest technology in soil P testing (DGT) correctly predicted 39 of the 46 data points (85%). Similar results were found from farmer strip trials run in 2009 on EP (Mason and Bates, EPFS 2009, pg 150) with the Colwell + PBI method correctly predicting the response of wheat in 11 out of 15 trials (73%).

Why the Colwell P + PBI method is not perfect?

The big assumption used for the relationship of the critical Colwell P value with PBI is that the Colwell P method is actually measuring just the quantity pool (sorbed P). It has been shown that the Colwell P method can measure some of the P forms that are in the fixed, unavailable pool (Bertrand et al. 2003) and overestimate the amount of P available to crop during the growth phase, especially in calcareous soils. Unfortunately the errors associated with the Colwell P method are not uniform for particular soil types and are dependent on interactions between soil properties.

Putting PBI values in perspective

The classification system for PBI values published by Moody 2007 is shown (Table 3). Soils with a PBI value below 280 are considered moderate, low below 140 and extremely low approaching values less than 15. Incorporating calculated P rates required to maximise yields early on growth stage (GS30) from the replicated field trial database (see above) suggests that these classifications are on the low side in terms of broad acre agriculture.

Table 2 Typical PBI values on EP by region and the performance of Colwell P + PBI in predicting crop response from subsequent P response trials. An underestimate occurs where Colwell P is less than the CCP but there is no response to P fertiliser, while and overestimate occurs where Colwell P is greater than the CCP but there is a response to P fertiliser.

Site	PBI	Critical Colwell	Colwell P mg/kg	Did Colwell + PBI work?
Buckleboo	128	30	42	Yes
Calca	41	20	11	Yes
Calca (2)	129	33	116	Yes
Edillilie	7	10	9	No (Underestimated)
Koongawa	83	26	24	Yes
Koongawa (2)	76	24	29	Yes
Koongawa (3)	39	15	31	Yes
Koongawa (4)	37	15	32	Yes
Kopi	97	30	48	No (Overestimated)
Koppio	39	19	30	No (Overestimated)
Lock	132	29	53	No (Overestimated)
Minnipa	91	26	30	No (Overestimated)
Minnipa (North, Deep)	44	20	25	Yes
Minnipa (North, Shallow)	56	22	35	No (Overestimated)
Minnipa (South)	48	21	27	Yes
Mt. Greenly	219	38	73	No (Overestimated)
Mudamuckla	139	32	25	Yes
Nundroo	237	38	49	Yes
Piednippie	226	38	61	n/a
Piednippie (2)	200	36	43	Yes
Port Kenny	249	40	39	Yes
Port Kenny (2)	208	35	60	Yes
Wirrulla	163	33	25	Yes
Witera	109	27	29	No (Overestimated)
				67% Predictive power

Table 3 PBI classification system from Moody 2007 with the range of P rates required to maximise yields at GS30 from replicated field trials for each category of PBI values. > values indicate trials where linear responses were observed suggesting higher P rates are required, therefore the top rate of P that was applied is used.

PBI Value	Classification	Number of Trials	P Rate required (kg/ha)
< 15	Extremely low	1	0
15 - 35	Very very low	3	0 to < 5
36 - 70	Very low	12	5 to > 20
71 - 140	Low	12	5 to > 20
141 - 280	Moderate	8	10 to > 30
281 - 840	High	0	n/a
> 840	Very high	0	n/a

At PBI levels that are classified as low and even very low the P rates required can still reach beyond 20 kg P/ha which is considered high and possibly uneconomical. In general terms a PBI of 140 and higher suggests rates of greater than 10 kg P/ha are required. It should be noted that the P rate required is also dependent on starting P levels in the soil and a response at GS30 will not always translate to a response at maturity. Further work is in progress that is aiming at utilising the PBI measurement (fertiliser efficiency) with DGT values (starting P level) to predict the rate of fertiliser required to maximise yields.

What does this mean?

Incorporating the PBI measurement into soil testing programs can provide valuable information for optimising fertiliser inputs.

PBI has been used to help with the Colwell P interpretation but it can also be useful in terms of mapping paddock potential to reduce the efficiency of applied fertiliser.

The PBI measurement does not need to be performed each year as it is quite stable with time. Soils should be sampled every 5 years for a PBI measurement to check consistency.

The potential of PBI to be incorporated with DGT soil testing to help improve fertiliser rate predictions will be further explored.

Acknowledgements

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THE UNIVERSITY OF ADELAIDE AUSTRALIA

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Measuring Soil Carbon in Calcareous Soils

RESEARCH

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Key messages

- **Organic carbon (OC) is overestimated in calcareous soils when standard methods are used.**
- **Carbonate has both a direct and an indirect effect on the accuracy of OC measurements.**
- **A method that more accurately measures OC in calcareous soils has been identified, but it involves the use of very dangerous chemical (hydrofluoric acid), so we used our results to develop a correction factor for the commercially available Walkley Black OC soil test.**
- **The correction factor for our soil set was:**

Corrected OC = 0.39 + (0.97 × commercial OC measurement) – (0.09 × $CaC0_3$% content)

Why do the trial?

Soil organic matter has an important role in soil health and fertility. Soil organic carbon (OC) is the simplest way to measure soil organic matter. Farmers and researchers have been perplexed by high soil test OC values recorded for highly calcareous soils of South Australia. High soil OC test values are taken as an indicator of good soil fertility, yet these soils are renowned for their infertility and lack of yield potential. This contradiction alerted us to the need for testing the accuracy of the soil OC test for these soils. One important farm management consequence of an overestimated soil OC test value is that N fertilizer requirement will be underestimated because the OC level is used in calculators of N fertilizer requirement.

It is known that dry combustion methods used to measure OC, will also detect the C from the carbonate in calcareous soils unless it is completely removed during pre-treatment, whereas wet oxidation techniques should be unaffected by the presence of carbonate. The aims of this experiment were to determine if the carbonate carbon in calcareous soils interferes with the techniques used to determine OC in Australian soil laboratories, and which method is best to accurately measure OC in calcareous soils.

How was it done?

This study compared soil OC contents determined by two methods - dry combustion and wet oxidation. The wet oxidation method used was the Walkley Black method, which is the most commonly used method for commercial soil OC tests and is ASPAC (Australian Soils and Plant Analysis Council Inc) accredited (Rayment and Higginson 1992). The dry combustion values were determined using a standard CSIRO protocol following pre-treatment with various acids.

Measurements were made on nine calcareous and nine non-calcareous soils. The majority of the soil samples were from South Australia, but soils from Queensland, New South Wales, Victoria and Western Australia were also included. The majority of the soil samples were from cropping systems, but a few were from pastoral and viticultural systems.

What happened?

The most promising methods for determining OC content in calcareous soils were the Walkley Black method and dry combustion following exhaustive pre-treatment with hydrofluoric acid. Pre-treatment with other acids followed by dry combustion resulted in over-estimation of OC due to incomplete removal of carbonate.

However, comparison between the Walkley Black and the combustion method suggested that the Walkely Black was still overestimating the soil OC level in calcareous soils. Figure 1 shows that there is a 1:1 relationship between the two soil tests in the non-calcareous soils, while the combustion method is predicting a much lower amount of soil OC than the Walkley Black test in calcareous soils. This cannot be due to direct interference by carbonate, since Walkley Black values are not affected by the presence of carbonate itself. The mostly likely explanation is that calcareous soils contain an abundance of sorbed OC that appears to be associated with the carbonate. This association is likely to make this sorbed OC not readily available for involvement in nutrient cycling. Sorbed OC would be liberated and lost during pre-treatment with hydrofluoric acid and hence would not be detected by the dry combustion method used here, but would be detected by the Walkley Black method.

There are two possible forms of sorbed OC in calcareous soils. The first is OC contained in shelly material that is present in some South Australian Calcarosols that are close to the coast. The second likely form is OC sorbed to carbonate minerals – previous research in our group has shown that organic chemicals, such as pesticides, can have an unusually strong affinity for carbonate, and this study indicates that carbonate may also have a strong affinity for dissolved OC. Further research is needed to confirm the mechanisms responsible for this effect, and to test over a wider range of calcareous soils.

Nutrition

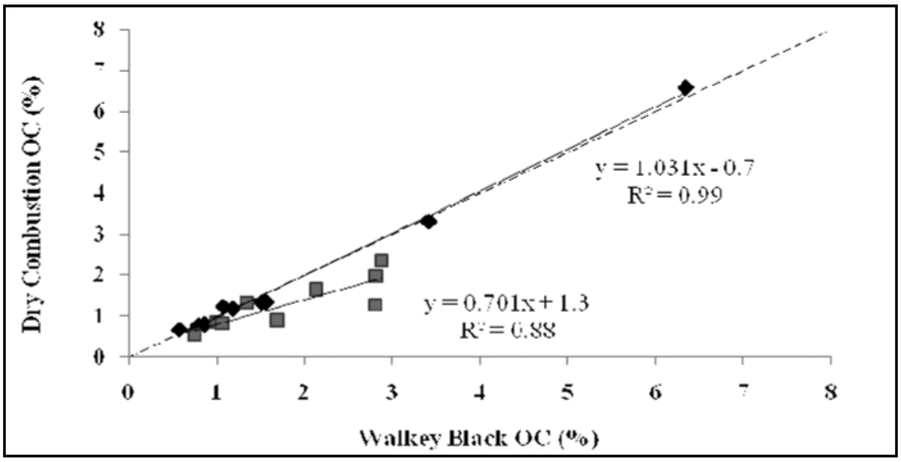

***Figure 1** Hydrofluoric acid (HF) pre-treatment followed by dry combustion resulted in lower OC values than the Walkley Black method. There are two distinct linear relationships for non-calcareous soils and calcareous soils. (♦) Non-calcareous soils, (♦), (- - -) 1:1 line (----) observed linear relationships for non calcareous and all calcareous soils.*

What does this mean?

The results from this study suggest that while the commercially available Walkley Black method for measuring soil OC does not suffer from direct carbonate carbon interference, it detects a different form of OC which may not be readily involved in nutrient cycling and therefore the apparent fertility of the soil. This different form of OC is sorbed OC which is made up of compounds sorbed to carbonate minerals (in calcic calcareous soils) or are incorporated within the structure of shells (in shelly calcareous soils). This would explain the existence of calcareous soils with high OC contents, but low fertility.

This study shows that careful consideration is needed when analysing soil OC in calcareous soils. The end-use of the OC measurement will affect the choice of method. The Walkley Black method would be the best method for determining OC for the purpose of carbon storage, as it is measures all OC (sorbed OC and OC involved in nutrient cycling). The hydrofluoric acid pre-treatment followed by dry combustion may be the best method for determining OC for the purpose of evaluating the potential contribution of OC to crop productivity, as it primarily measures the available OC, but excludes OC strongly associated with carbonate minerals (sorbed OC). However, hydrofluoric acid pre-treatment is not a commercially practical method, as hydrofluoric acid is very toxic and requires special equipment to be safely handled. It is therefore recommended that a very large and representative set of calcareous soils are analysed using this technique in a specialist laboratory. The outcome of this experiment would be the development of a correction factor that could be used to convert the OC content determined using the Walkley Black method on a Calcarosol to give a value that is comparable, in terms of predicting the fertility effect of OC, to Walkley Black values for non-calcareous soils.

We have determined such a correction factor using the data from this study (Equation 1), but we emphasise that this is based on a limited set of soils and it is likely that more data is required to provide a reliable equation.

Corrected soil OC = 0.39 + (0.97 × Walkley Black OC) − (0.09 × $CaCO_3$ % content) *(1)*
R2 = 0.99

Reference List

Rayment GE and Higginson FR (1992) Australian laboratory handbook of soil and water chemical methods. Inkata Press, Melbourne, Vic.

Acknowledgements

Thanks to Colin Rivers and Steve Szarvas of the CSIRO for their analytical support. Thanks to the GRDC, The Ranson Mortlock Trust, The Commonwealth Hills and Phil Watters Memorial for the award of scholarship to AS.

Australian Government
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SAGIT

The Role of Arbuscular Mycorrhizal Fungi (AMF) in Crop Phosphorus (P) Nutrition: A Need for Changed Ideas

RESEARCH

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Key messages

- **Arbuscular mycorrhizal fungi (AMF) play an important role in delivering P to crops.**
- **However, determination of the actual contribution of AMF to P uptake by different cereal varieties grown in different soil types is needed, to help understand the apparently contradictory results obtained in different cropping regions.**

Why are arbuscular mycorrhizal fungi (AMF) important?

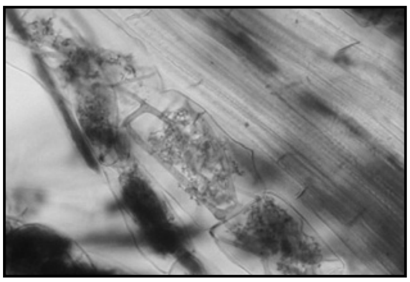
AMF are normal and ubiquitous components of the soil biota. They form beneficial symbiotic associations (partnerships) with the roots of more than 80% of plants, including major field and horticultural crops, as well as pasture species. The activities of fungus and root are closely integrated so that an AM root system is the norm in field conditions. The major exceptions are canola and lupins which do not associate with AMF.

There have been conflicting opinions on the benefits of AMF for cereals. Some research, particularly in the northern Australian grain region, consistently shows marked yield benefits of managing soils and crops to maintain and enhance the extent of AM colonisation of cereal root systems. Other work appears to indicate no benefit of AM colonisation and it has even been suggested that soils should be managed to reduce AMF populations, in order to increase yields. These conflicting views have led to uncertainty of how to manage AMF in field soils and to a situation where much crop research ignores the symbiosis.

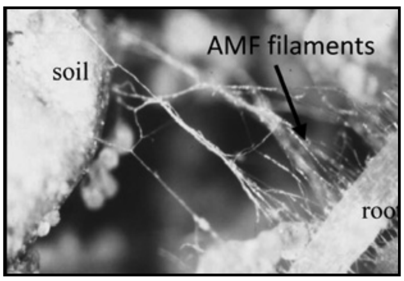
However, new information clearly shows that AMF make very significant contributions to crop phosphorus (P) uptake, regardless of any growth or yield benefits. This means that the AM fungus-plant partnership must not be ignored in research into ways of increasing P uptake efficiency. Such research is critical, because rock phosphate reserves are limited and the price of P fertiliser is rising and subject to both industry and political pressures.

What are AMF?

AMF are one of the biggest contributors to the soil biota and are found in almost all soils, both native and cropped. The AMF grow inside the roots and outside in the soil (Figure 1), forming a critical and highly active link between soil and plants. The natural condition in the field is for plants to be mycorrhizal; this cannot be avoided unless soil is fumigated or sterilised. AMF populations are promoted by minimum tillage and reduced by long fallows, stubble burning and repeat cropping of a non-mycorrhizal crop (e.g. canola). New DNA-based tests are being developed to assess soil populations and ability of the AMF to infect roots. The extent of AM colonisation of roots is often reduced by high applications of P fertiliser. The normal presence of AMF in soils and roots means that it is very difficult to obtain field data on their benefits. Soils have to be fumigated to eliminate or reduce the AMF and provide non-mycorrhizal treatments, but this reduces populations of detrimental pathogens as well as AMF, confounding results of experiments. Most information on function of AM symbioses has had to be obtained from pot experiments under controlled conditions.



AMF structures in wheat roots (blue) growing in soil from Cungena (EP)



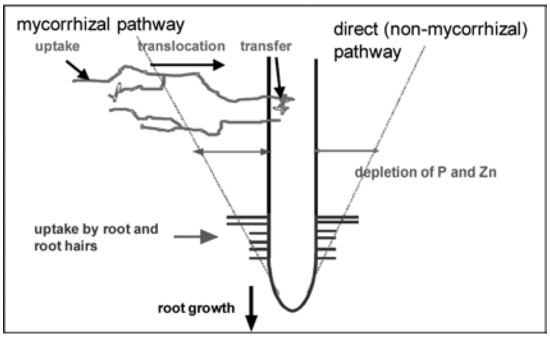
AMF filaments linking roots to soil particles

Figure 1 shows AMF structures (stained blue) inside wheat roots, where nutrients are exchanged and AMF filaments in soil which absorb nutrients. Photos by Lisa Li and Iver Jakobsen

What do AMF do?

Unlike free-living soil organisms which grow on soil organic matter, AMF grow using sugars produced by living plants and in return they deliver nutrients (particularly P and zinc (Zn)) to the plants. Amounts of P have been measured, but amounts of Zn are less clear. The AMF create an extra nutrient uptake pathway (the mycorrhizal pathway - Figure 2) which supplements or even replaces the direct (non-mycorrhizal) pathway. The AM fungal pathway acts like a rapid transit system bypassing the slow movement of nutrients in the soil solution. The hyphae of AMF also help to stabilise soil structure and their activities can improve plant drought tolerance.

Figure 2 shows the two nutrient uptake pathways in an AM root. In the mycorrhizal pathway, fine filaments produced by the fungi (hyphae) grow out from the root, take up nutrients from several centimetres away in soil. Rapid transport through the fungus and transfer to the plant overcome problems of low mobility of these nutrients in soil, which restricts uptake by the direct pathway in plants without AMF. The activity of the mycorrhizal pathway can be tracked using radioactive P isotopes.



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What is new in AM research on cereal P nutrition and growth?

It has always been assumed that the mycorrhizal pathway was 'not working' in plants (like cereals) that showed neither growth benefit nor increased P uptake when mycorrhizal. This led to the idea that AMF could act as parasites by using plant sugars, while not returning any nutritional benefit. This view is now shown to be wrong. New research, some on Eyre Peninsula soils funded by SAGIT and the Australian Research Council, has demonstrated that the mycorrhizal pathway for P uptake is very active in wheat and barley. The AMF delivered up to 80% of total plant P (Figure 3).

The fungi also played a key role in helping the plants to access fluid P fertiliser, as also shown in Figure 2. In a separate experiment it was shown that AMF hyphae could completely replace the activities of roots in P uptake if roots were prevented from accessing the fertilisers. These are very important findings because they show that AMF really are contributing to crop P nutrition. Importantly, research in Denmark showed that the mycorrhizal pathway delivered P to wheat in the field, validating results from pot experiments.

Changed ideas?

AMF play an important role in delivering P to crops. The AMF are not parasitic because they do deliver P in exchange for sugars from the plant. Very importantly, the AMF reduce uptake by the direct pathway and a very small amount of fungus inside the roots can bring this about. Why and how this happens is unknown, but the finding shows that AMF may be playing a controlling role. Another unknown is why AMF have positive effects in some regions of Australia and not in others. The answers most probably lie in differences in responses of crop varieties to local AMF, to the levels and types of P in the soils and in the fertiliser applications. These factors have not been systematically explored.

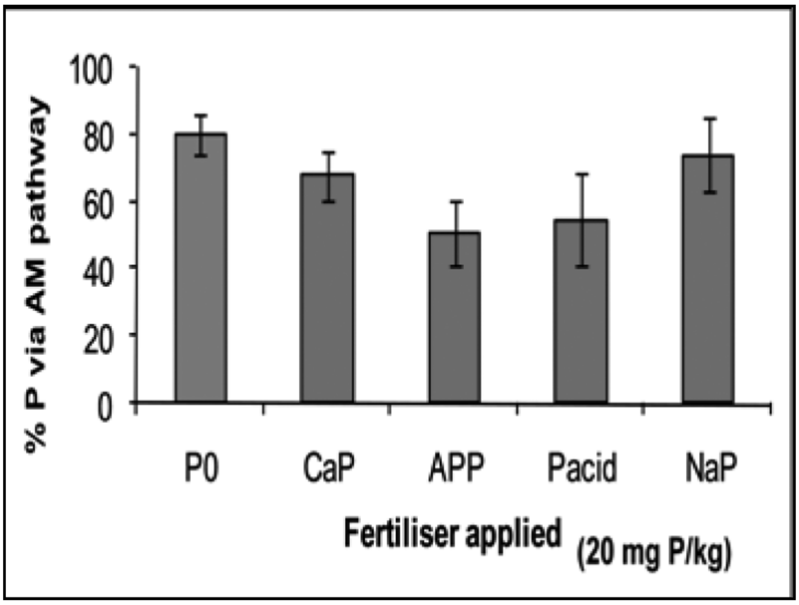


Figure 3 The contribution of the AM fungal pathway to P uptake by wheat grown in soil from Cungena (EP) was between 55 and 80% of the total P in the plants, even though there were no growth benefits, compared with non-mycorrhizal treatments. The activity of the AMF was tracked with 32P. The contribution was highest with no P fertiliser or with added calcium phosphate (CaP), but was still substantial with ammonium polyphosphate (APP), phosphoric acid (Pacid) and soluble sodium phosphate (NaP). The extent of colonisation of the roots was 35-57% of root length, which is high for wheat. Data of Lisa Li.

What is needed now?

Researchers and growers alike need to appreciate that AMF are playing integral roles in root function and P uptake, which are unavoidable because mycorrhizal roots are normal. At the basic level, research is needed to understand how the two pathways for P uptake are integrated and controlled by plant and fungus. A big question is why and how the AMF reduce direct P uptake by the roots but do not always fully compensate for the reduction, leading to P deficiency and poor growth. The knowledge could then be applied in long-term research to manipulate the two P uptake pathways and optimise crop P uptake. At the field level, determination of the actual contribution of AMF to P uptake by different cereal varieties grown in different soil types is needed, to help understand the apparently contradictory results obtained in different cropping regions.

Acknowledgements

Our research was funded by the Australian Research Council and the South Australian Grain Industry Trust. We are grateful for the important contributions of Iver Jakobsen, Bob Holloway, Lisa Li, Emily Grace and Dot Brace.

Nitrogen Management on Upper Eyre Peninsula

Cathy Paterson, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre, [2]Mudabie Pty Ltd

RESEARCH

Searching for Answers

Location:
Mudamuckla
Peter Kuhlmann
Rainfall
Av. Annual: 290 mm
Av. GSR: 216 mm
2010 Total: 347 mm
2010 GSR: 275 mm
Yield
Potential: 3.3 t/ha (W)
Actual: 2.3 t/ha
Paddock History
2009: Wheat
Soil Type
Grey calcareous sandy loam
Soil Test
Colwell P, Mineral N
Plot size
9 m x 4 reps

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 4.7 t/ha (W)
Actual: 2.6 t/ha (55 kg/ha DAP + 20 units N as urea upfront) (W)
Paddock History
2009: Wheat
2008: Wheat
Soil Type
Red sandy clay loam
Plot size
9 m x 4 reps
Yield Limiting Factors
Mice damage resulting in a late resowing

Key messages

- **At Minnipa the late sown (resown due to mice damage) wheat gave a yield response to 20 units of up-front N, but not to N applied in-crop in 2010.**
- **At Mudamuckla there was no response to applied N above base rates on soil with adequate N content in 2010.**

Why do the trial?

Applications of nitrogen fertiliser to wheat crops on upper Eyre Peninsula have been restricted because of concern that increased growth early in the season may reduce grain fill and cause haying off as the increased water use by the crop depletes soil moisture reserves. After an above average growing season in 2009, in some areas of upper Eyre Peninsula, many farmers had concerns about cereal on cereal crops being N limited and were therefore questioning when the best time to apply extra N was.

Previous research has shown that grain yield is not increased by late applications of nitrogen under dry, low yielding environments (EPFS 2002, pp104-105), as this method relies on the nitrogen being leached into the root zone for plant uptake and high levels of nitrogen are lost to volatilisation.

This trial was set up to compare up front applications of N with a split application of N, as well as the efficiency of foliar N compared to granular N.

How was it done?

Trials were established at Minnipa (10 June), Mudamuckla (2 June) and Wharminda (27 May). Due to mice damage the trial at Minnipa was sprayed out and resown on 2 July.

There were 9 treatments applied (Table 1) with Wyalkatchem wheat sown at 60 kg/ha. Measurements taken during the year included; mineral N (0-60 cm), plant establishment, dry matter at early tillering, anthesis and at maturity, grain yield and quality. All plots received standard weed management

What happened?

Soil tests taken before seeding indicated that the mineral N level (0-60 cm) was 79 kg/ha at the Minnipa site, 155 kg/ha at the Mudamuckla site and 66 kg/ha at Wharminda site. Plant establishment densities at each site were similar irrespective of treatment. Minnipa dry matter assessments of treatments at early tillering measured between 1.2-1.6 t/ha, anthesis 4.1-5.9 t/ha and maturity 6.5-8.3 t/ha. At Mudamuckla dry matter assessments of treatments at early tillering measured 0.7-0.9 t/ha, anthesis 5.1-6.1 t/ha and maturity 7.2-8.8 t/ha, however there were no statistical differences between treatments. At Wharminda no meaningful results were gained from this trial due to a high level of Brome grass.

At Minnipa the in-crop N was applied at Zadocks growth stage (GS) 36, at the time of the first available rain events following GS 31, to limit loss due to volatilisation. There was a general yield response to 20 units of N applied as urea up front compared to all other treatments. Yields were also similar or higher in response to N application up front or in crop compared to the nil N and base N DAP treatments. Grain protein and screening percentages were similar across all treatments.

At Mudamuckla there was no response to N applied in terms of grain yield or protein, but N applied generally resulted in higher screening percentages compared to the nil N treatment.

Location:
Wharminda
Ed Hunt
Wharminda / Arno Bay Ag Bureau
Rainfall
Av. Annual: 322 mm
Av. GSR: 222 mm
2009 Total: 479 mm
2009 GSR: 349 mm
Yield
Potential: 5.3 t/ha (W)
Actual: n/a
Paddock History
2009: Wheat
2008: Pasture
2007: Pasture
Yield Limiting Factors
Brome Grass

What does this mean?

At Minnipa the in-season application of N was not able to be done until 12 October when the crop was at GS 36, which is later than the recommended application time. This factor, in conjunction with the later sowing time which resulted in the crop having a shorter growing season, resulted in no response to N applied in-crop in 2010.

Gross margins benefited from applying extra N at Minnipa with an extra 0.2 – 0.4 t/ha grossing $60 - $120/ha (APW @ $300/t) at a cost of approximately $10-20/ha for product.

Soil tests taken at Mudamuckla indicated that the amount of mineral N was sufficient for crop production without the application of extra N, this proved to be the case with no yield response to applying extra N.

Acknowledgements

Thanks to Alex Watts and Jake Pecina for helping with sampling.

Table 1 Wheat grain yield (t/ha), protein (%) and screenings (%) at Minnipa and Mudamuckla in 2010

Treatment	Minnipa			Mudamuckla		
	Yield (t/ha)	Protein (%)	Screenings (%)	Yield (t/ha)	Protein (%)	Screenings (%)
55 kg/ha DAP + 10 units N as urea GS 31*	2.3	11.4	1.9	2.2	10.1	2.2
55 kg/ha DAP + 20 units N as urea GS 31*	2.3	11.4	1.8	2.2	10.3	2.9
55 kg/ha DAP	2.2	11.3	1.6	2.3	10.0	2.5
55 kg/ha DAP + 10 units N as UAN GS 31*	2.3	11.3	1.7	2.3	10.2	2.5
55 kg/ha DAP + 10 units N as urea up-front	2.4	11.4	1.9	2.1	10.0	3.1
55 kg/ha DAP + 10 units N as urea up-front + units UAN GS 31*	2.4	11.4	2.0	2.1	10.2	2.9
55 kg/ha DAP + 20 units N as UAN GS 31*	2.4	11.3	1.6	2.2	10.4	2.8
55 kg/ha DAP + 20 units N as urea up-front	2.6	11.4	1.8	2.0	10.2	3.1
triple super 11 units P	2.2	11.4	1.8	2.3	10.1	2.1
LSD ($P \leq 0.05$)	*0.2*	*NS*	*NS*	*NS*	*NS*	*0.6*

** Not applied until GS 36*

Nutrition

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE
GRDC Grains Research & Development Corporation

Critical Growth Stages for Maintaining Sound Nutrition of Crops on Upper EP

Dr Nigel Wilhelm
SARDI, Minnipa Agricultural Centre

INFORMATION

The information in this article was presented by Nigel Wilhelm at the EPARF Crop Growth Day – Growing Your Profit, July 2010.

General Principles

- Wheat requires fourteen essential elements to grow normally and complete its life cycle, which in the case of all annual crops is to produce viable grain.
- Wheat has evolved to be extremely efficient at accessing nutrients from its environment, and generally it is very successful. However, upper EP soils are, in general, very infertile and so present a serious challenge to wheat's ability to acquire nutrients.
- Soils provide the vast majority of nutrients to crops and it is only when the supply is below what is required for optimum performance that fertilisers are used to supplement the soil's reserves.
- Wheat requires a supply of all the essential elements for almost the entire time the plant is growing. It is only during the very first and last stages of development, germination and grain fill, respectively, that it can perform well on the nutrient reserves within itself.
- While a supply of all nutrients nearly all of the time is necessary for the optimum performance of wheat, there are critical times for supply of some elements to ensure healthy growth and grain production.
- For commercial crops, the economically optimum rate to supplement supply of a nutrient is to just below adequacy. However, it is rarely possible to achieve that level of precision in reality.
- There are four ways that the supply of a nutrient to a wheat crop can be supplemented by a fertiliser in a broad-acre, rainfed situation; boosting nutrient levels in the seed, adding nutrients around the seed as a dressing, adding the nutrient to the soil for the crop to find or spraying the nutrient directly onto the shoots of the crop.
- Wheat can only extract nutrients from damp soil.

This paper focuses on critical stages for particular nutrients during the life cycle of a wheat plant and will not deal with most of the issues around rates and dates of using fertilisers in commercial situations. It is constructed in such a way that each nutrient, which may require supplementation via fertilisers on the upper EP, is discussed separately in terms of critical stages of demand and when intervention can be most effective. Nutrients which are supplied in adequate to abundant amounts in upper EP soils for wheat will not be covered.

The primary purpose of this paper is to highlight particular stages in a wheat's life cycle when nutrient supply is most critical or when supplementing the nutrient is most effective (or not). For details sufficient to manage the nutrition of individual wheat crops, follow ups with your normal advisory sources will be necessary.

Nitrogen (N)

- Nitrogen is required in the largest amounts by wheat. It performs many functions within the plant but is best known for its effect on tillering. Without adequate N, wheat will not tiller well, or will even abort existing tillers. Adequate N supply is essential for satisfactory protein levels in grain.
- N can be quite toxic to germinating seeds, although the rates of N normally used at seeding on upper EP rarely cause such problems in wheat.
- If the supply of N from the soil drops below adequate levels, wheat can make use of supplementary N right up, to and including, early grain fill. Thus, the effectiveness of supplementary N is dictated more by environmental conditions (i.e. suitable conditions for applications) than the physiology of the crop, particularly in low rainfall environments.
- In crops yielding above 2 t/ha, maintaining good N supply from late tillering to head emergence is important to preserve the extra tillers required to reach such yield targets. Since this period generally coincides with increased release of N from soil organic matter in spring; N fertilisers are only required if this increased supply is still inadequate.
- Wheat can take up N directly through its shoots, but in most circumstances, most of the N applied as a foliar application still enters via the soil and the root system.
- As N is applied later in crop development, more and more of the extra N that gets into the plant is used to produce extra protein, rather than extra grain yield.

Phosphorus (P)

- Phosphorus is required in large amounts by wheat and since nearly all southern Australian soils are too low in P reserves for acceptable wheat performance, it is a very important nutrient in the economics of wheat production. P is a central component in the energy capturing molecules of plant cells and also assists in many defence pathways of wheat. A supply of P is required by wheat throughout nearly all of its life cycle but it is particularly damaging to the plant if its supply is poor early in the season (up to about stem elongation).
- Using seed high in P is a good way to ensure sound germination, rapid emergence and vigorous establishment.
- The most efficient way to supplement wheat with extra P (after boosting the seed content) is to apply P fertiliser in or near the seed row of the crop.
- When applying P fertiliser to wheat at seeding, the first 5-10 kg P/ha should be applied with the seed. If any more is to be applied, just under the seed row is the preferred position for maximum benefit.
- P can be applied to the shoots of wheat but this technique is proving too unreliable so far to be recommended.

Sulphur (S)

- Sulphur is required in moderate amounts by wheat but few southern Australian soils are deficient in S for wheat. S is important in protein metabolism and also assists in many defence pathways of wheat. A supply of S is required by wheat throughout nearly all of its life cycle but wheat is very adept at moving S around within the plant so supplies later in the season are not so critical.
- Like N, the effectiveness of supplementary S is dictated more by environmental conditions (i.e. suitable conditions for applications) than the physiology of the crop, particularly in low rainfall environments.
- Also like N, S in its available form to wheat (sulphate) is very leachable, so applications at seeding or soon after are vulnerable in this respect.

Zinc (Zn)

- Zinc is the most common and widespread of the three trace elements which occur on upper EP. Its most obvious role in the plant is to help maintain the integrity of cell membranes. When it is in deficient supply, many capabilities of the plant start unravelling (e.g. disease resistance, water use efficiency, rapid grain fill and haying off).
- Seed rich in zinc can really boost early growth in deficient soils.
- Foliar sprays on wheat are effective but best benefits are realised at the 2 leaf stage. The impact of a foliar spray gradually declines at later growth stages.
- To boost the content of seed, a foliar spray can be applied during grain set and early fill.
- Zinc moves very slowly in the soil so applications at seeding time are best in or very near to the seed row. Fluid applications near the seed row give the plant a solid band of Zn to intercept more easily.

Copper (Cu)

- Copper deficiency has been widespread on upper EP but was largely overcome with widespread applications of bluestone super mixes during the 1950s and 1960s. However, these historical applications are probably starting to wear out now and the string of dry springs we have been having make Cu deficiency worse.
- Copper is vital to the production of the building blocks for plants but it causes its most obvious problems at flowering. Copper is essential for the production of fertile pollen so if it is in deficient supply at flowering, flowers will not set, heads will not form normally and grain production can be severely reduced.
- A foliar application within 4 weeks of flowering will protect flowering and seed set.
- While soil reserves of copper can be boosted with applications into the soil at seeding, if springs are dry, Cu deficiency can still occur during flowering.
- With the proviso that they cannot guarantee protection during flowering, soil applications are the most cost effective strategy because they can last for decades.
- Stock grazing on feed low in copper can run into problems with Cu deficiency.

Manganese (Mn)

- Manganese is a trace element whose availability in soil drops rapidly with increasing pH. On upper EP it can occur on the very calcareous soils, on limestone ridges or in white infertile sands (where there is little total Mn in the profile). Mn is vital to maintaining disease resistance pathways in plants and for the production of the mortar which holds plants upright.
- Seed rich in Mn can really boost early growth in deficient soils.

- Foliar sprays on wheat are effective but providing that seed with reasonable Mn content is used, mid tillering timing is probably the most effective; sufficiently early to avoid major growth setbacks but late enough to prolong the benefits through to late in the crop development. Unless you are very experienced at detecting the onset of Mn deficiency, plant tests are the most reliable early indicator of a deficiency for predicting the need for a foliar spray.
- To boost the content of seed, a foliar spray can be applied during grain set and early fill.
- Mn moves very slowly in the soil and is rapidly fixed in calcareous soils so applications at seeding time are best in or very near to the seed row. Fluid applications near the seed row give the plant a solid band of Mn to intercept more easily. Applying with an acidic fertiliser (e.g. MAP) can prolong availability.

As far as we can reliably ascertain, all the other 8 essential elements required for normal wheat growth are supplied by EP soils in adequate amounts under most circumstances. For nutrients such as boron and salt (sodium and chloride) these supplies can be so "generous" that toxicities can occur. Since these nutrients are quite mobile in soils, over time they have been washed down through soil profiles and have tended to accumulate at the bottom of the long term wetting front of upper EP soils (40-80 cm). Where this has led to toxic amounts in these subsoils, B and salt toxicity can start occurring as lots of roots reach these deeper layers (often in spring as crops rely more and more on subsoils for a supply of water).

Section 6

Section Editor:
Cathy Paterson
SARDI, Minnipa Agricultural Centre

Livestock

The Impact of Livestock on Paddock Health

Roy Latta and Jessica Crettenden
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Pasture Dry Matter Production
Potential: 10 DM t/ha
Actual: 4.9 DM t/ha
Paddock History
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Soil Test
Organic C%: 1.18
Phosphorus: 22.8 mg/kg
Plot Size
8 sowing widths across paddock
Yield Limiting Factors
Nil
Livestock
Enterprise type: Self replacing merinos
Stocking rate: Rotational grazing and District practice
Environmental Impacts
Soil Health
Soil structure: Stable
Compaction risk: Plus and minus grazing treatments
Ground cover or plants/m^2: Grazed to 2 t/ha pasture residue
Perennial or annual plants: Annual
Grazing Pressure: High (8 DSE/ha) and medium (3 DSE/ha)

Key messages

- **The high input pasture treatment provided the opportunity to carry 8 DSE/ha with an estimated gross margin of $240/ha, however it was unable to utilise plant available water above 50% of potential water use efficiency (WUE).**

Why do the trial?

A well run mixed farming enterprise of cropping and livestock can be as profitable as a continuous cropping business for most districts across Eyre Peninsula, but carries less risk, as shown by a profitability analysis in the Eyre Peninsula Grain & Graze and Farming Systems projects. However, as livestock graze they remove large amounts of plant biomass which would otherwise have been ground cover then decomposed into the soil and thus contributed to the carbon pool.

In high rainfall areas the benefits of retaining stubble have been shown to improve soil carbon levels and microbial health. In low rainfall areas stubble retention helps reduce erosion and can help plant establishment in poor moisture conditions at sowing, but in an environment where biomass production, soil moisture and microbial activity levels are lower, a clear relationship with soil health is still to be established. Value adding to stubbles by grazing is usually regarded to be of greater economic value.

A broadacre trial was established on Minnipa Agricultural Centre (MAC) to test whether soil health and fertility can be improved under a higher carbon input system with or without grazing. This system is being compared against a more traditional ley (low input grazed) system, as well as a low input ungrazed system.

How was it done?

Paddock South 7 on MAC was divided into 4 x 3.5 ha sections prior to seeding in 2008 (Figure 1). Traditional ley system - grazed (A), Traditional ley system – ungrazed (B), High carbon input system – ungrazed (C) and High carbon input system - grazed (D). Sampling (soil, plant and grain) is carried out at 4 set points in each section. Refer to EPFS Summary 2009, pg 118 for 2008 and 2009 treatments and data collected.

Water Use:
Runoff potential: Low
Resource Efficiency:
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, NO_2, methane): Cropping and Livestock
Social/Practice
Time (hrs): No extra
Clash with other farming operations: standard practice
Labour requirements: Livestock may require supplementary feeding and regular checking
Economic
Infrastructure/operating inputs: High input system has higher input costs
Cost of adoption risk: Low

In 2010 there was a pasture phase imposed on all the treatments, initially the stubble on plots A and D were grazed from 24 to 31 March. Soil chemical analysis and water use efficiency estimates were made from soil water content (SWC) measurements collected on 23 March and 24 November (SWC only). Annual medic (Angel @ 5 kg/ha with 30 kg/ha of DAP) was sown on 22 April on Plots C and D, the high carbon input ungrazed and grazed sections respectively. Further grazing of plots A and D occurred from 16 to the 30 August and then 23 November to the 14 December. Biomass production figures were collected pre and post all grazing events. Medic seed pods were collected, processed and seed yields estimated pre and post the November – December grazing event. Selective chemical grass control was applied to all treatments.

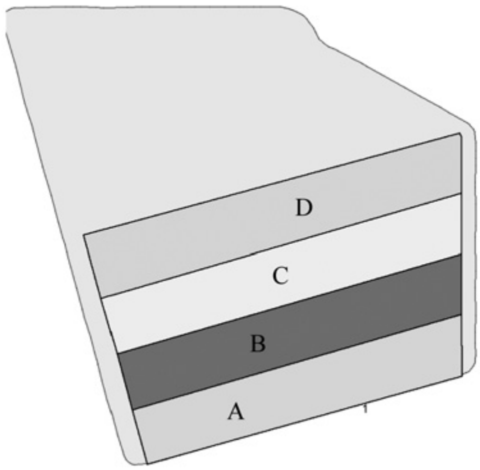


Figure 1 Paddock plan, South 7 MAC

What happened?

2010 was the third year of the trial and the first with a pasture phase.

Table 1 presents the chemical soil analysis, soil water content (SWC), biomass production and the estimated water use efficiency (WUE) of the 4 treatments.

Organic carbon percentage has not increased from the 2008 site mean of 1.2 and 0.6% in the 0-10 and 10-60 cm soil profiles respectively. Treatments did not use the available soil water and with 345 mm April-October growing season rainfall (an estimated 230 mm of plant available water) biomass and WUE figures were relatively low, however 55 mm in late October coincided with the onset of senescence of the annual medic.

Table 1 Organic carbon, soil water content, total biomass production and estimated WUE in 2010

System	Organic C (%)		SWC (mm 0 - 60 cm)		Biomass	WUE
	0-10 (cm)	10-60 (cm)	Mar 2010	Nov 2010	DM t/ha	kg DM/ha of PAW
Traditional ley system - grazed (A)	1.1	0.6	27	40	1.8**	
Traditional ley system - ungrazed (B)	1	0.5	21	38	3.9	17
High input system - ungrazed (C)	1	0.6	24	32	4.9	21
High input system - grazed (D)	1.2	0.5	23	36	3.8**	

** WUE, water use efficiency figures take into account 345 mm of growing season rainfall and soil water content in March and November.*
*** WUE was not calculated as no physical measurement of biomass loss due to grazing was made.*

Table 2 Comparative maintenance of plant residues over 12 months in response to grazing and pasture inputs, and livestock grazing days over the three March, August and November/December grazing periods

System	Plant residue (t/ha)		DSE grazing days			
	Dec 2009	Dec 2010	Mar 2010	Aug 2010	Nov 2010	Annual DSE/ha
Traditional ley system - grazed (A)	2.9	2.1	200 [a]	120 [c]	750 [e]	3
Traditional ley system - ungrazed (B)	3.5	3.1				
High input system - ungrazed (C)	4.7	4.2				
High input system - grazed (D)	3.6	3.3	200 [b]	1200 [d]	1500 [f]	8

[a]40 days grazing with 5 sheep @ 1 DSE, [b]14 days grazing with 28 sheep @ 1DSE, [c]14 days grazing with 7 sheep @ 1.2 DSE, [d]14 days grazing with 70 sheep @ 1.2 DSE, [e]21 days grazing with 24 sheep @ 1.5 DSE and [f] 21 days grazing with 48 sheep @ 1.5 DSE

What does this mean?

The 2010 pasture phase has resulted in a lower crop residue carryover than 2009 and was unable to utilise plant available water above 50% of potential water use efficiency irrespective of treatment; plus or minus grazing, improved sown annual medic or a self regenerating pasture, however reducing the available water by the 55 mm late October event, which coincided with the onset of senescence of the annual medic and may not have been available. If that was the case the WUE figure would increase to above 60% of potential.

The 2010 high input pasture production treatment provided the opportunity to carry 8 DSE/ha with an estimated gross margin of $30/DSE, $240/ha from grazing.

Over the next 3 seasons measurements will be continued to be carried out to assess any changes to soil or crop performance in the farming systems, followed by financial assessment to evaluate the merits of each system.

Acknowledgements

We gratefully acknowledge the help of Mark Klante, Trent Brace and Brett McEvoy for their assistance.

Livestock

Grain & Graze Profit through knowledge EYRE PENINSULA

GRDC Grains Research & Development Corporation

Forage Crops for Grazing at MAC 2010

Roy Latta and Ian Richter
SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Paddock History
2008: Wheat
2009: Wheat
Soil Type
Red sandy loam
Plot Size
20 x 1.5 m x 3 reps
Yield Limiting Factors
Nil
Environmental Impacts
Soil Health
Soil structure: High organic carbon
Compaction risk: Low to medium
Social/Practice
Time (hrs): Sowing pre normal seeding
Clash with other farming operations: Standard management
Labour requirements: Labour to shift sheep
Economic
Infrastructure/Operating inuts: Grazing benefits requiring electric fence, portable trough
Cost of adoption risk: Low

Key messages

- **Simulated grazing up to early tillering on cereals caused only a minor reduction in grain yield.**
- **There are broad leaf field crop alternatives, forage peas and vetch, that as a monoculture or as component of a cereal or oilseed mixture can increase total (anthesis) biomass production.**
- **There are further opportunities to develop farming systems around the multipurpose break crops on upper Eyre Peninsula.**

Why do the trial?

Increasing variation in rainfall patterns may require consideration of multi purpose crops for mixed farming systems. There are a range of alternative field crops that may produce more biomass than current wheat cultivars and can provide options in terms of enterprise diversification, i.e. grazing/stored forage/grain or sometimes combinations of all three.

The aim of this trial is to provide data to assist in decision making when planning to use a field crop as a potential resource for grazing, hay and/or grain based on seasonal conditions, while in some cases utilising the benefits of a break crop within the cropping rotation.

How was it done?

In paddock North 12 on Minnipa Agricultural Centre, field crop varieties (species, varieties and sowing rates are listed in Table 1) were sown into 20 x 1.5 m plots replicated 3 times on 31 May. Sowing rates were adjusted to establish 150 plants/m^2 of cereals, 75 of pulses and 50 of canola. DAP @ 60 kg/ha was applied at seeding, no further fertiliser or weed control was applied.

Plant counts, early biomass production and simulated grazing on 1 replicate (mowing) was carried out on 5 August and biomass production measurements were repeated on 28 September (approximately at anthesis) with grain harvest completed on 3 December from both the mown and unmown plots.

What happened?

Established plant numbers were 10 – 20% below targeted density. The barley and the forage pea produced the highest early biomass production, the winter wheat, Naparoo, canola and vetch the lowest. At anthesis the vetch oat and vetch canola mixtures produced the highest biomass yield, the winter wheat the lowest. Grain yield from the barley was highest, the vetch and canola lowest. Grain yield following mowing in August was similar to the unmown plots in the wheat, barley and oats, and was reduced by the greatest amount in the triticale, forage pea and barley.

Table 3 presents the estimated gross margins from sowing cereals for grazing, cutting hay or grain recovery in good seasonal conditions.

What does this mean?

The study has evaluated a range of crops that can provide both a risk management strategy in a mixed farming enterprise along and in some cases with a disease break and N input in the rotation. It has supported previous studies with cereals that have shown that grazing into early tillering on cereals will have only a limited impact on grain yield. These results were enhanced by 350 mm of growing season rainfall (66, 68 and 72 mm in August, September and October respectively).
This study has also shown that there are broad leaf alternatives, forage peas and vetch, that as a monoculture or as component of a cereal or oilseed mixture can increase total (anthesis) biomass production. The results suggest that there are further opportunities to develop farming systems around the multipurpose break crops on upper EP.

Table 1 Field crops sown and sowing rate (kg/ha)

Crop	Variety	Sowing rate (kg/ha)
Wheat	Naparoo & Gladius	50
Barley	Barque	50
Oats	Wintaroo	50
Triticale	Rufus	70
Canola	Tarcoola	4
Forage Peas	Morgan	70
Vetch	Blanchefleur	16
Oats + Forage Peas	Wintaroo + Morgan	25 + 35
Oats + Vetch	Wintaroo + Blanchefleur	25 + 8
Canola + Vetch	Tarcoola + Blanchefleur	2 + 8

Table 2 Plant establishment (plants/m²), Zadocks growth stages on 5 August and biomass production (DM t/ha) on 5 August and 28 September, and grain yield (t/ha) in 2010

	5 August			28 September	Not mown	Mown
Variety	plants/m²	Zadocks GS	DM t/ha	DM t/ha	Grain Yield (t/ha)	
Naparoo	130	1/5 - 2/5	0.4	1.9	2.9	2.6
Gladius	122	1/6 - 2/2	0.6	3.9	2.7	2.4
Barque	133	1/6 - 2/2	1.0	4.5	3.4	2.7
Wintaroo	126	1/5 - 2/4	0.7	5.3	2.6	2.6
Rufus	125	1/6 - 2/1	0.7	5.4	2.9	1.8
Tarcoola	38	7	0.4	3.9	0.8	0.6
Morgan	64	10	0.9	3.6	2.8	1.9
Blanchefleur	69	6	0.5	5.4	1.6	1.6
Wintaroo + Morgan	102		0.7	5.3	2.8	2.5
Wintaroo + Blanchfleur	106		0.6	7.7	2.7	2.5
Tarcoola + Blanchfleur	60		0.7	6.7	2.5	2.2
LSD (P=0.05)			*0.2*	*3.1*	*0.7*	

Table 3 Gross margin ($/ha) estimates from each component of the multipurpose enterprise

	[a]5 August ($/ha)	[b]28 September ($/ha)	[c]Unmown grain yield ($/ha)	[d]Mown grain yield ($/ha)
Naparoo	16	-107	603	528
Gladius	24	39	559	458
Barque	40	88	538	402
Wintaroo	28	148	302	297
Rufus	28	153	319	158
Tarcoola	16	42	274	124
Morgan	36	21	278	148
Blanchefleur	20	204	102	100
Wintaroo + Morgan	28	146	277	243
Wintaroo + Blanchfleur	24	400	266	231
Tarcoola + Blanchfleur	28	319	231	184

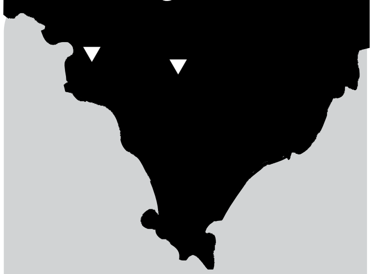
[a] Grazing value was calculated by multiplying the DSE (based on 1 kg DM/DSE/day) by $30 (gross margin/DSE) and dividing by proportion of year.
[b] The 28 September hay production gross margins are based on collecting 65% of total available biomass with a $115-130/t value and $249/ha variable costs.
[c] Grain value calculated as $250/t wheat, $194/t barley and $150/t oats, triticale and all feed grains (forage peas, vetch and mixtures), and $535 canola with total variable costs from Farm Gross Margin Guide.
[d] The mown grain yield figures represent only 1 replicate and should be treated with caution.

Enrich - Identifying Forage Shrub Options for Eyre Peninsula

Roy Latta[1], Neil Ackland[2] and Jessica Crettenden[1]

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

Searching for answers



Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Paddock History
2008: Wheat
2009: Wheat
Soil Type
Red sandy loam

Location: Piednippie
Tim and Trecina Hollitt
Rainfall
Av Annual: 379 mm
Av GSR: 305 mm
2010 Total: 456 mm
2010 GSR: 377 mm
Soil Type
Grey calcareous sandy loam

BOTH SITES
Plot size
Plant spacing 2 metres within rows and 3 metres between rows
Environmental Impacts
Soil Health
Soil structure: Stable
Compaction risk: Nil
Ground cover or plants/m^2: Forage shrubs
Perennial or annual plants: Perennial
Grazing Pressure: Nil
Water Use
Runoff potential: low
Resource Efficiancy
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, NO_2, methane): Cropping and livestock
Social/Practice
Time (hrs): Extra livestock management
Clash with other farming operations: Standard management
Labour requirements: Livestock will require feed rotation or supplementry feeding and regular checking
Economic
Infrastructure/Operating inuts: High cost of establishment
Cost of adoption risk: Low

Key messages

- **Trials of potential new fodder shrub species at Minnipa and Piednippie have shown generally strong establishment and early growth.**

Why do the trial?

There are opportunities on Eyre Peninsula for a more resilient crop-livestock system that allows for a highly flexible cropping program whilst maintaining a substantial livestock enterprise. Often this involves finding ways to gain greater grazing value and a more reliable forage base from soils that can be marginal for cropping. This has led to an interest in research that is aimed at identifying better perennial species than what is already available in low rainfall areas.

How was it done?

Fifteen species of perennials (Table 1) were planted at Minnipa as tubestock in July 2009, after the sites were deep ripped (30-50 cm deep) and weeds chemically controlled. Fourteen of the 15 species were planted in monoculture, and *Convulvulus remotus* (Pink Bindweed) was planted as a mixture with *Atriplex nummularia* (Old Man Saltbush). Each species was planted in plots of 36 seedlings, with each species replicated 4 times to account for soil, weed and germplasm variation across the site. The site was not grazed in 2010 to allow the shrubs time to establish. In autumn 2011 livestock will be introduced to both sites to quantify shrub performance under grazing. Ongoing measurements (Table 2) over the life of the trial will monitor shrub survival and growth. The Piednippie site was also established in 2009 using similar methods and includes mostly similar species (Table 1).

What happened?

Measurements taken at both sites have shown that *Atriplex nummularia* has been the fastest growing shrub, with good establishment and survival. However the biomass production results give advantage to the taller shrubs with the height x width x depth calculation used. A width x depth x height calculation would benefit the ground cover types such as *Atriplex semibaccata* (Creeping Saltbush).

What does it mean?

Measurements of shrub survival and growth will continue next year at Minnipa and Piednippie with livestock to be introduced to the site and more meaningful data of shrub performance under grazing will be collected. Grazing preferences by sheep for the different shrub species will also be assessed. This is an important consideration since diet selection by animals can tell us about nutritional and 'extra-nutritional' effects of plants that we cannot easily measure in the laboratory. Assessments of conventional forage quality will also be conducted and together with the survival and growth data, will provide more conclusive information on which to base forage shrub selection for the Eyre Peninsula environment. Shrub size and its early growth performance are important traits, but are not the only criteria to be considered when including new forage species into grazing systems.

Acknowledgements

We gratefully acknowledge the help of Tim and Trecina Hollitt for the opportunity to use their site for the project and the EPNRM for their assistance.

Table 1 Botanical and common names of the forage shrub species planted at the Minnipa and Piednippie Enrich field trials in 2009

Botanical Name	Common name/s	Location
Atriplex amnicola	Swamp Saltbush/River Saltbush	Both
Atriplex cinerea	Grey Saltbush/Coastal saltbush	Piednippie
Atriplex nummularia	Old Man Saltbush	Both
Atriplex nummularia / Convulvulus remotus	Old Man Saltbush + Pink Bindweed	Minnipa
Atriplex paludosa	Marsh Salt Bush	Piednippie
Atriplex rhagodioides	Silver Saltbush	Both
Atriplex semibaccata	Creeping Saltbush	Both
Chameacytisis prolifer	Tree Lucerne	Both
Chenopodium nitrariaceum	Nitre goosefoot	Both
Enchylaena tomentosa	Ruby Saltbush	Both
Eremophila glabra	Emu Bush/Tar Bush	Both
Eremophila maculata	Spotted Emu Bush	Piednippie
Medicago strasseri	Tree Medic	Both
Rhagodia crassifolia	Fleshy Saltbush	Both
Rhagodia parabolica	Fragrant Saltbush/Mealy Saltbush	Both
Rhagodia preissii	Mallee Saltbush	Both
Rhagodia spinescens	Thorny Saltbush	Both

Table 2 Plant establishment and survival from an initial 36 tubestock and average biomass production (average individual plant height x width x depth/100) at Minnipa and Piednippie

	Plant establishment and survival				Biomass production	
Minnipa	12 Nov 09	4 Feb 10	7 Apr 10	29 Oct 10	7 Apr 10	29 Oct 10
Atriplex amnicola	32	34	33	32	529	447
Atriplex nummularia	35	35	35	35	936	2776
Atriplex rhagodioides	36	36	36	31	499	1717
Atriplex semibaccata	22	20	22	15	219	159
Chameacytisis prolifer	34	33	34	10	6	93
Chenopodium nitrariaceum	29	30	28	27	156	412
*Convulvulus remotus**	16	14	mv	7	mv	mv
Enchylaena tomentosa	30	29	29	29	80	185
Eremophila glabra	31	23	24	16	16	51
Eremophila maculata	12	5	4	2	4	10
Medicago strasseri	26	27	27	23	6	87
Rhagodia crassifolia	22	21	24	19	36	292
Rhagodia parabolica	31	32	32	32	155	891
Rhagodia preissii	24	26	27	25	132	786
Rhagodia spinescens	35	35	35	34	125	703
	Plant establishment and survival				**Biomass production**	
Piednippie	1 Nov 09	21 Jan 10	3 Apr 10	31 Oct 10	3 Apr 10	31 Oct 10
Atriplex amnicola	31	31	31	31	271	305
Atriplex cinerea	31	27	29	20	100	322
Atriplex nummularia	36	36	36	35	272	1711
Atriplex paludosa	35	35	35	35	57	197
Atriplex rhagodioides	36	36	36	36	91	536
Atriplex semibaccata	32	31	31	27	217	286
Chameacytisis prolifer	36	34	34	6	5	30
Chenopodium nitrariaceum	26	25	29	17	3	184
Enchylaena tomentosa	35	34	34	31	37	101
Eremophila glabra	34	27	26	21	14	71
Medicago strasseri	29	26	28	25	14	121
Rhagodia crassifolia	26	25	26	22	18	154
Rhagodia parabolica	35	35	35	32	36	219
Rhagodia preissii	32	32	32	30	120	751
Rhagodia spinescens	36	35	35	27	62	163

* *Convulvulus remotus* growing with *Atriplex nummularia.*

Evaluation of Perennial Forage Legumes on Eyre Peninsula

Roy Latta and Jessica Crettenden
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RESEARCH

Key messages

- **The evaluation of alternative perennial legume forages has commenced at 4 sites on EP in 2010.**
- **The production and persistence of Tedera, Cullen and Sulla are being compared to Lucerne.**

Why do the trial?

The use of perennial legumes on Eyre Peninsula is largely restricted to lucerne which is not well adapted to shallow constrained soils common across much of the region. However the benefits of a perennial legume phase within an intensive cropping system for soil rehabilitation and economic weed management is well documented.

As part of a national program to identify alternative perennial legumes to lucerne suitable for incorporation within cropping systems, there are possibly at least 3 options adapted to areas within the Eyre Peninsula environment.

Research in South Australia has shown Sulla *(Hedysarum coronarium)* to be a highly productive, short lived perennial/biennial legume. The individual plants live for 2-3 years, but it will regenerate readily from seed. It is used for grazing or hay production and contains condensed tannins that make it bloat-safe, increase protein digestion and make Sulla less attractive to insects. These tannins also provide a reputed anthelmintic effect which may reduce worm and nematode burdens. Sheep grazing Sulla have been recorded to have less dags, considered to be a result of the tannin content.

Western Australian research is suggesting that *Bituminaria bituminosa var albomarginata,* or Tedera, as it is more commonly known in its native Canary Islands, has the potential to offer a solution to lucerne's shortcomings in Australian farming systems. Lucerne may survive summer drought by its deep roots accessing a water supply and decreasing evaporation by shedding its leaves. The result of this on many EP soils is that fodder quality is lost with the dropping of the leaves and often the plant dies in the more constrained, shallow soils. Tedera is shallow-rooted and reputedly it is very drought tolerant and does not drop its leaves.

The third option *Cullen australasicum*, a native perennial legume, has been as persistent and productive as lucerne in studies to date. These results suggest that Cullen species will have adaptations to both survival and productivity traits that make them suitable for use or further development as perennial pastures in a low rainfall, Mediterranean climate.

These 3 genera briefly described above were considered worthy of evaluation to compare to lucerne at a range of Eyre Peninsula sites in 2010.

How was it done?

Six lines of forage perennials (Lucerne 1, Sulla 1, Tedera 3 and Cullen 1) were established at four Eyre Peninsula sites in 2010 to represent four rainfall and soil type regions; Minnipa (325 mm), Rudall (350 mm), Edillilie (400 mm) and Greenpatch (450 mm). Soil types varied from calcareous sandy loam to slightly acidic, shallow duplex.

The trials were hand sown in 3 x 2 m plots; Minnipa 2 June, Edillilie 22 July, Rudall 30 July, then resown on 18 September and Greenpatch 11 October. There were 4 replicates sown at Minnipa but only 2 at the other three sites due to a seed supply constraint.

What happened?

More than 400 mm of 2010 rain at Minnipa established all perennials and allowed up to 3 biomass samplings (Table 1). At Rudall insects devastated initial emergence, however a total of almost 500 mm rain allowed plots to be resown quite late in the season, resulting in low established plant densities (Table 1). The wet winter/spring conditions at Edillilie (annual total of almost 600 mm) and Greenpatch (annual total of almost 700 mm) resulted in the waterlogging of newly emerged seedlings at Edillilie and the deferment of the establishment at Greenpatch until 11 October.

Table 1 Plant establishment (plants/m²) and total biomass (DM t/ha) at the four forage perennial sites sown in 2010

	Minnipa		Rudall	Edillilie		Greenpatch
	(plants/m²)	(DM t/ha)	(plants/m²)	(plants/m²)	(DM t/ha)	(plants/m²)
Tedera 27	17	1.3	5	9	0.6	9
Tedera 37	12	0.8	4	5	0.6	8
Tedera 42	10	1.2	4	6	0.9	7
Lucerne	10	4.1	3	8	1.0	6
Cullen	24	2.2	7	5	0.2	18
Sulla	15	4.1	4	21	3.4	17

Dry matter production was measured at 10% flowering of the individual trial entries. This resulted in Lucerne being sampled 4 times (27 October, 24 November, 18 December 2010 and 12 January 2011), Cullen was sampled 3 times, on all but the 18 December, Sulla twice (27 October and 24 November) and all 3 Tedera lines only once (24 November). Sulla and Lucerne produced highest production in the year of establishment at Minnipa, however Cullen established the most plants.

Low numbers of plants established at Rudall with late sowing date did not allow any measurable biomass production. At Edillilie increased densities of Sulla, in extended waterlogged conditions, was reflected in higher biomass production compared to other entries. At Greenpatch establishment was delayed due to waterlogged conditions and only very preliminary establishment measurements were taken in 2010.

What does it mean?

In support of previous documentation, trial indications are that Sulla will produce large amounts of biomass during the spring period in "wet" conditions, but will become dormant in the summer. Lucerne continues its productivity in conditions of adequate water availability, as has been the case in spring and early summer 2010. The Tedera has established well, albeit at relatively low numbers, and while its production and growth has been slow, compared to lucerne, the trial requires a long dry period to ascertain any benefits in persistence it may have over lucerne, especially on constrained soils. The Cullen established in reasonable numbers and being a native is seemingly adapted to a Mediterranean climate and therefore should persist over the summer/autumn period.

Both the Tedera and Cullen are only partially developed lines and as such will continue to be progressed through an intensive selection process in terms of establishment, management, persistence and animal production issues. However, these trials will give some indication as to the potential role of "improved" lines of these pasture species in the EP environment and farming systems.

Acknowledgements

Plots with Matthew Dunn at Rudall, Shane Nelligan at Edillilie and Arnd Enneking at Greenpatch.

Benchmarking the Genetic Potential of Sheep Flocks on Eyre Peninsula

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RESEARCH

Key messages

- **The Minnipa self replacing merino flock is being included in the national "Sheep Genetics" database with the aim to provide Eyre Peninsula sheep producers with a benchmark to judge their flock performance at a national level.**

Why do the trial?

For sheep breeding in Australia, there is a national database run by "Sheep Genetics" and two performance recording schemes "LAMBPLAN" and "MERINOSELECT" that evaluate the genetic merit of stud stock based on Australian Sheep Breeding Values or ASBVs. ASBVs can be used to compare the genetic merit of animals irrespective of where they are run in Australia.

The ongoing plan is to include the Minnipa flock within the program to help:

- educate ram buyers of the merits of ASBVs so they seek out, and buy rams from, breeders that are members of Sheep Genetics "LAMPLAN" or "MERINOSELECT".
- encourage more breeders to become members of Sheep Genetics "LAMPLAN" or "MERINOSELECT" and to offer ASBVs on sale rams.
- encourage more breeders to use ASBVs when buying stud sires or semen.

How was it done?

In 2010 we commenced, with the Minnipa sheep flock, to demonstrate that:

"a combination of visual selection and measurement can be used to breed a fast growing, plain bodied animal, with good constitution, conformation and wool quality while maintaining, or improving, fleeceweight and fibre diameter. It is envisaged that the flock can be successfully managed without the need for mulesing".

The flock is to be fully pedigreed, with both ewe and wether progeny measured for bodyweight, fleeceweight and fibre diameter. Wether progeny will be sold at 10-12 months of age. Ewe hoggets will be visually classed before being admitted into the breeding flock.

The first 2 matings, 2010 and 2011, will be used to benchmark the flock and assess traits that may need improving. In each year existing rams will be used, supplemented with 2 rams from the Turretfield flock to provide genetic linkage.

In subsequent years rams will be purchased from local Eyre Peninsula studs on the basis of visual assessment and ASBVs, concentrating on traits identified as important in the flock's breeding objective.

Once the genetic potential of the Minnipa flock has been benchmarked within the Sheep Genetics MERINOSELECT database it is possible that the flock could be used to benchmark other flocks, bloodlines or breeds on Eyre Peninsula.

What happened?

In 2010 the 2009 ewe hoggets were assessed both visually and through objective measurement to assist selection, results are presented in Table 1.

The MAC flock of 316 ewes were single sire mated in 8 randomly selected groups of approximately 40 ewes from February with each lamb subsequently identified to a specific ram and ewe. The performance of the eight rams in respect to lambing weights (July/August drop), lambing percentage weaned (mid-November) and weaning weights is presented in Table 2.

Table 1 September 2010 average, maximum and minimum greasy fleece weight (kg), fibre diameter (µm) and body weight (kg) of 115 2009 drop ewe hoggets at 15 months of age with 11 months wool growth, sown in 2010

Greasy fleece weight (kg)	Fibre diameter (µm)	Body weight (kg)	Visual Culls (%)
5.1 (3.3 - 7.5)	17.5 (14.4 - 21.5)	63 (40 - 71)	30

Table 2 Average birth and weaning weight (kg), and percentage lambs weaned (%) from the eight single sire mating groups.

Group	Birth weight (kg)	Weaning weight (%)	Weaned percentage (%)
1	6.0	32	110
2	6.2	30	118
3	6.5	30	116
4	8.7	33	78
5	5.7	30	92
6	6.3	27	118
7	6.6	33	103
8	5.8	28	129
Average	6.4	30	117

What does it mean?

There is a wide variation in the production performance of the 2009 drop hoggets that was addressed with a 30% culling rate that included a mix of visual and objective measurement.

We have collected initial measurements from the 2010 drop lambs. Further bodyweight gain over summer and wool quality and quantity in June measurements will be collected after which the wethers and culled ewes will be sold.

Acknowledgements

Trent Brace for his livestock management support and MAC staff Brett, Naomi and Linden for support in the shed and sheep yards.

A Review of Sheep Management in 2010

Brian Ashton
Sheep Consultancy Service Pty Ltd, Port Lincoln

INFORMATION

Key messages

- **The sheep business is now completely different to what most people are used to.**
- **Sheep prices doubled in 2000 and have now doubled again (approximately).**
- **Wool prices are approaching what they were in 1988 – in US$ terms.**
- **Sheep sales now earn more than wool, but wool is still a major income earner in most flocks.**

Background

The year of 2010 has been a steep learning curve for many sheep producers. After many frustrating years, sheep are now really earning their place on the farm. We have not experienced returns like this since the wool boom year of 1988. Farmers who have been on the farm less than 22 years are in completely new territory.

Now is an ideal time to completely review your approach to the sheep enterprise.

What was done?

Four farmer groups on Eyre Peninsula attended the FarmReady workshops “Sheep planning to reduce farm risk”. These farmers discussed the key things that affected the profitability of their enterprise. They realize that to make the most of the current good times they may need to do things very differently to what they have done in the past.

What we found out

Together with the change in returns, good seasons also bring some problems with sheep management and 2010 was no different.

Most people are spending time and money drenching sheep. But, to manage worms on your farm, the first step is to WORMTEST at least the weaners (before they are drenched). This is a measure for how the worm control program for your whole flock is going.

Ten farmers with good WORMTEST results indicated they have a good control program (or were lucky). They averaged 90 strongyle eggs per gram of dung. The best result was from sheep that had been drenched 18 months earlier and still had zero eggs.

Twelve farmers had high WORMTEST results. It is really good that these people tested or they would have had a severe worm problem (some did). They averaged 1,400 eggs per gram. The highest results were two lots of lambs and a mob of ewes with 2,400 to 3,400 eggs per gram.

Sheep usually suffer some production loss above 250 eggs per gram – although sheep in good condition can tolerate more worms.

People also need to rotate between drench groups and use the best drench available in the group chosen.

Mineral deficiencies, flystrike, foot abscess and lupinosis are all issues in wet years. Successful farmers attend to these issues before they cost time and production loss.

In good seasons everyone can carry more stock. However, the real test is how many you can carry in the poor years. In good years it is worth thinking about how you will cope with the next dry one because it will creep up on us. Preparation makes all the difference.

Several group members conducted FEEDTESTS on pasture. The results confirm that rank pasture is lower in quality and short rapidly growing pasture is higher in quality.

The best FEEDTEST was of Tall wheat grass, which is often not a high quality feed. This was short, rapidly growing pasture and was 31.6% protein and 12.7 MJ of energy. This compares to a test of pure medic that was about 30 cm high. It had 30% protein and 10.7 MJ of energy. Of course, the medic stand has other benefits to the farm system such as self regeneration, nitrogen fixation and as a disease break.

One farmer had a paddock of vetch to finish his lambs on. From past experience the 900 lambs would have lasted about three weeks on the paddock. Instead an electric fence was used and the area was strip grazed. The lambs were allowed about 3 ha at a time and the fence was moved twice a week.

The farmer’s comment was the result was “unreal”. About double the expected grazing was achieved. The fence took about 20 minutes to move with the use of a “Rappa” unit on the back of a four wheel motorbike.

Electric fencing can dramatically improve pasture utilization. There are many excellent units available, from small solar powered units to large, mains powered units.

Economics

Returns from sheep are good but how good? You need to calculate how much you are making and compare it with your other enterprises and with your neighbours.

The simple calculation is;
Total income from sheep (wool, sheep sales)

Add Increase in the value of sheep on-hand (if you increased your flock size)

Less Decrease in the value of sheep on-hand (if you decreased your flock size)

Less Direct sheep costs (include the opportunity cost of conserved fodder)

Less Overhead costs (the sheep proportion of all other costs)

= Sheep enterprise profit

Calculate the winter grazed area (arable area not cropped and a proportion of non-arable area)
= Sheep profit per winter grazed hectare

Compare this to the profit per hectare from crops on similar ground (sheep usually get the "problem" paddocks). If it is too hard to calculate the sheep proportion of overhead costs just work on gross margins. However, remember that sheep generally have low overhead costs and that sheep returns are more stable.

This would be a great discussion point at your Agricultural Bureau or Farm Group meeting.

More detailed benchmarking programs are available. For example, the MLA Cost of Production Calculator, search in; MLA.com.au COP.

Sheep planning

Many people could plan their enterprise better. If you are in doubt, ask for help.

The planning steps, once you have clear goals;
Monitor - Measure, or at least observe, how you are going
Record - Keep good records so you can look back
React - Act on the information before it is too late
Progress - Remember, and learn, from your experiences

Where to from here?

Future sheep prices are uncertain, however it is well worthwhile improving your sheep management to reflect the returns you are now getting.

There will never be a better time to improve your sheep management.

Acknowledgements

Members of the four FarmReady groups "Sheep planning to reduce farm risk".
The Australian Government for FarmReady Reimbursement Grants.

Can Silage Reduce the Cost and Risk of Fodder Conservation

INFORMATION

Bruce Heddle
Minnipa

Searching for Answers

Location:
Minnipa
Farmer: The Heddle Family
Rainfall
Av. Annual: 350 mm
Av. GSR: 250 mm
2010 Total: 381 mm
2010 GSR: 345 mm
Paddock History
2009: Wheat
2008: Wheat
2007: Medic
Soil Type
Red and grey calcareous sandy loam

Why did we try making silage?

Conserving fodder to even out the feed supply is an expensive process and can have a severe negative impact on the profitability of a livestock enterprise. However, it also provides important flexibility and some real agronomic advantages in a mixed farming system. Therefore, we have been looking for cost effective ways of gaining these advantages, reducing the risks associated with hay making and maximising the nutritional value of the conserved feed. The majority of fodder conserved for use 'on farm' around the world is stored as silage, yet it has been largely ignored as an option on Eyre Peninsula since the late sixties, so we wondered if it does in fact have a role in our system.

Why now?

- We had a large reserve of hay on hand already (from 2009) and faced another opportunity to conserve fodder.
- Livestock returns are strong.
- Physical removal of pasture has been an excellent way of managing weeds, especially where we have a long history of using selective herbicides.
- If the process is done well, silage has the longest storage life of any conservation option – up to twenty years by many reports.
- It uses the equipment we already use or had access to for hay and reduces the time that the fodder is exposed to damage by rain.

How did we do it?

- The paddock was dry sown with 44C73 Canola at 3 kg/ha, 5 kg/ha of Angel medic and had the background medic stand left in it. I was unable to get control of the mice at plant emergence so ended up with a patchy canola but exceptional medic establishment.
- DAP was applied at 25 kg/ha with the seed.
- Targa® was applied when the grass was at very early tillering.
- Thanks to an excellent growing season, growth was exceptional, with much of the medic in the canola 450 mm to 600 mm high. Medic seems to grow extremely well with canola.
- The pit was dug with an excavator to be 1.5 m deep, 6 m wide and about 20 m long with an access ramp one end.
- We started cutting with a mower conditioner on 25 September (about one week earlier than we would have started cutting hay) and raked on 27 September.
- Commercial silage inoculant was sprayed onto the windrows immediately in front of the baler.
- Silage was baled into 1.9 m x 0.8 m x 0.9 m big square bales at about 50% moisture starting on 29 September, carted and stacked immediately and covered with 200 micron silage cover within 6 hours. This is a critical point in the process – plenty of labour and equipment with no breakdowns are important. A breakdown at this point was stressful and has probably compromised part of the stack.
- The stack ended up about 1 metre above ground level and is covered completely by at least 400 mm of soil.

What happened?

- Silage dramatically increased the 'dry' yield of fodder per hectare. Losses from the row are noticeably reduced because the cut material is wet and tough rather than dry and brittle. As usual, the hay rows were rained on, turned and as a result yielded around 30% less.
- Every part of the process seemed 'time critical', especially when we were completely inexperienced. However, the much shorter timeframe from start to finish is a major advantage and more experience would make the whole process more straightforward than making hay.
- Because each bale is largely water, they are heavy and hard on equipment. Sale and transport are simply not an option so some flexibility in end use is foregone.
- Surprisingly, almost no slumping of the stack has occurred yet. Hopefully the biological process that provides the preserving environment has worked – it may be a pit full of expensive compost!
- As the stack cannot be opened at all to inspect it because it must remain airtight, it will not be possible to judge the feed value of the stored fodder or the success of the exercise until we need it. This is a problem and we may use half of the stack soon simply so we can decide whether to pursue the concept further.

What does this mean?

- Reducing the cost of conserving fodder and increasing the feed value is a challenge that impacts significantly on the profitability of feeding livestock.
- The dairy industry puts far more focus on these issues and we can probably learn much from them.
- Herbicide dependency, no-till and more profitable livestock enterprises are significant changes over the last few years, and have 'changed the game'.
- Contract wrapped round bale silage would be an easier and more cost effective way of investigating the role of silage without a large capital investment.
- While silage in general has significantly lower costs per unit of feed, energy and protein, it is not without its challenges and we still have a lot to learn.

Acknowledgements

Tom Hage, Naracoorte was generous with his information and advice.

Andrew Makin, 'Integrated Packaging'.

Pioneer Australia Technical Advice team in Toowoomba.

Ian Gosling, Poochera – an extremely cooperative baling contractor.

Alternative Pasture in the Upper North

Charlton Jeisman
Rural Solutions SA, Jamestown

RESEARCH

Try this yourself now

Location:
Upper North
Farmer: Gilmore Catford
Upper North Farming Systems
Rainfall
Av. Annual: 325 mm
Av. GSR: 233 mm
2010 Total: 379 mm
2010 GSR: 255 mm
Yield
Potential: 3.2 t/ha (W)
Actual: 3 t/ha Wheat (farmer Paddock)
Paddock History
2009: Fallow
2008: Fallow
Soil Type
Alkaline, red clay loam
Plot size
15 m x 2.2 m x 4 reps
Livestock
Enterprise type: Crossbred lambs
Stocking rate: 4 DSE/ha
Type of stock/breed: 1st cross Merino
Water Use
Water use efficiency: 11.7 kg/ha/mm

Key messages

- **Amount and quality of feed are important considerations when grazing livestock.**
- **Trade off between dry matter produced and nitrogen fixed by legumes.**
- **Barley and canola/vetch had fastest early growth rate to mid August.**
- **Oats/vetch and canola had the fastest growth rate between August to September.**
- **Alternative pastures produced more dry matter overall than current medic varieties.**

Why do the trial?

In low rainfall areas, growth and development of annual regenerating medic pastures is often slow due to hard seed content and naturally slow early growth rates. In the Upper North this often occurs under cold conditions resulting in delayed development until warmer temperatures and longer days later in the season enable faster growth rates and more dry matter production. Medic pastures often provide an abundance of feed at a time when growers already have a lot of feed. This trial was established to compare the growth rates and dry matter production of alternative pastures with traditional medic pastures, attempting to provide more feed earlier in the growing season to help reduce the 'feed gap' between late summer and winter.

How was it done?

The treatments included in the trial are shown in Table 1. A range of alternative pastures were selected including some pod retention medic varieties (Cheetah barrel and Jaguar strand). All treatments were sown on 6 May at appropriate seeding depths into soil with a dry surface but moist seed bed. Medic plots were scratched into the surface and were sown in two passes (half seed and fertiliser rate each time) with the second pass being sown 'inter-row' of the first (to simulate a regenerating pasture). DAP was applied at 50 kg/ha to all plots at seeding. The site was treated with 1 L/ha PowerMax and 50 mL/ha Lemat prior to seeding. A follow up application of 500 mL/ha Select, 250 mL/ha Targa and 1% Hasten was applied on 3 July.

Pasture cuts were taken from each treatment at various stages during the growing season to determine dry matter produced per hectare. Each sample was dried and weighed. These measurements were also useful to compare growth rates between treatments. Plots containing oats and barley were harvested on 19 November while all other treatments were harvested on 23 November.

What happened?

Barley and canola/vetch produced the greatest dry matter by 21 August and also had the fastest growth rates of all treatments. Oats/vetch had overtaken barley, canola/vetch and canola by 28 September and remained the highest producer all season (Figure 1). Table 2 includes the total dry matter produced for all treatments until the beginning of November.

After 28 September, growth rates of oats/vetch, peas and Cheetah medic began to plateau while canola, vetch and Angel medic SR2 began to decline, indicating senescence of plant material had occurred. This means less dry matter that livestock could consume. Dry matter of barley and canola/vetch however continued to keep increasing.

Figure 1 shows that canola/vetch had a more steady and consistent growth rate than canola when grown alone. Overall dry matter was the same by 4 November, however the vetch in the mix would have increased the quality of the feed. In terms of plant establishment in the canola/vetch mix, the ratio was approximately 5:1. Although canola plants were superior in this mix, vetch still added value to the pasture.

Table 1 Treatments sown in the Morchard pasture trial 2010

	Treatment	Seeding rate (kg/ha)
1	Jaguar medic	10
2	Tarcoola canola	4.5
3	Wintaroo oats + Morava vetch	Oats: 60 Vetch: 20
4	Angel medic sowing rate 1 (SR1)	10
5	Hindmarsh barley	60
6	Cheetah medic	10
7	Angel medic sowing rate 2 (SR2)	20
8	Oasis juncea	4.5
9	Morgan forage peas	100
10	Jester medic	10
11	Tarcoola canola + Morava vetch	Canola: 2.5 Vetch: 25
12	Morava vetch	30

Of the medic varieties grown, Angel SR2 produced slightly more dry matter by 21 August however by 28 September Angel SR1 had a slight advantage and continued to all season. Cheetah and Jaguar medics (pods retained on plant runner so they can be harvested with a conventional header) competed well with traditional varieties throughout the season, until the last month when they remained greener for longer and maintained their bulk (as is their nature). The higher seeding rate of Angel SR2 (compared with Angel SR1) appeared to cause Angel SR2 to senesce (die off) earlier.

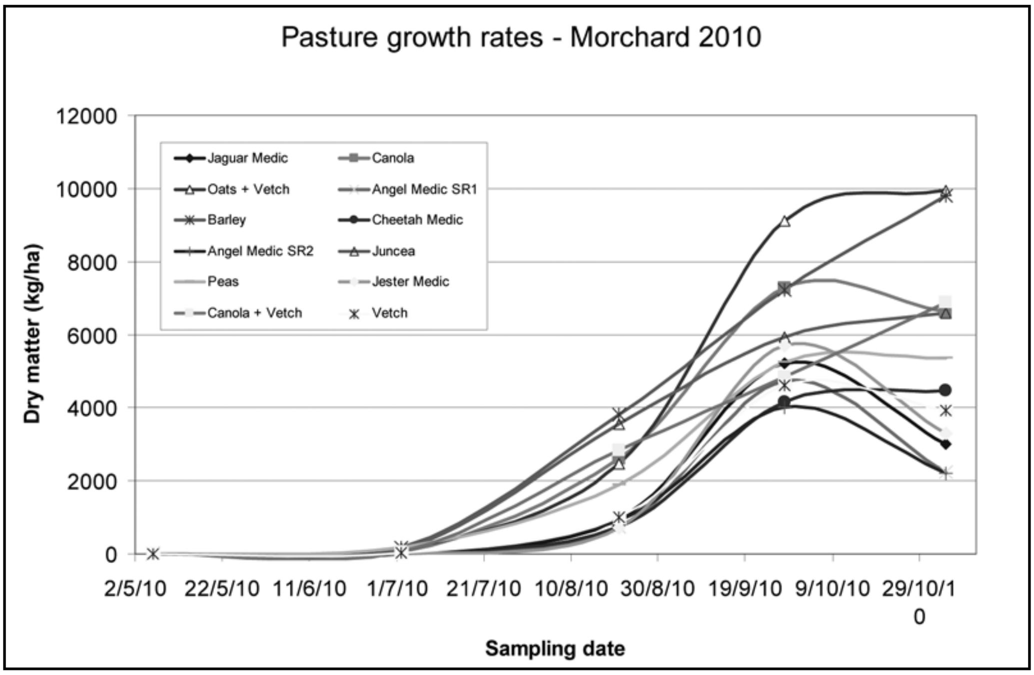

Figure 1 Dry matter production and growth rates for selected pastures grown at Morchard to 4 November 2010.

Table 2 Full results of pasture dry matter production at Morchard up until 4 November 2010

Treatment	Dry Matter (kg/ha)			
	2 July	21 August	28 September	4 November
Angel medic SR1	0.6	748.9	4719.4	2243.1
Angel medic SR2	0.7	914.3	3997.3	2218.8
Cheetah medic	0.7	751.1	4158.0	4479.1
Jaguar medic	0.7	956.7	5217.9	3013.9
Jester medic	0.7	710.9	5710.3	3288.2
Tarcoola canola	64.6	2603.1	7263.9	6604.7
Canola + vetch	68.8	2825.9	4839.8	6879.4
Oats + vetch	145.8	2457.9	9113.6	9949.6
Morava vetch	40.3	998.3	4602.8	3923.6
Oasis juncea	100.7	3562.8	5923.8	6578.2
Hindmarsh barley	159.7	3806.3	7210.8	9794.9
Morgan peas	159.7	1891.3	5238.2	5365.4

What does this mean?

Some of the alternative pastures (to medics) such as oats/vetch, barley and canola produced more dry matter; however they also required nitrogen to achieve this. Medic and vetch based pastures fix atmospheric nitrogen in the soil; however non legume based pastures cannot do this. Therefore the cost of nitrogen must be factored in.

The benefit of legumes in a rotation is an important consideration, not only for nitrogen fixation but also for a root disease break. In 2010, in low rainfall areas, the benefits of legumes grown in 2009 really showed up in 2010 wheat crops. Therefore if some non-legume pastures are grown to maximise dry matter, the absence of suitable disease breaks and cost of additional nitrogen must be considered.

Barley and canola/vetch had the fastest early growth rates of all treatments meaning these feed sources would have helped reduce the feed gap in this season. While pastures cannot be grazed immediately from emergence, barley and canola/vetch would have provided feed for livestock for around three to four weeks before medic pastures could have been grazed. This would reduce the amount of time spent supplementary feeding livestock to prevent them grazing poor quality pastures in autumn and losing condition.

Areas in plots where dry matter cuts were taken indicated how well these pastures would recover from grazing. All medic varieties recovered well from early and late grazing throughout the season, as did cereals; however Morgan forage peas and canola/vetch pastures only recovered from early grazing.

While medic pastures have feed quality benefits and are tolerant to grazing and trampling, particularly in good seasons like 2010, some alternative pastures have other advantages such as providing abundant feed early in the season and allowing livestock to graze earlier and for longer periods. While medic pasture is high in quality and has benefits for paddock rotations, a grazier must be patient for it to grow bulky enough before it can be grazed.

When pasture production reaches its peak in mid-late spring, growers often struggle to utilise all the available feed due to insufficient livestock. In favourable seasons such as 2010, cutting some paddocks for hay (or making silage) is a good option to ensure plenty of feed is on hand for when grazing options are scarce.

In a drier season or on a different soil type, the above results and trends are likely to be different, however the relative comparisons between different pasture types is likely to remain similar.

Acknowledgements

Gilmour Catford (Morchard farmer); Andrew Lake (seed distribution, Pristine Forage Technologies); Jake Howie (SARDI); Craig John (Juncea oilseed, Viterra); Phil Green (fertiliser distribution and low drift nozzles, Northern Ag, Booleroo Centre); Larn McMurray (seed distribution, SARDI); Barry Mudge (paddock activities); Nigel Wilhelm (trial sowing, SARDI); Peter Telfer (trial sowing, SARDI).

Product acknowledgement

Le-Mat – registered trademark of Bayer

RoundUp Powermax – registered trademark of Nufarm

Select – registered trademark of Arysta LifeScience Corporation

Targa – registered trademark of Sipcam Pacific Australia Pty. Ltd.

Hasten – registered trademark of Victorian Chemical Co Pty Ltd.

UNFS Eyre Peninsula Farming Systems

GRDC Grains Research & Development Corporation

Demonstrating Pasture Zoning in the Upper North

DEMO

Jodie Reseigh[1], Michael Wurst[2]

[1]Rural Solutions SA, Central Eyre Peninsula, [2]Rural Solutions SA, Jamestown

Key messages

- **On farm zoning puts into practice farmer and agronomists' knowledge and intuition combined with relatively cheap technologies such as free maps available from the internet (e.g. Google Earth©) and satellite imagery (e.g. NDVI).**
- **This project is helping farmers put into practice their understanding of how their property can be managed to achieve greater sustainability and production outcomes.**

Why do the trial?

A property can be divided into a number of production zones, through the use of maps (such as Google Earth©), landholder experience and the use of satellite technology. The number of production zones may vary depending on landholder experience and technologies available. Generally three or four production zones/areas are adequate. For example:

- Better cropping areas
- Unviable cropping areas
- Un-arable pastures

These can be further sub-divided where there is significant variation in production. Grazing management of these zones may be managed with a combination of permanent and/or electric fencing and portable watering points.

This demonstration follows from the innovative work that the Upper North Farming Systems Group (EPFS 2009 pp. 169-170) has undertaken implementing best practice grazing management in the low rainfall cereal zone. The aim of this local case study is to demonstrate the benefits of maximum utilisation of the best cropping areas, improved grazing efficiency and increased production from poorer (unviable) cropping areas, whilst maintaining production and ground cover. The initial focus of the trial is in improving production and sustainability in poorer (unviable) cropping areas.

The aim of the farm demonstration is to increase production and sustainability and reduce costs by identifying production zones across a property and managing these zones differently. However, it is important these zones are large enough to be managed.

How was it done?

The demonstration farm in the Upper North used a range of tools and technologies to determine production zones including maps (Google Earth© and farm maps), Normalised Difference Vegetation Index (NDVI), agronomist advice and landholder experience. As a result the farm was divided into three major areas/zones: better cropping areas; unviable cropping areas and un-arable pastures. Better cropping and unviable cropping areas were further subdivided due to significant variation in production (Figure 1). On the demonstration farm, good cropping areas produce an average of 1.8 t/ha; average cropping zones produce an average 1.4 t/ha and unviable/ poor cropping zones average 0.8 t/ha.

1. **Better cropping zone –** These are the highly productive soils on the property and can be intensively cropped with cereals. This zone was further split into two further zones:

   (1A) Good cropping: Cropping and annual pasture rotation; and

   (1B) Average cropping: Cropping and two years pasture rotation.

By separating these two zones, areas may be more intensively cropped without the risk and costs of cropping poorer areas. It is envisaged with the use of precision agriculture that these zone will be further divided and managed more intensively.

2. **Unviable cropping zone/ Poor cropping –** These are areas of the farm which have consistently been cropped over the years but may no longer be producing profitable crops (average < 1.0 t/ha and in some seasons totally fail). In most years these areas will produce enough to cover the variable costs (seed, fertiliser, chemical, etc.), but not all of the overhead costs. It may be more profitable to take these areas out of cropping or only crop them on an opportunistic basis (low inputs). This zone was also split into two further zones:

   (2A) Poor cropping to be improved with native pastures; and

   (2B) Poor cropping to be improved with fodder shrubs.

The native pasture area will be sown with valuable native grass species such as Wallaby grass *(Austrodanthonia* species*)* for both grazing and native grass seed production. The fodder shrub area will be sown with 3 rows of fodder shrubs, with inter-rows of approximately 16 m wide to allow opportune cropping for both grazing and grain production dependent on the year. The best fodder shrub species in terms of production and palatability have been selected from the local ENRICH site. Once established these shrubs will be grazed to maximise production and utilisation. It is envisaged that the fodder shrubs will also provide valuable shelter to livestock in the future.

3. **Un-arable zone –** These areas of the farm have traditionally been set stocked over the winter/spring period. Livestock have selectively grazed the more palatable species and bared out (stock camps) other areas of the paddock. Only the less palatable native grass species, such as Spear Grass (*Austrostipa* species) have generally survived in many areas, and annual grasses and weeds have out competed many of the native species. These areas will be rotationally grazed, either through the winter or throughout the whole year depending on seasonal conditions.

Over the last 3 years, the landholder has undertaken a whole farm program of subdividing large paddocks into smaller units with portable watering points. This un-arable zone contains a mix of pasture species including good native pastures such as Wallaby grasses and Curly Windmill grass *(Enteropogon acicularis)* along with some less productive grass species.

What does this mean?

The project is still in the planning phase and results will be available over the next 18 months with a field day to be held in September/October 2011.

Through on-farm application the benefits of increased biomass production, improved biomass quality, greater grazing efficiency, maintaining and improving soil cover whilst increasing production and sustainability outcomes results will be demonstrated to landholders, extension staff and the community through field days.

Acknowledgements

Project funding was provided by the Australian Government through Caring for Our Country: Best practice management grazing systems for native grass pastures in the low rainfall cereal zone, Project No. SA NY MR05 and Grain and Graze 2.

Our thanks to our demonstration farm landholders Trevor and Diane Gum and family.

Figure 1 Assignment of zones to demonstration farm in the Upper North

Section Editor:
Roy Latta
SARDI, Minnipa Agricultural Centre

Section 7

Soils

Modification of Sandy Subsoils on EP

David Davenport and Brett Masters
Rural Solutions SA, Port Lincoln

DEMO

Searching for answers

Location:
Ungarra & Edillilie
Farmer: John Houston, Sam & Jim Snodgrass, Terry Young and Peter Treloar Butler - Ungarra Agricultural Bureau and Edillilie Landcare Group with support from LEADA

Soil Type
Sand over clay

Plot Size
Replicated trials: 1.5 m x 22 m x 3 reps
Demonstration sites: 12 m x 8 m

Key messages

- **In sand over clay soils, bleached A2 horizons restrict root growth.**
- **Incorporation of clay and organic material into the A2 horizons delivered greater dry matter production but yield results varied.**

Why do the trial?

Claying and delving of sandy soils has been conducted in South Australia for over 30 years. Historically the major focus has been on eliminating non-wetting on sandy soils. Recent work on EP and elsewhere has indicated that bleached A2 horizons (light coloured sands with little clay or organic material) in many of these soils are as great if not a greater impediment to production as non-wetting sands. The reasons for this have not been clearly identified but are thought to be related to the very low fertility levels of these horizons, but compaction and low water holding capacity may also play a role. Delving has partially addressed these issues, however more even incorporation of clay through spading has achieved better results. The addition of organic material in this process can deliver even more significant results (refer LEADA update 2009) but results have been inconsistent. These trials and demonstrations have been conducted to provide further understanding of what is driving these responses and how soil modification techniques can be improved.

How was it done?

Sites were established as detailed in Table 1.

What happened?

Houston Ungarra

The Houston site compared District Practice (60 kg/ha 18:20), District Practice with additional N (50 kg/ha applied 17 July 2010) and District Practice with trace elements (3 kg/ha Cu, 3 kg/ha Zn, 5 kg/ha Mn) on areas that were unspaded, spaded in spring 2009 (green manure treatment) and spaded in autumn 2010.

Plant emergence counts were taken in early July with no treatment difference. Dry matter cuts and plant tissue tests were taken on 18 August 2010. The plant tissue analysis showed no treatment difference. There were higher levels of dry matter measured on the spaded plots as compared to the unspaded control, with higher levels in the plots spaded in spring of 2009 plots compared to the autumn 2010 spaded sites (Figure 1).

Root DNA analysis from samples taken on 23 September also identified that plants in the spring 2009 spaded plots had greater root mass at 10-30 cm depth than the 2010 spaded plots that were also higher than the control (Table 2).

Table 1 Trial site details

Co-operator	Location	Trial Type	Crop	Measurements	Treatments
Houston	Ungarra	Replicated small plot	Correll wheat	Plant emergence, plant tissue analysis dry matter, root DNA, fungal biomass, yield	Non-spaded, spaded spring 2009, spaded autumn 2010
Young	Ungarra	Replicated small plot	Wonga lupins	Plant emergence, plant tissue analysis, dry matter	Delved 2008, delved 2008 and spaded autumn 2010
Young	Ungarra	Demonstration	Canola	Visual only	Spaded with vetch incorporated spring 2009
Snodgrass	Ungarra	Replicated small plot	Fleet barley	Plant emergence, plant tissue analysis, dry matter, yield	Clay spread 2008, clay spread 2008 and spaded autumn 2010
Treloar	Edillilie	Demonstration	Canola	Yield	Control, spaded 2009, spaded with lucerne straw 2009

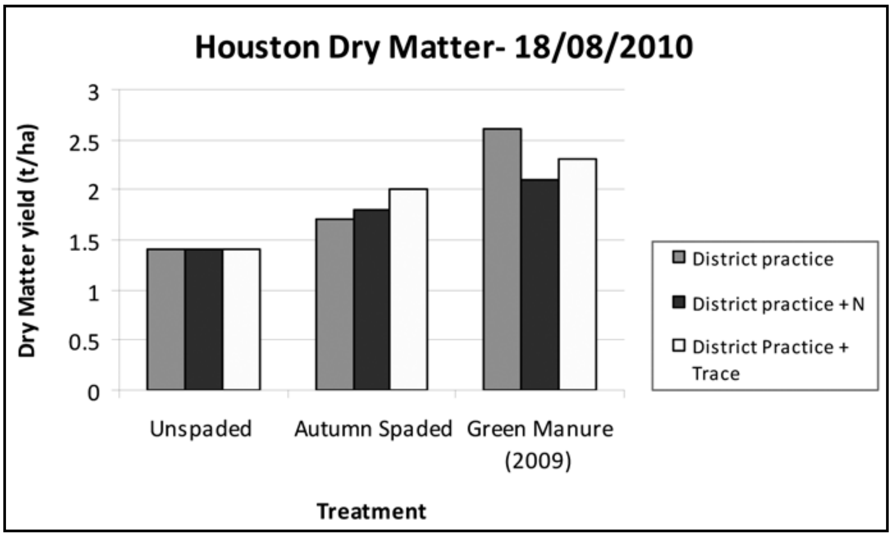

Figure 1 Dry matter cuts taken from Houston site in August 2010

Although these results showed differences in plant growth between treatments they did not translate to grain yield with no difference between the yields (Table 3). A gradual decline in yield was observed on plots in the southern portion of the trial and site variability may have been a factor.

Young Ungarra

The Young trial site was lupins on sand over clay delved in 2008 with half of the trial site spaded in 2010. Nutrition treatments applied across the site compared a Nil fertiliser control, P only (superphosphate at 113 kg/ha), District Practice (60 kg/ha of 18:20) and District Practice with trace elements (3 kg/ha Cu, 3 kg/ha Zn, 5 kg/ha Mn).

Plant emergence and dry matter cuts were taken on the site, but as the spaded portion of the trial was totally dominated by ryegrass harvest yields were not taken. This trial has raised issues about the timing of spading and subsequent weed management; these issues will be further explored in 2011.

The canola demonstration was also not harvested; however there was a significant visual difference with plants considerably taller and with more pods on the spaded area compared to unspaded areas. Spading has been conducted on an adjacent vetch paddock to allow replicated trials to be conducted in the 2011 season.

Snodgrass Ungarra

This site was on a sand over clay soil that had been clay spread with a high rate of clay (>250 t/ha) in 2008. Half of the trial site was also spaded in 2010. Nutrition treatments applied compared a District Practice (60 kg/ha 18:20) and District Practice with trace elements (3 kg/ha Cu, 3 kg/ha Zn, 5 kg/ha Mn).

Plant emergence counts taken in early July recorded 10% higher plant numbers on the unspaded treatments compared to the spaded treatments. Dry matter cuts and plant tissue tests were taken on 18 August 2010. Plant tissue analyses were similar between treatments. Dry matter results on both of the spaded treatments were over twice that of the unspaded treatments (Figure 2).

Soils

Table 2 Root DNA Samples taken from Houston site in September 2010

Treatment	Depth 0-10 cm (pgDNA A/g)	Depth 10-30 cm (pgDNA A/g)
Control	644	1001
Spaded spring 2009	508	2904
Spaded Autumn 2010	470	1819

Table 3 Houston wheat yields (t/ha), December 2010

Treatment	District Practice	District practice + Trace elements	District practice + N
Control	5.8	5.7	5.9
Autumn 2010 Spaded	6	5.9	5.9
Spring 2009 Spaded	5.7	5.8	5.7

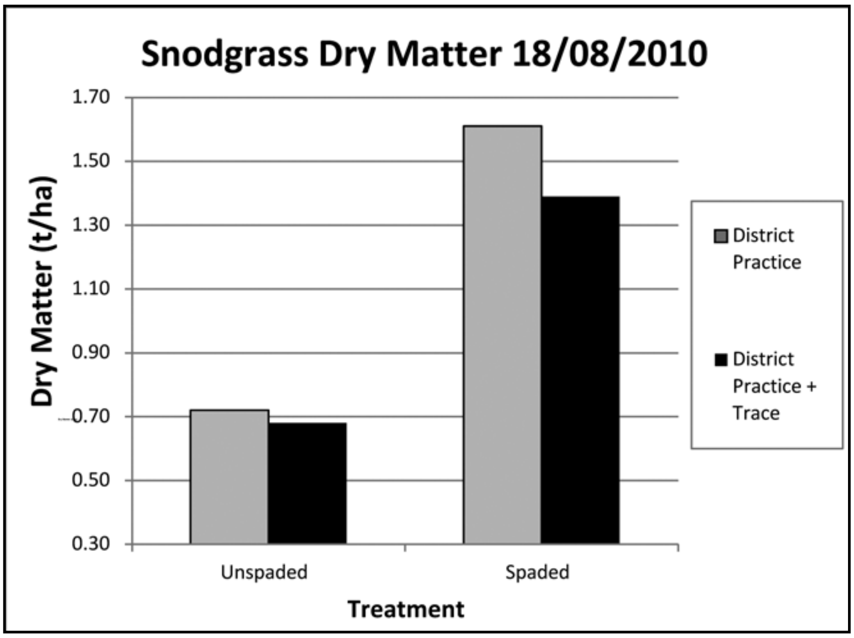

Figure 2 Dry matter cuts taken from Snodgrass site in August 2010

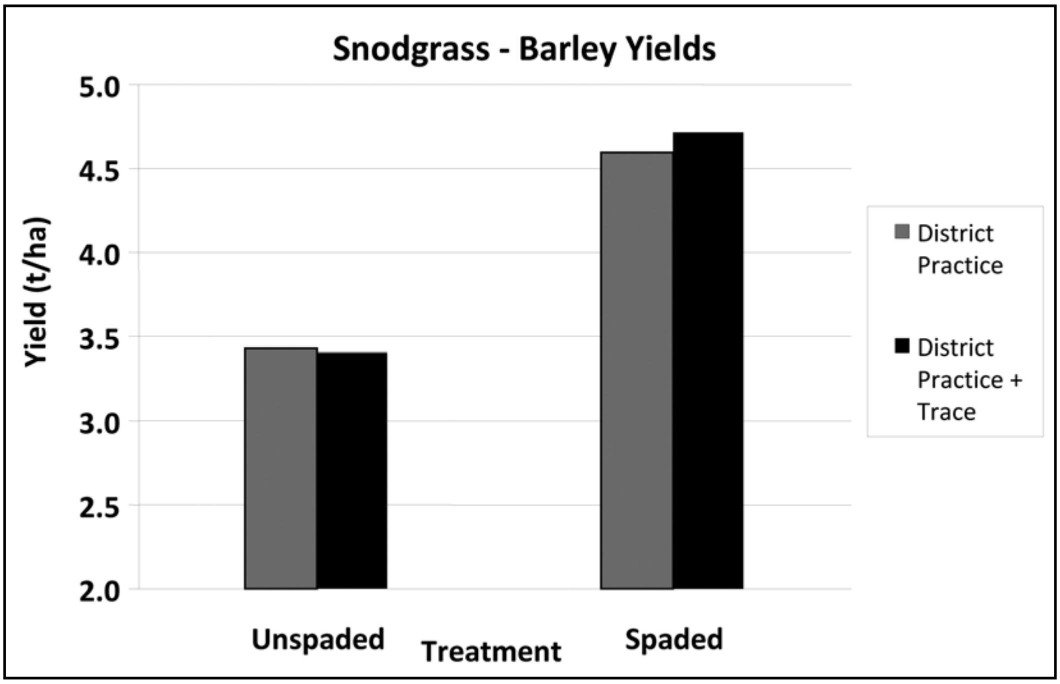

Figure 3 Grain yield from Snodgrass site, December 2010

These early differences in plant growth carried over to grain yield with the spaded plots yielding in excess of 1 t/ha (20%) higher yield than the unspaded treatments (Figure 3).

Treloar Edillilie

A significant increase in plant size and pod numbers was observed in canola on spaded plots with lucerne straw incorporated in early 2009. This followed a yield increase in lupins on these plots in 2009. The site had not been harvested at the time of writing.

What does this mean?

This series of trials and demonstrations are early scoping investigations designed to provide areas of interest requiring more detailed investigation. Issues to be researched in 2011 include:

- What form of organic material will provide the greatest dry matter and yield increases?
- What is driving these increases – nutrition, soil biology, soil water holding capacity or a combination?
- What are the changes to plant root mass and location following treatments?
- If cereal stubble is incorporated is there the need to provide additional nitrogen to reach suitable N:C ratios?
- How long are the potential gains going to last? Identification of organic carbon fractions may provide useful indicators.
- Will different soils respond better than others? For example soils with thicker bleached A2 horizons appear to provide greater response to incorporation of clay and organic material.
- How to best manage herbicide resistant weeds following spading.

This work will be conducted in conjunction with trials being developed on sand over clay soils in the South-East through the McKillop Farming Systems Group.

Acknowledgements

The authors would like to thank the landholders involved in this trial; John Houston (and Jason Durdin), Sam and Jim Snodgrass, Terry Young and Peter Treloar. They also extend their thanks to Terry Blacker, SARDI (Port Lincoln) for his efforts in sowing, maintaining and harvesting the sites.

Addressing a Change in Soil Erosion Risk through a Tender-based Management Approach

DEMO

Neil Ackland

Eyre Peninsula Natural Resources Management Board, Port Lincoln

Key messages

- **Reducing impact of soil erosion on private and public land.**
- **Ability to match land use to land capability.**
- **Landholders deciding their own management actions for erosion mitigation.**
- **Cost effective approach to address soil degradation.**

Why do the trial?

The Eyre Peninsula Natural Resources Management Board's (EPNRM) "Soil Management Projects" aim to achieve a reduction in soil erosion risk at vulnerable sites on private land across Eyre Peninsula.

This pilot program on Eastern Eyre Peninsula was implemented to assist landholders adopt better land management practices that would reduce erosion on their poorer farming land. Using a tender-based (Market Based Instrument - MBI) approach, landholders entered into management contracts through a competitive process, to undertake a range of activities that would support the adoption of better land use that would maintain and enhance the sustainability of farming systems on Eyre Peninsula.

How was it done?

Landholders within the targeted area submitted expressions of interest on how they would address soil surface cover issues to reduce soil erosion on areas of their properties. To demonstrate their intent to achieve the target, landholders agreed to a set of appropriate management actions for each site. Proposed management actions were at the discretion of the landholder, however, these needed to meet standards set by EPNRM to ensure the quality of outcomes.

Preferred management actions were those that could most cost-effectively achieve the soil erosion risk reduction target for the site for the duration of the contract (3 years).

Eligible management actions included:

- Changed stocking rates and times
- Stubble management
- Revegetation
- Planting of perennial vegetation
- Relocation of watering points and fencing

What happened?

A total of 21 properties (782 ha) were assessed during the expression of interest stage of this pilot project. Twelve landholders over 32 sites were offered 3-year contracts for the management of a total of 495.6 ha. Sites selected were all classified as having high erodibility, with 70% of the area classified as Land Class 3a or 4a.

Landholders bids were assessed on an "Erosion Risk Index" (ERI) taking into account the area protected, site erosion risk and tender price. The ERI is increased through either a high erosion risk site or a lower price per ha being protected (therefore, the higher ERI the better value for money).

What does this mean?

Landholders entered into contracts to increase and maintain 50% ground cover on designated areas of their property over a 3 year period. The average district cover level at the time of offering these contracts was 47.7% and the successful landholders applying through this tender process, averaged 7% below other sites in similar land classes in the region. This cover level was below the target level for adequate reduction of soil erosion risk (1 t/ha.). By early 2010, the difference in soil surface cover between managed and control sites had dropped to approximately 2% and were no longer significantly different from the district average.

Change in soil surface cover at managed sites was significant (see the difference in distribution between white bars (2009) and black bars (2010) in Table 1). The increase in cover represents a site compliance rate of approximately 80% in the first year of the program. This project also showed that increases in soil surface cover occurred at managed sites and that approximately 80% of sites met their soil surface cover targets in the first year of 3-year contracts. This is the first known demonstration of soil erosion risk reduction being achieved through tender for management contracts on Eyre Peninsula. The contract compliance rate of 80% is considered high for the first year of implementation of this novel project approach as landholders change to more conservative soil management techniques. Follow-up monitoring of landholders in 2011 will be necessary to see if differences in soil surface cover between managed and control sites have reduced further or disappeared.

This pilot project has been able to demonstrate that the tender-based approach to allocation funds for erosion protection was evidence-based, transparent and focussed on prioritisation of sites to achieve cost-effective outcomes for funds allocated. This in turn has lead to a subsequent MBI program being implemented to further improve Eastern EP's high risk erosion prone soils.

Acknowledgements

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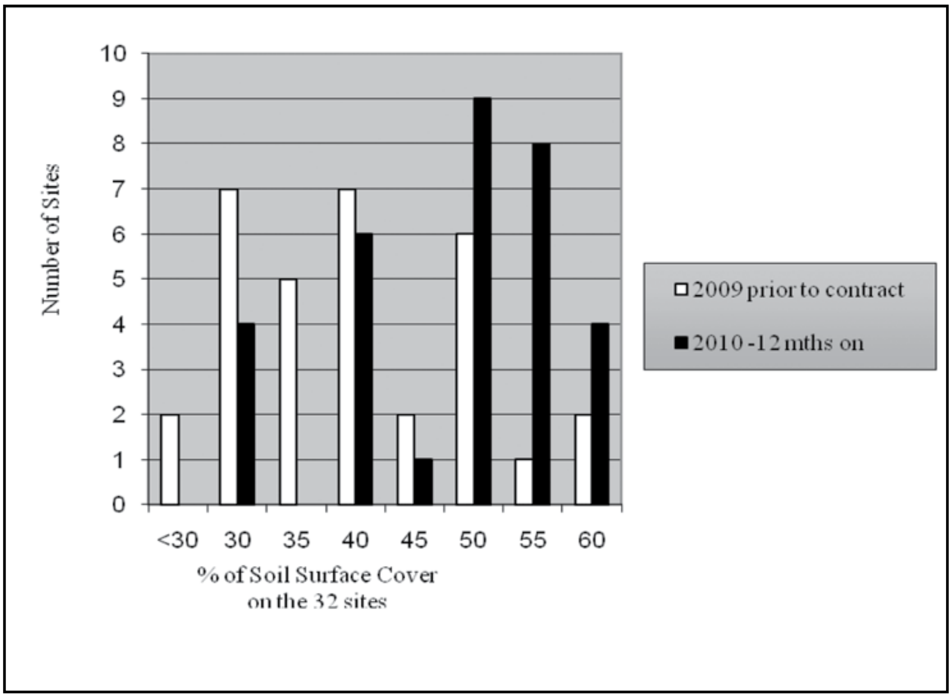

Table 1 Change in soil surface cover on managed sites from 2009 to 2010

Soils

RURAL SOLUTIONS SA

Government of South Australia
Eyre Peninsula Natural Resources Management Board

CARING FOR OUR COUNTRY

Soil Exposure Mapping via Remote Sensing Satellite Imagery

Neil Ackland
Eyre Peninsula Natural Resources Management Board, Port Lincoln

RESEARCH

Key messages

- **Aim to reduce impact of soil erosion on private and public land.**
- **Ability to target high risk erosion areas of EP.**
- **Cost effective approach to identify potential soil degradation.**

Why do the trial?

The Eyre Peninsula Natural Resources Management Board's (EPNRM) "Regional Target A" (Land condition is maintained and improved, and risk to land degradation are reduced from 2009 levels) has a focus on reducing soil erosion on Eyre Peninsula's (EP) high risk soils on private land through their "Sustainable Farming Systems" program.

The main targeted area covers the upper and western regions encompassing all the dune swale country, across to eastern EP and the Cowell flats. This area covers over 840,000 ha that is inherently subject to soil erosion and equates to approximately 30% of the farming area of EP.

Agricultural production takes in over 60% of EP, with large areas negatively impacted by continuing dry seasons. Identifying these areas that are at higher risk to climate variability and also to wind borne soil erosion and subsequently targeting EPNRM programs to these areas will enhance productivity on these more marginal, high risk cropping soils.

Research into the use of satellite imagery is one of the tools the EPNRM is using in an attempt identify these high risk areas along with other current technology such as the road side surveys and landholder consultation.

How was it done?

In generating a map of Eyre Peninsula's high risk erosion prone soils, 4 satellite images were used over two seasons, 2 in 2006-07 (drought) and 2 in 2009-10 (good season). In each of the seasons, 2 sets of images were taken, one in spring (when ground cover is at its best) and the other in autumn (when soil is most exposed). The areas within each image were then given a rating on the amount of ground cover present and subsequently combined together to generate a risk assessment map of EP's low, medium and high erosion risk areas.

What happened?

Satellite imagery is available on regular intervals; however, cloud cover can be a factor and can restrict good quality imagery, mainly during the winter months. The preliminary risk map (Figure 1) developed from those 2006-07 and 2009-10 images, has shown an estimated area of over 500,000 ha involving approximately 470 landholders being at medium to high risk to erosion potential if sufficient ground cover is not maintained in autumn (a minimum of 1 t/ha dry matter coverage is optimal to reduce soil erosion). This risk assessment map will require further ground truthing to establish the correlation between imagery and actual cover on ground at the time.

What does this mean?

Improving the quality of this cost effective data information, EPNRM and their external funding organisations will have the capacity to monitor soil erosion, improved farming practices and have the ability to provide accurate data of an overall change in the condition of our natural resource base that EP's farming production relies on.

Further trial work and ground truthing of this satellite imagery will be undertaken over the next two years on specific sites located across EP. Jointly funded through the Department of Environment and Natural Resources (DENR) and the Australian Government's Caring for Our Country program, this work will deliver a better understanding of what satellite remote sensing can provide and monitoring of EPNRM projects being delivered.

Acknowledgement

James Cameron – Department of Environment & Natural Resources.

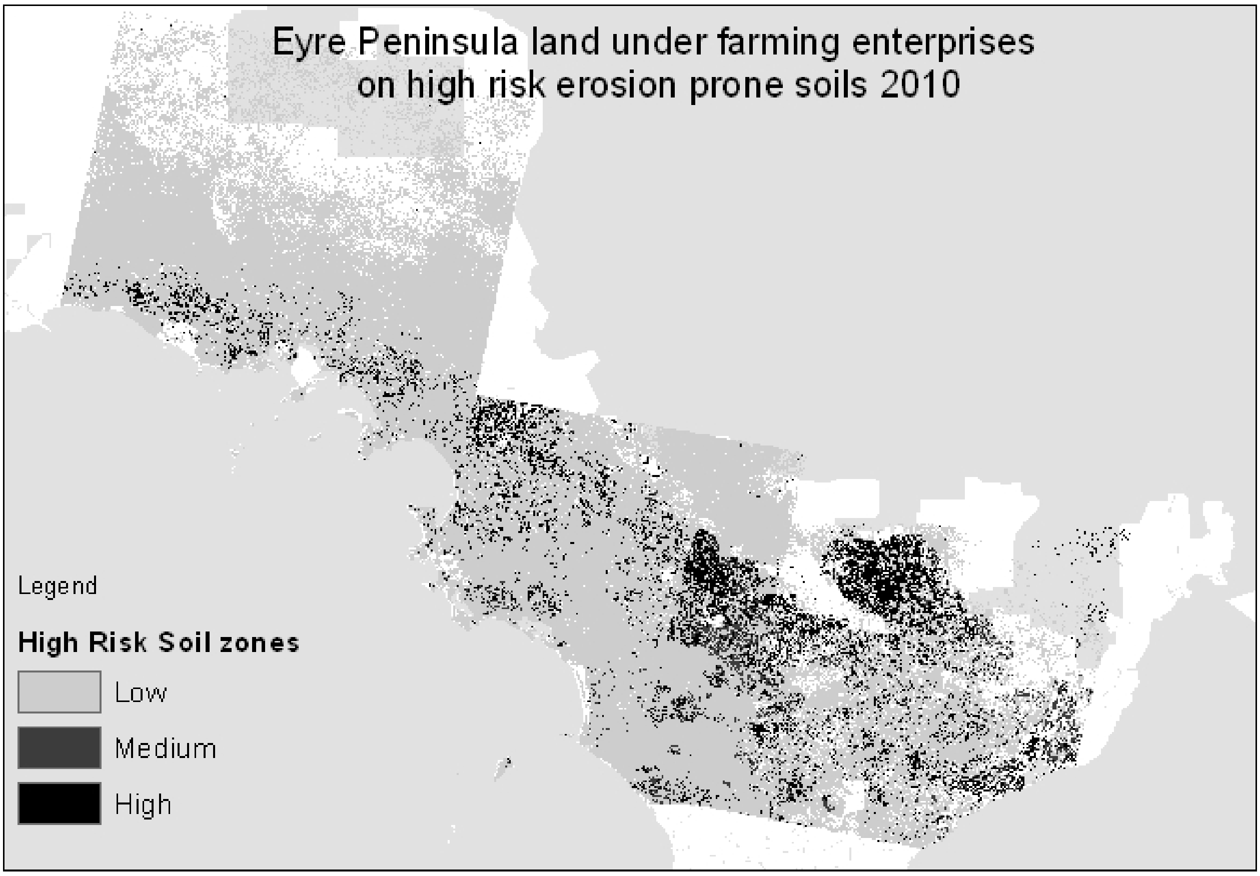

Figure 1 High risk erosion areas on upper Eyre Peninsula, 2010

Soils

EM38 Mapping on MAC – Farm Approach

DEMO

Linden Masters[1] and Peter Treloar[2]

[1]SARDI Minnipa Agricultural Centre, [2]Precision Ag Services, Minlaton

Key messages

- **EM38 is a valuable component in building variable rate technology (VRT) maps.**
- **Yield maps record what happens, not why it happens.**
- **EM38 mapping aids understanding of plant available water.**
- **Soil testing is essential for good decision making for different zones.**

What is EM38?

EM38 is a form of electro-magnetic soil mapping that measures the electrical conductivity of soils. This reading is predominately driven by soil salinity, texture and moisture. Other factors like boron and sodicity contribute to the value. These factors are also the major drivers of crop lower limits and thus plant available water and hence the relationship with EM38 results. The relationship between EM38 soil surveys and plant available water allows us to look into VRT using EM38 mapping.

Why do the demo?

EM38 mapping has been demonstrated in other parts of South Australia and Australia, but had not been done on Minnipa Agricultural Centre. With the technology becoming more available through commercial sources, farm machinery having yield mapping and variable rate capability, how can these technologies be integrated to provide a useful tool to make informed decisions regarding matching inputs to soil type?

Previous work in the Mallee has shown the EM38 technology has benefited farm profit. On that basis we have commenced a demonstration on the Minnipa Agricultural Centre to validate previous Mallee outcomes.

How was it done?

The MAC farm was EM38 mapped over 2 days; an average sized property can generally be mapped in 1 - 2 days, with the cost being the equivalent of a summer weed spray. The EM38 unit was placed in a sledge and towed around the paddock attached to a laptop computer in the 4WD which received the signal. The information was then downloaded into a program that placed the signals into coloured variances as a paddock or farm map.

What happened?

To ground truth what the signals and related output meant, GPS points were selected in the different colour zones (Figure 3) and soil samples were taken of the different horizons at those locations. These samples were sent to a soils laboratory and results identified drivers for the electrical conductivity such as salts, soil texture and rocks. Other related chemical indicators include sulphur, boron, magnesium and calcium carbonate levels, which give a good indication of any subsoil constraints.

Figure 1 Peter Treloar explains EM38 mapping to Dot Brace. The EM38 unit is attached to the back of a 4WD.

Figure 2 Information is fed directly into the laptop computer.

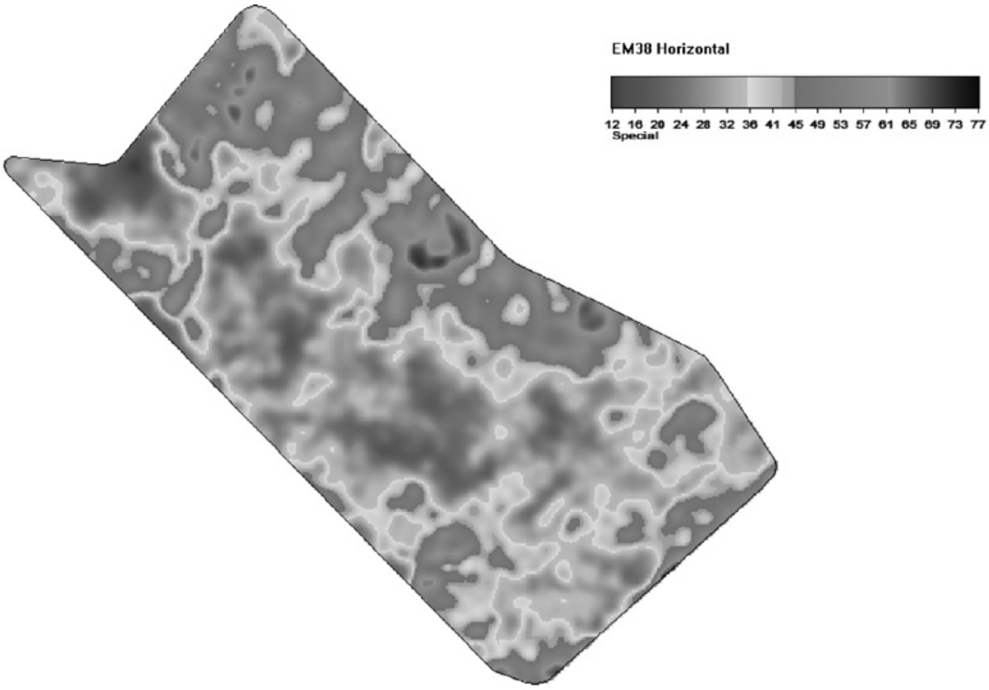

Figure 3 A soil zone map produced as a result of EM38 mapping.

What does this mean?

From the subsoil constraint information and testing of soil nutrition in the 0-10 cm layer, high quality data is available for input into VRT for varying fertiliser and seed inputs at sowing.

By understanding the variability in soil potential we are able to reduce risk and achieve a better gross margin through targeting areas that will more likely respond to higher inputs. By using soil maps as the main driver of zoning we are creating consistent zones from year to year thereby applying the cost of zoning over several years. Yield maps tend to flip flop due to varying seasons as they tell you what has happened, not why it has happened.

Continuing work will be undertaken to improve the accuracy of zoning and monitoring the stability of zones over time. Work is continuing on improving the estimation of plant available water and crop lower limit, through better understanding of subsoil constraints and by investigating the use of decision support programs such as Yield Prophet®.

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

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Naomi Scholz
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Section 8

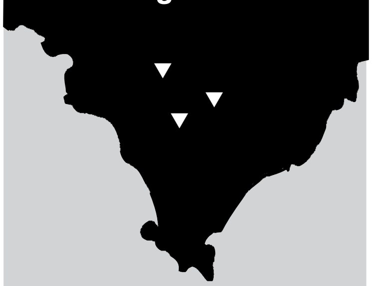
Weeds

Barley Grass, an Emerging Weed Threat

Ben Fleet and Gurjeet Gill
University of Adelaide, Waite Campus

RESEARCH

Searching for answers



Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 322 mm
Av. GSR: 222 mm
2010 Total: 410 mm
2010 GSR: 326 mm
Yield
Actual: Paddock around trial 2.65 t/ha Wyalkatchem
Management
Sown with 65 kg/ha seed + 50 kg DAP (18:20)
Zinc Sulphate + LVE MCPA 500 applied late August
50 kg/ha sulphate of ammonia applied end of August
Paddock History
2009: Wyalkatchem wheat
2008: Yitpi wheat
2007: Scythe wheat

Key messages

- **Barley grass is becoming more prevalent in many cropping districts.**
- **The ecology of barley grass has changed making it a more problematic weed in crops.**
- **Herbicides trialled provided various levels of control, with Sakura providing the highest and most consistent control.**

Why do the trial?

Barley grass has historically been a problematic weed in pastures or where crops were sown dry without an effective knockdown. However, a number of growers had suggested that they were now finding barley grass regularly in their crops. This was supported by our recent survey where growers ranked their most problematic weeds currently, compared with 5 years ago. Results from this showed that on the Eyre Peninsula barley grass had moved from fifth worst weed to third in the last five years. In the Upper North barley grass now appears at fourth position and is found in the top ten weeds in Lower and Mid North. In the Mallee, while not quite in the top five weeds, it has moved up in ranking significantly over this time. The reasons behind this change in ranking were unknown. This could be due to a run of dry seasons where growers have increasingly used dry and early sowing, resulting in no or ineffective herbicide knockdown. Alternatively the behaviour of barley grass may have changed in response to crop management practices. In addition, some growers reported that barley grass had remained a significant issue, even when paddocks were not sown dry. Following this, investigations have begun to understand why barley grass is becoming more problematic and how it can be best managed.

How was it done?

Barley grass seed was collected, just prior to harvest in 2008 and 2009, from a number of cropping paddocks across Eyre Peninsula (Yaninee, Minnipa, Buckleboo and Lock). Seed biology of these populations was studied in laboratory tests and pot studies. The germination pattern of these populations was studied, in 2009 and 2010, to assess seed dormancy. Investigations then followed into the effect of light, seed scarification, plant hormones and temperature on seed dormancy to understand field behaviour of these populations.

A field trial was set up at Roseworthy that investigated the impact of three seeding systems on four barley grass populations. Seeding systems where conventional (pre-sowing cultivation and sown with sweeps), knife point (flexicoil with Harrington point), and single disc (John Deere 90 series).

Location: Lock
Rainfall
Av. Annual: 340 mm
Av. GSR: 225 mm
2010 Total: 479 mm
2010 GSR: 321 mm
Yield
Actual: Paddock around trial 2.15 t/ha Wyalkatchem (mouse damage was concentrated on sandy ridge where trial located)
Management
Sown with 60 kg/ha seed + 30 kg/ha urea + liquid fert mix (6 kgP, 1 kgMn, 1 kgZn, Cu 70g/ha)
Broadleaf spray 350ml LVE + 15ml Brodal
Foliar trace 1 kg/ha manganese sulphate + 1 kg/ha zinc sulphate (Hepta) + 200g/ha copper sulphate
Foliar N 15 L/ha UAN
Triad fungicide @ 1L/ha
Paddock History
2009: Wyalkatchem Wheat
2008: Wyalkatchem Wheat
2007: Wyalkatchem Wheat

Location:
Buckleboo
Rainfall
Av. Annual: 305 mm
Av. GSR: 216 mm
2010 Total: 333 mm
2010 GSR: 242 mm
Yield
Actual: Paddock around trial 2 t/ha Yitpi Wheat
Management
Sown with 65 kg/ha seed + 65 kg/ha (27:12)
Paddock History
2009: Wheat
2008: Wheat
2007: Oats

Barley grass populations included Lock, Owen, Roseworthy-cropping and Roseworthy-pasture. A known amount of this seed was spread on plots in March and sowing treatments overlaid. Barley grass populations were then tracked through the season.

Also five field trials were set up at three locations on the EP in 2010.

Location 1, Buckleboo:

- Herbicide efficacy trial: two times of sowing (TOS), 29 April/4 June and 18 June with different herbicide treatments (Table 1). Machinery complications resulted in the first TOS having pre-emergent herbicides applied on 29 April and not incorporated by sowing until the 4 June. This would be similar to applying pre-emergent herbicides with an early knockdown herbicide. The second TOS herbicides were incorporated by a sowing pass soon after application. Plots were 5 x 14 m in size and herbicide treatments covered a single pass with the air-seeder. Measurements taken included crop density, weed density at two timings, weed seed head density, weed seed production, crop yield, grain size and barley grass contamination of grain.
- Seed-bank study: soil cores taken to track decline in barley grass soil seed-bank when no new seed is added, to establish how many years of control are required to exhaust barley grass seed-bank.

Location 2, Lock:

- Herbicide efficacy trial: as above, but only one TOS (17 May). Set up similarly to Buckleboo, but plot size 5 x 12 m.
- Seed-bank study: see Buckleboo

Location 3, Minnipa

- Herbicide efficacy trial: two times of sowing (29 April and 17 June) herbicide treatments same as other sites (Table 1), but plots size was 5 x 9 m. The second TOS was re-sown 1 July following severe mouse damage during establishment.
- Seed-bank study: see Buckleboo

What happened?

Dormancy studies showed that many of these barley grass populations had high levels of seed dormancy at maturity and in some populations dormancy persisted for a long time (Figure 1). Populations ranged anywhere from 80-90% germination (Yaninee and Minnipa-roadside) in March, as would be expected in barley grass, to populations such as that from Minnipa-paddock, Lock and Buckleboo that barely germinated in the lab test, even though all populations had highly viable seeds.

Table 1 Herbicide treatments used in herbicide efficacy trial, Buckleboo, Minnipa and Lock 2010

Herbicide Treatments
1. Control (only knockdown herbicide pre-seeding)
2. Trifluralin (480 g/L) @ 1.6 L/ha (immediately before sowing, **IBS**)
3. Trifluralin (480 g/L) @ 1 L/ha + Logran (triasulforon 750 g/kg) @ 30 g/ha **(IBS)**
4. Metribuzin (750 g/kg) @ 150* g/ha **(IBS)**
5. Trifluralin (480 g/L) @ 1 L/ha + Diuron (900 g/kg) @ 500 g/ha **(IBS)**
6. Metribuzin (750 g/kg) @ 150* g/ha + Diuron (900 g/kg) @ 250 g/ha + Logran (triasulfuron 750 g/kg) @ 30 g/ha **(IBS)**
7. Avadex Xtra (tri-allate 500g/L) @ 2 L/ha **(IBS)**
8. Avadex Xtra (tri-allate 500g/L) @ 3 L/ha **(IBS)**
9. Boxer Gold (prosulocarb 800 g/L, S-metolachlor 120 g/L) @ 2.5 L/ha **(IBS)**
10. Sakura (pyroxasulfone) @ 118 g/ha **(IBS)**
11. Sakura (pyroxasulfone) @ 79 g/ha **(IBS)**
12. Sakura (pyroxasulfone) @ 39 g/ha **(IBS)**
**180 g/ha Metribuzin applied at Minnipa due to heavier soil texture*   *The above herbicide treatments are for research purposes and may not be registered.*

Weeds

This was consistent with germination studies from 2009. The large difference of germination between Minnipa-paddock and Minnipa-roadside is of interest. This large difference in germination pattern demonstrates how seed dormancy has developed in barley grass under intensive crop production. This finding explains why barley grass is becoming a greater problem in crop, as it avoids knockdown herbicide with its dormancy and then germinates in crop where control is far more limited.

The mechanisms of this dormancy have been studied with various influences on dormancy, such as light, seed husk, and cold requirement (chilling). In 2009 the chilling effect seemed to be the most influential in the highly dormant populations, this was repeated in 2010 across a wider range of EP populations; while the impact was not quite as dramatic the same trend existed with highly dormant populations. This means that the dormant barley grass requires not only moisture, but a period of colder temperatures to germinate. This is also evident in 2009 when comparing barley grass plant numbers between the first (22 April) time of sowing and the second (17 May) at Buckleboo with 376 plants/m^2 and 95 plants/m^2 respectively. This is a large reduction in barley grass due to about three weeks of cooler moist conditions in late autumn-early winter encouraging a break in dormancy and allowing better control of barley grass with knock down herbicide before seeding. A larger reduction was seen at Minnipa in 2010 with a much longer time between TOS, with 97 plants/m^2 and 8 plants/m^2 for first (29 April) and second (17 June) TOS respectively.

Barley grass control from herbicide treatments at each field site is shown in Table 2. Barley grass control has been reported as seed set reduction from the control treatment. This has been used to demonstrate reduction in the paddock's barley grass seed bank, and future barley grass infestations. At all the sites, knockdown herbicide alone provided unacceptable barley grass control as shown by seed set/m^2 in brackets. Out of the lower cost pre-emergent treatments, both the metribuzin+ diuron + Logran and the trifluralin + Logran mixes seemed to give the most consistent control in both 2009 and 2010. While the level of control was adequate where barley grass levels were low it was mostly inadequate under higher barley grass pressure. Most of the other available pre-emergent treatments lacked both level and consistency of control in both 2009 and 2010.

Sakura provided the highest and most consistent control over all the herbicides trialled in both 2009 and 2010. In 2010 Sakura was trialled at lower rates, which provided higher than expected levels of control. Sakura was expected to be available in 2011, but has been delayed until 2012. The first TOS trial at Buckleboo that had a long period between herbicide application and incorporation by sowing, and had surprisingly high levels of control which is an indication of the stability of some of these herbicides like Boxer Gold, Sakura and Logran. The trifluralin treatment provided far more than expected control given the herbicide's high volatility. A possible explanation is that the site has been under no-till for a number of years and the weed seed bank would be mostly located on or close to the soil surface, allowing trifluralin to be directly applied to much of the seed; having activity before volatilising.

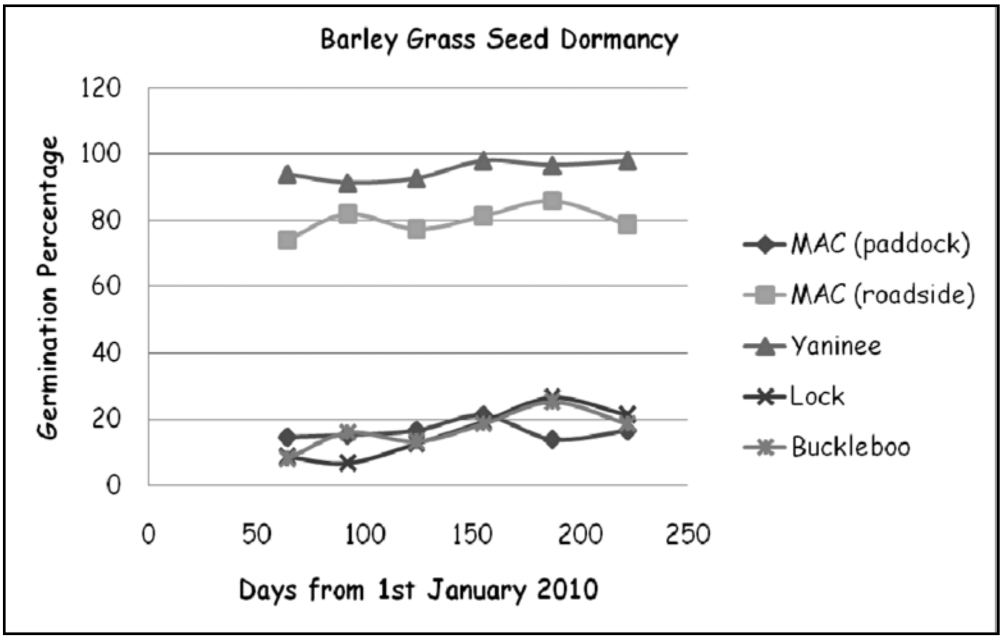


Figure 1 Barley Grass seed dormancy

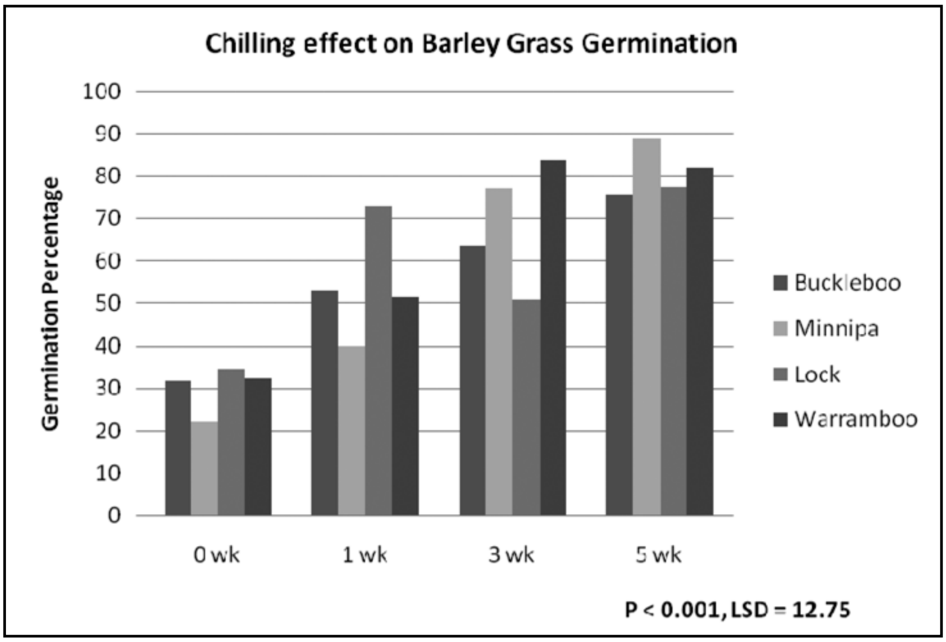


***Figure 2** Effect of chilling on germination of four barley grass populations. Cold treatments ranged from no cold treatment to 5 weeks cold treatment.*

***Table 2** Barley Grass control in terms of reduction seed production (%) across field sites*

Herbicide	Buckleboo TOS-1 * (see below)	Buckleboo TOS-2 (18 June)	Lock (17 May)	Minnipa TOS-1 (29 April)	Minnipa TOS-2 (17 June)
Control (knockdown herbicide only)	0 % ***ab*** (7871 seed/m^2)	0 % (106 seeds/m^2)	0 % ***ab*** (12,888 seeds/m^2)	0 % ***a*** (4577 seeds/m^2)	0 % ***a*** (606 seeds/m^2)
Trifluralin @ 1.6 L/ ha (IBS)	44% ***bc***	*ns*	11% ***a***	38% ***b***	62% ***bc***
Trifluralin @ 1 L/ ha + Logran @ 30 g/ha (IBS)	89% ***cd***	*ns*	21% ***ab***	61% ***c***	96% ***d***
Metribuzin @ 150 - 180 g/ha (IBS)	-9% ***a***	*ns*	3% ***a***	28% ***b***	37% ***b***
Trifluralin @ 1 L/ ha + Diuron @ 500 g/ha (IBS)	68% ***cd***	*ns*	1% ***a***	45% ***bc***	68% ***c***
Metribuzin @ 150 - 180 g/ha + Diuron @ 250 g/ ha + Logran @ 30 g/ha (IBS)	89% ***cd***	*ns*	18% ***ab***	65% ***cd***	89% ***cd***
Avadex Xtra @ 2 L/ha (IBS)	23% ***b***	*ns*	24% ***ab***	18% ***ab***	63% ***bc***
Avadex Xtra @ 3 L/ha (IBS)	38% ***bc***	*ns*	32% ***ab***	23% ***b***	70% ***cd***
Boxer Gold @ 2.5 L/ha (IBS)	62% ***c***	*ns*	21% ***ab***	68% ***cd***	92% ***cd***
Sakura @ 118 g/ ha (IBS)	100% ***d***	*ns*	78% ***b***	100% ***d***	100% ***d***
Sakura @ 79 g/ ha (IBS)	97% ***d***	*ns*	73% ***b***	95% ***d***	95% ***cd***
Sakura @ 39 g/ ha (IBS)	95% ***d***	*ns*	57% ***b***	86% ***d***	93% ***cd***

Barley Grass seed production as percentage of Control herbicide treatment for each site,
Statistical (P=<0.05) differences displayed with letters for each site
ns = no statistical difference
** Buckleboo TOS-1 herbicides applied 29 April and incorporated by sowing 4 June*

Weeds

Table 3 Wheat yields (t/ha) for all field sites

Herbicide	Buckleboo TOS-1* (see below)	Buckleboo TOS-2 (18 June)	Lock (17 May)	Minnipa TOS-1 (29 April)	Minnipa TOS-2 (17 June)
Control (knockdown herbicide only)	1.78 ***a***	1.79 ***a***	1.56 ***a***	1.58 ***a***	2.26
Trifluralin @ 1.6 L/ ha (IBS)	1.90 ***ab***	1.88 ***ab***	1.60 ***ab***	1.68 ***ab***	2.24
Trifluralin @ 1 L/ ha + Logran @ 30 g/ha (IBS)	2.11 ***b***	1.88 ***ab***	1.87 ***ab***	1.83 **bc**	2.23
Metribuzin @ 150 - 180 g/ha (IBS)	1.80 ***a***	1.90 ***b***	1.60 ***ab***	1.71 ***b***	2.33
Trifluralin @ 1 L/ ha + Diuron @ 500 g/ha (IBS)	2.11 **bc**	1.90 ***b***	1.77 ***ab***	1.75 ***b***	2.38
Metribuzin @ 150 - 180 g/ha + Diuron @ 250 g/ ha + Logran @ 30 g/ha (IBS)	2.24 **c**	1.84 ***ab***	1.79 ***ab***	1.96 **c**	2.26
Avadex Xtra @ 2 L/ha (IBS)	1.75 ***a***	1.85 ***ab***	1.66 ***ab***	1.59 ***ab***	2.40
Avadex Xtra @ 3 L/ha (IBS)	1.70 ***ab***	1.90 ***b***	1.81 ***ab***	1.74 ***b***	2.29
Boxer Gold @ 2.5 L/ha (IBS)	1.98 ***b***	1.88 ***ab***	1.90 ***b***	1.77 ***b***	2.25
Sakura @ 118 g/ ha (IBS)	2.25 **c**	1.90 ***b***	2.19 ***b***	1.97 **c**	2.20
Sakura @ 79 g/ ha (IBS)	2.21 **c**	2.03 **c**	2.18 ***b***	1.92 **c**	2.28
Sakura @ 39 g/ ha (IBS)	2.15 **c**	1.94 **bc**	1.95 ***b***	1.96 **c**	2.28

Statistical (P=<0.05) differences displayed with letters for each site
** Buckleboo TOS-1 herbicides applied 29 April and incorporated by sowing 4 June*

Wheat yields for each herbicide treatment at each site are displayed in Table 3. Increased yields seem to be related to improvements in barley grass control. This shows up well when comparing the two sites at Minnipa, where in TOS-1 (high barley grass) wheat yields trends followed barley grass control and TOS-2 (low barley grass) had no statistical differences between herbicide treatments.

In 2009 the Minnipa TOS-2 trial included a seeding system component, which compared a knife point (DBS) to a disc (K-Hart) seeding system. While there were no herbicide treatments that were affected by seeding system treatments. The disc (K-Hart) had 16% more barley grass plants than the knife point (DBS). Following this a seeding system trial was conducted at Roseworthy in 2010. This trial compared impact of three seeding systems, conventional (Conv.), knife point (KP) and single disc (SD) on four barley grass populations. Preliminary results from this trial supported the trend seen at Minnipa in 2009 where barley grass seemed to favour lower disturbance systems (Figure 3). These results indicate that unlike annual ryegrass, barley grass is not disadvantaged by the disc seeding system and possibly advantaged. Reasons for this are likely to be related to the nature of the barley grass seed. The sterile florets and thick husk would increase the surface area of the seed for water absorption and could protect the seed from fluctuations in moisture and the ability of the seed for self-burial, would make it well adapted to seeding systems that keep seed on the soil surface.

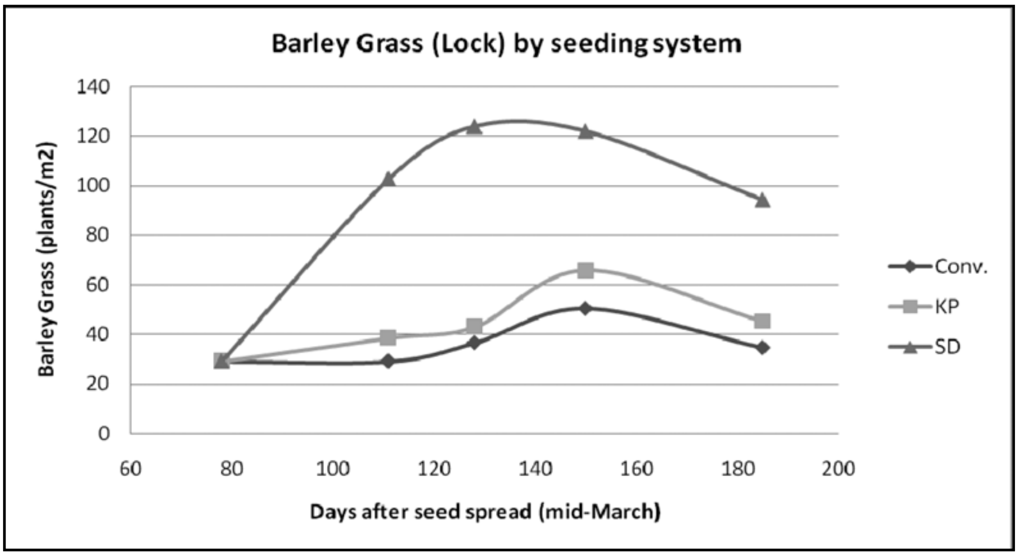


Figure 3 Seeding system effect on barley grass population

What does this mean?

Barley grass is now a problematic crop weed for many growers. This appears to be due to high levels of seed dormancy in many paddock populations. High dormancy and chilling requirement in barley grass would enable these populations to avoid knockdown herbicides and germinate in crop where control options are far more limited. Herbicides trialled showed variable levels of control, with Sakura providing the highest and most consistent control.

Further barley grass work on the seed-bank life and time required to change seed dormancy will continue in 2011.

Recommendations from work done in 2009/2010 include:

- Take barley grass seriously as a crop weed.
- Be sure to achieve maximum control at every opportunity particularly in pasture phases and break crops where high levels of control can be achieved. Consider barley grass control when deciding on herbicides in cereal.
- Assess barley grass escapes in spring and undertake seeding in problem barley grass paddocks right at the end of your seeding program. This approach will not delay overall seeding time for the farm, but gives barley grass longer exposure to chilling conditions, thereby achieving higher germination which can be controlled by a knock-down herbicide before seeding.

Acknowledgements

This work is part of a GRDC project into emerging weed threats (UA00105) and we would like to thank the GRDC for their funding and support of this work. We would also like to thank Michael & Mary Schaefer, Andrew and Jenny Polkinghorne, and Mark Klante for providing field sites for this work. Also we would like to thank Malinee Thongmee, Brett McEvoy, Ashley Spiers, Leigh Davis, Brenton Spriggs, Mick Zerner and Sam Kleemann for their contributions to the project.

Identifying and Controlling Nightshades

Iggy Honan
Eyre Peninsula Natural Resources Management, Cleve

INFORMATION

It is always difficult to broach the subject of identifying and controlling nightshades, because it can be quite difficult from both the identification angle as well as control options. I guess the first thing one has to know before looking at whether 'your' nightshade is truly a pest, is whether it appears to be having an impact on your crops or pastures.

So to set the scene, Silverleaf *(Solanum eleagnifolium)* is the weed with Southern American origins and is proclaimed under the *Natural Resources Management Act, 2004* for control right across South Australia. Along with that, we have a plethora of native nightshades on Eye Peninsula, some of which are quite pretty like Native Pepper *(Solanum capsicforme)* and then some that can vary from just being small clumpy bushes to others like Rock nightshade which are very weedy but usually limited to a specific soil type.

The bottom line for you is this, if you have one or more nightshades on your property make sure they are properly **IDENTIFIED!** This is not easy and even botanists can come unstuck, so don't feel inadequate if you are not sure which one you have.

I will attempt to simplify the subject and relate my knowledge on controls which is by no means complete, so here goes:

Silverleaf Nightshade *(S. eleagnifolium)* as mentioned previously has come from the Americas and in our environment it is mainly spread by livestock who will after some taste testing, grow to love eating the pods, which can give them a bit of a "chilli" like spark. The ingested seeds mostly pass through the stock and are quite viable wrapped in the manure, where they sit in the soil until conditions are ripe for germination, which is usually from November until March (hot days and cool nights) and of course requiring a large rain event to ensure seedlings survive the drying conditions until autumn. In our climate and sandy soils we rarely see plants grow from root fragments. This is a serious weed causing yield losses of 5-50% if left uncontrolled.

We also have a series of weedy nightshades such as Rock *(S. petrophilum)*, Afghan *(S. hystrix or hoplopetalum)*, Quena *(S. esuriale)* and Western *(S. coatiliferum)*. We also at times can see Desert Raisin *(S. centrale)* and Solanum terraneum (no common name), mainly in the northern and far west regions.

All of these species can be quite weedy as they are deep-rooted perennials suited to desert conditions. Yield losses vary depending on soil type but 10-25% is not unusual and again they are mostly spread through contaminated stock, with only Afghan appearing to grow from fragments in our EP environment.

Now I have given you the botanical names not to sound like a nerd or to send you into a spin, but so you can go to Google® images or visit your favourite website and punch in the various botanical names and hopefully get some helpful images. As I mentioned earlier though it pays to contact your local NRM Officer and either get them to call on your patch or bring in excellent plant samples with flowers, leaves and fruit if you can. Table 1 is a very simplified guide that may assist you.

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Table 1 Solanum species: features and methods of control

Plant names	***Key ID feature***		***Notes of interest when controlling***
Silverleaf Nightshade *Solanum elaeagnifolium*		Purple sometimes white flowers, some prickles, wavy leaf, 20-60 cm high	**Spot treat** with glyphosate mix, or Tordon® depending on soil and aspect. **Broadacre** – Best results obtained with Gylphosate + Surpass® type 2,4-D herbicides. Complete kill of this plant is rare with one treatment unless it is a small new shoot. Yield increases 10-30% common.
Rock Nightshade *Solanum petrophilum*		Purple flowers, prickles give it a rusty look. Stiff upright plants, 40-80 cm high	**Spot treat** with glyphosate mix, or Tordon® depending on soil and aspect. **Broadacre** – Best results obtained with 2,4-D Amine, as a slow kill seemed best. Complete kill of this plant is rare, but **persistence** will reduce markedly.
Afghan Nightshade Solanum *hystrix* or *hoplopetalum*		Purple to white flowers, sprawling plant. Waxy leaves. Bone coloured spines, 10-30 cm high	**Spot treat** with glyphosate mix, or Tordon® depending on soil and aspect. **Broadacre** – Best results obtained with Gylphosate + Surpass® type 2,4-D herbicides. Complete kill of this plant is rare, but persistence will reduce markedly, especially with good **penetrant.**
Quena *Solanum esuriale*		Purple flower, slight wavy leaf, few pickles, 10-25 cm high	**Spot treat** with Tordon® depending on soil and aspect. **Broadacre** – this plant has proved near impossible to control with herbicides and even high rates of glyphosate have little impact. It does spread slowly!
Desert raisin *Solanum centrale*		Similar to quena but more sprawling 10-25 cm high	**Spot treat** with Tordon® depending on soil and aspect. **Broadacre** – Little experience with this plant as yet but would be willing to run trials if site is suitable.
Solanum terraneum		Purple flower, thick grey leaf, 10-20 cm high	**Spot treat** with glyphosate mix. **Broadacre** – Little knowledge on this one and not seen in large areas of cropped land.

Section 9

Section Editor:
Naomi Scholz
SARDI, Minnipa Agricultural Centre

Sharing Info

Climate Change and Wheat Crop Responses - FACING *the Future*

RESEARCH

Rob Norton[1], Glenn Fitzgerald[2] and Michael Tuasz[3]
[1]International Plant Nutrition Institute, Horsham,
[2]Victorian Department of Primary Industries, Horsham,
[3]The University of Melbourne

Key messages

- **Climate change, with higher temperatures and lower rainfall is challenging us now and will continue to do so in the future.**
- **Some of the adverse effects of changing weather patterns will be reduced through the beneficial effects of higher carbon dioxide, even in low yielding environments.**
- **There are traits in current varieties that could provide keys to develop varieties better adapted to a warm, hot and carbon rich future.**

Why do the trial?

We need to know how crops will respond to a future climate that is warmer, drier but has more carbon dioxide in the air.

The past decade has seen difficult seasonal conditions, with a string of below average rainfall years, coupled with warmer temperatures. Figure 1 is taken from weather records held by the Bureau of Meteorology showing that since the 1970s, the 5 decades leading up to 2010 has seen around 45 mm less annual rainfall on the Eyre Peninsula (Figure 1).

It is predicted that changes in "greenhouse" gases such as carbon dioxide will continue to increase temperatures and interfere with weather patterns (see http://www.ipcc.ch/). Predictions for much of the grain producing regions of southern Australia suggest that by 2050, rainfall will decline by around 5-10% and temperature will rise by 1-2°C (see http://climatechangeinaustralia.com.au).

Farmers have adapted to these changes through careful crop selection and management and adopting flexible programs to deal with uncertain seasons. A recent survey of growers in the Victorian Mallee showed that farmers have changed their management practices by a combination of increasing pasture or fallow frequency, reducing plant density, selecting shorter season crops and increasing residue retention. Such changes are risk management strategies really to deal with drier and warmer seasons.

But the real question is will this be enough to adapt to a future climate and keep farm business productive and profitable?

Role of Carbon Dioxide

Carbon dioxide is part of the cause of global warming, but rising CO_2 levels also have a positive effect. This trace gas is used by plants as the building block of sugars and other plant materials in the process of photosynthesis. The literature from overseas supports this view with plants like wheat (C3 plants) showing increased growth and yield of up to 30% in their response. However, other plants such as sorghum (C4 plants) do not show this response as their carbon capture mechanisms are much more efficient than C3 plants.

An added bonus is that carbon dioxide also causes the pores in the leaf (stomata) to close, so that relatively less water is used. The upshot of these responses is that wheat crops should show high water use efficiency when grown under the higher carbon dioxide expected in the future.

Again, the research on this topic also shows that temperature and water availability could affect the response expected to high carbon dioxide. The actual impact of higher temperatures and reduced water availability may in fact reduce any growth benefit from the high carbon dioxide.

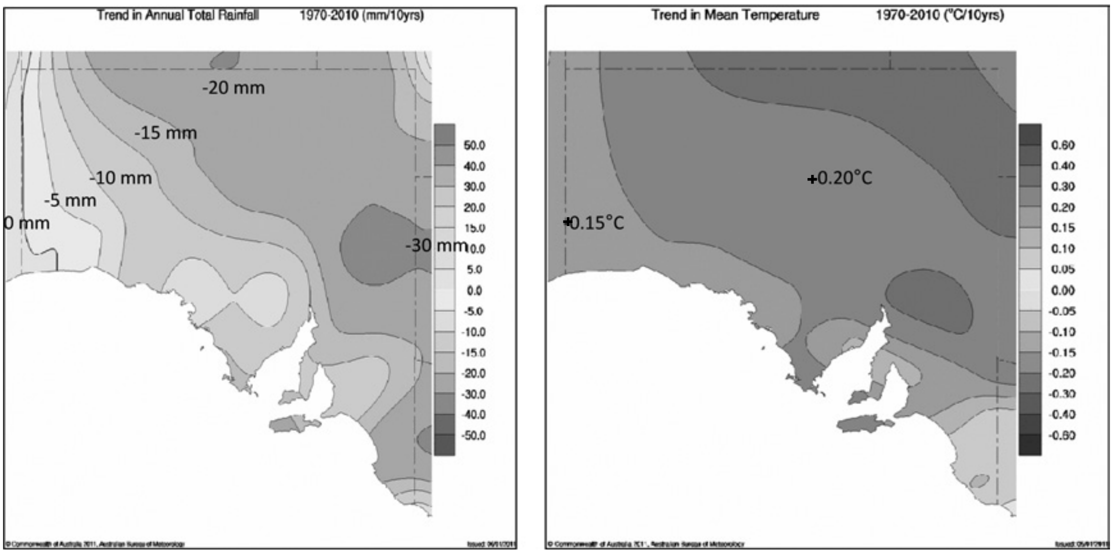


Figure 1 Decadal changes in annual total rainfall (a) and mean temperature (b) for South Australia for the period 1970 to 2010
(Source: Bureau of Meteorology *http://www.bom.gov.au/cgi-bin/climate/change/trendmaps.cgi).*

How was it done?

In 2007, the University of Melbourne and the Victorian Department of Primary Industries with support from the (then) Greenhouse Office and GRDC to commission the Australian Grains Free Air Carbon Dioxide Enrichment (AGFACE) facility to test the interaction of water, temperature and carbon dioxide. Two facilities were established, one at Horsham in the Wimmera and the other at Walpeup in the Mallee.

At these FACE sites, the crop is grown in the open air and in normal soil and the carbon dioxide level is raised in an area by fumigating those treatments through distributors around the perimeter. Each two seconds, the level of carbon dioxide is measured and adjusted to the target – which for our experiments is 550 ppm. This compares to the current level of 385 ppm during the day in the field.

At the Walpeup site, the rings were sown with Yitpi wheat at normal sowing rates but at two different sowing times – either in mid May or late June – to force the crop growth from the later sowing into relatively warmer conditions during grain fill. Growth, yield, quality, nitrogen dynamics and water use were all measured on the experiments in 2008 and 2009.

What happened?

In simple terms, we found that crops grown under high carbon dioxide gave on average about a 50% increase in yield. This increase occurred irrespective of the sowing time or year. The May to November rainfalls were a dry 148 mm in 2008 and a more normal 264 mm for 2009. The harvest index of these crops – the proportion of growth that goes to grain – was not reduced with high carbon dioxide so the plants were actually operating more efficiently with the extra carbon available to them in the atmosphere.

Figure 2 One of the eight free-air carbon dioxide enrichment rings in the field at Walpeup, Victoria. Eight normal plot areas well spaced from these rings were used as comparisons.

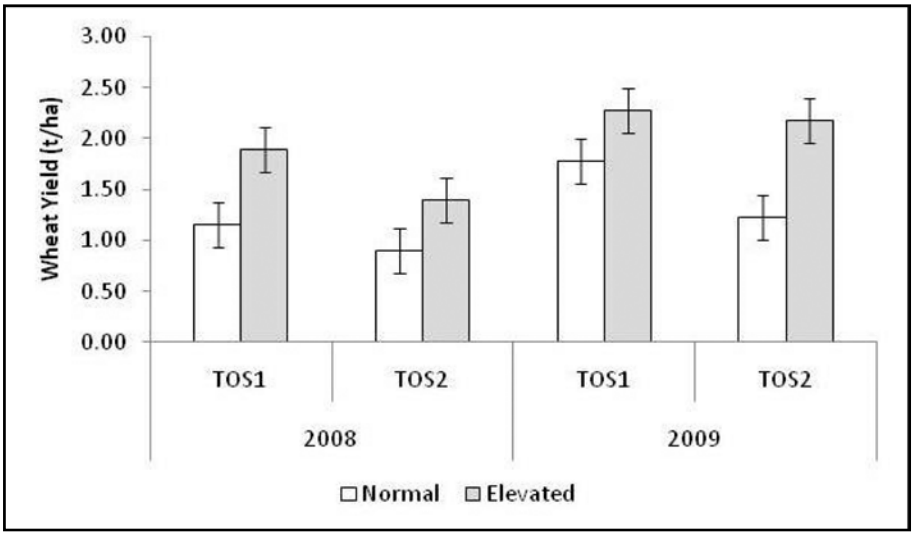


Figure 3 Mean wheat grain yield response to elevated carbon dioxide (550 ppm versus 385 ppm) with two sowing times at Walpeup in 2008 and 2009.

What does it mean?

This response suggests that carbon dioxide will help reduce the impact of higher temperatures and lower rainfalls, even in the low rainfall regions of Australia.

But there is much more to this story. The higher yields come with lower grain protein content, which is part of a physiological adaptation to having more carbon dioxide. The plant invests less nitrogen in proteins associated with photosynthesis so that when grain filling starts, there is less nitrogen to move to the grain. Our sites were well fertilized with nitrogen but the grain protein contents still slipped from 15.3% (2008) and 15.5% (2009) under normal conditions to 13.4% (2008) and 13.5% (2009) under elevated carbon dioxide.

Our research has also noted changes in grain mineral content and other aspects of grain quality. Part of the work now undertaken is to investigate strategies to adapt wheat to produce high quality grain. In 2009 and 2010 at Horsham, a range of varieties are being evaluated for their comparative growth, yield and quality. This research has shown that even with the small number of varieties tested, there are differences that will help develop better adapted types.

What we have reported here is only a small part of a large multi-discipline research project that seeks to identify and develop strategies to cope with impacts of climate change in the grains industry. Other research at the FACE site is on soil nutrient cycling processes, legumes responses and pest and disease impacts. The data is also being used to calibrate crop simulation models to test adaptation strategies for the warm, dry and carbon rich world which seems to await us.

Acknowledgements

This research project is supported by the Grains Research & Development Corporation, Victorian Dept. Primary Industries, Australian Dept. Ag, Fisheries & Forestry, Australian Dept. Climate Change, University of Melbourne, and the International Plant Nutrition Institute. Others involved are Garry O'Leary, Mahabubur Mollah, Roger Armstrong, Nicole Mathers, Jason Brand, Jo Luck, Piotr Trebicki, Ivan Mock, Wendy Griffiths, Joe Panozzo, James Nuttall, Debra Partington, Graeme Thomson, Russel Argall, Justine Ellis (all VDPI) and Saman Seneweera, Sabine Posch, Shu Kee Lam, Nemisha Fernando, Lakmini Thilakarathne, Marc Nicolas, Peter Howie (all UoM).

Eyre Peninsula Drought Task Force - A Snapshot

INFORMATION

Brenton Parsons
Eyre Peninsula Drought Task Force

The Eyre Peninsula Drought Task Force was initiated by the region in response to drought seasons from 2004 onwards.

A snapshot of what was a difficult decade reveals:

- 2001 season. Record crop 2.6 million tonnes. High prices for grain. Increased equity, rising farm values, increased confidence in the industry.
- 2002 & 2003. Highest period of capital investment into farming equipment.
- 2004. Drought hits Upper and Western Eyre Peninsula.
- 2005. Reasonable production year. Lowest grain prices in 30 years.
- 2006, 2007, 2008. Severe drought years over most of Eyre Peninsula. Grain Market deregulation 2006. Farmers encouraged to enter futures market significantly increasing exposure to risk. Farmers had washout contracts of $100,000 plus. 2006 – Drought Task Force initiated. Early 2007 - All Eyre Peninsula declared under Exceptional Circumstances (EC). October 2007 – Regional Drought Coordinator appointed.
- 2009. Partial recovery following a generally good growing season. Some parts of the region experienced "rain shadows" and continued on in drought. Grain prices not as good as hoped.
- 2010. Generally good growing conditions across the region (estimated 1 in 20 year "La Nina" effect). Potential record crop volumes offset by persistent rain periods over harvest. Significant downgrading of grain quality. Improved grain prices. March 2010 – EC expired across the region.
- June 2011 – Drought Coordinator funding expiring and Drought Task Force wound down. Transition plans prepared for incorporation into Regional Adaptive Governance model.

Task Force Model

The Eyre Peninsula Drought Task Force was established using a model that had been effective in dealing with a number of previous events affecting the region. It contains membership from key regional agencies, the agricultural business community and of course farmers. It retains the flexibility to incorporate any other people required to get jobs done.

The Task Force is sifting through the processes and initiatives undertaken over the last few years, to determine what worked well and what could be done better when the next exceptional circumstance arrives.

Learnings

When the Drought Task Force Chairmen were asked to jot down their "learnings and reinforcements" over the last few years, the dot points raised made interesting reading;

- That the region can experience four consecutive years of drought.
- That crop failure to below 25% of average can occur.
- That farm businesses can 'pull through' extended drought periods.
- That some farm business structures are able to support a succession plan.
- That it is not demeaning to admit inability to cope.
- That stress is sinister.
- That communication is critical.
- That it is important to engage support when dealing with tough situations (such as consulting with Bank Managers).
- That people have enormous capacity to care for others.
- That the demise of 'ordered' grain marketing (in the same time frame as drought) introduces a new level of risk.
- That grain prices can fall $60 in a 20 minute timeframe.
- That finance institutions generally are anxious to avoid equity slides.
- That 'household support' is critical.
- That interest rate subsidies (IRS) are applied inequitably.
- That sheep (at current meat values) are an important income cash flow consideration.
- That feed-lotting is a viable alternative.
- That water harvesting is an option.
- That new-age tillage practises are beneficial in terms of soil protection.
- That there is still need to protect 'sensitive' soil areas.
- That showers are not a substitute for rain to reduce 'magnesia' patches.
- That a semi-formal structure involving farmers & businesses is a valuable consultative mechanism (Drought Task Force).
- That communication with representatives of the finance and accounting service was valuable.

- That government and bureaucracy need constant 'grass-root' intelligence to stay in touch (Drought Task Force, Coordinator – Brenton Parsons, Premiers Adviser – Dean Brown).
- That EP is a clearly defined region. The structure used to establish & operate the Drought Task Force is valuable & well respected beyond our boundary.

Where to from here?

Adaptation and Sustainability

Given the:

- Predictions for climate change,
- Transition towards long term industry sustainability,
- Lessons learnt from previous drought periods,
- Federal Government preference to deal direct with the regions in many cases,
- Need to retain some control over our own future,
- Necessity of formalising regional delivery models beyond "personality based" systems,
- Government budget restrictions,
- The withdrawal of PIRSA resources from regional areas, and
- The desire to ensure that a system of dealing with local issues at a local level with Federal and State assistance is achieved,

the region is looking to secure a collaborative approach to addressing the multi-faceted issues and challenges that the region will face.

Regional Sector Agreement

The recently signed **"Regional Sector Agreement"** between the Minister for Sustainability and Climate Change and key agencies in the region, formalises this cooperative intent within the activities of the participating bodies. The regional "model" has previously been utilised to deliver strategies relating to drought, bushfire and water security.

A steering committee has been appointed, and a framework structure is being developed to support the agreement, where the findings of the Drought Task Force will be integrated into the "Agriculture" component, covering a multi-faceted focus on climate change and sustainability for the region.

Further Federal and State Government support will be crucial to ensure that issues emerging in regions can be investigated and acted upon locally.

Risks and Opportunities

- All change brings both risks and opportunities. Agencies (particularly the Eyre Peninsula Natural Resources Management Board) continue to lead the region in encouraging local research into climate change, so that communities can "drive" and understand the emerging risks and opportunities.
- Research continues to add to the store of knowledge enabling better gauging of the direction and rate of change. People in the region will have access to information that allows better informed decisions about how they manage risk, and capitalise on opportunities.
- Understanding of the nature of climate change and weather variability is central to planning for a sustainable and productive future for the region.
- It is important that the region "deals" with whatever weather comes as an **opportunity**, rather than be fearful. On-ground transformation happens because of opportunity, not risk.
- Climate change is not unknown, however it is uncertain. This is reason for increased and ongoing focus, learning more and acting on climate change, to determine the best ways forward for the region. It is not an excuse to do nothing.
- **Action** in communities is now required, not only investigation and understanding, and the writing of plans. The extensive reporting and monitoring stage of climate change needs to progress to the implementation of on-ground programs, with actions that include the flexibility for them to fail, and the capacity to continue the learning.
- **Predictions for temperature rises over the next century (3-4 degree increase) have not occurred for 3 million years, so the level of predicted change has not been experienced before by humans.**

Self Assessment

The "roller-coaster" rides of successes and failures, emotions, social issues, economic survival, business adaptation and farmer focuses in the region over the last few years, have changed somewhat with the advent of wetter seasons. Now is the time for everyone to consider where we can progress from here.

As well as transitional, sustainability and adaptation developments, the issues to be discussed basically revolve around the changes that have been advised about Government assistance in the future and particularly the demise of 'exceptional circumstance' support. The Federal Drought Policy Pilot Program currently being undertaken in Western Australia is being monitored. Obviously the tragedy for Eastern states farmers (flooding and cyclones) has thrown up a new challenge.

Everyone in the Agricultural sector in the region should ask themselves;

What thoughts have you had or things have you done to prepare for another exceptional circumstance event and what message would you convey to Government about how it needs to act in response to dealing with such events?

The Eyre Peninsula Drought Task Force welcomes any feedback.

Responding to Climate Change on Eyre Peninsula

INFORMATION

Mark Stanley[1] and Peter Day[2]

[1]Eyre Peninsula NRM Board, Port Lincoln, [2]Peter R Day Resource Strategies Pty Ltd, Adelaide

Communities, primary producers and natural resource managers on the Eyre Peninsula all confront the risks, uncertainties and opportunities of a changing climate. The Eyre Peninsula Natural Resources Management Board (EPNRM) has encouraged local research into climate change to help people manage these risks and to plan for a more sustainable and productive future. This research has been in partnership with a range of organisations including the CSIRO, SARDI at Minnipa Agricultural Centre, the Universities of Adelaide and South Australia, Flinders University, Rural Solutions SA and Greening Australia.

Climate change predictions

The Earth's atmosphere is changing. Greenhouse gas levels are rising and climatologists believe this is trapping heat in our atmosphere and causing changes to our climate and oceans. Predicting climate change is not an exact science, but there is a high degree of confidence among climate researchers that the planet will continue to heat up as more greenhouse gases are emitted. Computerised climate change models predict that over the coming decades, Eyre Peninsula will experience:

- higher temperatures;
- less rainfall (with longer and more frequent droughts, but possibly more heavy rain events); and
- increased evaporation.

Global warming will cause sea levels to continue rising and increased carbon dioxide (CO2) in the atmosphere will result in increased CO2 concentrations in the oceans, causing them to become more acidic.

If the Eyre Peninsula's climate changes as predicted, it will affect the environment, communities and regional economy:

- crucial groundwater resources may become stressed and require special management;
- changes may be necessary in the biggest land use - agriculture;
- natural ecosystems and native species will come under increased pressure; and
- a rise in sea levels and changes in the ocean will affect coastal developments and townships, marine life, and the aquaculture and fishing industries.

Risks and opportunities

All change brings both risks and opportunities. The EPNRM has encouraged local research into climate change so the community can understand the potential risks and the opportunities that may emerge. Research helps identify what to monitor so that we can better gauge the direction and rate of any future change. This will allow people in the region to make informed decisions about how they manage risk and capitalise on opportunities. Communities on Eyre Peninsula have long experience in coping with drought and climate variability and in managing scarce water supplies, which places them at an advantage in dealing with climate change. Understanding the possible nature of climate change is central to planning for a sustainable and productive future - for individuals, businesses, industries, communities and the region.

Research findings

Climate change related investigations on Eyre Peninsula have highlighted that:

- Our vulnerability to climate change varies between sites and is influenced by our ability to respond - as well as by the extent of change. Change is likely to amplify any existing weaknesses in communities. Building strong communities and supportive social networks are great foundations from which to tackle change and the stresses it may bring.
- The groundwater basins on which much of Eyre Peninsula relies for reticulated water are likely to be more affected by reductions in rainfall and recharge than by rising sea levels. It will be important to monitor the use, recharge and condition of the groundwater basins, and explore ways to augment and make better use of our water resources.
- The fragmented cover of native bush throughout the region may restrict the migration of native plants or animals in response to shifts in climate. Revegetating patches of bush and protecting unique environments can improve the landscape's capacity to cope with climate change.
- Farmers on Eyre Peninsula are experienced in managing drought. They, and their researchers, have a good understanding of the tactics and strategies needed to adapt to drier conditions and the features of farming systems needed to survive drought. The impact of climate change will be an 'arm wrestle' between climatic factors and the strategies employed by farmers. There may also be opportunities for farmers and researchers to export their farming knowhow to countries with less experience of drought and to diversify their outputs.

- A range of factors (climate change, a 'carbon economy' and nature conservation) may collectively promote increased planting of perennial vegetation and other land use changes. Innovative programs will be needed to help landholders make such changes and investigations are under way to determine how to best do that. Although traditional grant programs have proved popular, landholders are also embracing more targeted 'tender' type investments that may be more effective in promoting change.
- Social surveys have identified 'market segments' among rural landholders who each have different attitudes and motivations, and different preferences about how they receive information. Understanding the variety of viewpoints within communities, and engaging with them through different mechanisms, will be important in building shared knowledge and the capacity and intent to adapt to climate change.

Future research

The Eyre Peninsula NRM Board plays an important role in signalling local research needs to research institutions and research funders, and in collaborating with researchers. It is not in a position to dictate what research occurs, but it can influence the research agenda and has been successful in encouraging co-ordination between different research projects and institutions. The Board's Climate Change Research Strategy is an important tool in this regard and comments or suggestions for future research priorities on Eyre Peninsula are welcomed.

Further reading

A more detailed research report, Responding to "Climate Change – Eyre Peninsula Research Findings 2010" (edited by Peter Day et al, 2010), can be obtained from EPNRM or can be downloaded at www.epnrm.sa.gov.au.

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Analysis and Interpretation of Long Term Spotlight Monitoring in Relation to Fox *(Vulpes Vulpes)* populations on Eyre Peninsula

INFORMATION

Rob Coventry
Eyre Peninsula Natural Resources Management Board, Elliston

Key messages

- **The Eyre Peninsula Natural Resources Management Board (EPNRM) invests significant funds into fox control and monitoring provides ongoing information to enable an assessment of the effectiveness of control and allocation of resources.**
- **Fox populations in most areas decreased over the survey period 2002-2009.**
- **Fox observations were on average 55% lower in 2009 than in 2002.**
- **Decreases in fox populations are likely attributed to the annual community coordinated baiting programs but further data collection and analysis should provide a conclusive link between baiting and fox population declines.**
- **EPNRM spotlight monitoring program represents one of the best databases of information collected for informing pest management decision making anywhere Australia.**

Why do the trial?

The implementation of a coordinated spotlight monitoring program was an original component of the West Coast Integrated Pest Management Program (WCIPMP) and later the Eyre Peninsula Pest Management Program (EPPMP) and aimed to determine the influence of control activities (baiting) on the changes in populations of observable fauna (both introduced and native species) with a notable focus on the presence of foxes.

How was it done?

- 2002 – Six initial spotlight monitoring transects established within the WCIPMP area, with monitoring undertaken on one night every second month. Spotlight monitoring protocol developed to ensure consistency of approach across all survey sites.
- 2003 – Additional survey site added to program.
- 2004 – Initial analysis of data completed and recommendations provided by O'ConnorNRM (consultant) to improve monitoring efficiencies and maximise results.
- 2005 – 2009 – Monitoring program extended to wider Eyre Peninsula region. Change in monitoring methodology to survey sites 3 times within a 2 week period, in both February and August each year.
- 2009 – Further analysis of data completed by O'ConnorNRM with recommendations on further refinement of survey methodology and report prepared discussing the change in fox presence.

What happened?

Analysis of the data was undertaken by O'ConnorNRM and concluded that fox populations on Eyre Peninsula (EP) have declined significantly over the survey period and that the use of an adaptive monitoring approach based on species detectability can improve the ability to detect changes in population trends whilst not putting additional pressure on project resources.

A definite causal link between the decline in fox populations and the increase in community coordinated baiting still requires further monitoring and forms part of the recommendations for the future of the program. This is based on the fact that coordinated baiting was underway prior to the start of spotlight monitoring and as such no true baseline data of pre-baited fox populations is available.

Preliminary analysis of additional species data indicates over the survey period no decline in rabbit or kangaroo populations were observed. This leads to the suggestion that the decline in fox populations is not principally linked to environmental factors experienced throughout the survey period such as drought, but could most likely be associated with the increase in coordinated landholder fox baiting across the Eyre Peninsula landscape.

What does this mean?

- Analysis of long term spotlight monitoring data shows a decline in fox populations on EP between 2002 and 2009.
- Further research and monitoring is required to conclusively determine the role of community coordinated fox control in the population decline and what effort will be required to sustain this decline.
- Further research to determine the causal link may require variations in methodology and potentially the temporary halting of baiting for a period of time in some districts.
- Further research, including economic analysis, could identify optimal control strategies for managing feral animals for production and conservation outcomes.
- Further analysis of spotlight data needs to be undertaken for additional species such as rabbits and feral cats to determine the inter-relationship between population dynamics.
- Anecdotal reports from across EP suggest an increase in sightings of native fauna such as echidnas, goannas and malleefowl which are vulnerable to predation by foxes. Further research is required to draw conclusive relationships between the decline in fox populations and an increase in these species.

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Patrick J. O'Connor (O'ConnorNRM), Scott A. Field, Andrew J. Tyre, David Armstrong (Department for Environment and Natural Resources)

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Australian Grains Outlook for 2011

Wayne Gordon
Rabobank Food & Agribusiness & Advisory

Key message

- **Despite extreme weather conditions and a high dollar, the outlook is positive for the Australian grains market in 2011, according to a recently-released report *Australian Grains Outlook – Cold November Rain* by agribusiness bank Rabobank.**

After intense flooding across the eastern states and near-drought conditions in the west, 2010 has seen grain quality and quantity downgrades, however prices have been a saving grace, the report says.

As 2010 came to a close, most would concur the year could not have turned out more differently than initial expectations. In addition to Australia's wet harvest in the east and drought conditions in Western Australia, we have had weather shocks in Russia, Western Europe and Canada, as well as poor conditions in the United States winter wheat areas impacting on prices.

This year, we expect macroeconomic and weather events will still dominate market sentiment, with each driving the market at some stage, much the same as in 2010.

While the outlook is positive, it is not without risks. There will be high price volatility, as macroeconomic factors and fundamentals take turns at driving market sentiment, but current expectations are for crop balances to be tight for much of 2011, particularly for corn and cotton. Less spring wheat will be planted in the US and the strong demand for feed grain are all positives for Australian producers.

In addition, sharp gyrations in prices are expected, particularly in the more sensitive corn and soybean markets, as the 'battle for acres' gets underway in the US.

According to the Rabobank report, the uncertainty around the persistence of the La Niña event makes it difficult to predict planting conditions for the 2011 Australian winter crop, however the latest forecast from the BOM (Bureau of Meteorology) suggests above-medium rainfall will persist into March which is positive news for growers.

The favourable new-season outlook, combined with stored moisture from the wet spring, suggests a good start to the eastern winter cropping season and a slight increase in area sown to grain, particularly wheat and malting barley. Similar areas of canola are anticipated, with a 'battle for acres' of our own brewing between cotton and winter grain production in northern NSW and Queensland.

In contrast to the east, Western Australia, aside from a few brighter spots, witnessed the driest winter conditions on record across the wheat belt. As we embark on 2011, the good news for WA is that the Bureau of Meteorology's improving outlook for rainfall provides some optimism that production may shift back toward average levels in 2011/12 which, assuming average yields, wheat production should reach 8.1 million tonnes.

The Rabobank report predicts the Australian dollar will remain elevated for some time, posing problems for grain exporters. The strong dollar will be problematic for exporters in the second half of 2011, particularly if corn supplies increase substantially and global wheat quality improves in Northern Hemisphere harvests.

With such extreme volatility in crop prices expected to continue, price-side events remain difficult to predict for the whole of 2011. There are three key swing factors that are likely to determine global crop prices over the coming year – crop areas, weather, and policy developments such as export bans in Russia and China's policy attempts to combat food inflation. If these swing factors play out as we expect, a definite bullish picture can be proposed for crop prices this year.

The report also highlights that margins will again be a strong focus for growers as stronger crop prices will lead to higher chemical and fertiliser prices in 2011. This means relative crop margins will again need to be watched carefully.

The Rabobank report warns grain-handling infrastructure will be the limiting factor for Australian grain exports in the near-term, expecting Australian grain exports to remain at similar levels going into 2011. The rain-delayed harvest is only adding to what was already a difficult logistical exercise due to the unbalanced split between Australia's east and west. The question is how hard will these infrastructure bottlenecks bite?

Working with the Female Farming Community on Upper Eyre Peninsula

Kim Blenkiron
Partners in Grain, Strathalbyn

Key messages

- **The 'women's only' learning environment is beneficial for many women.**
- **Groups need a local group coordinator.**
- **An annual Training Needs Analysis process allows all group members to contribute to planning the group's annual training calendar.**
- **Logistics of training for women needs to consider training during school term time, at a time during the day when children are at school, available childcare days and in a local venue to reduce travel time.**
- **Social interaction is an important part of the learning experience and group dynamics.**

Why work with the female farming community?

Partners in Grain (PinG) is a national initiative facilitating professional development opportunities for all partners in grain businesses, aiming to strengthen the knowledge and generate innovation in the grains industry. The project is funded by Grains Research and Development Corporation (GRDC) and has been running for nine years.

Partners in Grain SA works primarily with women and young people in the grain industry to encourage continuous professional development. It has a number of groups across the grain growing regions of South Australia and after consultation with local women, a Training Needs Analysis Workshop was held at Minnipa. The project also offered women in the region the opportunity to participate in a Women's Field Day at the Minnipa Agricultural Centre (MAC) to allow women to experience what a Field Day at the Centre is like and encourage women to attend the annual MAC Field Days in the future.

The aim of the project is to increase opportunities for women on Upper Eyre Peninsula to participate in professional development to enable them to increase their involvement in their farm business. Initial discussions with local women highlighted a lack of training opportunities for women in the community that was targeted to their needs and delivered in a method that suited their requirements.

How was it done?

Partners in Grain Groups

Partners in Grain identified that the Upper Eyre Peninsula was a region where it had no groups running. In February 2010 discussions were held with a local female farmer about the concept of PinG, if there would be interest in the Minnipa area and her role as a volunteer group coordinator. In April 2010 a Training Needs Analysis Workshop was held with women interested in participating from the Minnipa region, 11 women attended this workshop. At the workshop women were asked to think about issues for their business and industry in 2010, what their business and industry may look like in five years time and to identify what some of the skills and knowledge they will need to manage this change. This process came up with a number of training topics which the group prioritised as their training activities for 2010. The Minnipa Group then completed three training activities in 2010 including grain marketing, off farm investing and a social event for group members and families pre-harvest.

After a successful start with the Minnipa Group, groups at Wudinna/Kyancutta and Streaky Bay were also formed. Both of these groups also have volunteer group coordinators. In June 2010 members of the Wudinna/Kyancutta Group participated in a Training Needs Analysis Workshop to develop a training program and completed two workshops in 2010. The Streaky Bay group did not do a Training Needs Analysis Workshop but completed three workshops.

All three groups will continue in 2011, with all groups planning to participate in a Training Needs Analysis Workshop during the year to reassess training requirements.

An evaluation was done after each workshop to ensure the material was appropriate and to gauge what the women plan to do with the information they have learnt. In 2011 individual women from all three groups will be interviewed to determine practice change that has occurred within their businesses as a result of the training they have participated in.

The volunteer group coordinators have also been networked with other group coordinators from across South Australia so the groups can share information about future training ideas.

Minnipa Agricultural Centre Women's Field Day

A Women's Field Day was held at MAC on 22 September 2010. The Field Day was a joint activity between PinG SA and MAC. The format for the day was a conference style with a number of speakers in the morning and in the afternoon the women were given a tour of MAC and an opportunity to speak to research staff. The day concluded with small groups working on evaluation questions and discussing if women would attend the main field day in 2011. The day was well received by the women present with most indicating they would attend a similar event if held again. Most women indicated they still would not attend the main MAC Field Day for varied reasons.

What does this mean?

- The 'women's only' learning environment is beneficial for many women as it can be run at times that suit family commitments. They often feel more comfortable to ask questions and share information.
- Groups need a local group coordinator as this keeps ownership of the group in the community and assists with logistics when organising events. When the group is first starting people are often more comfortable talking to someone they know. As this is a volunteer position it needs to be circulated around the group.
- Logistics of training for women needs to consider training during school term time, at a time during the day when children are at school or childcare and in a local venue to reduce travel time. This reduces the barriers for women attending training and still allows women to get children on and off school buses and home in time for family commitments.
- Social interaction is an important part of the learning experience and group dynamics. Often women don't have time to catch up socially with other women in their local community or the group has women from outside their immediate circle of friends, so the group is creating community networks. The lunch and smoko breaks are important for social interaction but most women leave as soon as the workshop is over as they need to collect children off school buses.
- The three groups on the Upper Eyre Peninsula have developed and run themselves in a similar manner to the other 10 PinG groups across SA. Each group has different training priorities but grain marketing, office management and off farm investing have been the main training areas in 2010.

Where to from here?

In 2011 Partners in Grain will continue to support the Minnipa, Wudinna/Kyancutta and Streaky Bay groups and has also received funding from the EP Natural Resources Management Board to run Training Need Analysis Workshops at Kimba, Lock and Cummins.

Acknowledgements

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Minnipa Agricultural Centre EYRE PENINSULA

Rabobank

Government of South Australia
Eyre Peninsula Natural Resources Management Board

GRDC Grains Research & Development Corporation

WildEyre: Understanding Landholder Attitudes and Perceptions on the Role of Sheoak Grassy Woodlands in a Productive System

INFORMATION

Emma Coates[1] and Rob Coventry[2]

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Key messages

- **In 2010 the Native Vegetation Council funded a small research project entitled "Investigations into landholder attitudes and the feasibility of incentive schemes for large-scale restoration of the State Vulnerable Drooping Sheoak (Allocasuarina verticillata) Grassy Woodland Communities on Eyre Peninsula".**
- **The WildEyre group were interested in learning about landholders' perceptions and knowledge of sheoak in terms of its potential role in production systems and also to discuss the importance of sheoak woodlands persisting in the landscape.**
- **Drooping Sheoak (Allocasuarina verticillata) Grassy Woodlands were once widespread across Eyre Peninsula, but due to clearance and intensive sheep and rabbit grazing, they are now listed as Vulnerable in SA.**
- **Landholders at 14 different properties were interviewed across Western Eyre Peninsula, talking about their perceptions of the role of Sheoak grassy woodlands in their production system, with a focus on determining whether sheoak plays a role in primary production and what value they might attribute to it.**
- **The research has led to an improvement in the understanding of the drivers behind sheoak conservation. The information provided through the interviews helped to develop a market based instrument to funding allocation for the broad scale restoration of sheoak woodlands on Eyre Peninsula.**

Why do the study?

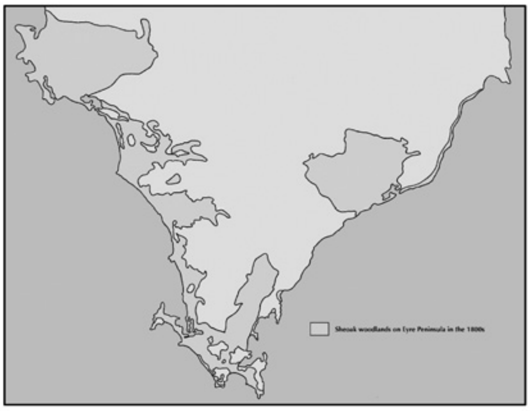
Bishop and Venning (1986) suggest the extensive decline of drooping sheoak on Eyre Peninsula was a result of early land clearing for agriculture, the palatability of sheoak seedlings and intensive grazing pressure by sheep and rabbits. This intensive and ongoing pressure combined with the short lived nature of sheoaks resulted in poor species recruitment and the contraction in the distribution of sheoak across the Peninsula. This lack of regeneration meant that many older trees die of old age without leaving behind any new progeny.

Whilst the WildEyre group's key focus is on conserving the natural assets of the WildEyre area, the group realised that conservation measures must be delivered in the context of viable sustainable production. This research would encourage discussion about what incentives might enable more effective participation in conservation programs.

Environmental or conservation incentives have taken many forms; many of which are not relevant for primary producer's circumstances. The aim of this study was to determine what incentive measures would be viable for landholder involvement in large scale sheoak restoration.

How was it done?

The WildEyre group developed a survey which examined both the social and environmental value of sheoak woodlands. One on one interviews were held with landholders at their own properties and kept as informal as possible taking the form of a guided discussion than a formal interview. Landholders spoke freely about their perceptions of Sheoak, both in terms of its role in production systems and its intrinsic environmental and social amenity values. The survey also asked landholders about what incentive, if any, might be feasible on their properties and what support they would require over the longer term to actively participate in sustainable sheoak woodland management.



Sheoak Distribution on Eyre Peninsula EP (1800s)

Sheoak Distribution on EP (2000s)

What happened?

Results from the interviews indicate that farmers have a strong sense of protecting the land and are interested in restoring it to 'what it was before'. This often very passionate feeling comes from family connections to the land and generations in the district. They also have a strong feeling towards the 'aesthetic value' of the land – a sense of what a healthy country should look like.

Some farmers' spoke of the production value of sheoaks for shade, shelter and fodder but this was not presented as an overriding motivation to retain Sheoak in the landscape.

Most farmers are interested in support in protecting their sheoak woodlands. In most cases this was either financial support for putting up fencing and other management practices and some indicated that some payment for loss of production as a result of excluding stock from some land was important. After all, it's hard to be green when you are in the red.

Most farmers thought a 10 year program of de-stocking to allow for sheoak regeneration would be reasonable. Ongoing support for controlling rabbits and weeds in de-stocked areas was also considered a management priority.

Several farmers expressed interest in technical advice for identifying sheoaks, collecting and storing seed and on the best way of propagating seedlings.

Most landholders expressed a strong interest in working together and having the support of regionally based officers.

It was reiterated that conservation initiatives must be timed well and consider seasonality and other management activities. For example, it is not feasible for landholders in the middle of shearing or harvesting to commit time to fencing native vegetation.

Each farmer recognised that coordinated, larger scale projects across entire districts would be a more successful approach than one or two properties.

What does this mean?

This research into landholder attitudes and the feasibility of incentive schemes for large-scale restoration of the State Vulnerable Drooping Sheoak (Allocasuarina verticillata) Grassy Woodland Communities on Eyre Peninsula has revealed several key items for consideration when developing incentives for Sheoak restoration. These include, but are not limited to:

- Determining the appropriate levels of in kind or financial support.
- Avenues to sharing technical advice and knowledge amongst interested parties.
- High degree of interest in social implications – maintaining regionally based support over long time frames and the importance of sharing information from those in the community.
- Recognition that each farm is different and so is each landholder's requirements. Any incentive program needs to be flexible and specifically tailored to each individual landholders needs.

What will the results be used for?

This research has led to an improved understanding of the drivers for Sheoak restoration in productive systems and the logistical constraints of incentive schemes. These interviews gave the WildEyre working group a better understanding of the drivers and motivations or landholders in the district; both in terms of their individual property and personal environmental goals.

This information will assist the WildEyre team to develop and implement a market based instrument for large scale Sheoak restoration on Eyre Peninsula. Although this research was specific to the Drooping Sheoak (Allocasuarina verticillata) on Eyre Peninsula, many of the research outcomes are applicable more broadly in other grazing areas of Australia.

Acknowledgements

Landholders of Western Eyre Peninsula who were interviewed and made the time to discuss the research. Your time, experiences, knowledge and expertise is greatly appreciated.

WildEyre Working Group and supporting organisations; Department for Environment and Natural Resources; Eyre Peninsula Natural Resources Management Board, The Wilderness Society (SA), Greening Australia (SA) and the Nature Conservation Society of SA.

Barry Lincoln interPART & Associates (consultant) for designing the survey, analysing the data and preparing the final report.

LEADA Lower Eyre Agricultural Development Association

"A grower group that specifically addresses issues and finds solutions to improve farming systems in your area"

LEADA is committed to providing support and attracting research activity to the Lower Eyre Peninsula (LEP). It is driven by local issues and the search for solutions that suit local systems.

LEADA's 2010 achievements and 2011 focus

2010 was another productive year for the Lower Eyre Agricultural Development Association (LEADA) with 11 trial sites and 5 paddocks being managed and monitored on the LEP. Issues addressed included improving canola and malting barley agronomy, pest and disease management, soil amelioration and improving water use efficiency.

Our links with GRDC, the Australian Government, State NRM, Rural Solutions SA, SARDI and the Eyre Peninsula NRM Board were further strengthened throughout the year. This positive collaboration is resulting in a greater research and extension effort on sustainable and profitable farming systems for the LEP.

2011 will build on previous work and looks towards another intensive trial and extension year with a continuation of the canola and barley production focus, plus striving to improve the water use efficiency (WUE) of LEP farming systems. Trials will focus on:

- **Barley –** Disease, water logging, nitrogen and canopy management
- **Canola –** Commercial vs Farmer kept seed, integrated pest management, harvest (direct heading, windrowing), Diamond back moth management
- **Pulses –** Best pea alternative, Lupins – time of sowing (TOS), seeding rates, improving harvest index (HI)
- **Wheat –** Pushing yields economically, improving HI, disease management and TOS for various varieties
- **WUE –** Soil classification for APSIM and agronomic management
- **Soil amelioration –** Improving efficiencies with precision ag and spading

Membership

LEADA offers membership for a small fee of $50 per business for 12 months. This provides entry to our Ag Expo in March, our trial results booklet from local and national research, free entry to our spring crop walk and all other crop walks plus a minimum of four newsletters per year.

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Dates for the diary:

LEADA Ag Expo – 17 March 2011

Spring Crop Update – August

SARDI South Australian Research and Development Institute · GRDC Grains Research & Development Corporation · Government of South Australia Eyre Peninsula Natural Resources Management Board · Rural Solutions SA · Caring for our Country

Improving Farmer Capacity to Manage Profitability and Risk

Geoff Thomas
Low Rainfall Collaboration Project, Adelaide

Farmers have been seeking guidance for years on how they can better fit the various components of their farm systems together to improve overall profitability and management of risk.

In the past a lot of attention has been placed on agronomic considerations and hence a concentration on varieties, rates, seeding dates, row spacing and similar types of work. Similarly with livestock there has been work on topics such as grazing cereals and other crops as well as animal genetics. While all of this work has a place, farmers are now seeking more advice on how to fit the various technologies together to best effect on their business. This no longer simply means greater production - profitability, reduced inputs and management of risk are increasingly recognised by farmers as major factors affecting the performance of their businesses and the resilience to tough times.

Since each farmer's business is different, a one size fits all approach is not appropriate. Rather, what is required are simple budgets and guidelines which allow farmers and their advisers to feed in their own figures and ask the "what if" questions appropriate to them. These budgets inform their decisions, yet do not make them for the farmer or adviser. These budgeting tools are available but are not widely used.

Demand for practical farm business management skills training is now coming from farmers, groups and consultants and there is a need to respond quickly to meet this demand.

One response by GRDC has been the Profitability/Risk Management Project conducted through the Low rainfall Collaboration Project using a whole farm, case study approach which brings together past experiences and activities and involves farm business experts, consultants and farmers. This builds on some excellent pioneering work done on EP in recent years and the results of a pilot project run with Birchip Cropping Group.

The aim of the project is to evaluate adaptive farm systems and to develop simple approaches which farmers can use to help their decision making, especially in the face of more uncertain seasons and profit margins. Understanding the sensitivity of changes to farm systems and investments with volatile seasons is essential to achieving profitability and managing risk. Traditional farm business analysis techniques often do not pick up this risk whereas this project uses decile break-even points to assess sustainability of the business in difficult times.

The project will roll out on Eyre Peninsula in 2011 and expand through 2012 and 2013 by establishing and working with groups as indicated above and building on previous work. There is also an important additional component with consultants/accountants working with groups of newer/younger farmers to provide an introduction to farm finance and risk management.

LOW RAINFALL COLLABORATION GROUP

GRDC Grains Research & Development Corporation

EPARF Eyre Peninsula Agricultural Research Foundation Inc.

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Acronyms and Abbreviations

ABA	Advisory Board of Agriculture
ABS	Australian Bureau of Statistics
AFPIP	Australian Field Pea Improvement Program
AGO	Australian Greenhouse Office
AGT	Australian Grain Technologies
AH	Australian Hard (Wheat)
AM fungi	Arbuscular Mycorrhizal Fungi
APSIM	Agricultural Production Simulator
APW	Australian Prime Wheat
AR	Annual Rainfall
ASW	Australian Soft Wheat
ASBV	Australian Sheep Breeding Value
AWI	Australian Wool Innovation
BCG	Birchip Cropping Group
BYDV	Barley Yellow Dwarf Virus
CBWA	Canola Breeders Western Australia
CCN	Cereal Cyst Nematode
CLL	Crop Lower Limit
DAP	Di-ammonium Phosphate (18:20:00)
DCC	Department of Climate Change
DENR	Department of Environment and Natural Resources
DGT	Diffusive Gradients in Thin Film
DM	Dry Matter
DPI	Department of Primary Industries
DSE	Dry Sheep Equivalent
EP	Eyre Peninsula
EPARF	Eyre Peninsula Agricultural Research Foundation
EPFS	Eyre Peninsula Farming Systems
EPNRM	Eyre Peninsula Natural Resources Management Board
EPR	End Point Royalty
FC	Field Capacity
GM	Gross Margin
GRDC	Grains Research and Development Corporation
GSR	Growing Season Rainfall
IPM	Integrated Pest Management
LEADA	Lower Eyre Agricultural Development Association
LEP	Lower Eyre Peninsula
LRCP	Low Rainfall Collaboration Project
LSD	Least Significant Difference
MAC	Minnipa Agricultural Centre
MAP	Monoammonium Phosphate (10:22:00)
ME	Metabolisable Energy
MLA	Meat and Livestock Australia
MRI	Magnetic Resonance Imaging
NDF	Neutral Detergent Fibre
NDVI	Normalised Difference Vegetation Index
NLP	National Landcare Program
NRM	Natural Resource Management
NVT	National Variety Trials
PAWC	Plant Available Water Capacity
PBI	Phosphorus Buffering Index
PDRF	Premier's Drought Relief Fund
PEM	*Pantoea agglomerans, Exiguobacterium acetylicum* and *Microbacteria*
pg	Picogram
PIRD	Producers Initiated Research Development
PIRSA	Primary Industries and Resources South Australia
RDE	Research, Development and Extension
RDTS	Root Disease Testing Service
SAFF	South Australian Farmers Federation
SAGIT	South Australian Grains Industry Trust
SANTFA	South Australian No Till Farmers Association
SARDI	South Australian Research and Development Institute
SBU	Seed Bed Utilisation
SED	Standard Error Deviation
SGA	Sheep Genetics Australia
SU	Sulfuronyl Ureas
TE	Trace Elements
TT	Triazine Tolerant
UNFS	Upper North Farming Systems
WP	Wilting Point
WUE	Water Use Efficiency
YEB	Youngest Emerged Blade
YP	Yield Prophet

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GRDC Grains Research & Development Corporation

GRDC's Eyre Peninsula Farming Systems Project

...increasing the relevance and impact of research in low rainfall areas...

Eyre Peninsula Grain & Graze Project

...maximising returns to growers while improving the natural resources and increasing social capital...

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