Eyre Peninsula Farming Systems Summary 2011

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Eyre Peninsula Farming Systems Summary 2011

Editorial Team

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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 2012

Front Cover:

(Clockwise) Harvest time, Lock women visit MAC, Crop sequencing trial site, sheep grazing the EP Grain & Graze Enrich trial site.

Back Cover:

(From top to bottom) Harvesting MAC farm, rainbow over the hay paddock, EPARF day participants in the sheep breeding session.

Inside Back Cover:

Photos from various Eyre Peninsula agricultural events in 2011.

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Minnipa Agricultural Centre Update

Welcome to the Eyre Peninsula Farming Systems Summary 2011. This summary of research results from 2011 is proudly supported by Viterra, Grains Research & Development Corporation (GRDC) through the Eyre Peninsula Farming Systems project (EPFS 3), and the GRDC and Caring for our Country funded Eyre Peninsula Grain & Graze project (EPG&G 2). 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 business on EP and beyond in other low rainfall areas.

Research highlights

The Grain and Graze 2 project has had a successful year with some significant research outcomes. The ongoing 'Impact of livestock on paddock health' project has measured wheat yield increase in response to grazing a previous year pasture phase and a further benefit to an intensively grazed improved annual medic pasture. The 'Enrich' project is identifying suitable perennial forage shrubs for the upper EP environment to contribute to whole-farm profitability and sustainability. The grazing crops work is confirming that with the right conditions and timing, grazing can be carried out with no detriment to crop yield.

The results of the Water Use Efficiency Survey undertaken as part of the EPFS 3 project have some interesting insights into current farming practices on upper Eyre Peninsula. The survey will be repeated in 2013 to see what changes have been made to farming systems and farmers' attitudes towards farming on upper EP.

Staff news

Jake Pecina of Karcultaby Area School commenced a school based apprenticeship in 2011, attending MAC one day per week to gain skills in farm and research field work. Upon completion in 2012, Jake will receive a Certificate III in Agriculture.

Some event highlights from 2011

The 2011 EPARF Members Day titled CHOICES FOR MIXED FARMING SYSTEMS - Best Bets, focused on what you can do if you can't keep growing wheat on wheat. The program looked at how to identify if you have a problem (pests, disease, nutrition etc.), the options available for addressing issues (pastures, break crops, maintaining cereal production, sheep genetics etc.) and what the profitability and risk implications were of addressing the problem (including changing enterprise, using pastures in rotations etc.). 140 people attended the day, including presenters, staff and sponsors.

Once again the MAC Annual Field Day was well attended, with 150 farmers, researchers and advisors able to visit trial sites and hear about the latest developments in low rainfall agriculture.

Current funded projects include:

- **Eyre Peninsula Farming Systems 3 – Responsive Farming Systems**, GRDC funded, partnership with University of Adelaide, researchers: Cathy Paterson/Roy Latta, Nigel Wilhelm, CSIRO collaborator: Therese McBeath
- **Eyre Peninsula Grain & Graze 2,** GRDC/Caring for our Country funded, partnership with University of Adelaide, researchers: Jessica Crettenden/Roy Latta
- **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
- **Increased rate of adoption of Sheep Genetics/ MERINOSELECT Breeding Values on Eyre Peninsula**, funded by Australian Wool Innovations, researchers: Jessica Crettenden/Roy Latta
- **Introduce New Perennials and Systems Adapted to Semi-arable Farm Land on Eyre Peninsula,** funded by Caring for our Country, researcher: Roy Latta

2012 events

It will be a busy year for major field day events at Minnipa Agricultural Centre in 2012:

- 'Snot the Snails' workshops (January)
- Getting The Crop In (March)
- EPARF Day – Spraying (July)
- MAC Field Day (September)
- Women's Day (September)
- Student Field Day (October)

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.

Also please take the time to fill in and return the survey (coloured insert) to help us provide agricultural information to you more effectively.

We look forward to seeing you all at farming system events throughout 2012, and all the best for a great season!

Naomi Scholz/Roy Latta

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 (Rhizoctonia)
Catherine Paterson	Research Officer (EP Farming Systems)
Jessica Crettenden	Research Officer (EP Grain & Graze)
Leigh Davis	Agricultural Officer (NVT, Contract Research)
Wade Shepperd	Agricultural Officer (EP Farming Systems, Rhizoctonia)
Brenton Spriggs	Agricultural Officer (NVT, Contract Research)
Ian Richter	Agricultural Officer (Climate Change, Crop Sequencing)
Brett McEvoy	Agricultural Officer (MAC Farm)
Trent Brace	Agricultural Officer (MAC Farm)
Sue Budarick	Field Assistant
Jake Pecina	Field Assistant

DATES TO REMEMBER

Getting The Crop In: Tuesday 27 March 2012

EPARF Members Day: Wednesday 27 June 2012

Women's Field Day: Tuesday 4 September 2012

MAC Annual Field Day: Wednesday 12 September 2012

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

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Eyre Peninsula Agricultural Research Foundation Report 2011

EPARF
Eyre Peninsula
Agricultural Research Foundation Inc.

Matthew Dunn, Chairman

Board Members

Farmers: Matthew Dunn (Chairperson), Simon Guerin (Vice Chairperson), Peter Kuhlmann, Dean Willmott (retired September 2011), Craig James, Bryan Smith, Mark Fitzgerald (elected September 2011).

Special Skills and Expertise

Geoff Thomas, Andy Bates

SARDI

Prof Simon Maddocks

University of Adelaide

Dr Glenn McDonald

LEADA

Jordan Wilksch

EPNRM

Mark Stanley

MAC

Roy Latta (Leader), Dot Brace (EO)

Vision Statement

To be an independent advisory organisation providing strategic support for the enhancement of agriculture.

Mission Statement

To proactively support all sectors of agriculture research on Eyre Peninsula including the building of partnerships in promoting research, development and extension.

Objectives

- Build capacity of the agricultural sector through education and training
- Promote the advancement and practical application of agricultural scientific research, development and extension in dryland farming systems relevant to Eyre Peninsula and like environments across Australia
- Provide advice and strategic direction on short, medium and long term needs of the agricultural sector to include current, innovative and future issues
- Conduct agricultural activities and ensure that farmers, agribusiness and the scientific community are an integral part of the planning
- Establish interaction with various industry bodies, negotiate funding opportunities and utilise reserves to leverage other funds
- Be responsive and relevant to our farmer and industry members

Election of Board Members

There are 6 elected EP farmer members on the board and each year, two members are elected for a three year term. Dean Willmott completed his term and chose not to re-nominate due to increasing farming commitments. The board sincerely thank him for his strong input into MAC over the last 6 years.

We welcome Mark Fitzgerald from Butler Tanks to the board as his location covers the area on Eastern Eyre Peninsula between LEADA and MAC and look forward to his involvement and contribution.

I chose to renominate and am honoured to be given the opportunity to chair the board.

We continually seek people to represent EP farmers on the board who have a keen interest in research and extension and are prepared to make the time and commitment to work with staff in developing programs of benefit to farmers and to the Eyre region in general.

Finance

EPARF is a foundation and its income is from membership, sponsorship and reimbursements and expenditure is on administration support, meeting expenses, leveraging and funding projects when required and services to members.

Membership

To our 248 members, thank you for your continued support of agricultural research in our dryland environments, through contributing ideas, attending field days or hosting research sites. Our membership base is an important factor when we are seeking funding for Eyre Peninsula research. Your membership is important to us.

MAC Staff

It is great to welcome Jessica Crettenden as the new Research Officer for the Grain and Graze 2 Project. We are constantly looking for new opportunities to build up capacity and staff at MAC.

EPARF Member's Day

The 2011 'Choices for mixed farming systems' was a great event with 140 attendees which included a lot of younger faces. The day reinforced to many members the need for good rotations and sound financial acumen.

Our Member's Day for 2012 will focus on getting herbicides right. On the back of a couple of good seasons, the issue of grass weed control is raising its ugly head. We do see this as an opportunity for further research. Be a member and come along!

Low Rainfall Systems Collaboration Group

2011 was the last year that all groups including BCG, Mallee Sustainable Farming, Upper North and Central West Farming group will be hosted under this banner by Geoff Thomas. The conference was held at Waite and MAC was represented by Andy Bates, Bryan Smith, Matthew Dunn, Naomi Scholz, Cathy Paterson, Linden Masters, Leigh Davis and Brenton Spriggs.

GRDC

The Southern Panel recently visited MAC explaining a new strategy of encouraging short term responsive trial work. This sits comfortably with EPARF's objectives so hopefully we can leverage funding to lift MAC's ability to perform in low rainfall agricultural research.

Minnipa Research Review Committee

After a strategic planning session, a sub committee of EPARF was formed, solely looking at current and future research opportunities. This comprises of a dedicated group of board members who are putting in many days of exciting work. This committee, under the chair of Bryan Smith, has the flexibility to pull in all the expertise they require to lift research on EP.

Student Field Day 2012

We are supporting a student day later in the year to showcase MAC with the intention to increase the profile of agriculture as a career opportunity on EP. The day will engage middle and senior students from EP schools interested in agriculture.

Sponsorship

Thanks to all our sponsors for your vital investment to support agriculture research on EP.

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BRONZE	Seednet
	EP Grain
	Letcher & Moroney Chartered Accountants

Appreciation and thanks

The SA Government through SARDI for its continued support of the Minnipa Agricultural Centre, GRDC, the Federal Government and all of our industry funders and partners. Your continued commitment is vital for our farming communities.

A special thank you to our dedicated team at MAC for being able to maintain a well run, functional research program.

EPARF Board members in 2011

EPARF Day 2011

Naomi Scholz
SARDI, Minnipa Agricultural Centre

140 people attended the EPARF Members Day on 5 August 2011 at the Minnipa Agricultural Centre. The theme of the day was 'Choices for mixed farming systems - Best Bets'. The intent of the day was to give farmers management options, particularly when cereal on cereal systems were becoming less productive due to disease, pests and weeds or nutrition issues. Allen Buckley, a farmer from Waikerie, South Australia, gave the keynote address on how he manages to maintain cereal production – rotations and flexibility in his system is critical.

Research results relevant to Eyre Peninsula were presented on sheep, pastures and broadleaf crops, demonstrating production potential and limitations. The first half of the program was about identifying problems in intensive cropping systems, with small group sessions on nutrition, disease, weeds and pests.

Brian Wibberley started the afternoon session with a keynote address on the economics of different enterprise mixes and how and why it is necessary to accurately calculate the contribution each enterprise makes to the whole farm business. He provided a practical economic framework to assist in decision making when it comes to evaluating options in changing the mix of farming enterprises. Small group sessions in the second half of the program focused on getting the most out of different enterprises, with sessions on cost of production scenarios, pastures, sheep, break crops and maintaining cereals. Ed Hunt discussed profit and risk of the whole farm business at the conclusion of the day, and challenged people to build resilience to climate, production and price into their businesses.

According to evaluation at the end of the day, an average of 93% of farmers found the sessions relevant to their farm business, an average of 87% learnt something new or reinforced something they had heard before and an average of 58% said they would do something differently as a result of attending the EPARF day. Some of the comments made by farmers about what they would do differently include: *Maybe look at different rotations which help in weed & disease control through the 4 years in 2 years out rotation; Look at this program [ASBV's] to buy rams; Sow medics like a crop; Grow canola; Look at cost of production; Put more emphasis on improving pastures for N source; More crop monitoring for disease; Be careful on chemical selections & rates; Use more selective chemical applications for insects; Improve financial analysis of business; Sow medics to improve break pasture option; Encourage studs to adopt a merino objective measurement system; Tune up risk analysis.*

Figure 1 Small group session led by Roy Latta at the pasture plots sown for demonstration

Figure 2 Large session in the shed

Acknowledgements

Thanks to the speakers (in order of appearance) Allen Buckley, Darryl Smith, Roy Latta, Andrew Ware, Craig James, Nigel Wilhelm, Cathy Paterson, Amanda Cook, Linden Masters, Ken Webber, Kym Perry, Brian Wibberley, Ian Richter, Jessica Crettenden, Mark Klante, Leigh Davis, Brenton Spriggs, Wade Shepperd, Mike Krause, Ed Hunt. Thanks to Dot Brace, Leala Hoffmann and MAC staff for organising the event. EPARF would like to thank their sponsors for 2011: Viterra, Nufarm, GPS Ag, Rabobank, CBH, Bank SA, AGT, Seednet, EP Grain and Letcher & Moroney Chartered Accountants.

Eyre Peninsula Agricultural Research Foundation Members 2011

Adams	Daniel	CUMMINS SA
Agars	Steve	PORT LINCOLN SA
Agars	Brad	LOCK SA
Allan	Ben	LOCK SA
Ashton	Brian	PORT LINCOLN SA
Baillie	Terry	TUMBY BAY SA
Baldock	Graeme	KIMBA SA
Baldock	Heather	KIMBA SA
Bammann	Geoff	CLEVE SA
Bammann	Paul	CLEVE SA
Barns	Ashley	WUDINNA SA
Bates	Andy	STREAKY BAY SA
Beinke	Peter	KIMBA SA
Beinke	Lance	KIMBA SA
Berg	Dean	via KYANCUTTA SA
Berg	Ben	via KYANCUTTA SA
Blumson	Bill	SMOKY BAY SA
Blumson	Vinnie	SMOKY BAY SA
Boylan	Damien	WUDINNA SA
Brace	Reg	POOCHERA SA
Brace	Dion	POOCHERA SA
Bubner	Daryl	CEDUNA SA
Burrows	Alfie	WUDINNA SA
Burrows	Ian	LOCK SA
Burrows	Warren	LOCK SA
Cant	Brian	CLEVE SA
Cant	Mark	KIMBA SA
Cant	Sonia	KIMBA SA
Carey	Peter	MINNIPA SA
Carey	Matthew	STREAKY BAY SA
Carey	Damian	STREAKY BAY SA
Carmody	Steven	COWELL SA
Chase	Symon	COWELL SA
Cliff	Trevor	KIMBA SA
Cliff	Kerri	KIMBA SA
Cook	Matt	MINNIPA SA
Crettenden	Brent	LOCK SA
Cronin	Brent	STREAKY BAY SA
Cronin	Pat	STREAKY BAY SA
Cummins	Richard	LOCK SA
Cummins	Neil	LOCK SA
Cummins	Lyn	LOCK SA
Daniel	Neil	STREAKY BAY SA
Daniell	Wes	MINNIPA SA
Dart	Robert	KIMBA SA
Dart	Kevin	KIMBA SA
DuBois	Ryan	WUDINNA SA
Dunn	Matthew	RUDALL SA
Dunn	Mignon	RUDALL SA
Eatts	Austen	KIMBA SA
Edmonds	Graeme	WUDINNA SA
Elleway	David	KIELPA SA
Elleway	Ray	KIELPA SA
Endean	Jim	MINNIPA SA
Eylward	Andre	STREAKY BAY SA
Fitzgerald	Leigh	KIMBA SA
Fitzgerald	Clem	KIMBA SA
Fitzgerald	Mark	TUMBY BAY SA
Fitzgerald	Brendan	KIMBA SA
Forrest	Scott	MINNIPA SA
Foster	Daniel	WUDINNA SA
Foxwell	David	CLEVE SA
Foxwell	Tony	CLEVE SA
Francis	Brett	KIMBA SA
Freeth	John	KIMBA SA
Freeth	Thomas	KIMBA SA
Fromm	Jerel	MINNIPA SA
Fromm	Jon	MINNIPA SA
Gill	MJ	LOCHIEL SA
Gill	Isaac	COWELL SA

Gilmore	Trevor	STREAKY BAY SA
Grund	John	KIMBA SA
Grund	Gary	KIMBA SA
Guerin	Simon	PORT KENNY SA
Guest	Terry	SALMON GUMS WA
Gunn	Angus	PORT KENNY SA
Gunn	Ian	PORT KENNY SA
Hamence	Les	WIRRULLA SA
Harris	John	KIMBA SA
Heath	Basil	PORT LINCOLN SA
Heath	Andrew	PORT LINCOLN SA
Heath	Stacey	WUDINNA SA
Heddle	Bruce	MINNIPA SA
Hegarty	Kieran	WARRAMBOO SA
Hentschke	Andrew	LOCK SA
Herde	Bill	RUDALL SA
Hitch	Max	PORT LINCOLN SA
Hitchcock	Peter	LOCK SA
Hitchock	Nathan	LOCK SA
Holman	Kingsley	LOCK SA
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Hood	Mark	PORT KENNY SA
Horgan	John	STREAKY BAY SA
Horgan	Mark	STREAKY BAY SA
Horne	Jennifer	WHARMINDA SA
Howard	Tim	CEDUNA SA
Hull	Geoff	STREAKY BAY SA
Hull	Jake	STREAKY BAY SA
Hull	Leroy	STREAKY BAY SA
Hunt	Ed	PORT NEILL SA
Hunt	Evan	PORT NEILL SA
Hurrell	Leon	LOCK SA
James	Craig	CLEVE SA
Jericho	Neville	MINNIPA SA
Jericho	Marcia	MINNIPA SA
Jolly	San	WALKERVILLE SA
Kaden	Paul	COWELL SA
Kay	Dylan	LOCK SA
Kay	Saxton	LOCK SA
Kelsh	Craig	PORT KENNY SA
Kenchington	Cassy	KIMBA SA
Kobelt	Rex	CLEVE SA
Koch	Daryl	KIMBA SA

Koch	Jeff	KIMBA SA
Kuhlmann	Peter	GLENELG STH SA
Kwaterski	Robert	MINNIPA SA
Lawrie	Andrew	TUMBY BAY SA
LeBrun	Dion	TUMBY BAY SA
LeBrun	Maria	TUMBY BAY SA
LeBrun	Leonard	TUMBY BAY SA
Lee	Howard	STREAKY BAY SA
Lienert	Bill	KIMBA SA
Lienert	Matt	KIMBA SA
Lienert	Roger	ARNO BAY SA
Lienert	Ben	ARNO BAY SA
Little	Nathan	PORT KENNY SA
Little	Ken	PORT KENNY SA
Longmire	Andrew	SALMON GUMS WA
Longmire	Jeffrey	LOCK SA
Lovegrove	Barry	CLEVE SA
Lovegrove	Martin	CLEVE SA
Lymn	Chris	WUDINNA SA
Lymn	Allen	WUDINNA SA
Lynch	Christopher	STREAKY BAY SA
Lynch	Bradley	STREAKY BAY SA
Lynch	Brenton	STREAKY BAY SA
Lynch	Damien	POOCHERA SA
Lynch	Joel	POOCHERA SA
Major	Justine	KIMBA SA
Major	Andrew	KIMBA SA
Malcolm	Shane	ARNO BAY SA
Malcolm	Beth	ARNO BAY SA
Masters	John	ARNO BAY SA
Matthews	Wes	KYANCUTTA SA
May	Nigel	ELLISTON SA
May	Debbie	ELLISTON SA
May	Paul	KYANCUTTA SA
May	Ashley	KYANCUTTA SA
Mayfield	Shannon	KIMBA SA
Michael	John	WUDINNA SA
Michael	Ashley	WUDINNA SA
Millard	Darren	ARNO BAY SA
Montgomerie	John	STREAKY BAY SA
Montgomerie	Ian	STREAKY BAY SA
Moyse	Ian	SMOKY BAY SA
Mudge	Caroline	STREAKY BAY SA
Mudge	Darren	STREAKY BAY SA

Murray	Lynton	PENONG SA
Murray	Amy	PENONG SA
Nicholls	Anthony	CEDUNA SA
Noble	Ian	WHARMINDA SA
Norris	Daryl	RUDALL SA
Octoman	Nick	TUMBY BAY SA
Octoman	Matthew	TUMBY BAY SA
Oswald	John	YANINEE SA
Oswald	Clint	YANINEE SA
Ottens	Tim	WHARMINDA SA
Pearce	Chris	CLEVE SA
Phillips	Darcy	MINNIPA SA
Phillis	Jamie	UNGARRA SA
Polkinghorne	Andrew	LOCK SA
Pollock	James	MINNIPA SA
Pope	Lindsay	WARRAMBOO SA
Pope	Ben	WARRAMBOO SA
Preiss	Kevin	ARNO BAY SA
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Prime	Andrew	WHARMINDA SA
Prime	Chris	WHARMINDA SA
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Ranford	Ben	CLEVE SA
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Rayson	Peter	KIMBA SA
Rehn	Gavin	ARNO BAY SA
Ryan	Martin	KIMBA SA
Sampson	Allen	KIMBA SA
Sampson	Brett	WARRAMBOO SA
Sampson	Kane	WARRAMBOO SA
Sampson	Veronica	WARRAMBOO SA
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Schmucker	Thomas	KYANCUTTA SA
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Scholz	Nigel	WUDINNA SA
Scholz	Neville	WUDINNA SA
Scholz	Lyle	YANINEE SA
Scholz	Micheal	YANINEE SA
Scholz	Gareth	MINNIPA SA
Scholz	Leigh	MINNIPA SA
Scholz	Stuart	WUNINNA SA
Scholz	Yvonne	WUDINNA SA
Schopp	Kevin	LOCK SA
Schwarz	Noel	CEDUNA SA
Seal	Brook	KIMBA SA

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Simpson	John	WUDINNA SA
Smith	Bryan	COORABIE SA
Smith	Reid	MAITLAND SA
Sparrow	Dustin	WUDINNA SA
Story	Rodger	COWELL SA
Story	Suzanne	COWELL SA
Thomas	Geoff	BLACKWOOD SA
Traeger	Sarah	CLEVE SA
Trezona	Neville	STREAKY BAY SA
Trowbridge	Shane	CEDUNA SA
Turnbull	Mark	CLEVE SA
Turnbull	John	CLEVE SA
Van der Hucht	Peter	WUDINNA SA
Van loon	Tim	WARRAMBOO SA
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Veitch	Simon	WUDINNA SA
Veitch	Leon	WARRAMBOO SA
Vorstenbosch	Daniel	WARRAMBOO SA
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Waters	Dallas	WUDINNA SA
Waters	Tristan	WUDINNA SA
Watson	Peter	WIRRULLA SA
Webb	Paul	COWELL SA
Wendland	David	MINNIPA SA
Wheare	Craig	LOCK SA
Wheaton	Philip	STREAKY BAY SA
Wilkins	Gregor	YANINEE SA
Wilkins	Barry	YANINEE SA
Wilksch	Jordan	YEELANNA SA
Williams	Ken	STREAKY BAY SA
Williams	Dion	STREAKY BAY SA
Williams	Dene	KIMBA SA
Williams	David	PORT NEILL SA
Willmott	Dean	KIMBA SA
Wilmott	Peta	KIMBA SA
Woolford	Peter	KIMBA SA
Woolford	James	KIMBA SA
Woolford	Nathan	KIMBA SA
Woolford	Graham	KIMBA SA
Woolford	Barb	KIMBA SA
Woolford	Dion	KIMBA SA
Woolford	Simon	KIMBA SA
Zacher	Michael	LOCK SA
Zerna	Allan	COWELL SA

Eyre Peninsula seasonal summary 2011

Linden Masters[1], Brett Masters[2] and Kieran Wauchope[2]

[1]SARDI and EPNRM, Minnipa Agricultural Centre, [2]Rural Solutions SA, Port Lincoln

OVERVIEW

2011 will be seen by many as a consolidation year after two good seasons of 2010 and 2009. The huge size of the peninsula and variation in soil types and rainfall throughout the region was again reflected in large variations in crop yields. In 2011 a dry spell in September negatively impacted on yields compared to increased rainfall during that period in 2010.

Overall, above average grain yields were recorded for the region, however yields varied widely within districts and properties. Whilst areas around Wirrulla, Haslam and Yantanabie recorded some of their best ever yields, yields on heavy soils around Kimba, Eastern Cleve Hills and Franklin Harbour were well below average. In general wheat yields were average to above average, however dry conditions during September seemed to impact on barley crops and yields were more disappointing. Canola crops generally yielded well with some of the more reliable areas of Western and Eastern Eyre recording 0.8 to 1.9 t/ha and reports of Lower Eyre crops yielding well over 2 t/ha.

An abundance of summer weeds meant growers were kept busy spraying from soon after the 2010 harvest through until rains in April and May gave the 2011 cropping season a start.

Seasonal rainfall tracked on or just below decile 5, before a 6 week dry period from August to mid September brought growing season rainfall back to little over decile 3 in most districts. The exception to this however was areas around Ceduna, Minnipa and Streaky Bay which maintained a decile 5 rainfall for the growing season.

Prior to this dry spell in early spring crops looked excellent with a high yield potential. However this dry period at flowering and early grain fill had a damaging effect on crop yields and quality. This effect was amplified with variations in soil type, stored subsoil moisture and crop maturity. Barley was generally affected worse than wheat.

There was some frost damage reported across central Eyre districts (Kyancutta, Lock, Darke Peak, Kielpa and Gum Flat) which impacted on crop yields. Mice were again an issue in the Elliston and Minnipa districts and increasing numbers in the Eastern Eyre Peninsula districts of Kielpa, Rudall, and Franklin Harbour saw growers begin baiting early. Snail numbers were the worst seen for many years, particularly on the west coast and western and northern parts of Lower Eyre, and they appear to be an increasing problem. Late rains saw an extra hatching of snails which caused significant problems for grain quality samples at harvest. Many growers employed the use of crushers to try to minimise the level of contamination at harvest. Conical snails caused rejection at many sites. Snails invaded windrowed canola and lodged barley crops. They were also a large problem in pulse crops with some growers saying that they are considering not growing peas again.

Grass weeds were a large problem again this season with many growers' grass-freeing or spray-topping pastures to try to control seed set going into 2012. The amount of grasses which were not effectively controlled in cropping paddocks is also concerning growers.

Although seasonal conditions provided potential for significant crop damage by fungal disease, most growers found early fungicide applications to be effective in controlling leaf and stem rust. Powdery mildew was a concern again this season along with a fungal mould being reported on pulse crops in Lower Eyre Peninsula and white grain disorder (a fungal species of Botryosphaeria) on wheat crops in the Kimba and Cleve Districts.

Thankfully good harvest conditions allowed the crop to be delivered by mid December in most areas without grain quality being compromised by weather damage as it was in 2010, except for on some early sown barley paddocks. In some areas mild conditions and high germination of summer weeds in cropping paddocks led to "a green salad mix" which caused reaping delays due to difficulties in lowering grain moisture content. This was a particular problem on areas of Eastern Eyre which required re-sowing due to damage from mice and wind erosion.

Whilst harvest yields were generally well above average, protein levels varied dramatically. Many of the cereal paddocks in the Lower Eyre districts yielded well above average but had low protein and were delivered as ASW or general purpose. In drier districts protein levels were good and a lot of grain was delivered as APW or AH. Prices for high quality grain at delivery were not as high as growers would have liked, there may have been a benefit in warehousing high protein wheat to be sold at a later date. Coupled with the higher cost of inputs required to control summer weeds and fungal disease in 2011, many growers were concerned wheat prices of $170-180/tonne only gave a very small gross margin. The influence of world markets could be seen with many growers not being able to find a market for lupins and beans.

The impact of poor summer weed control on reducing crop yields was evident in 2011. Growers need to concentrate on reducing the amount of summer weeds to try and minimise the impact of diseases as well as try to reduce the number of snails and mice before going into season 2012.

DISTRICT REPORTS

WESTERN EYRE PENINSULA

Rainfall

Good rainfall events were recorded across the region in early April which allowed some farmers to begin sowing. Rapid germination and good early growth of these crops gave excellent yield potential by mid winter. Continued rains into May ensured that the season was tracking well with Penong, Wudinna and Minnipa receiving decile 5 May rainfall and well above average (decile 7) rainfall being received near Kyancutta, Streaky Bay and Elliston. However, June rainfall was well below average causing topsoils to dry out and crops relying on good stored subsoil moisture during this period. The main limitation to yield potential was a six week dry period from August into late September which caused some damage to barley yields. Rains in late September and throughout October helped to fill grains.

Crops

Moist conditions during May allowed an uninterrupted seeding with most growers finishing in early June. The strong winds on 21 May sand blasted newly emerged crops with some crops needing to be resown as a result of the damage. Continuing high mice levels, especially around Minnipa and Elliston required most growers to bait at seeding. These mice numbers declined in early July, however warmer conditions saw an increase in mouse activity from mid August.

Leaf and stem rust and powdery mildew on cereal crops appeared in mid to late August. There was also an increase in damage from Take-all observed. Grass weeds were also a problem this season with most growers spray-topping and some growers spraying out areas of crop with a high infestation.

An increase in canola plantings saw flowering in early July with some early sown cereals coming out in head in mid August. Maturity was “normal” with harvest well under way early November. Canola crops yielded well with yields ranging from 0.8 t/ha to 1.9 t/ha in the more reliable areas.

Wheat yields were generally above average with areas around Haslam and Mt Cooper recording their best yields ever (4-6 t/ha). Barley yields were generally disappointing with yield being severely affected by the dry period in August/September, lodging and poor sample weight.

Patsures

Stock remained in good condition through the season with many growers trashing in early cereal for feed in response to the good conditions in May. Pastures contained a high amount of feed and there were reports of good medic stands, although many were hampered by downy mildew carried over from the 2010 season. Stock prices were generally excellent during the 2011 season.

EASTERN EYRE PENINSULA

Rainfall

Good rainfall events in early May and widespread follow up rains on 22 and 23 of May ensured that May rainfall was well above average across the region. June and July rainfall was generally below average and whilst stored subsoil moisture was moderate the topsoil had dried out considerably by the end of June. Whilst early crop yield potential looked good growing season rainfall to August was average to below average (Deciles 3-5). A period of six weeks of dry in August/September saw rainfall deciles dip sharply and crops on heavier soils in the Kimba and Franklin Harbour districts began to suffer. A large rainfall event in mid September restored crops to some degree, however yields were only average and did not achieve what was hoped.

Crops

Significant rains (>10mm) in the first week of May allowed most growers to begin their winter crop seeding program. Follow-up rains in the third week of May resulted in good seeding conditions. Strong winds on 21 May caused cultivated paddocks around Franklin Harbour south along the coast to Arno Bay to drift, many were re-sown. Stored subsoil moisture across the region was high and crops used this as topsoils dried out.

Mice numbers were high around Franklin Harbour, Arno Bay and Wharminda. Many growers needed to bait to minimise crop damage. Early crops such as canola and early sown cereals were particularly affected. Frosts at flowering reduced yields on lighter textured soils at Darke Peak, Kielpa and Rudall (reports of yield being reduced from 2.5 t/ha crops to 1.6 t/ha due to frost damage). There was also some hail damage to crops around Cleve and Arno Bay. Except for the Franklin Harbour district and heavy soils around Kimba, grain yields were generally average to above average across the region where leaf and stem rust were controlled, despite below average growing season rainfall.

Pastures

Early sown cereal paddocks provided a high amount of early feed for stock. However cool conditions during June and July followed by a rapid increase in temperature in August saw many pasture paddocks with little feed. Growers had to rotate sheep through paddocks to ensure that they maintained condition. Many growers posed the question of what impact the higher mice numbers had on pasture seed stores and hence a lack of pasture bulk. There was also a high incidence of powdery mildew impacting medic pasture stands.

LOWER EYRE PENINSULA

Rainfall

Well above average rainfall (Decile 8) was received in most districts in May. Good rainfall events in early May and widespread follow up rains on 22 and 23 May allowed most growers to complete seeding by mid June. Stored subsoil moisture was high by the end of May with growers on heavier textured soils south of Cummins reporting water logging. Topsoils had dried out by the end of June due to below average June rainfall. July/August rainfall was close to average for this region. September rainfall was below average with crops drawing from subsoil moisture during this period. Crop growth and grain fill was aided by significant rainfall in the last week of September and throughout October. Thunderstorm activity on 9 and 17 December brought December rainfall totals above average, however there was little damage reported to standing crops.

Temperatures in June/July were cool to mild with daytime temperatures increasing in August leading to earlier crop maturity than average.

Crops

Mild conditions in late May allowed good germination and rapid early growth of crops. Snails were a significant issue with growers on the west coast and more northern parts of lower EP having to bait canola and pulse crops prior to sowing. Late rains stimulated an increase in population prior to harvest which caused significant problems for grain quality. Many growers hired crushers to try to reduce numbers in samples. Seasonal rainfall resulted in minimal post sowing applications of urea.

Grass weeds were a significant issue this season with a high level of in-crop control required. A number of growers crop-topped cereal crops to try and control weed seed set ahead of the 2012 season. Early fungicide applications were effective in controlling leaf and stem rust and powdery mildew. Growers also found early treatments effective for minimising damage by blackleg on canola crops. There was some stem rust damage reported on paddocks which were too wet to apply preventative fungicide applications. There were some reports of eyespot damage in paddocks around Edillilie where wheat was grown on wheat stubble, reducing 4 t/ha crops to 1 t/ha.

Cereals finished flowering in early October with later rains helping grain fill. Many growers were monitoring canola crops in spring to gauge Diamond Back Moth numbers, however levels generally remained below the threshold for spraying. Canola paddocks were windrowed in mid October. Canola yields and quality were generally above average with many paddocks yielding in excess of 2 t/ha. All pulses have had significant issues at delivery due to field mould and fungal staining.

Mild conditions in early December caused some harvest delays due to higher grain moisture. There were a number of reports of growers drying grain prior to delivery. Generally favourable harvest conditions saw 95% of the crop area harvested by the end of the first week of January.

Despite reports of highly variable yields from paddock to paddock, most growers report generally above average crop yields. Barley yields were more affected by the drier conditions in September than wheat.

Pastures

Early sown cereal paddocks and perennial pastures provided a high amount of early feed for stock. However cool conditions during June and July slowed annual pasture growth. Pastures responded to warmer conditions and stored subsoil moisture in late August generating a high level of paddock feed. Pastures were spray-topped in early September to reduce seed set of grass weeds. Late rains germinated summer weeds providing a high level of green feed.

RURAL SOLUTIONS SA
GRDC Grains Research & Development Corporation
Government of South Australia
Eyre Peninsula Natural Resources Management Board
SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

MAC Farm Report 2011

Mark Klante
SARDI, Minnipa Agricultural Centre

INFORMATION

Try this yourself now

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 320 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Key outcomes

- **MAC average wheat yields 2.3 t/ha, barley 2.4 t/ha.**
- **80% of total farm area cropped.**
- **333 breeding ewes produced 128% lambs at marking.**
- **230 tonnes of seed sold to growers off the header.**

Background

The performance of the Minnipa Agricultural Centre (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.

2011 season

Sowing commenced on 2 May with Kaspa peas. This was followed by canola on 4 May, following 10 mm of rain on 2 May. Wheat sowing commenced on the 5 May, finishing on 27 May. The area sown was 915 hectares (wheat 630, barley 140, peas 93 and canola 52) with 205 ha of permanent or regenerating pasture.

In March we had a Topcon variable rate system fitted to our air seeder box. This allowed us to use VRT on 6 paddocks including North 1, our EPFS 3 Focus Paddock. Seeding went well with no major problems. We baited our canola paddocks and two of our wheat paddocks for mice immediately after seeding. We also baited a number of paddock boundaries for snails.

What happened?

The average farm wheat yield of 2.3 t/ha was limited in some paddocks by grass competition. Barley yielded an average 2.4 t/ha. We received 252 mm of growing season rainfall (GSR), falling on 73 days, compared to 345 mm of GSR in 2010 when the wheat averaged 3.1 t/ha, barley 3.7 t/ha. The crops benefited from 128 mm of rainfall in February and March which may have contributed to the water use efficiency estimate of 17 kg/mm of plant available water based only on GSR. The crop was considered to have suffered from a lack of rainfall in August and September during grain fill.

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

What does this mean?

The MAC farm has continued to maintain comparative grain yield productivity at approximately 17 kg/mm of available water over the past 3 years.

In 2011, 333 Merino ewes were mated in February producing 426 lambs at marking (128%), 118% lambs at weaning in 2010.

230 tonnes of seed grain was sold to growers off the header with a further 120 t of seed kept for certification from the 2011 crop, providing quality grain to the industry on Eyre Peninsula.

Acknowledgements

MAC farm staff Brett McEvoy and Trent Brace.

Table 1 Harvest results at Minnipa Agricultural Centre 2011

Paddock	Paddock History 07-10	Crop 2011	Sowing Date	Yield (t/ha)	Protein (%)
South 1	W W W W	Axe	25 May	1.82	11.0
South 1 Scrub	W W W B	Scope	27 May	0.98	12.8
South 2/8	W W P P W W P W W W P P	Mace Wyalkatchem Justica CL Plus	16 May 17 May 16 May	3.14 2.78 2.75	12.1 11.0 13.8
South 3 S	W P P W	Mace	13 May	2.86	11.0
South 3 N	Pe P W W	44C79	7 May	1.20	
South 4	P W W W	Hindmarsh	26 May	1.97	13.0
South 5	W W Pe W	Wyalkatchem	20 May	2.65	10.2
South 7	W W W P	Wyalkatchem	9 May	2.72	10.0
Barn	W W B B	Duram	27 May	2.52	11.5
North 1	W W W W	Hindmarsh	6 May	2.90	11.6
North 2	W W B Pe	Kord CL Plus	5 May	2.80	13.0
North 4	W P P W	Mace	12 May	2.45	11.0
North 6 E	W P P W	Wyalkatchem	8 May	1.76	9.8
North 6 W	C W W B	Kaspa	3 May	1.90	
North 7/8	P W W W	Wyalkatchem	25 May	1.86	10.5
North 9	B Pe O P	Kord CL Plus	5 May	2.41	13.2
North 10	W W W Pe	Scout	19 May	2.64	12.5
North 11	P W W W	Wyalkatchem	24 May	2.77	9.5
North 12	T W B W	44C79	4 May	1.20	
Competition Paddocks		Hindmarsh	7 May	2.62	12.1

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

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Understanding trial results and statistics

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.

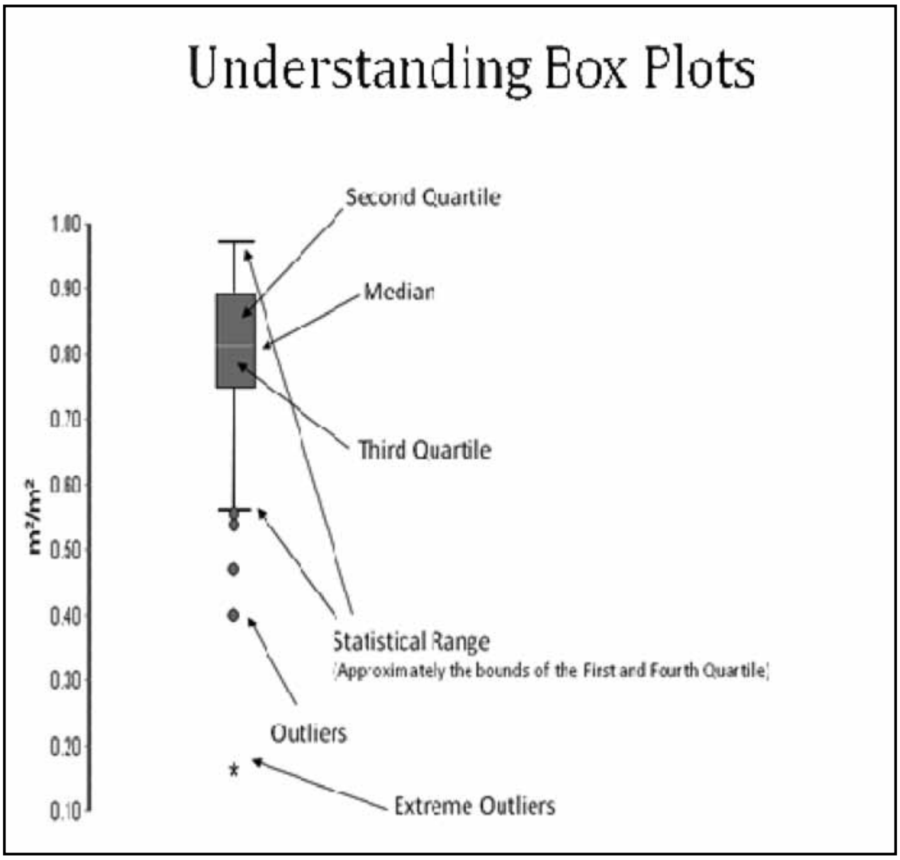
The carefully planned and laid out farmer un-replicated trial or demonstration does have a role in agriculture as it enables a farmer to verify research findings on his particular soil type, rainfall and farming system, and we all know that "if I see it on my place, then I'm more likely to adopt it". 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.



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 m² (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)

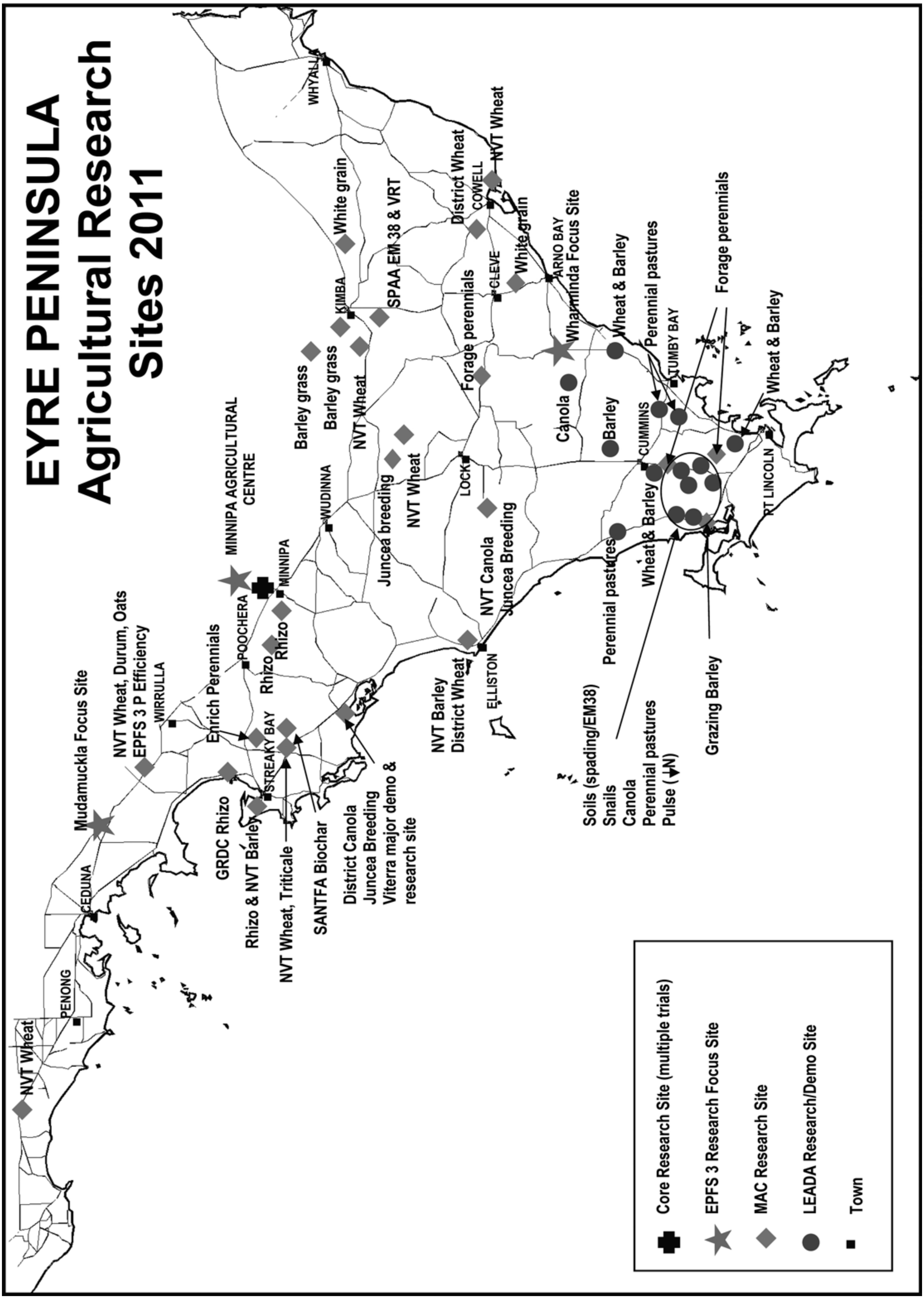
25 psi = 1.7 bar = 172 kPa

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 2011
NVT Wheat
PENONG
CEDUNA
Mudamuckla Focus Site
NVT Wheat, Durum, Oats
EPFS 3 P Efficiency
WIRRULLA
Enrich Perennials
POOCHERA
MINNIPA AGRICULTURAL CENTRE
MINNIPA
Rhizo
Rhizo
GRDC Rhizo
Rhizo & NVT Barley
NVT Wheat, Triticale
SANTFA Biochar
District Canola
Juncea Breeding
Viterra major demo & research site
STREAKY BAY
WUDINNA
Barley grass
Barley grass
NVT Wheat
KIMBA
White grain
WHYALLA
SPAA EM 38 & VRT
Juncea breeding
NVT Wheat
LOCK
NVT Canola
Juncea Breeding
ELLISTON
NVT Barley
District Wheat
Forage perennials
CLEVE
White grain
District Wheat
COWELL
NVT Wheat
ARNO BAY
Wharminda Focus Site
Canola
Barley
CUMMINS
Wheat & Barley
Perennial pastures
TUMBY BAY
Forage perennials
Wheat & Barley
PT LINCOLN
Perennial pastures
Wheat & Barley
Soils (spading/EM38)
Snails
Canola
Perennial pastures
Pulse (↓N)
Grazing Barley
Core Research Site (multiple trials)
EPFS 3 Research Focus Site
MAC Research Site
LEADA Research/Demo Site
Town

Section 1

Section Editor:
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Cereals

Cereals

The 2011 production figures for Upper Eyre Peninsula were approximately 1.22 million tonnes of wheat, 308,000t of barley, 20,000t of oats and 8,500t of triticale. The Lower Eyre Peninsula production figures were approximately 432,000t of wheat, 258,000t of barley, 6,400t of oats and 2,500t of triticale.
[PIRSA Crop & Pasture Report SA, January 2012]

Triticale variety yield performance

2011 and long term (2005-2011) expressed as % of site average yield and as t/ha

Variety	2011 (as % of site average)				Long term average across sites within region			
					Lower Eyre		Upper Eyre	
	Greenpatch	Minnipa	Streaky Bay	Wharminda	% sites av.	# Trials	% sites av.	# Trials
Berkshire	100	103	90	98	107	6	103	6
Bogong	115	104	109	96	110	10	106	9
Canobolas	111	103	104	99	105	10	102	9
Chopper	98	89	92	110	104	8	99	8
Endeavour	82	-	-	88	90	4		
Goanna	92	92	91	100				
Hawkeye	106	104	98	102	106	12	103	11
Jaywick	100	93	98	98	102	12	98	11
Rufus	82	94	99	91	97	10	95	10
Tahara	96	99	106	99	97	14	100	13
Tickit	96	98	105	99	99	14	97	13
Tuckerbox	94	-	-	95	93	6		
Yowie	95	95	96	104	100	4	95	4
Yukuri	88	-	-	75	99	6		
Site av. yield t/ha	**3.92**	**3.82**	**2.30**	**2.45**	**3.1**		**2.07**	
LSD (P=0.05) as %	*8*	*4*	*10*	*10*				
Date Sown	18 May	5 May	20 May	12 May				
Soil Type	L	L	SCL	NWS				
J-M/A-O rain (mm)	108/494	129/252	124/242	84/222				
pH (water)	5.4	8.3	7.8	6.9				
previous crop	canola	pasture	fallow	pasture				
Stress factors								

Abbreviations
Soil Types: S=sand, C=clay, L=loam, NWS = non wetting sand

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

SA Wheat variety yield performance *2011 and long term (2005-2011) expressed as % of site average yield and as t/ha*

Variety	Mid and Lower Eyre Peninsula						Upper, Eastern and Western Eyre Peninsula									
	2011 (% site average)			Long Term av. across sites (05-11)			2011 (as % site average)							Long Term av across sites (05-11)		
	Cummins	Rudall	Ungarra	t/ha	% site av.	# Trials	Kimba	Minnipa	Mitchelville	Nunjikompita	Penong	Streaky Bay	Warramboo	t/ha	% site av.	# Trials
AGT Katana	100	107	103	3.45	103	14	107	100	97	100		104	107	1.73	103	28
Axe	96	97	101	3.32	99	20	102	94	96	98		89	80	1.64	98	39
Catalina	96	93	102	3.28	98	17	100	102	100	99		89	96	1.61	96	32
Clearfield Jnz	98	99	94	3.19	95	8	92	98	96	95		98	90	1.46	87	17
Cobra	110	107	106	-	-	-	105	113	102	104		114	106	-	-	-
Corack	109	100	111	3.48	104	5	117	93	109	96		97	103	1.71	102	11
Correll	92	93	98	3.37	101	20	91	87	104	109	GRASS	105	97	1.69	101	39
Derrimut	104	97	103	3.43	102	20	98	99	94	92	WEEDS	89	98	1.63	97	39
Elmore CL Plus	100	94	95	-	-	-	91	93	91	97	NO	93	85	-	-	-
Emu Rock	98	99	95	3.36	100	5	100	91	105	100	VALID	91	86	1.64	98	11
Espada	100	111	102	3.45	103	17	103	112	114	108	RESULT	103	106	1.76	105	32
Estoc	92	100	88	3.33	100	11	97	95	102	103		94	97	1.67	100	22
Frame	-	85	85	3.17	95	18	-	-	-	-		-	-	-	-	-
Gladius	99	105	105	3.43	103	20	100	93	106	102		94	100	1.71	102	39
Justica CL Plus	95	94	95	3.24	97	5	87	91	98	96		88	108	1.57	94	11
Kord CL Plus	99	103	106	3.27	98	5	106	100	104	96		102	97	1.59	95	11
Lincoln	100	94	101	3.35	100	14	100	97	93	111		107	94	1.68	100	28
Mace	105	113	108	3.55	106	8	115	113	113	110		109	115	1.84	110	17
Magenta	94	112	100	3.40	101	20	103	105	114	111		107	109	1.72	103	39
Peake	101	96	99	3.37	101	20	102	95	103	93		83	97	1.62	96	39
Scout	106	105	107	3.59	107	8	100	113	100	106		106	113	1.80	108	17
Wallup	101	97	97	3.41	102	4	97	100	86	102		100	91	-	-	-
Wyalkatchem	100	103	104	3.44	103	20	102	103	105	102		109	100	1.73	103	39
Yitpi	92	91	93	3.32	99	20	87	85	86	95		97	98	1.65	99	39
Site av. yield t/ha	**6.58**	**3.33**	**4.63**	**3.35**	**100**		**3.84**	**4.24**	**1.89**	**1.99**		**2.06**	**1.84**	**1.67**	**100**	
LSD (P=0.05) as %	*4*	*5*	*6*				*7*	*4*	*7*	*7*		*12*	*9*			
Date Sown	15 May	13 May	16 May				27 May	6 May	12 May	25 May	19 May	20 May	11 May			
Soil Type	CL	SL	SL				LS	L	LS	SCL	SCL	SCL	SL			
J-M / A-O rain (mm)	79/254	125/213	104/243				153/265	129/252	117/204	107/221	103/210	124/242	129/218			
pH (Water)	8.1	8.0	7.7				7.2	8.3	7.4	8.5	8.7	7.8	7.3			
Previous Crop	lentil	canola	canola				canola	pasture	pasture	pasture	pasture	fallow	pasture			
Stress Factors		e						lr	de				de,pm			

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), lr=leaf rust, pm=powdery mildew

Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2000-2011) Data analysis by GRDC funded National Statistics Group

SA Barley variety yield performance *2011 and long term (2005 - 2011) expressed as % of site average yield and as t/ha*

Variety	LOWER EYRE PENINSULA					UPPER EYRE PENINSULA							
	2011 (% site average)		Long Term average across sites (2005-2011)			2011 (as % site average)					Long Term average across sites (2005-2011)		
	Cummins	Wanilla	t/ha	% site av.	# Trials	Darke Peak	Elliston	Minnipa	Streaky Bay	Wharminda	t/ha	% site av.	# Trials
Barque	96	86	3.36	100	18	101	100	99	108	98	2.31	103	25
Bass	-	-	3.43	102	12	-	-	-	-	-	2.20	98	12
Baudin	102	92	3.25	97	20	75	53	71	80	91	2.06	92	21
Buloke	98	97	3.47	103	20	101	89	94	68	98	2.26	101	25
Capstan	113	100	3.53	105	10	-	-	-	-	-	-	-	-
Commander	98	109	3.50	104	20	93	107	108	118	103	2.33	104	25
Fathom	108	120	3.65	109	6	147	97	131	122	128	2.50	111	8
Flagship	94	88	3.33	99	20	100	104	95	98	102	2.20	98	25
Fleet	104	106	3.58	107	20	111	107	118	107	117	2.49	111	25
Gairdner	95	94	3.19	95	17	-	-	-	-	-	2.09	93	9
Henley	102	114	3.53	105	8	65	117	123	134	89	2.34	104	12
Hindmarsh	113	107	3.37	109	17	133	103	106	87	105	2.46	109	21
Keel	90	91	3.41	101	20	114	-	71	46	91	2.36	105	23
Macquarie	96	90	-	-	-	-	-	-	-	-	-	-	-
Maritime	81	99	3.36	100	20	99	69	76	68	94	2.18	97	25
Navigator	-	-	3.20	95	6	-	-	-	-	-	-	-	-
Oxford	112	126	3.69	110	10	50	135	108	190	99	2.47	110	12
Schooner	85	79	3.15	94	20	99	74	69	44	72	2.03	90	25
Scope	92	103	3.34	99	8	103	91	94	67	101	2.19	97	12
Shepherd	-	-	3.34	99	6	78	107	115	153	79	2.24	100	12
Skipper	97	98	3.52	105	8	126	96	105	61	111	2.36	105	12
Sloop SA	91	81	3.24	96	20	108	71	69	53	82	2.10	94	25
Westminster	107	112	3.42	102	4	-	-	-	-	-	-	-	-
Wimmera	105	109	3.57	106	6	-	-	-	-	-	-	-	-
Site av. yield t/ha	**6.30**	**4.35**	**3.36**	**100**		**2.01**	**2.71**	**2.73**	**1.56**	**1.93**	**2.24**	**100**	
LSD (P=0.05) as %	*9*	*10*				*17*	*11*	*8*	*15*	*10*			
Date Sown	15 May	17 May				27 May	13 May	6 May	20 May	12 May			
Soil Type	CL	S				SL	S	L	SL	NWS			
J-M/A-O rain (mm)	79/254	59/390				116/222	107/358	129/252	120/235	84/222			
pH (water)	8.1	5.9				7.9	7.8	8.3	8.4	6.9			
Previous Crop	lentil	canola				pasture	pasture	pasture	pasture	pasture			
Site Stress Factors	ld	wl				de, dl, ld	lr, ld	lr, ld	lr	r, hl, ns			

***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: de=dry pre-anthesis, dl=dry post anthesis, hl=headloss, ld=lodging, lr=leaf rust, ns=spot form net blotch, r=rhizoctonia, wl=waterlogging
Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites)
Data analysis by GRDC funded National Statistics Group

Cereals

SA Oat variety yield performance

2011 and long term (2005-2011) expressed as % of site average yield and as t/ha

	2011 (as % site average)		Long Term average across sites within region as % site average and number of trials			
Region	**Lower Eyre**	**Upper Eyre**	**Lower Eyre**		**Upper Eyre**	
Variety	**Greenpatch**	**Nunjikompita**	**% sites av.**	**# Trials**	**% sites av.**	**# Trials**
Euro	100	96	99	6	96	11
Kojonup	-	-	103	3	99	5
Mitika	97	101	102	6	102	11
Mortlock	-	-	90	3	82	6
Numbat	76	63	75	2	55	6
Possum	92	101	101	6	103	11
Potoroo	104	107	100	6	106	11
Wombat	115	115	104	3	107	6
Yallara	98	113	98	6	98	11
Site av. yield (t/ha)	**3.17**	**1.51**	**3.59**		**1.64**	
LSD (P=0.05) as %	*12*	*13*				
Date sown	18 May	25 May				
Soil Type	L	SCL				
pH (water)	5.4	8.5				
J-M/A-O rain (mm)	108/494	107/221				
Previous crop	canola	pasture				
Stress factors	wl					

Abbreviations

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

Stress factors: wl=waterlogging

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

Data analysis by GRDC funded National Statistics Group

Witera (Mt Cooper) and Elliston district wheat and barley trials

Andrew Ware[1], Leigh Davis[2], Brian Purdie[1], Ashley Flint[1] and Brenton Spriggs[2]

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

RESEARCH DEMO

Cereals

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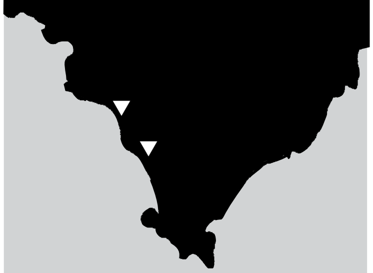

Location: Witera
Craig Kelsh
Mt Cooper Ag Bureau

Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2011 Total: 459 mm
2011 GSR: 257 mm

Yield
Potential: 4.0 t/ha (W)
Actual: 4.1 t/ha

Paddock History
2010: Medic pasture
2009: Keel barley
2008: Wheat

Soil Type
Clay loam over red brown earth

Yield Limiting Factors
Rust

Location: Elliston
Nigel and Debbie May
Elliston Ag Bureau

Rainfall
Av. Annual: 427 mm
Av. GSR: 353 mm
2011 Total: 501 mm
2011 GSR: 358 mm

Yield
Potential: 5.8 t/ha (W)
Actual: 3.79 t/ha (W)

Paddock History
2010: Grass free pasture
2009: Barley
2008: Pasture

Soil Type
Sand

Yield Limiting Factors
Rust

Key messages

- **Scout and Mace continue to out-yield the rest of the pack at Witera.**
- **Oxford and Fathom (WI4483) break 3 t/ha under severe leaf rust pressure at Witera.**
- **Espada and Scout top Elliston yields in 2011.**

Why do the trial?

These variety demonstrations were identified as priorities by local Agricultural Bureaus to compare current varieties to potentially new varieties in soil types and rainfall regions where National Wheat Variety trials are not conducted.

Witera District Wheat and Barley Trials

How was it done?

Fourteen wheat varieties and 12 barley varieties replicated 3 times were sown on 12 May with wheat receiving 88 kg/ha of DAP fertiliser at seeding with 90 kg/ha of urea applied 2 months later. The barley received 84 kg/ha 19:13:0:S9.4 and also received 90 kg/ha of urea broadcast after 2 months. 0.80 L/ha SpraySeed + 0.80 L/ha Triflur Xtra + 0.80 L/ha Lorsban were applied to both trials pre seeding. 0.25 L/ha Dimethoate was used for insect control and 1.2 L/ha Bromicide MA + 20 g/ha Broadstrike + 100 ml/ha Lontrel + 250 ml/100L water Chemwet 1000 for broadleaf weed control.

What happened?

Longreach Scout and AGT Mace have been the best performing lines across the state over multiple seasons and was no exception at Witera in 2011 where they significantly out-yielded 12 other varieties with 4.84 t/ha and 4.83 t/ha respectively. The average yield across all varieties in the trial was 4.10 t/ha. Test weight was a major problem in this trial due to the enormous amount of rust (leaf, stem and stripe). The trial did not receive any fungicides to control rusts which gave farmers a good picture of what these varieties look like without a fungicide spray at field days. Scout and CL Kord were the only varieties to scrape through the 74 kg/hL minimum test weight mark whereas all other varieties were downgraded.

Oxford and Fathom (WI4483) produced the highest yields under severe leaf rust pressure yielding 3.40 t/ha and 3.15 t/ha respectively. Again, like the wheat, the barley trial did not receive any fungicide sprays which severely affected grain yield and quality. Oxford (the most rust resistant variety) gave the best quality sample, however test weight was the issue. Commander and Flagship performed the best out of the malting varieties both yielding 2.39 t/ha but failed to meet the malting quality standards.

With the application of fungicides yields and grain quality would be expected to be different in some varieties. This needs to be taken into consideration when analysing this data.

Table 1 Grain yield and quality of wheat varieties sown at Witera in 2011

Variety	Yield (t/ha)	Protein (%)	Test Weight (kg/hL)	Screenings (%)
Scout	4.84	10.8	75	4.3
Mace	4.83	10.9	72	3.1
Lincoln	4.43	11.2	73	4.7
Espada	4.40	11.9	71	2.8
VW2316 (Corack)	4.15	11.3	70	4.0
Wyalkatchem	4.12	11.3	73	3.4
Estoc	4.09	12.3	73	5.0
Gladius	3.98	12.4	69	3.7
Kord CL	3.94	12.6	74	3.8
Axe	3.93	12.4	70	3.3
AGT Katana	3.88	11.4	73	6.9
Justica CL	3.87	12.0	70	3.4
Corell	3.79	13.2	69	5.6
Yitpi	3.21	11.4	68	11.1
Mean	**4.10**	**11.79**	**71.56**	**4.65**
LSD (P=0.01)	*0.18*			

Table 2 Grain yield and quality of barley sown at Witera in 2011

Variety	Yield (t/ha)	Protein (%)	Test Weight (%)	Retention (kg/hL)	Screenings (%)
Oxford	3.40	12.2	55	21.6	25.9
WI 4483 (Fathom)	3.15	12.7	50	34.6	15.1
Hindmarsh	2.45	12.2	50	19.5	27.7
Commander	2.39	11.9	50	18.5	35.0
Flagship	2.39	13.0	53	11.6	34.0
Fleet	2.26	12.5	48	39.5	16.9
Buloke	2.06	12.7	50	6.6	44.8
WI 4446 (Skipper)	1.89	12.1	49	12.5	50.3
Scope	1.88	12.6	51	7.9	37.7
Sloop SA	1.46	12.1	52	9.4	45.2
Schooner	1.37	12.3	52	6.4	46.5
Keel	1.37	12.0	44	7.6	57.7
Mean	**2.17**	**12.4**	**50.4**	**16.3**	**36.4**
LSD (P≤0.05)	*0.48*				

Elliston District Wheat Trials

How was it done?

Fourteen wheat varieties, replicated 3 times were sown on 13 May with 100 kg/ha of DAP fertiliser. The site received 1 L/ha glyphosate 490 g/L and 1 L/ha of trifluralin prior to sowing. 400 g/ha of Achieve and 500 ml/ha of MCPA LVE was applied mid-tillering in late June to control post emergent weeds. A foliar application of zinc, copper and manganese was applied with the post emergent herbicide. 250 ml/ha of epoxiconozole was applied on 14 September to control leaf disease.

What happened?

Espada was the highest yielding variety at Elliston in 2011, followed by Scout and Lincoln, with yields of Kord CL plus, Estoc, Katana, Yitpi, and Mace all similar (Table 3), indicating that a range of varieties performed well in the Elliston environment in 2011. This site was sprayed late in the season for rust, however it was expected that some damage to yield potential would have occurred prior to application.

The long term yields, relative to Yitpi, (Table 4) show that over the last 6 years a trend towards longer season, Yitpi types (Yitpi, Estoc and Scout) performed well at Elliston.

Table 3 Grain yield and quality of wheat varieties sown at Elliston 2011

Variety	Yield (t/ha)	Protein (%)	Test Weight (kg/hL)	Screenings (%)
Espada	4.18	12.6	69.5	1.7
Scout	4.17	11.4	73.2	2.2
Lincoln	4.10	12.6	76.8	4.1
Kord	4.06	12.6	72.8	1.9
Estoc	4.04	13.9	69.4	3.2
Katana	4.04	13.6	75.2	2.9
Yitpi	4.04	13.1	66.3	2.4
Mace	3.99	12.0	72.3	2.1
Gladius	3.65	12.7	66.8	1.7
Corack (VW2316)	3.42	11.6	69.9	3.5
Wyalkatchem	3.41	12.4	68.7	2.1
Correll	3.38	13.7	67.0	2.6
Axe	3.34	13.9	75.9	1.1
Justica	3.28	11.0	67.8	2.0
Mean	**3.79**	**12.8**	**70.8**	**2.4**
LSD (P=0.01)	*0.52*			

Table 4 Long term yield of wheat varieties in Elliston trials as a percentage of Yitpi, 2006-2011

Variety	2011	2010	2009	2008	2007	2006	Average
Axe	83	82	58	91	103	120	89
Correll	84	95	85	85	104	136	98
Derrimut	-	87	71	100	99	-	89
Espada	104	101	76	105	-	-	97
Estoc	100	105	-	-	-	-	103
Frame	-	94	88	94	83	95	91
Gladius	90	91	83	91	112	103	95
Guardian	-	100	71	87	96	120	95
Lincoln	102	96	78	-	-	-	92
Mace	99	89	80	-	-	-	89
Scout	103	102	-	-	-	-	103
Wyalkatchem	85	87	78	88	102	115	92
Yitpi	100	100	100	100	100	100	100
Young	-	84	61	95	96	111	89
Yitpi (t/ha)	**4.04**	**4.01**	**4.10**	**2.48**	**2.21**	**0.98**	**2.76**

The varieties tested at Witera and Elliston were selected to be the best bet option. For more extensive options and details on any variety characteristics visit the National Variety Trials (NVT) website at www.nvtonline.com.au or refer to the NVT Cereal Performance Tables and the Cereal Variety Disease Guide.

Acknowledgements

Thanks to Craig Kelsh and Nigel and Debbie May for the use of their land.

Achieve – registered trademark of Crop Care, Spray Seed – registered trademark of Syngenta, TriflurX – registered trademark of Nufarm, Lorsban – registered trademark of Dow Agrowsciences, Dimethoate – registered trademark of Nufarm, BromicideMA – registered trademark of Nufarm, Broadstrike – registered trademark of Dow Agrosciences, Lontrel – registered trademark of Dow Agrowsciences and Chemwet 1000 – registered trademark of Nufarm.

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Viterra wheat trials at Witera

Josh Hollitt
Viterra, Streaky Bay

RESEARCH

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Location:
Witera
Craig and Len Kelsh
Port Kenny and Viterra
Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2011 Total: 454 mm
2011 GSR: 280 mm
Yield
Potential: 5.0 t/ha (W)
Actual: 4.5 t/ha (W)
Paddock History
2010: Medic pasture
2009: Keel barley
Soil Type
Clay loam over red brown earth
Soil Test
0-10 cm, deep N and root disease
Diseases
Leaf rust
Plot Size
10 m x 1.8 m x 3 reps
Yield Limiting Factors
Dry September
Water Use efficiency
15 kg/mm/ha

Key messages

- **Post emergent N applied to wheat did not give an economic return in this trial.**
- **Consider trialling premium wheat seed treatments.**
- **Seed treatment Veteran Plus (180 g/L imidacloprid + 6.25 g/L flutriafol) gave the best net return on investment ($32/ha) compared to the untreated control.**
- **Baytan T ($27/ha) and Dividend + Emerge ($24/ha) seed treatments also gave respectable net returns.**

Why do the trial?

New cereal seed treatments and post emergent applications of N were examined at Witera. Each wheat trial was designed to observe yield, grain quality and vigour differences; one from the application of different seed dressings and the other from applying post emergent N at various rates and timings. Both trials focused on the net return on investment from each treatment.

Trials at Witera were designed to complement the existing research and development occurring on the upper Eyre Peninsula while keeping in line with district agronomic practices.

How was it done?

The wheat seed treatment trial was sown on 11 May (Scout) at 75 kg/ha, with 90 kg/ha DAP applied at sowing and 90 kg/ha urea applied on 8 July. Measurements included plant vigour, plant counts along with grain yield and quality. Treatments included Veteran C (1 kg/t), Premis Protect (1.5 L/t), Veteran Plus (4 L/t), Hombre (4 L/t), Baytan (1.5 L/t), Dividend (1.3 L/t) + Cruiser Opti (1.65 L/t), Dividend (1.3 L/t) + Emerge (1.2 L/t).

The wheat post emergent N trial was sown on 11 May, with 90 kg/ha DAP applied at sowing. Yield and grain quality measurements were recorded. Treatments included 3 different rates (50, 100 and 150 kg/ha urea) and 2 different timings of application (GS32 and GS39, or second node and flag leaf fully emerged).

What happened?

The economic benefit of applying various seed treatments to Scout wheat varied depending on the seed treatment used. The difference in yield between treatments was not significant, however the difference in the net return over the untreated control is worth noting.

Veteran Plus recorded the highest net return ($32/ha) over the untreated treatment, while Baytan ($27/ha) and Dividend + Emerge ($26/ha) also recorded reasonable net returns.

None of the various post emergent N treatments applied gave an economic return over the untreated control (Table 2). This result reinforces the importance of understanding stored soil N and soil moisture along with yield potential when considering post emergent N applications.

What does this mean?

The inclusion of seed treatments can provide a small economic return. The likely reasons for this are improved seedling vigour, early season rust and/or other disease control in combination with good agronomy and favourable growing conditions. The differences in net return ($/ha) between seed treatments may have been less with lower yields; however it may be worth trialling one of the better performing seed treatments in order to assess any differences on a larger scale.

When considering post emergent N applications it is important to use visual symptoms of N deficiency to assist decision making. The trial displayed no visual signs of N deficiency at the time of application and subsequently the results showed there was no economic benefit from applying post emergent N. It is also important to consider applied and stored soil N levels, along with plant available water and yield potential when determining the economic benefit of post emergent N.

Table 1 Yield (t/ha) and net return ($/ha) of Scout wheat by seed treatment

Treatment	Rate (ml/100 kg)	Yield (t/ha)	Cost ($/ha*)	Net return over untreated ($/ha)
Untreated		4.64	$0.00	0.0**
Veteran C	100	4.66	$1.60	2.40
Premis Protect	150	4.65	$3.50	-1.50
VeteranPLUS	400	4.84	$7.50	32.50
Hombre	400	4.74	$6.80	13.20
Baytan	150	4.79	$2.70	27.30
Dividend + Emerge	130+120	4.80	$6.60	26.40
Dividend + Cruiser Opti	130+165	4.89	n/a	n/a
LSD (P=0.05)		*0.62 (ns)*		

**Note: cost ($/ha) of seed treatment is based on a sowing rate of 75 kg/ha*
***Net return ($/ha) over untreated: (yield x price ($200/t) – cost/ha) – (untreated yield x price)*

Table 2. Yield (t/ha) and net return ($/ha) of Scout wheat by post emergent N treatments

Treatment	Urea rate (kg/ha)	Timing (growth stage)	Yield (t/ha)	Net Return over untreated ($/ha*)
1 *untreated*	0		4.84	0
2	50	GS32	4.81	-44
3	100	GS32	4.78	-83
4	150	GS32	4.94	-83
5	50+50	GS32+GS39	4.60	-123
6	50	GS39	4.67	-71
7	100	GS39	4.87	-65
LSD (P=0.05)			*0.48 (ns)*	

**Note: net return ($/ha) over untreated: (yield x price ($200/t) – N rate x $1.41/kg N – $5/ha spreading cost) – untreated yield x price*

Acknowledgements

Thanks to Craig and Len Kelsh for providing the land to conduct the trials and for all their help throughout the year. Thanks to Leigh Davis and Brenton Spriggs for managing the trials. Thanks to those within Viterra who assisted with the trial program, in particular Clint McEvoy and the team at Viterra, Streaky Bay.

Veteran C, Premis Protect and Veteran Plus – registered trademark of CropCare
Hombre and Baytan - registered trademark of Bayer Crop Science
Dividend and Emerge - registered trademark of Syngenta

Wheat variety response to P on grey calcareous soil

RESEARCH

Cathy Paterson, Wade Shepperd and Ian Richter
SARDI, Minnipa Agriculture Centre

Searching for Answers

Location:
Nunjikompita
Tim Howard
Rainfall
Av. Annual: 306 mm
Av. GSR: 212 mm
2011 Total: 345 mm
2011 GSR: 221 mm
Yield
Potential: 2.8 t/ha (W)
Actual: 1.6 t/ha (Yipti - 4 units P/ha)
Paddock History
2010: Pasture
2009: Wheat
2008: Wheat
Soil Type
Grey calcareous sandy loan
Soil Test
Cowell P, mineral N
Plot Size
12 m x 4 reps
Yield Limiting Factors
Grass weed competition
Dry spell Aug - Sept

Key messages

- **Axe, Wyalkatchem and Gladius appear to be the wheat varieties that use added P efficiently.**
- **Scout is able to maintain yield when no P is added.**

Why do the trial?

Previous research has shown that there is considerable variation in the phosphorus use efficiency (PUE) among varieties of wheat (EPFS Summary 2009, pp 37-38). In trials conducted last year at Mudamuckla (EPFS Summary 2010, pp 117-119) there was no response to the addition of P fertiliser in any of the wheat varieties tested.

This trial has been repeated in 2011 to explore the variation of PUE among varieties of wheat across a range of seasons in order to provide farmers with better knowledge of their current varieties. This information can be used to select varieties which have a lesser requirement for P fertiliser addition or to develop fertiliser management plans that respond to the P fertiliser requirement of different varieties.

How was it done?

A replicated trial was established at Nunjikompita on 6 May on a grey calcareous sandy loam. Six varieties of wheat were grown at 2 rates of phosphoric acid (4 and 10 kg P/ha) and 2 rates of granular fertiliser (7 and 14 kg P/ha). Nil P was used as a control treatment and N was balanced at 15 kg N/ha on all treatments. All varieties were sown at a calculated density of 150 seeds/m^2.

Measurements taken during the year included; soil chemical analysis, plant establishment, dry matter at GS 31 and anthesis (flowering), grain yield and grain quality. All plots received standard weed management.

What happened?

Soil tests taken before sowing showed Colwell P level of 38 mg/kg, a pH of 8.5 (in H_20) and mineral N levels of 55 kg/ha (0-60 cm). All varieties showed a dry matter response to P at GS 31 (Figure 1), with Axe showing the greatest response. Axe continued to show a greater response to applied P at anthesis (Figure 2) and Gladius and Scout had increased biomass in response to increased P.

Axe, Gladius and Wyalkatchem all showed a yield increase to added P (Figure 3), while Scout was not responsive to the addition of P fertiliser. The addition of P did not make any difference to grain quality with test weights, protein and screenings percentages all similar within each variety (not reported).

What does this mean?

The response to P shown by all varieties supports the findings from the 2009 trials that there is significant variation between varieties in terms of PUE. The interpretation of these results will depend on how PUE is defined. If you define PUE as a crop being able to maintain yield when no P is added, Scout would be the variety of choice. Conversely if PUE is defined as the ability of the crop to respond to added P, then Axe followed by Wyalkatchem and Gladius are the more phosphorus efficient varieties.

More work is needed to fully understand the reasons for the differences in PUE, which would allow more specific characteristics of plant growth to be targeted by plant breeders going forward.

Acknowledgements

Thank you to GRDC for providing the funds for this project (UA00107). Thanks to the Howard family for allowing us to have this trial on their property and thanks to Therese McBeath and Nigel Wilhelm for their advice throughout the year.

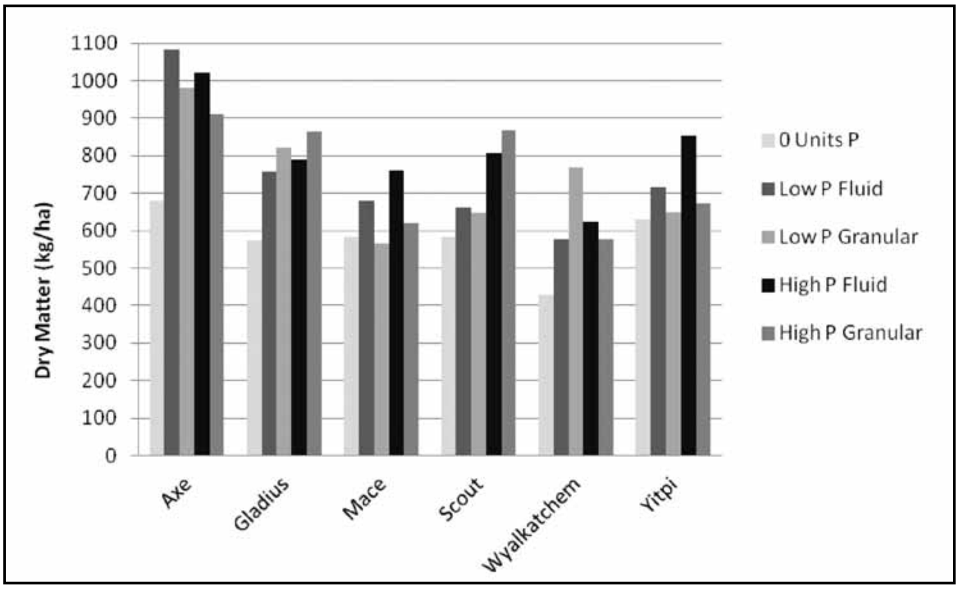

Figure 1 Wheat dry matter response to P at GS 31, 2011

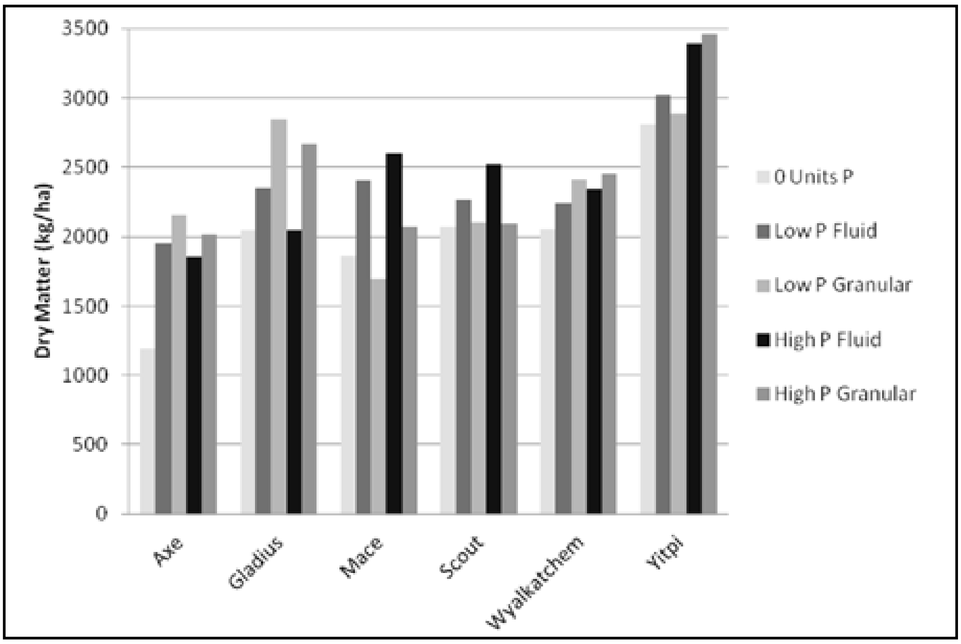

Figure 2. Wheat dry matter response to P at anthesis, 2011

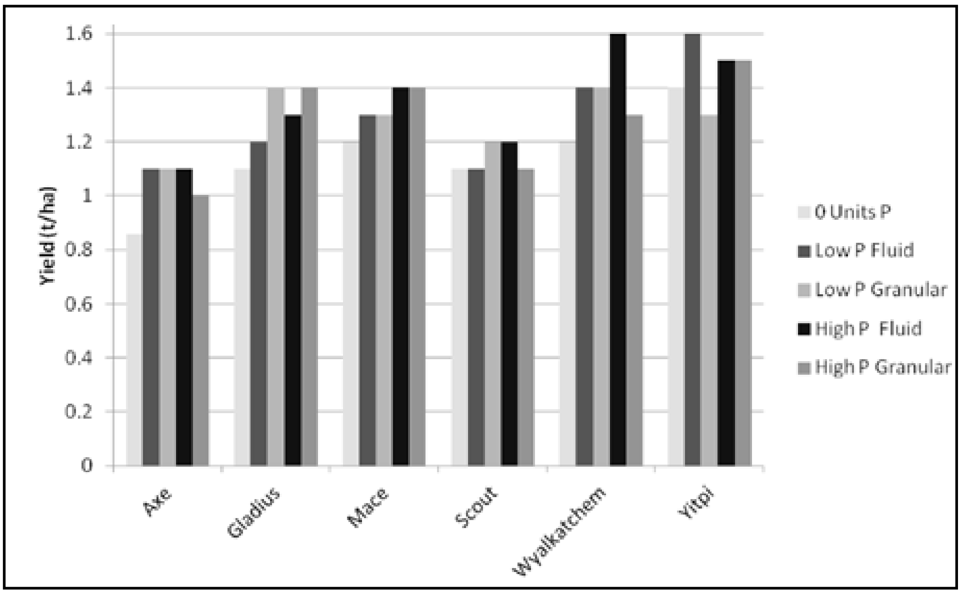

Figure 3. Wheat yield response (t/ha) to P, 2011

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Understanding the risk of heat stress: what do we know about the likelihood and consequence?

Bronya Alexander[1], Peter Hayman[1] and Glenn McDonald[2]
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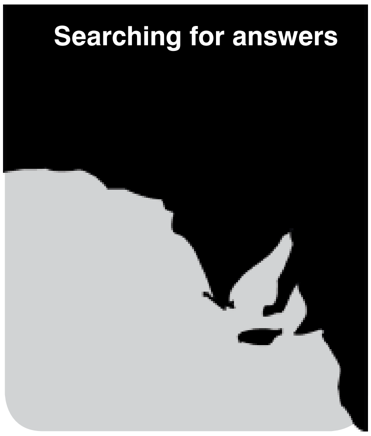

Key messages

- **When considering the time of flowering it is apparent that a warmer, low rainfall location like Minnipa (flowering in September) may have less risk of heat events than a medium rainfall region like Roseworthy (flowering later in October).**
- **A purpose built chamber was able to function well in the field and heat the enclosed air to 35°C.**
- **More work is needed to quantify the impact of hot days on wheat yields.**

Why do the trial?

High temperatures during spring have long been recognised as one of the weather risks for grain farmers in southern Australia, particularly if they occur around crop anthesis. Risk is defined as the likelihood x consequence. Therefore to investigate the risk of heat stress we look at the likelihood by considering the climatology (chance of getting high temperatures in the climate records) and the consequence by reproducing heat events in the field using a purpose built chamber.

Spring heat events in the SA grain belt are due to a northerly flow of air associated with a passing high pressure system to the east of the region and an approaching cold front to the west (Figure 1).

Background

There has been an increase in the average number of hot days (>35°C) for Australia since digitised temperature records from 1957 (http://www.bom.gov.au/cgi-bin/climate/change/extremes/timeseries.cgi). Minnipa and Roseworthy are consistent with this trend having set recent records in the number of days over 30, 35 and 37°C. Minnipa has more hot spring days than Roseworthy. Table 1 shows that between 15 September and 24 November there is an equal or higher chance of getting a hot day at Minnipa than Roseworthy. However, when assessing the risk of heat stress on crops, flowering must be considered. Wheat crops at Minnipa would commonly flower mid-September, whereas most crops at Roseworthy flower around mid-October. The earlier flowering at Minnipa is due to warmer growing conditions and also variety choice to match spring moisture availability. At Roseworthy not only are there advantages of a longer growing season, early flowering has an unacceptable frost risk. The chance of getting over 30°C at Minnipa around 15 September is only 0.2% compared to 1.2% at Roseworthy on 15 October, suggesting Roseworthy crops are at higher risk of heat stress at flowering than Minnipa. Late sown crops in a mild year could still be flowering into November at Roseworthy, but hot November temperatures in Minnipa are aiding harvest. Table 1 also highlights the increase in heat stress risk as flowering becomes later.

How was it done?

We wanted to investigate whether we could show any affect on field wheat yield after just one hot day. To do this we required 4 main components: the chamber, heater, thermostat control and monitoring equipment.

- The chamber, with dimensions of 1.5 x 0.5 x 1.2 m (L x W x H), was constructed with Standard-Clear-Greca polycarbonate sheeting ($200-$300 per box) which blocks most UV radiation (200 to 400 nm) and has a very high (90%) and uniform transmittance between 400 and 1600 nm. An adjustable lid was also constructed which allowed some air flow in/out due to the corrugation of the polycarbonate. Each chamber enclosed two rows of wheat for a length of 1.5 m.
- The heating was provided by a standard 1200 W fan heater ($20), powered in the field by a generator.
- We used a commercially available control thermostat (Carel) that allowed temperature control to 0.1°C. The thermostat, attached to a power board (total $560), controlled the heater.
- Temperature and humidity inside the box was monitored at 5 minute intervals using a TinyTag Ultra2 temperature and humidity logger ($470) placed inside a small Stevenson type screen ($70) and hung from the centre of the chamber just below canopy height.

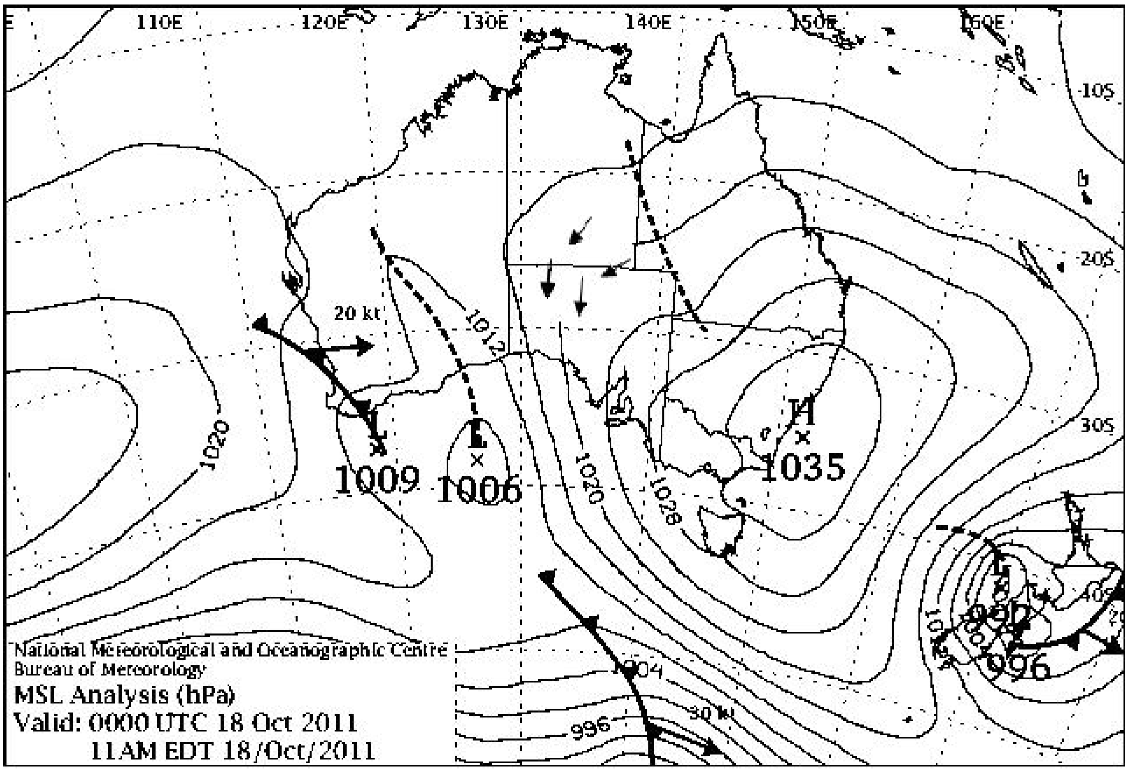

Figure 1 Mean Sea Level Pressure chart for 18 October 2011. Arrows show the northerly direction of winds affecting SA due to the high pressure cell (H) to the right. The recorded maximum temperature on this day was 36°C in Minnipa, Eyre Peninsula.

Field trials were conducted at the Waite Campus, Urrbrae (6 km south of Adelaide), during the 2009 (Figure 2) and 2010 seasons, and at Roseworthy during 2011. Each plot was heated for just a single day during the season, around anthesis. The thermostat control was used from 10am to slowly increase the temperature to a maximum of 35°C at midday, and maintained for 3 hours before being allowed to decrease steadily back to ambient temperature by 5pm when the chambers were removed.

What happened?
The TinyTag measurements inside the heat chambers showed that temperatures during the day of heating successfully reached 35°C as intended (Figure 4). In the first year of the experiment (2009) we measured losses of around 20%. In the second year the overall trend was for the most sensitive period to be the relatively small window between ear emergence and the start of flowering. Although the average of the heated treatment was about 10% less than the average of the unheated control, the plot to plot variability was too high for this to be statistically significant. Last year we did not find any differences between the heated and control plots.

What does this mean?
There is plenty of evidence from other researchers and farmer experience that hot spring weather is damaging to crop yields. In some cases researchers have subjected wheat to prolonged and extreme heat whereas in this trial we were trying to mimic the effect of a single spring day that was hot (35°C for three hours) but not extreme (12 October 2004 was over 40°C in parts of the Mallee).

Possible reasons for our results not showing an impact in two of the three years include:

- The single day of heating (with 35°C for three hours) may not have a damaging impact on the crop.
- Other factors such as soil moisture at the time of the event and conditions in the weeks leading up to or following the heat event may be major factors influencing the level of damage.
- The heat chamber may not accurately mimic the heat event in the field.
- In each year the treatments were applied in the weeks prior to and just after flowering. However the time of the crop stage when the heat is applied might be so critical that small differences in the timing of the heating influenced the results.

It is difficult to define a clear relationship between air temperature and crop damage due to other factors such as crop stage and soil moisture. In low rainfall farming regions, the use of early sowing and quick varieties seem to be sound ways to escape moisture stress and heat stress. This strategy will only work in areas where late frosts are rare. Where frost risk is higher there is a complex trade-off between risks of frost, heat and moisture stress.

Acknowledgements
This work has been part of the Managing Climate Variability funded project “Assessing and managing heat stress in cereals”.

Table 1 The chance (%) of getting a maximum temperature of 30, 35 or 37°C at least once during a 10 day window centred on the given date between 15 September and 24 November. Probabilities are for Minnipa (left side of column; M) and Roseworthy (R), South Australia, 1957-2009

Temp (°C)	15 Sept		25 Sept		5 Oct		15 Oct		25 Oct		4 Nov		14 Nov		24 Nov	
	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R
30	3.6	0.7	7.6	2.7	12	5.2	16	8.7	24	15	28	18	35	27	41	33
35	0.2	0.0	1.1	0.0	1.9	0.4	3.5	1.2	5.7	2.9	8.4	5.0	13	9.6	18	14
37	0.0	0.0	0.0	0.0	0.7	0.2	1.7	0.5	2.8	0.7	4.6	2.2	7.5	4.5	11	8.0

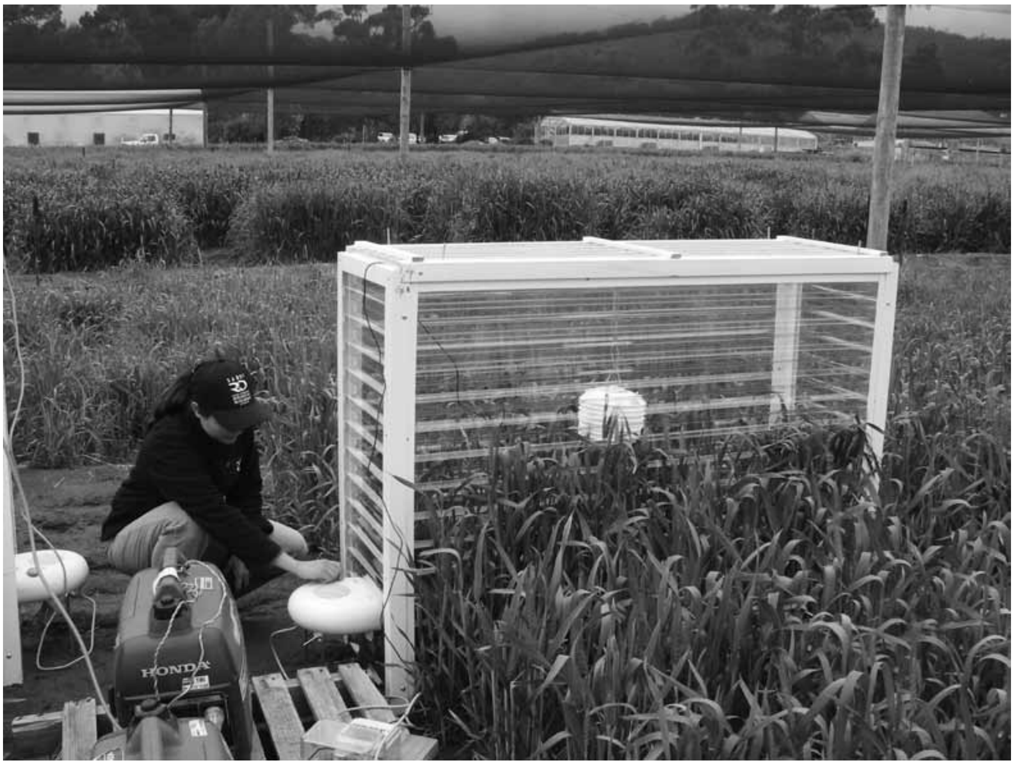

Figure 2 Chamber set up in the field over two rows of wheat, showing a heater at the bottom and TinyTag in a Stevenson screen hanging at canopy height within the chamber

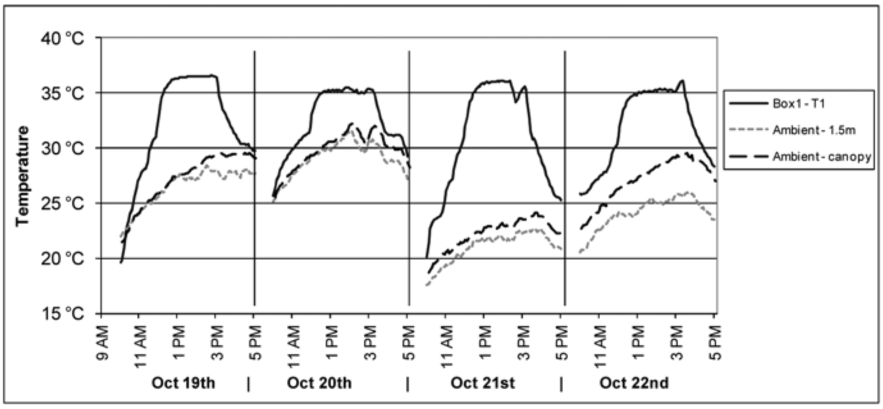

Figure 3 Temperature at crop canopy height in a heat chamber (Box 1-T1) exposed to high temperatures during post anthesis stage. Ambient air temperature was taken at the edge of the plots at 1.5 m height, and at canopy height in non-treated crops. The chamber was placed over a different plot on 4 consecutive days, 19-22 October 2009

RESEARCH

Beating the heat - impact of heat stress on some current wheat varieties

Dion Bennett, Haydn Kuchel, Jason Reinheimer and James Edwards
Australian Grain Technologies, Roseworthy Campus

Searching for Answers

Key messages

- **There has been a poor understanding of the magnitude of the impact of heat stress on bread wheat production in southern Australia and the level of variation for heat stress tolerance in current varieties.**
- **A study of previous field trial and climatic data revealed each degree rise in average maximum temperature during grainfill resulted in a 370 kg/ha lower grain yield and each day greater than 40 degrees lowered grain yield by up to 840 kg/ha.**
- **To screen for heat stress tolerance, without other confounding effects (such as drought, maturity or disease), we developed a novel controlled environment assay, capable of exposing plants to hot, dry winds, similar to those routinely experienced in southern Australia during the spring growing season.**
- **This assay has improved our understanding of how different varieties respond to heat stress and the levels of variation within these responses and will be a useful tool for screening large numbers of lines needed to identify those with levels of tolerance that can be incorporated into future varieties.**

Why do the trial?

It is well documented that heat stress has a negative impact on grain yield in wheat. However, the precise impact on production in southern Australia has not been extensively examined; nor has the level of tolerance currently available to farmers through commonly grown varieties.

While it is clear to growers that heat stress has a severe negative impact on grain yield, can growers minimise this impact by growing varieties that are potentially more tolerant to this stress? Development of a controlled environment assay that is high throughput, repeatable and representative of southern Australian field conditions would greatly aid in the identification of more heat tolerant varieties through minimising the confounding effects that may be present in field assessments, such as disease, drought and differences in maturity.

How was it done?

Grain yield data from the AGT advanced trial network, grown in yield plot trials at approximately 45 sites across Australia was combined with relevant climatic data from the nearest available Bureau of Meteorology station. All trials were sown, managed and harvested in accordance with best local practices. Various climatic variables derived from the weather data were regressed against grain yield to identify those having a significant impact on production. The same strategy was taken for analysis of data from southern Australian National Variety Trials (NVT).

Development of the controlled environment assay set up involved a 1 m diameter, 7.5 kW fan pushing air through recirculating ducting (900 x 900 mm) and across the fins of nine 'W' shaped elements and into a Perspex enclosed chamber, where plants were placed during treatment. Varieties studied were the same as those in the field trials and were grown as single plants in each pot. Plants of each variety were heat stressed 10 days after flowering and kept well watered throughout the experiment. Measurements included the number of fertile grains per head, grain size, biomass production, flag leaf size and leaf damage in response to heat treatment.

What happened?

A study of trial average grain yield data and a number of climatic variables from over 600 trial by year combinations across southern Australia from 2005 to 2010 identified that high temperature indeed had a large effect on grain yield, particularly around the flowering growth stage (Table 1). Each millimetre of rainfall received during flowering and grainfill periods resulted in an increase in grain yield of 22 kg/ha (similar to what the Finlay-Wilkinson model predicts), whilst the impact of hotter average temperatures and the number of 'hot' and 'very hot' days also resulted in a significantly ($P<0.001$) lower grain yield for that trial. Data on climatic variables for each trial was kindly provided by Dr Scott Chapman and Dr Bangyou Zheng, CSIRO Plant Industry.

Table 1 Effect of various climatic variables on grain yield across more than 600 field trials in southern Australia 2005-2010. Average grain yield across all trials was 2530 kg/ha.

Growth Stage	Climatic Variable	Unit	Effect (kg/ha)
Flowering	Rainfall	mm	22
	Av. daily min	°C	-161
	Av. daily max	°C	-371
	Days > 30 degrees	number	-379
	Av. temp	°C	-490
	Days > 40 degrees	number	-837
Grainfill	Rainfall	mm	23
	Av. daily min	°C	-125
	Days > 30 degrees	number	-130
	Days > 40 degrees	number	-179
	Av. daily max	°C	-225
	Av. temp	°C	-244

The controlled environment heat stress assay that was developed generally had a negative effect on the number of fertile grains per head and grain size over the varieties tested (Figure 1), with a number of different responses observed. Varieties such as Excalibur and Correll maintained the number of fertile grains per head but the heat stress treatment reduced their capacity to fill grain. Varieties including Magenta, Wyalkatchem and Kukri suffered similar proportions of loss of the number of fertile grains per head and grain size, whilst H45 and Halberd did not suffer significant reductions in either of these traits. The fourth response was where the line suffered a loss of the number of fertile grains per head but as a result, was able to achieve a similar or even greater grain size than the control plant. Varieties in this group included RAC875 (major parent of Axe, Gladius and Correll) and Mace. The latter two responses would be more desirable in varieties, particularly the H45/Halberd response of minimal loss in response to heat stress.

The Heat Response Index, which incorporated the reduction in spike fertility and grain size in both the primary tiller and secondary tillers at the flowering growth stage in the assay, accounted for a highly significant (P<0.001) percentage of grain yield when regressed against performance across both AGT field trials and NVT trials in southern Australia over the last 5 seasons. A second trait, flag leaf damage, caused by heat and wind, also accounted for a significant proportion of grain yield across the same field trial data sets. A summary of the heat response index values and flag leaf damage scores for a range of varieties are presented in Table 2.

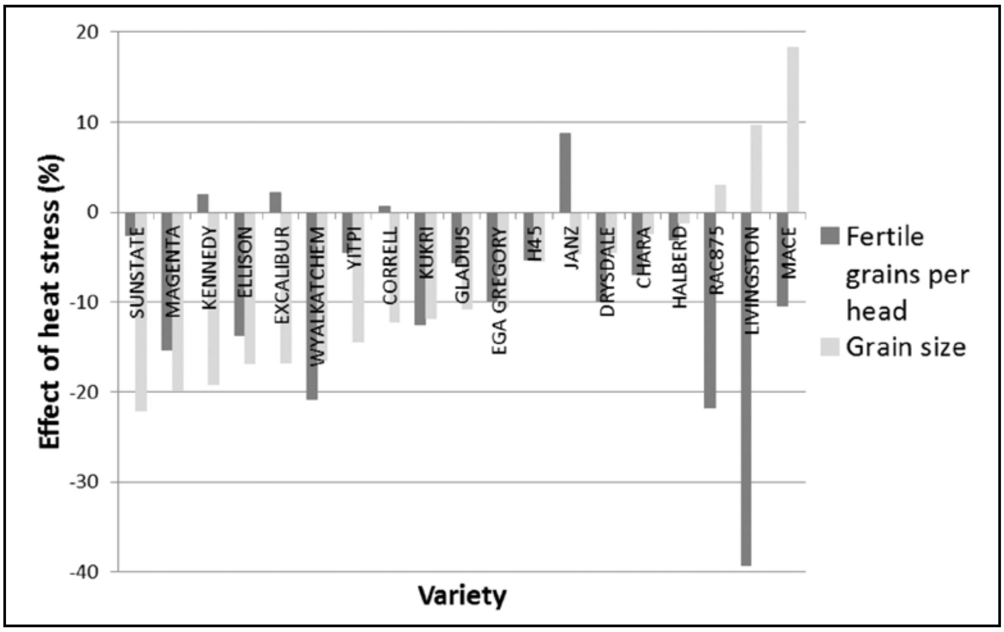

Figure 1 The response of the number of fertile grains per head and grain size of 19 varieties to a controlled environment heat stress treatment at 10 days after flowering

Table 2 The Heat Response Index and leaf damage scores for 19 varieties to a controlled environment heat stress treatment

Variety	Heat Index	Leaf Damage
Mace	-1.5	3.5
Gladius	0.0	3.6
Correll	0.5	4.0
Halberd	5.3	2.0
Excalibur	6.0	6.7
Magenta	7.3	5.8
Janz	7.5	3.8
Drysdale	8.8	7.7
H45	8.9	3.9
RAC875	9.1	3.4
Wyalkatchem	10.4	4.4
Yitpi	13.7	2.8
Chara	14.3	4.8
Kennedy	14.9	5.4
EGA Gregory	15.0	5.0
Sunstate	15.4	8.4
Kukri	17.5	5.4
Ellison	18.1	4.6
Livingstone	26.6	4.0
LSD (P<0.05)	*4.82*	*0.64*

What does this mean?

Heat stressed trials were lower yielding, particularly when the stress occurred during the sensitive flowering period.

Previous studies of the effect of heat treatment on Australian and international germplasm, most of which are more than 20 years old, found significant variation between varieties. Our study of more recent varieties has confirmed significant amounts of variation exist within locally adapted varieties. We have also identified 4 distinct responses to heat stress amongst the varieties assessed in our assay, which will aid in understanding variety response to heat stress in the field.

The Heat Response Index accounted for a significant amount of yield variation in field trials across southern Australia and therefore in the future, it could have value in assisting with identifying germplasm with superior heat stress tolerance.

Future research includes the development of suitable populations to improve our understanding of the genetic control of heat stress tolerance. This will enable targeted breeding for varieties with improved heat stress tolerance in the future.

Acknowledgements

Funding assistance from the South Australia Grains Industry Trust (SAGIT) is gratefully acknowledged. Thanks also to Mr Phil Keatley and Mr Jake Schutz for assistance with design and construction of the heat chamber.

AGT Australian Grain Technologies SEEDS FOR SUCCESS

SAGIT

Section 2

Section Editor:
Amanda Cook
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Break Crops

The 2011 production figures for Upper Eyre Peninsula were 10,500t of peas, 6,200t of lupins, 150t of beans and 17,700t of canola. Lower Eyre Peninsula produced approximately 8,000t of peas, 26,000t of lupins, 8,000t of beans and 104,000t of canola.

[PIRSA Crop & Pasture Report SA, January 2012]

Field pea variety trial yield performance 2011
(as a % of site mean) and long term (2005-2011) average across sites (as % of site mean)

	Lower Eyre Peninsula				Upper Eyre Peninsula		
Variety/Line	**2011**		**2005-2011**		**2011**	**2005-2011**	
	Lock*	**Yeelanna**	**% Site mean**	**Trial #**	**Minnipa**	**% Site Mean**	**Trial #**
Kaspa	63	93	96	13	107	103	6
Parafield	69	91	93	13	89	97	6
PBA Gunyah	101	87	100	11	92	101	5
PBA Twilight	130	97	97	10	92	102	5
PBA Oura	100	111	105	10	101	104	6
PBA Percy	86	76	104	4	91	104	4
Sturt	-	-	102	7	103	107	6
Yarrum	64	89	98	13	110	104	6
Site mean yield (t/ha)	**0.93**	**2.59**	**1.81**		**1.88**	**1.74**	
LSD (P=0.05) as %	*22*	*11*			*17*		
Date sown	14/5	2/6			18/5		
Soil Type	S	LSCL			L		
Previous Crop	Wheat	Wheat			Barley		
Rainfall (mm) J-M/A-O	93/212	102/297			129/252		
pH (H_2O)	7.4	7.7			8.2		
Site stress factors	fr, dl	wl			ht, pm		

* = Variable and low yield dual to severe reproductive frost, use caution.

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

Site stress factors: dl = post flowering moisture stress, fr = reproductive frost damage
wl = waterlogging, ht = high temperatures during flowering/pod fill, pm = powdery mildrew

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

EP Faba Bean Variety Trial Yield Performances

2011 and predicted regional performance, expressed as % of site yield

	Lower Eyre Peninsula				Upper Eyre Peninsula			
Variety	**2011**	**Long term average across sites**			**2011**	**Long term average across sites**		
	Cockaleechie (as % site mean)	**t/ha**	**% Site Mean**	**# Trials**	**Lock (as % site mean)**	**t/ha**	**% Site Mean**	**# Trials**
Doza	95	2.23	95	8	NO VALID RESULTS TRIAL FROSTED			
Farah	90	2.34	99	10		1.64	100	3
Fiesta	86	2.36	101	10		1.65	100	3
Fiord	98	2.32	99	9				
Nura	99	2.34	100	10		1.63	99	3
PBA Rana	95	2.19	93	7				
Site av. yield (t/ha)	**3.45**	**2.35**				**1.65**		
LSD (P=0.05) as %	*12*							
Date sown	6 May				14 May			
Soil Type	CLS				S			
pH (water)	8.5				7.4			
Rainfall J-M/A-O (mm)	102/297				93/212			
Previous Crop	Barley				Wheat			
Site stress factors					f			

Abbreviations
Soil Types: S=sand, C=clay, L=loam
Site stress factors: f = frost
Data source: SARDI/GRDC, NVT and PBA - Australian Faba Bean Breeding Program.
2005-2011 MET data analysis by National Statistics Program

SA Lupin Variety Trial Yield Performances

2011 and predicted regional performance, expressed as % of site yield

	Lower Eyre Peninsula				Upper Eyre Peninsula			
Variety	**2011**	**Long term average across sites**			**2011**	**Long term average across sites**		
	Ungarra	**t/ha**	**% of Site Mean**	**# Trials**	**Tooligie**	**t/ha**	**% of Site Mean**	**# Trials**
Coromup	99	1.90	102	12	103	1.91	98	5
Jenabillup	107	2.00	107	10	113	2.01	103	4
Jindalee	87	1.61	86	13	102	1.80	92	5
Mandelup	98	1.96	105	13	99	1.96	101	5
PBA Gunyidi	102	1.96	105	6	95	2.00	103	3
Wonga	100	1.80	96	12	89	1.89	97	5
Site av. yield (t/ha)	**2.28**	**1.87**			**1.31**	**1.95**		
LSD (P=0.05) as %	*14*				*15*			
Date sown	10 May				16 May			
Soil Type	S				S			
pH (water)	5.7				7.8			
Rainfall J-M/A-O (mm)	104/243				132/285			
Previous Crop	Wheat				Wheat			
Site stress factors					h			

Abbreviations
Soil types: S=sand
Site stress factors: h = hail

Data source: SARDI/GRDC & NVT
2005 - 2011 MET data analysis by National Statistics Program

SA Chickpea Variety Trial Yield Performance on Eyre Peninsula

2011 and Long term (2005-2011) yields expressed as % of site mean yield

Variety	LOWER EYRE PENINSULA			
	2011		2005-2011	
	Lock	Yeelanna	% Site mean	Trial #
Desi trials	NO VALID RESULTS TRIAL FROSTED			
Genesis 509			93	5
Genesis 079#		101	102	4
Genesis 090#		90	94	6
Howzat			98	6
PBA Boundary				
PBA HatTrick			93	4
PBA Slasher		98	103	6
Sonali			97	4
Site mean yield (t/ha)		**2.69**	**1.88**	
LSD (P=0.05) as %		7		
Kabuli trials		NO VALID RESULTS WATER LOGGING		
Almaz			92	6
Genesis 079#			118	6
Genesis 090#			109	6
Genesis 114			89	6
Kalkee (Genesis 115)			89	2*
Site mean yield (t/ha)			**1.35**	
LSD (P=0.05) as %				
Date sown	14 May	2 June		
Soil Type	S	LSCL		
Rainfall (mm) J-M/A-O	93/237	102/297		
pH (H_2O)	7.4	7.7		
Previous Crop	Wheat	Wheat		
Site stress factors	fr, pe	wl		

 # Small kabuli type

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

***Site stress factors:** pe = poor establishment, wl = waterlogging, fr = reproductive frost damage*

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

****Varieties have only had limited evaluation at these sites, treat results with caution***

Lentil variety trial yield performance 2010

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

Variety	LOWER EYRE PENINSULA		
	2011	2005 - 2011	
	Yeelanna	% site mean	Trial #
Aldinga	NO VALID RESULT - TRIAL WATERLOGGED	89	6
Boomer		100	6
Nipper		96	7
Northfield		85	7
Nugget		95	7
PBA Blitz		104	5
PBA Bounty		100	7
PBA Flash		105	7
PBA Herald XT		92	3
PBA Jumbo		103	6
Site mean yield (t/ha)		**1.48**	
LSD (P=0.05) as %			
Date sown	2/6		
Soil Type	LSCL		
Rainfall (mm) J-O/A-O	102/297		
pH (H_20)	7.7		
Previous Crop	Wheat		
Site stress factors	wl		

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

***Site stress factors:** wl = temporary waterlogging*

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

Long Term early maturing canola 2005 - 2011

Varieties	Upper Eyre Peninsula	
Conventional	% mean	# Trials
AV Garnet	118	4
CB Agamax	107	2
Hyola 433	116	3
Hyola 50	114	5
Tarcoola	99	4
Xceed Oasis CL	73	2
Site mean (t/ha)	**1.35**	
Triazine tolerant		
ATR Cobbler	106	4
ATR Snapper	114	2
ATR Stingray	117	2
CB Junee HT	116	2
CB Mallee HT	104	2
CB Scaddan	100	3
CB Tanami	101	3
CB Telfer	96	4
Tawriffic TT	105	4
Site mean (t/ha)	**1.35**	

Long Term mid maturing canola 2005 - 2011

Varieties	Lower Eyre Peninsula	
Conventional	% mean	# Trials
AV Garnet	111	12
AV Zircon	98	2
CB Agamax	102	4
Hyola 433	108	6
Hyola 50	111	12
Victory V3001	98	2
Site mean (t/ha)	**1.90**	
Clearfield		
Hyola 571CL	98	2
Hyola 575CL	105	4
Pioneer 43C80 CL	93	2
Pioneer 43Y85 CL	94	2
Pioneer 44C79 CL	91	4
Pioneer 44Y84 CL	105	8
Pioneer 45Y82 CL	100	6
Pioneer 46Y78	99	8
Pioneer 46Y83 CL	108	6
Site mean (t/ha)	**1.91**	
Triazine tolerant		
ATR Cobbler	103	10
ATR Gem	116	2
ATR Snapper	111	4
ATR Stingray	114	4
CB Henty HT	130	2
CB Jardee HT	114	7
CB Junee HT	113	3
CB Mallee HT	103	5
CB Scaddan	97	8
CB Tumby HT	104	4
Crusher TT	125	4
Fighter TT	108	2
Hyola 444TT	106	2
Hyola 555TT	125	4
Hyola 751TT	113	4
Monola 506 TT	93	2
Monola 605 TT	100	2
Monola 707 TT	89	2
Monola 76TT	99	8
Monola 77TT	99	8
Tawriffic TT	103	10
Thumper TT	122	4
Site mean (t/ha)	**1.64**	

Data source: *NVT & SARDI / GRDC (long term data based on weighted analysis of sites, 2005 - 2011)*

NVT Canola yield trials, 2011 yield as a % of site mean yield

Variety	Mt Hope	Yeelanna	Lock
AV - Garnet	103	105	111
AV Zircon	89	105	105
CB Agamax	110	99	101
Hyola 433	93	101	113
Hyola 50	111	100	114
SARDI515M			67
Site mean (t/ha)	**2.40**	**2.62**	**1.62**
LSD (P=0.05) as %	*14*	*8*	*12*
Hyola 474 CL	96	95	113
Hyola 575 CL	87	105	117
Pioneer 44Y84	111	101	117
Pioneer 45Y82	90	98	
Pioneer 46Y78	115	101	
Xceed Oasis CL			68
Pioneer 43Y85			99
Pioneer 44C79			94
Pioneer 43C80			88
Site mean (t/ha)	**2.41**	**2.53**	**1.49**
LSD (P=0.05) as %	*17*	*6*	*9*
ATR Cobbler	101	99	99
ATR Gem	99	110	106
ATR Snapper	104	107	110
ATR Stingray	100	102	112
Bonanza	79	84	
CB Henty HT	122	121	94
CB Jardee HT	116	115	
CB Junee HT	103	96	
CB Mallee HT	100	90	89
CB Scaddan	97	91	
Crusher TT	115	114	
Hyola 444 TT	93	98	115
Hyola 555 TT	107	112	122
Hyola 751 TT	107	103	
Monola 506 TT	83	84	
Monola 605 TT	86	94	
Monola 707 TT	72	88	
Monola 76 TT	95	89	
Monola 77 TT	89	93	
Tawriffic TT	89	92	98
Thumper TT	113	108	
CB Telfer			78
Site mean (t/ha)	**2.33**	**2.46**	**1.60**
LSD (P=0.05) as (%)	*13*	*9*	*19*
Date sown	5 May	5 May	11 May
Soil Type	LS	LSCL	SL
Rainfall J-M/A-O	78/336	96/297	145/248
pH (water)	5.2	7.7	6.7
Previous Crop	Wheat	Wheat	Barley
Site Stresses	dl		pe

Soil types: S=sand, C=clay, L=loam
Site stress factors: dl = dry late, pe = poor establishment
Note: All NVT 2011 canola trials were treated with fungicide

Data source: *NVT & SARDI / GRDC*

Data analysis by GRDC funded National Statistics Group

Brassica juncea and canola *(Brassica napus)* in low rainfall South Australia - trials over the past several years, blackleg and new varieties

RESEARCH

Trent Potter[1], Jack Kay[1] and Leigh Davis[2]

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

Try this yourself now

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 250 mm
2010 Total: 404 mm
2010 GSR: 252 mm
Yield
Potential: 2.72 t/ha (C)
Actual: 2.41 t/ha
Paddock History
2010:Barley
2009: Wheat
2008: Wheat
Soil Type
Brown loam
Plot size
10 m x 1.48 m x 3 reps

Location:
Lameroo
Rainfall
2011 Total: 558 mm
2011 GSR: 189 mm
Yield
Actual: 1.4 t/ha
Paddock History
2010: Wheat
Soil Type
Sandy loam
Yield Limiting Factors
Dry conditions during late grain fill

Key messages

- ***Brassica juncea* has the potential to be grown on a substantial area of low rainfall cropping country in South Australia with a likely area of up to 165,000 ha per year.**
- **Production may be expected to vary from year to year based on the timing of the seasonal break.**
- **Previous trials have shown that under low yield conditions, *B. juncea* can produce higher grain yields than canola.**
- **In the past two years with mild, wet conditions canola has performed relatively better than *B. juncea.***
- **We are starting to see more blackleg occurring in low rainfall regions as the area sown to canola increases. It is not yet enough to cause problems but we need to keep our eye on it.**
- **Even more canola varieties have been released that may be good options in low rainfall areas.**

1. *Brassica juncea* compared to *Brassica napus*

Why do this research?

Research into *Brassica juncea* in Australia has occurred over the past 25 years with the aim of developing an oil crop with equivalent oil quality to canola (Burton et al., 2003). *B. juncea* has many characteristics that should make it a viable crop in lower rainfall areas of Australia. These include good early vigour, early flowering, good blackleg tolerance, shatter tolerance and higher grain yields than canola when site yields are 1.2 t/ha or less. Both canola and *B. juncea* have ready acceptance by farmers in lower rainfall areas as both crops have been shown to fit into cropping rotations and act as disease break crops in cereal production (Potter et al., 1997; Angus et al., 1999). Interest in *B. juncea* in Australia centres around three uses: as a food crop equivalent to canola, as a condiment crop and also as a feedstock for biodiesel. The first canola quality *B. juncea* cultivars were commercialised in 2008 and have low erucic acid, low glucosinolates and oleic acid levels of greater than 60%. This paper outlines recent data comparing *B. juncea* with *B. napus* and discusses where *B. juncea* could be grown in South Australia.

How was it done?

A series of trials was sown at Lameroo and Minnipa in South Australia during 2008-2010. These trials included investigations into nitrogen application rates. Trials were successful at Lameroo in all years. Plot size was 8 m long by 8 rows at 15 cm row spacing. Three replications were used. The cultivars tested were 44C79 and OasisCL. Dry matter was measured during the growing season and also at harvest. Time of sowing trials were successfully conducted at Minnipa in 2009 and 2010 following drought in 2008. At both sites grain yield was determined by machine harvest.

What happened?

Seasons at Lameroo were characterised by a hot dry finish in 2008, high rainfall in 2009 and 2010, April to October rainfall being 168, 269 and 231 mm respectively. At Minnipa, drought in 2008 was followed by high rainfall in 2009 and 2010, April to October rainfall being 139, 333 and 386 mm respectively.

However, trials at Minnipa in 2010 were not sown until late May due to the late break.

At Lameroo, grain yields in the N application rate trials averaged 0.32, 0.75 and 0.83 t/ha in 2008-2010 respectively. Only in 2009 was there a significant response to nitrogen so mean data were used in Table 1 for 2008 and 2010 and the grain yield @ 60 kg N/ha for 2009. The dry matter accumulated at stem elongation was similar for 44C79 and OasisCL for all three years (Table 1). By flowering, 44C79 produced greater dry matter than OasisCL in 2008 and 2009 but similar in 2010. Similarly, at maturity, total dry matter was comparable for both cultivars but was reduced by dry hot conditions in 2008. Dry matter in 2010 was much higher than other years (Table 1) due to cool conditions in spring. Harvest index (HI) varied greatly between years. The hot dry conditions in 2008 resulted in very low HI (mean 0.12). In 2009, HI was similar for 44C79 and OasisCL (mean 0.25) but in 2010 where high dry matter was measured the HI was lower than expected. This resulted in a grain yield measured by plot harvester of 1.05 t/ha for 44C79 and 0.71 t/ha for OasisCL.

Table 1 Dry matter (g/m^2), measured at different growth stages and harvest index for canola (44C79) and juncea (OasisCL) at Lameroo in 2008-2010

Year	Elongation DM (g/m^2)		Flowering DM (g/m^2)		Harvest DM (g/m^2)		HI	
	44C79	OasisCL	44C79	OasisCL	44C79	OasisCL	44C79	OasisCL
2008	145	100	389	216	264	289	0.13	0.11
2009	124	119	363	201	377	430	0.26	0.24
2010	122	119	361	311	797	790	0.18	0.15

Table 2 Grain yield (t/ha) of canola and juncea at Minnipa in 2009

Entry	TOS 1*	TOS 2*	TOS 3*
Canola			
Hyola 50	2.74	2.52	1.83
Tarcoola	2.56	2.19	1.47
44C79	2.33	2.01	1.26
Juncea			
Dune	2.02	1.56	0.94
JC6019	2.13	1.63	1.17
Sahara CL	1.88	1.20	0.66
Oasis CL	2.33	1.73	1.09
SARDI515M	2.37	1.93	1.36
Site Mean	**2.30**	**1.85**	**1.22**
CV%	7.52	6.88	7.14
LSD (P=0.05)	*0.202*	*0.146*	*0.102*

** TOS 1, 3 May, TOS 2, 27 May, TOS 3, 11 June*

Table 3 Grain yield (t/ha) of canola and juncea at Minnipa in 2010

Entry	TOS 1*	TOS 2*	TOS 3*
Canola			
44C79	1.46	1.58	1.29
Hyola 50	1.62	1.70	1.58
Tarcoola	1.54	1.65	1.44
Juncea			
Oasis CL	1.13	1.05	0.84
Sahara CL	1.01	1.01	0.98
SARDI515M	1.24	1.21	1.00
Site Mean	**1.33**	**1.37**	**1.19**
CV%	6.06	4.60	8.92
LSD (P=0.05)	*0.097*	*0.069*	*0.121*

** TOS 1, 27 May, TOS 2, 11 June, TOS 3, 24 June*

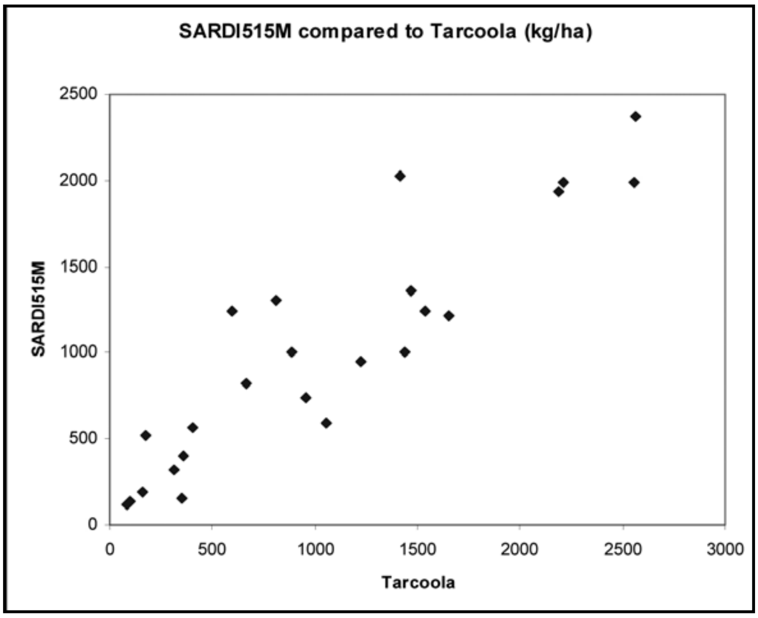

Figure 1 Comparison of grain yield of SARDI515M* (B. juncea) *with Tarcoola* (B. napus) *over a range of sites

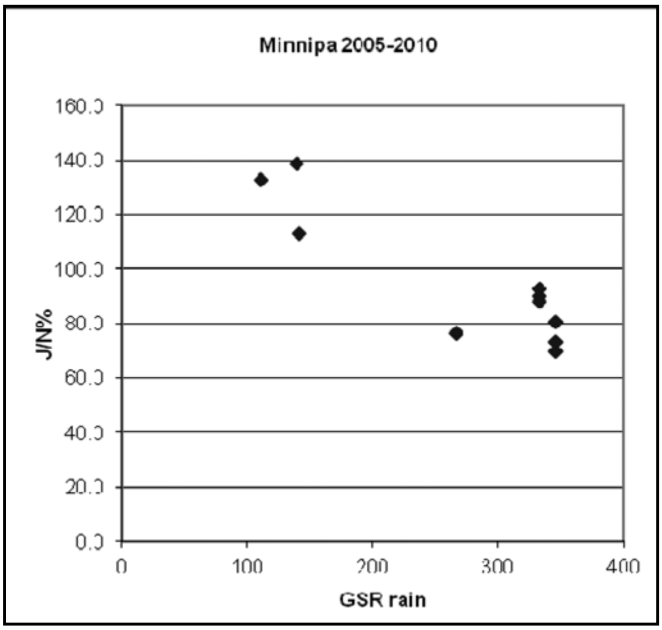

Figure 2 Relationship between yield of* B. juncea *and* B. napus *at Minnipa as affected by different amounts of growing season rainfall

Time of sowing trials were conducted at Minnipa in all three years but drought resulted in crop failure in 2008. Trials sown in 2009 and 2010 are detailed in Tables 2 and 3. In both years, canola produced higher grain yields than juncea (Tables 2 and 3).

Brassica juncea has often been shown to produce higher grain yields than *B. napus* in lower rainfall conditions, especially when grain yields achieved have been less than 1.2 t/ha. However, at Lameroo, in 2010 canola produced higher grain yields than juncea and similar grain yields in 2008 and 2009 where site mean yield was 0.32 and 0.75 t/ha respectively. At Minnipa, in the time of sowing trials, high grain yields were achieved and canola did produce higher yields than juncea. This would be expected as above average rainfall ensured high yields. However, at the late (June) sowings in both years the juncea did not perform as well as canola. The relatively good performance of canola in 2009 and 2010 may be due to the wet cool conditions of both years. Such conditions have not been experienced for a long period of time and are regarded as unusual in the low rainfall zone of SA. While the harvest indices of both crops were highly variable over the three years of trials, the HI achieved in 2010 was particularly low given the good season. The most likely reason could be the dry conditions after mid September but it appears that juncea was worse affected than canola. Frost damage was not noted so is unlikely to have caused the low HI.

Data from a range of trials has shown that *B. juncea* can produce higher grain yields than B. napus at low yield levels (Figure 1). The main exceptions were in northern NSW where *B. juncea* was better adapted. Data from Minnipa (Figure 2) showed that the relative yield performance of *B. juncea* was higher than *B. napus* when growing season rainfall was less than 200 mm. A range of sites was used to determine the effect of growing season rainfall on grain yield. For SARDI515M the relationship was 6.24 GSR - 592.66 r^2=0.69, for Tarcoola the relationship was 7.79 GSR - 856.45 r^2= 0.78.

Table 4 Area (ha) of crop types sown in recognised low rainfall areas of South Australia in 2010 Source: PIRSA crop reports

Region	Total Cereal (ha)	Total Pulse (ha)	Total Brassica (ha)
Western Eyre Peninsula	565,000	7,200	1,500
Eastern Eyre Peninsula	470,000	11,200	3,000
Upper North	360,000	40,000	13,000
Northern Murray Mallee	260,000	1,500	3,000
Southern Murray Mallee	241,000	2,000	6,000
Total low rainfall	**1,896,000**	**61,900**	**33,500**

The area of a range of crop types grown in recognised low rainfall areas of South Australia was determined in 2010 (Table 4). Total break crops make up a very small component of the total area cropped.

Based on current rotations, if *B. juncea* could be grown on 10% of the total cereal growing area in the low rainfall winter cereal zones, the production area for Australia would be over 600,000 ha (Norton et al., 2005). Table 4 shows the large area sown to cereals in the low rainfall zone of South Australia and the very low area sown to the cereal disease break crops whether they are a pulse or a Brassica. If only 10% of this total crop area was sown to a cereal disease break crop then at least 200,000 ha could be grown.

In South Australia, we have estimated that up to 165,000 ha could be grown at maximum uptake of *B. juncea.* In order to achieve this uptake, additional herbicide tolerant types will be needed and improved grain yield and quality will also be necessary to compete with *B. napus*. With the further development of improved *B. juncea* it is likely that this crop will increase in area up to this estimation and provide farmers with another crop that can fit into rotations with good economic returns and also provide a disease break for the following cereal crop. Production of Brassica crops in the low rainfall zone will still be expected to vary from year to year, however, as a late break to the season would be expected to reduce the area sown in that year due to the reliance on good spring conditions to get competitive yields.

What does this mean?

Brassica juncea has the potential to be grown on a substantial area of low rainfall cropping country in South Australia with a likely area of up to 165,000 ha per year. However, production may be expected to vary from year to year based on the timing of the seasonal break. Previous trials have shown that under low yield conditions, *B. juncea* can produce higher grain yields than canola. However, in the past two years with mild, wet conditions canola has performed relatively better than *B. juncea.*

Table 5 Mean internal infection and % of plants with more than 50% internal infection at 16 paddocks in the southern Mallee 2011

Location	Rating 2011	Variety	Mean % internal infection	% plants with more than 50% internal infection
Parilla	MS-S	Tanami	17.5	12
Pinnaroo	MS	43C80	22.1	12
Pinnaroo	MS	43C80	13.9	6
Pinnaroo	MS	44C79	26.7	16
Pinnaroo	MS	44C79	21.7	10
Lameroo south west	MS	44C79	18.7	14
Lameroo south west	MS	44C79	5.3	0
Lameroo south west	MS	44C79	11.0	6
Parilla north	MS	44C79	19.4	18
Parilla north	MS	Scaddan	2.6	0
Lameroo west	MR-MS	44Y84	11.8	8
Lameroo west	MR-MS	45Y82	18.2	12
Lameroo south west	MR	Fighter TT	5.1	6
Parilla	MR	Hurricane TT	3.2	0

2. Blackleg in canola in lower rainfall areas

A survey was conducted of canola crops in the southern Mallee in October 2011 to investigate the levels of blackleg in that district. A range of crops were sampled (Table 5) and 50 plants were taken randomly across the field (approximately 1 plant every 10 m travelled). These plants were cut at ground level and the amount of internal infection was scored per plant. The mean % internal infection was calculated for each paddock.

In previous years we have scored a variety (ATR-Beacon, BravoTT or Tawriffic TT) at the NVT trial at Lameroo to determine the level of infection with blackleg. The level has always been low (2, 5, 0% in 2004-2006 respectively). Very little evidence of blackleg has also been noted in more recent years.

The data presented in Table 5 show that we are now seeing a greater level of blackleg in the southern Mallee and that many of the crops are being sown to varieties that have a low level of blackleg resistance. The increase in blackleg can be attributed to a greater area being sown to canola in 2010 and 2011, as well as the summer and autumn rain in 2010-11 that resulted in a likely more rapid and greater release of blackleg spores throughout the district. With a further increase in area being cropped to canola in 2012 blackleg may begin to be an issue in the Mallee.

While the levels of internal infection are not as high as noted in the medium to high rainfall zone, if the amount of blackleg continues to increase, we should be looking to move to varieties with better resistance or consider limited use of fungicides in future.

3. New canola varieties that may be useful in the low rainfall zone

New canola varieties released in 2011

Blackleg ratings are those released in March 2011.

Conventional varieties

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. Blackleg resistance rating MR-MS (P). CB Agamax has not yielded as well as other conventional varieties when no fungicide was applied in 2010 trials. Tested in NVT trials in 2010 for the first time. Marketed by Canola Breeders.

Herbicide tolerant

Clearfield varieties

Hyola 575CL (tested as K9317). Mid-early season hybrid. Pacific Seeds indicate high grain yield and oil content about 1% more than Hyola 571CL. Medium plant height. Blackleg resistance rating MR (P). Tested in SA NVT trials in 2010 where it had higher grain yields than Hyola 571CL. Bred and marketed by Pacific Seeds.

44Y84 (CL) Early/early-mid season hybrid. Blackleg resistance rating MR-MS. Included in NVT trials in 2010. Similar grain yields to Hyola 571CL in 2010 trials. Bred and marketed by Pioneer Hi-Bred.

Triazine tolerant varieties

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. Blackleg resistance rating MS (P). Tested in NVT trials in 2010 for the first time. Bred and marketed by Canola Breeders.

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. Blackleg resistance rating MR (P). Tested in NVT trials in 2010. Bred and marketed by Pacific Seeds.

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. Blackleg resistance rating MR-MS (P). Tested in NVT trials in 2010. Bred and marketed by Pacific Seeds.

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 (P). First tested in NVT trials in 2010. Bred and marketed by Pacific Seeds.

ATR-Snapper (tested as NT0049). Early-mid maturing. Medium-short height. High oil and protein content. Blackleg resistance rating MS (P). Bred by Canola Alliance. Marketed by Nuseed Pty Ltd.

ATR-Stingray (tested as NT0045). Early maturing. Short height. High oil and protein content. Blackleg resistance rating MR-MS. Bred by AgSeed Research and DPI Victoria. Marketed by Nuseed Pty Ltd.

Likely new varieties for 2012

Clearfield varieties

Hyola® 474CL. Mid-early maturing CL Hybrid. Pacific Seeds indicate higher yield than Hyola 571CL, very high oil and high protein content. Medium-tall plant height. Ideally fits medium-low to high rainfall areas including irrigation, and exhibits excellent hybrid vigour. Anticipated high blackleg resistance rating R-MR. Tested in NVT trials in 2011. Bred and marketed by Pacific Seeds. New release for 2012.

43Y85CL (tested as 08N102I). Early maturing hybrid Clearfield canola. Pioneer Hi-Bred suggest it will be MR (P) for blackleg resistance and equivalent oil content to 44C79. Selected for short plant height and standability. Tested in NVT trials in 2011. Bred and marketed by Pioneer Hi-Bred.

Triazine tolerant varieties

Jackpot TT Mid-early maturing open pollinated TT variety. Pacific Seeds indicate very high yield, very high oil and very high protein content. Medium-short height. Ideally fits low to medium-high rainfall areas, exhibits good early vigour. Anticipated Blackleg resistance rating of MR. Bred and marketed by Pacific Seeds. Due to be released in 2012.

Bonanza TT Early maturing double haploid open pollinated TT variety. Pacific Seeds indicate good yield for maturity. Good oil and very high protein content. Short plant height suited for direct heading. Ideally fits low to medium rainfall areas, exhibits excellent early vigour similar to some TT Hybrids. Anticipated Blackleg resistance rating of MR. Currently being tested in NVT trials in 2011. Bred and marketed by Pacific Seeds. Due to be released in 2012.

ATR-Gem (tested as NT0107). Early-mid maturity triazine tolerant open pollinated variety with better blackleg resistance MR (P) and vigour than TawrifficTT. Slightly shorter than TawrifficTT and with slightly higher oil content. Bred and marketed by Nuseed. First year of NVT testing in 2011.

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Selection of canola lines for low rainfall environments in south eastern Australia

Nigel Wilhelm and Geoff Thomas
Low Rainfall Collaboration Project

RESEARCH

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 3.6 t/ha
Actual: 1.7 t/ha
Paddock History
2010: Barley
Soil Type
Red sandy loam
Plot size
1.8 m x 10 m x 2 reps

Location:
Walpeup, Victoria
Rainfall
Av. Annual: 338 mm
Av. GSR: 217 mm
2011 Total: 447 mm
2011 GSR: 157 mm
Yield
Potential: 1.5 t/ha
Actual: 1.5 t/ha
Paddock History
2010: Volunteer pasture
Soil Type
Mallee loam
Plot size
10 m x 1.5 m x 2 reps

Location:
Condobolin, New South Wales
Rainfall
Av. Annual: 459 mm
Av. GSR: 217 mm
2011 Total: 550 mm
2011 GSR: 189 mm
Yield
Potential: 1.7 t/ha
Actual: 1.5 t/ha
Paddock History
2010: Lucerne based pasture
Soil Type
Deep heavy red soil
Plot size
10 m x 1.8 m x 2 reps

Key messages

- **Canolas and mustards performed well at sites with low growing season rainfall and high levels of stored water.**
- **Roundup Ready lines show great promise over current commercial lines in better seasons.**
- **At the one site tested over the last three years under low rainfall conditions, there was good promise of higher yields with acceptable quality for both canola and mustards.**

Why do the trial?

The development of a profitable break crop in a low rainfall cereal growing areas is essential for sustainable and profitable systems. Canola has many valuable characteristics as a break crop for cereals (e.g. non-host for nearly all cereal diseases, herbicide tolerance, high value grain and well-anchored stubble).

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 third year of trials has now been completed.

In 2011, well over one hundred lines were trialled at each of the three locations. These included triazine tolerant (TT), immy tolerant (IT), Roundup Ready (RR) (except in SA because of the GM Moratorium) and conventional lines, most of which were grown with their respective registered herbicides applied. A summary of each of the last two seasons of results has appeared in the EPFS Summary 2010 and 2009.

The aim of the trials was to identify early generation lines of canola and mustard which are well suited to low rainfall environments.

How was it done?

Each trial tested up to fifty lines of early generation material from each of four companies (Nuseed, Pioneer, Pacific Seeds and Canola Breeders Western Australia Pty Ltd), giving a maximum of 200 lines in total to be tested each year. Several commercial varieties were included in each trial to evaluate performance of breeding lines against current commercial varieties and allow "calibration" with the NVT program. All experiments including GM material were conducted by practitioners trained in the Monsanto protocols for management of GM crops.

Site characterisation for each trial included soil fertility to depth, soil description, paddock history (including herbicide management) for previous five years, disease bioassay by RDTS, and meteorological data from a nearby station as well as pre seeding and post harvest soil moistures (except where rain fell between maturity and harvest).

Replicates were restricted to two because of limited seed supplies, but all plots were approximately 12 metres long by 6-8 rows wide. All experiments were seeded as soon as practical after 20 April each year, following the first suitable rain, at a seeding rate of 2.5 kg/ha.

Lines were blocked according to their herbicide tolerance (e.g. TT, RR, conventional) and herbicides managed according to the protocol for that particular type (although in some locations, absence of weeds meant these herbicides were not applied). Trials were managed according to best practice for each district and plots direct headed after desiccation if necessary.

The lines were observed for early vigour, height, standability, the actual days to 50% flowering (i.e. 50% of plants have at least one open flower), days to end of flowering and days to physiological maturity. Any other characteristics which may have been of commercial significance (e.g. sensitivity to herbicides) were also noted.

All grain was analysed by standard commercial NIR tests for oil content, protein and glucosinolates.

What happened?

Only grain yield data was available and fully analysed by the time of publication of this article.

Minnipa

Due to the GM moratorium in place in SA, RR material was not tested at this site. The mean yields of conventional, TT and IT lines were similar at 1.72, 1.68 and 1.78 t/ha, respectively. The season at Minnipa was the third in a row with above average annual and growing season rainfall totals.

Several conventional lines out-performed current commercial varieties (Tarcoola and Garnet), but most by less than 20%. Flowering times of early generation material was up to 3 weeks prior to the commercial varieties (Tarcoola was at mid flowering on 18 August and AV Garnet on 24 August). TT and IT lines were slightly later than conventional, the earliest at mid flowering on 8-9 August. No early generation material flowered later than the commercial varieties included for comparison.

Similar to the other two sites, no early generation TT lines out-yielded current TT commercial varieties.

Seven IT lines were tested at this site, but only some out-yielded the control (Oasis CL, a mustard Clearfield variety).

Mustards struggled to match the yield performance of their canola cousins at all sites. Grain quality analyses have yet to be received.

Condobolin

Grain yield of Roundup Ready lines (RR) averaged 1.8 t/ha in a year with above average rainfall but only because of the wet summer preceding the growing season. They outperformed conventional (average of 1.7 t/ha) and triazine tolerant (TT) material (average of 1.6 t/ha). Some RR early generation lines substantially outperformed current commercial RR varieties (by up to 0.5 t/ha), giving yields of up to 2.4 t/ha.

The yields of all conventional lines were similar and around that average of 1.7 t/ha.

No early generation TT lines out-yielded current TT commercial varieties.

Walpeup

The mean yields of conventional, RR, TT and IT lines were respectively 1.55, 1.71, 1.38 and 1.35 t/ha with the average of the RR material out-yielding the mean of the conventional and TT ($P<0.05$). The average of the IT material was below that of the average of the conventional material. The season at Walpeup was similar in pattern to Condobolin in that the growing season was less than average but the annual total was higher due to substantial rains at the start of the year. However, Walpeup also had a wet end to the year.

Grain yields of conventional lines varied from 2.21 t/ha to 1.28 t/ha, a higher degree of variation than found at Condobolin.

Some RR early generation lines substantially outperformed current commercial RR varieties (by up to 0.5 t/ha), giving yields of up to 2.1 t/ha.

As at Condobolin, no early generation TT lines out-yielded current TT commercial varieties. Only five IT lines were tested and there was little variation in grain yield between them.

What does this mean?

- The 2011 season proved to be another of above average moisture supply at the three sites used in this project. This means that the early generation material was not tested under tough moisture conditions, which was the aim of this project. However, the results from the 2011 season show that there is much promise for the better years with improved RR lines in the system, gains are still being made in conventional material, but that TT development is struggling at the moment.
- Some lines excelled under the tough conditions of one site in 2009 and also maintained their competitiveness in the better years.
- Canola and mustards performed well at the two sites in 2011 which had low growing season rainfall but high levels of stored water at seeding. This suggests that these brassicas could efficiently extract stored soil water, an important quality to reduce their risk in low rainfall areas.
- While mustards do have some innate characteristics which make them more suited to low rainfall conditions than canola, some canola lines were competitive with mustard under tough conditions and most canola lines were superior under better conditions.

Commercial practice: what this means for the farmer

The purpose of this project was to investigate whether early generation material existed with the current Brassica breeding companies that is better adapted to low rainfall environments than current commercial varieties. Based on one site in one year, this appears to be the case. This material does not seem to have the same advantage in the better seasons, but at least some lines do not lose against current commercial varieties and there seems to be a lot of substantially better material in the RR family across a range of production levels.

Since the focus of this project was assessing early generation material, there will not be any immediate releases of new varieties as a direct result, but it has highlighted the potential to improve Brassica performance in low rainfall environments without losing potential in the better years.

The pattern of results from this project also suggest that while mustard has some inherent qualities which make it better suited to low rainfall environments than canola, it is struggling to keep ahead of the improvements being made in canola.

Acknowledgments

This project was funded by GRDC and the authors would like to thank the expert field teams (headed by Neil Fettell at Condobolin, Ivan Mock at Walpeup and Leigh Davis at Minnipa) for their diligence and skills at conducting the field trials.

LOW RAINFALL COLLABORATION GROUP

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SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

District canola variety trial at Witera and time of sowing trials at Minnipa

Leigh Davis and Brenton Spriggs
SARDI, Minnipa Agricultural Centre

RESEARCH

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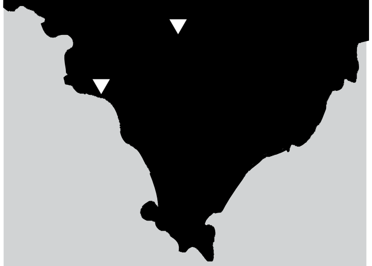

Location:
Witera
Port Kenny
Craig Welsh
Port Kenny Ag Bureau
Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2011 Total: 447 mm
2011 GSR: 257 mm
Yield
Potential: Canola 3.0 t/ha
Actual: 1.8 t/ha
Paddock History
2010: Medic Pasture
2009: Keel Barley
2008: Wheat
Soil Type
Clay loam over red brown earth
Plot size
10 m x 1.5 m x 3 reps
Yield Limiting Factors
Chemical damage and some mice damage

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: Canola 2.72 t/ha
Actual: 2.41 t/ha
Paddock History
2010: Barley
2009: Wheat
2008: Wheat
Soil Type
Brown loam
Plot size
10 m x 1.5 m x 3 reps
Yield Limiting Factors
Mice damage in TOS 1, not very bad in TOS 2

Key messages

- **Early break to the season triggers a very early canola sowing time (22 March) in a time of sowing trial at Minnipa.**
- **Disappointing yields and no stand out varieties in time of sowing 1 (TOS1) at Minnipa missing the full potential for early sowing due to shattering and mice damage.**
- **Exceptional yields in TOS2 Clearfield trial at Minnipa where Hyola 571 CL, Pioneer 44Y84 CL and Pioneer 43C80 CL all exceeded 2.5 t/ha.**
- **ATR Stingray, CB Junee HT and ATR Snapper are the highest yielding TOS2 TT lines at Minnipa.**
- **Hybrids Hyola 571 CL, Pioneer 45Y82 CL and Pioneer 44Y84 CL shine in the Clearfield trial at Witera yielding above 2 t/ha.**
- **ATR Cobbler, ATR Stingray and Tanami are the best performing TT lines at Witera.**
- **Oil content in canola is above 42% across all trials.**

Why do the trial?

There is limited ongoing released canola variety yield data available for low rainfall areas such as Minnipa and none for the Mount Cooper area. These trials compare current released varieties at two locations on Eyre Peninsula.

The very early break to the season and good subsoil moisture provided an opportunity to plant a TOS trial to see how early canola can successfully be grown and what yields are possible.

How was it done?

Minnipa

The time of sowing (TOS) 1 trial was sown 22 March, with 6 Triazine Tolerant (TT) and 5 Clearfield canola lines (CL). The TOS2 was sown 3 May with 9 TT and 6 Clearfield canola lines, 3 conventional canola lines were evaluated at both times of sowing. The management details of this trial are shown in Table 1.

Witera

The trial was sown on 3 May with 9 TT canola, 6 Clearfield canola and 3 conventional canola lines. The management details are shown in Table 2.

What happened?

Minnipa

The TOS1 trial at Minnipa germinated well after 67 mm of rain the week before sowing, but these conditions didn't last long with only 9 mm of rain falling in April. The canola did struggle through this period, turning all shades of purple until 10 mm of rain fell on the 1 and 2 May which allowed the canola to recover and the second TOS treatment to be sown. The trials enjoyed good rainfall events for the next 4 months allowing multiple applications of nitrogen and successful weed control. Mice started to show up in the TOS1 trial in early podding varieties, trimming and eating every fresh pod, which had a negative effect on yield. Baiting did reduce mice numbers but never totally controlled the problem. The canola was very adaptable given favourable conditions, as it branched out and continued to produce flowers and pods. TOS1 had massive growth and cabbage for a low rainfall environment; in contrast TOS2 reached half the height of TOS1.

Table 1 Trial management of canola TOS and variety evaluation at Minnipa, 2011

	MAC Distict TOS 1 Canola (Conventional TT & Clearfield)	MAC District TOS 2 TT	MAC District TOS 2 CL	MAC District TOS 2 Conventional
Seeding Date	22 March	3 May	3 May	3 May
Fertiliser	19:13:0:9.4 @ 79 kg/ha & 46:0:0:0 @ 92 kg/ha	19:13:0:9.4 @ 63 kg/ha & 46:0:0:0 @ 92 kg/ha	19:13:0:9.4 @ 63 kg/ha & 46:0:0:0 @ 92 kg/ha	19:13:0:9.4 @ 63 kg/ha & 46:0:0:0 @ 92 kg/ha
Date and chemical applied	22 March 1 L/ha Gramoxone + 1 L/ha TreflurX + 1 L/ha Lorsban	22 March 1 L/ha PowerMax + 70 ml/ha Hammer + 1 L/100 LI700	22 March 1 L/ha PowerMax + 70 ml/ha Hammer + 1 L/100 LI700	22 March 1 L/ha PowerMax + 70 ml/ha Hammer + 1L/100 LI700
	6 May 400 ml/ha Select + 200 ml/ha Astound Duo + 1 L/100Lwater Hasten	17 June 350 ml/ha Select + 300 ml/ha Astound Duo + 1 L/100Lwater Hasten	17 June 350 ml/ha Select + 300 ml/ha Astound Duo + 1 L/100Lwater Hasten	17 June 350 ml/ha Select + 300 ml/ha Astound Duo + 1 L/100Lwater Hasten
	6 June 400 ml/ha Astound Duo	1 July Sulphate of Ammonia @ 75 kg/ha	1 July Sulphate of Ammonia @ 75 kg/ha	1 July Sulphate of Ammonia @ 75 kg/ha
	8 June 250 ml/ha Dimethoate	2 July Sulphate of Ammonia @ 75 kg/ha	2 July Sulphate of Ammonia @ 75 kg/ha	2 July Sulphate of Ammonia @ 75 kg/ha
	1 July Sulphate of Ammonia @ 150 kg/ha	8 June 250 ml/ha Dimethoate	8 June 250 ml/ha Dimethoate	8 June 250 ml/ha Dimethoate
		7 July 1 L/ha Gesaprim 600 Sc + 1 L/100L Hasten + 400 ml/ha Astound Duo	7 July 550 ml/ha Intervix + 1 L/100L Hasten + 400 ml/ha Astound Duo	
		12 July Urea @ 90 kg/ha	12 July Urea @ 90 kg/ha	12 July Urea @ 90 kg/ha
		19 October 1.5 L/ha Gramoxone	19 October 1.5 L/ha Gramoxone	19 October 1.5 L/ha Gramoxone
Harvest Date	17 October	31 October	31 October	31 October

Table 2 Trial management of canola variety evaluation at Witera, 2011

	Witera Distict TT	Witera District CL	Witera District Conventional
Seeding Date	3 May	3 May	3 May
Fertiliser	19:13:0:9.4 @ 94 kg/ha & 46:0:0:0 @ 39 kg/ha	19:13:0:9.4 @ 94 kg/ha & 46:0:0:0 @ 39 kg/ha	19:13:0:9.4 @ 94 kg/ha & 46:0:0:0 @ 39 kg/ha
Date & Chemical Applied	3 May 1 L/ha PowerMax + 1.5 L/ha TriflurX + 60 ml/ha Hammer + 1 L/100L LI 700 + 1 L/ha Lorsban	3 May 1 L/ha PowerMax + 1.5 L/ha TriflurX + 60 ml/ha Hammer + 1 L/100L LI 700 + 1 L/ha Lorsban	3 May 1 L/ha PowerMax + 1.5 L/ha TriflurX + 60 ml/ha Hammer + 1 L/100L LI 700 + 1 L/ha Lorsban
	7 June 250 ml/ha Dimethoate	7 June 250 ml/ha Dimethoate	7 June 250 ml/ha Dimethoate
	8 July Urea @ 90 kg/ha	8 July Urea @ 90 kg/ha	8 July Urea @ 90 kg/ha
	8 July 1.2 L/ha Gesaprim 600 Sc + 1 L/100L Hasten	8 July 600 ml/ha Intervix + 1 L/100L Hasten	
		12 July 150 ml/ha Lontrel	
	24 October 1.5 L/ha Paraquat	24 October 1.5 L/ha Paraquat	24 October 1.5 L/ha Paraquat
Harvest Date	8 November	8 November	8 November

Table 3 Canola variety evaluation at Minnipa and Witera, 2011

Variety	Minnipa TOS 1 2011		Minnipa TOS 2 2011		Witera 2011		
Triazine Tolerant	**Yield (t/ha)**	**Oil (%)**	**Yield (t/ha)**	**Oil (%)**	**Yield (t/ha)**	**Oil (%)**	**Average (t/ha)**
ATR Stingray	na	na	2.53	47.5	1.87	47.5	2.20
CB Junee HT	na	na	2.52	47.7	1.67	47.4	2.10
ATR Snapper	na	na	2.40	43.1	1.73	43.6	2.07
Hurrican TT	1.31	44.9	2.33	43.3	1.70	47.3	1.78
ATR Cobbler	1.32	45.7	2.31	48.3	1.91	45.6	1.85
CB Tanami	1.43	46.6	2.29	48.5	1.87	48.0	1.86
Tawriffic TT	1.30	45.2	2.07	42.3	1.79	46.1	1.72
CB Telfer	0.84	42.1	2.05	44.4	1.38	43.0	1.42
Tornado TT	1.37	44.2	1.83	45.0	1.53	44.6	1.58
Mean	**1.26**		**2.26**		**1.72**		**1.84**
CV	11.25		5.60		6.50		
LSD (P=0.05)	*0.37*		*0.30*		*0.19*		
Clearfield							
Hyola 571 CL	1.38	49.4	2.67	46.4	2.27	47.1	2.11
Pioneer 44Y80 CL	1.40	48.4	2.66	50.2	2.03	46.0	2.03
Pioneer 43C80 CL	1.23	42.9	2.54	45.4	1.66	44.2	1.81
Pioneer 45Y82 CL	1.57	47.9	2.47	45.4	2.09	47.7	2.04
Pioneer 44C79 CL	1.31	43.2	2.31	41.8	1.50	43.3	1.71
Xceed Oasis CL	na		1.79		1.40		1.60
Mean	**1.38**		**2.41**		**1.83**		**1.88**
CV	4.12		8.50		10.89		
LSD (P=0.05)	*0.16*		*0.54*		*0.51*		
Conventional							
Hyola 50	1.57	45.5	2.59	47.5	1.99	49.8	2.05
AV Garnet	1.82	50.5	2.46	48.4	1.86	49.5	2.05
Tarcoola	1.33	46.7	2.16	46.8	1.50	44.1	1.66
Mean	**1.57**		**2.40**		**1.78**		**1.92**
CV	3.56%		2.72%		3.12%		
LSD (P=0.05)	*0.21*		*0.25*		*0.21*		

Unfortunately when the TOS1 canola was ready for harvest it became very windy and wet which shattered the trial and the full yield potential of early sowing was lost. Across the trial, TTs averaged 1.26 t/ha (Table 3), Clearfield 1.38 t/ha and conventional 1.57 t/ha which was disappointing considering the growth. TOS2 on the other hand produced fantastic yields with the Clearfields Hyola 571 CL, Pioneer 44Y84 CL and Pioneer 43C80 CL exceeding 2.5 t/ha. Two of the best TT lines, ATR Stingray and CB Junee HT, yielded over 2.5 t/ha also. See Table 3 for full yield and oil content details.

Witera

The trial site at Witera had abundant subsoil moisture due to good rains in February, March and April, receiving 205 mm in those 3 months. The canola trials were sown on 3 May with confident moisture levels and continued to receive good rainfall events through to the end of September. This produced healthy bulky, canola crops. The only set back was some drift of MCPA LVE which knocked the trial around at early flowering, which may explain the lower than expected yields. Hybrid Clearfield canolas Hyola 571 CL, Pioneer 45Y82 CL and Pioneer 44Y84 CL performed well, producing yields above 2 t/ha where the trial averaged 1.83 t/ha (Table 3). In the TT lines ATR Cobbler (1.91 t/ha), ATR Stingray (1.87 t/ha) and Tanami (1.87 t/ha) were the highest yielding lines with the trial averaging 1.72 t/ha. Table 3 provides full yield and oil content details.

What does this mean?

The best performing lines across all three trials for TTs were ATR Stingray, CB Junee HT (Hybrid) and ATR Snapper. For the Clearfields, Hyola 571 CL (hybrid), Pioneer 45Y82 CL (hybrid) and Pioneer 44Y84 CL (hybrid), and the best non hybrid was Pioneer 43C80 CL. Hyola 50 and AV Garnet averaged the same with 2.05 t/ha in the conventional lines across all 3 trials, out-yielding Tarcoola which averaged 1.66 t/ha. Oil content this year across the trials was excellent with all varieties above 42%.

Very early sowing like TOS1 on the 22 March is possible if an early break occurs and canola can be established. However some problems with early establishment may be early mice damage, dry periods after establishment and shattering when growing season rainfall is still occurring. One option to avoid shattering problems is to wind row the mature lines. Minnipa does not have wind rowing capability with small plot trials to counteract this problem.

Hybrid seed production is where there is cross pollination of two distinctly different pure lines which will produce a hybrid (F1 seed) that exhibits a marked improvement in performance over either parent. Performance traits such as grain yield, disease resistance, herbicide resistance, relative maturities, lodging resistance, oil content and meal quality are the result of hybrid vigour. However, seed from the next generation (F2 or retained seed) and subsequent ones is not hybrid and it will not have the heterosis of the original purchased hybrid canola seed and may have lost some useful agronomic and physiological traits. http://www.pacificseeds.com.au/images/stories/canola/information/agronomy/2010HyolaGenerationTrialResults.pdf

Hybrid seed is expensive to produce therefore attracts a premium for the purchase of the seed in the range of $25 per kilogram. This is very expensive and risky in low yielding environments.

For further yield evaluation see the NVT tables for canola in this section or, browse the NVT web site www.nvtonline.com.au for varietal characteristics, yield and quality data.

Acknowledgements

Thanks to Craig Kelsh for the use of his land.

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Viterra canola trials at Witera, 2011

Josh Hollitt
Viterra, Streaky Bay

RESEARCH

Searching for answers

Location:
Witera
Craig and Len Walsh
Pt Kenny Ag Bureau and Viterra
Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2011 Total: 454 mm
2011 GSR: 280 mm
Yield
Potential: 5.0 t/ha Wheat
Actual: 4.5 t/ha Wheat
Paddock History
2010: Medic pasture
2009: Keel barley
Soil Type
Clay loam over red brown earth
Soil Test
0-10cm, deep N and root disease
Diseases
Leaf rust
All root disease at levels below detection
Plot Size
10 m x 1.8 m x 3 reps
Yield Limiting Factors
Dry September
Water Use Efficiency
15 kg/mm/ha

Key messages

- **Early May sowing of XCEED™ Oasis CL canola *(Brassica juncea)* improved yield by 0.25 t/ha when compared to sowing in early June.**
- **As time of sowing was delayed, increasing the seeding rate increased yield.**
- **Lontrel™ (300 g/L clopyralid) caused no yield loss or crop effect when applied at 80 ml/ha at the 6-8 leaf stage. Care needs to be taken when applying Lontrel™ to XCEED™ Oasis CL canola as it can cause crop injury under certain conditions.**

Why do the trials?

XCEED™ Oasis CL canola *(Brassica juncea)* is commercially new and was bred from wild mustard for low rainfall environments. It has been included in National Variety trials in 2010 and 2011 and is available for commercial planting this year. The trials at Witera observed the effect of seeding rate, time of sowing, nutrition and the application of Lontrel™ on yield. These results will improve the agronomic knowledge we currently have on XCEED™ Oasis CL canola.

How was it done?

The XCEED™ Oasis CL canola seeding rate and time of sowing (TOS) trial had two times of sowing and three seeding rates with three replicates. TOS 1 was 4 May and TOS 2 was 2 June. Seeding rates were to 2, 3 and 4 kg/ha. Fertilizer (19:13:0:9) was applied at 90 kg/ha at sowing and a further 90 kg/ha of urea was applied on 8 July. Measurements included plant establishment, plant vigour, grain yield and oil content.

The XCEED™ Oasis CL canola Lontrel™ trial was sown on 4 May at 3.5 kg/ha, with 90 kg/ha 19:13:0:9 applied at sowing and a further 90 kg/ha urea applied on 8 July. Three Lontrel (300 g/L clopyralid) rates (80, 120 and 160 ml/ha) were applied on 8 July (6-8 leaf stage). Measurements included crop phytotoxicity, grain yield and oil content.

What happened?

XCEED™ Oasis CL canola treatments sown on 4 May (TOS 1) yielded higher than treatments sown on 2 June (TOS 2), reinforcing the benefit of sowing on time (Figure 1).

Seeding rate influenced yield differently depending on TOS (Figure 2). The 2 kg/ha seeding rate recorded the highest yield at TOS 1 and the lowest yield at TOS 2. As seeding was delayed increasing the seeding rate up to 4 kg/ha increased yield. This suggests optimal seeding rates will vary depending on conditions and time of sowing.

Lontrel™ (300 g/L clopyralid) applied to XCEED™ Oasis CL canola at the 6-8 leaf stage resulted in a slight yield reduction as application rates increased (Table 1). This shows the potential effect on yield of high applications of Lontrel™ even though the results weren't significant and yield losses were minor.

What does this mean?

XCEED™ Oasis CL canola is suited to early sowing. Under optimal sowing conditions (e.g. early sowing, adequate soil moisture, sound machinery setup and paddock preparation) a seeding rate of 2-3 kg/ha targeting 60 plants/m^2 achieved the highest yield at this site. A seeding rate of 4 kg/ha targeting more than 70 plants/m^2 is advised if conditions at sowing are compromised in any way (e.g. late sowing, poor machinery setup or paddock preparation) or it is the first time growing the variety.

XCEED™ Oasis CL canola yield may be reduced slightly from the application of Lontrel™ (300 g/L clopyralid) above 80 ml/ha past the 6-8 leaf stage. Speak with an agronomist before using rates above 80 ml/ha or applying later than the 6-8 leaf stage.

Acknowledgements

Thanks to Craig and Len Kelsh for providing the land to conduct the trials and for all the help throughout the year. Thanks to Leigh Davis and Brenton Spriggs for managing the trials. Thanks to those within Viterra who assisted with the trial program, in particular Clint McEvoy and the team at Viterra, Streaky Bay.

Lontrel™ - Dow AgroScience

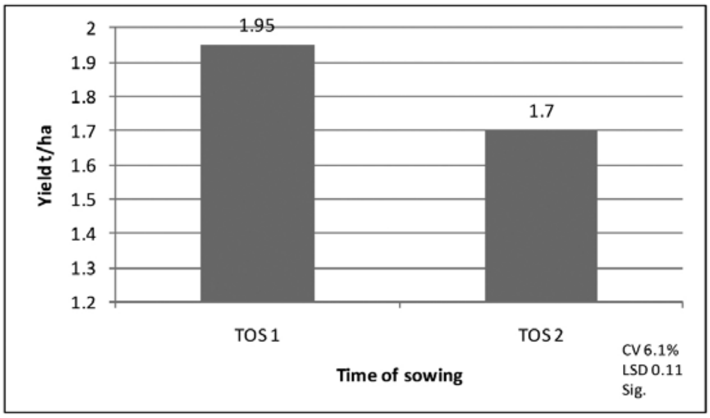

Figure 1 Yield (t/ha) of Xceed Oasis™ by TOS

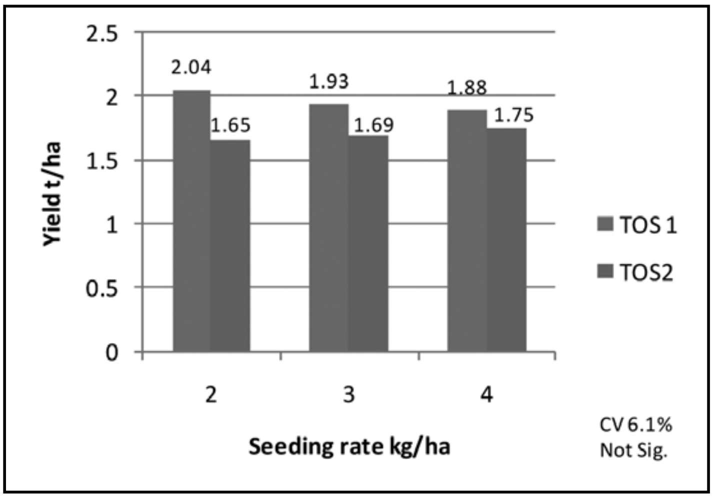

Figure 2 Yield (t/ha) of Xceed Oasis™ by seeding rate (kg/ha) and TOS

Table 1 Yield (t/ha) of Xceed Oasis™ by Lontrel™ rate (ml/ha)

Lontrol Rate (ml/ha)	Yield (t/ha)
0	1.63
80	1.63
120	1.60
160	1.58
CV%	5.2
LSD (P=0.05)	*0.171 (ns)*

Viterra trial site at Witera, 2011

VITERRA™

Field pea varieties and agronomy for low rainfall regions

Michael Lines[1], Tony Leonforte[2], Leigh Davis[3] and Larn McMurray[1]

[1] SARDI, Clare, [2] DPI Victoria, Horsham, [2] SARDI, Minnipa Agriculture Centre

Almost Ready

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2010 Total: 404 mm
2010 GSR: 252 mm

Yield
Potential: Pulses 2.4 t/ha
Actual: 1.9 t/ha

Paddock History
2010: Barley
2009: Wheat
2008: Wheat

Soil Type
Brown loam

Yield Limiting Factors
High temperatures during flowering/pod fill

Key messages

- **Pea yields were high in 2011, but less than in the previous 2 years.**
- **Later maturing lines were favoured by the longer season, and apart from lower yields in Parafield there was generally little difference in grain yield between named varieties.**
- **A four week delay in sowing from early May resulted in a 32% yield loss across all varieties.**
- **Agronomy trials showed no significant effect of stubble management of grain yield in 2011, however standing stubble treatments showed increased standing height and reduced lodging compared to slashed stubble plots, which could aid harvest.**

Why do the trial?

Pulse Breeding Australia (PBA), together with the GRDC funded Southern Region Pulse Agronomy Project, is committed to the expansion of field peas into lower rainfall areas of southern Australia. This is being achieved through the development of new cultivars and identification of agronomic methods to improve yield and yield reliability, to provide an economically viable break crop option in areas where pulses are not widely grown. These areas are generally characterized by variable soil types and low rainfall, of which Minnipa is a key part of the program.

The Southern Region Pulse Agronomy Project aims to identify best management practices to maximise the performance of new pulse varieties in farming systems. Research conducted on lentils in the mid-north of South Australia has shown the benefit of inter-row sowing into standing stubbles in relation to yield and increased standing plant height. Height and lodging improvements were generated by the stubble providing a trellis to support the stem of the plant, leading to improved harvestability. A field pea sowing date trial was set up at the Minnipa Agricultural Centre to compare and identify optimum sowing times of 6 pea varieties to maximise grain yield and minimise impacts of disease. It also aimed to investigate whether field peas could benefit from sowing into standing stubble compared to slashed stubble in low rainfall areas in terms of grain yield, disease infection or harvestability. 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 PBA field pea breeding trial containing 9 commercial entries and 97 advanced breeding lines was sown into good soil moisture levels on the 18 May at Minnipa.

An agronomic pea inter-row by time of sowing trial with 5 varieties (Kaspa, Parafield, PBA Gunyah, PBA Twilight and PBA Oura) and 1 advanced breeding line (OZP0819) was sown on 2 May (early) and 31 May (late) also at Minnipa. Stubble treatments were Standing (wheat stubble 30 cm high, ~3 t/ha) and Slashed stubble. All plots were sown inter-row, at 25 cm spacings.

All trials were sown with 63 kg/ha of DAP and a spray mix comprising 700 ml/ha paraquat, 800 ml/ha trifluralin and 1 L/ha chlorpyrifos. Post-sowing pre-emergent chemical applications included metribuzin @ 160 g/ha and 1.5 L/ha glyphosate with 20 ml/ha carfentrazone-ethyl (Hammer). 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, height, maturity, lodging, shattering and selection potential were recorded during the year and grain yields were measured at harvest.

What happened?

Growing season rainfall was close to average at Minnipa in 2011, but yields were higher than average boosted by stored soil moisture from late 2010-2011 summer rainfall. Similar to 2010, low to moderate levels of blackspot and powdery mildew were observed, but had little effect on yield. Yields were above average, although not to the extent of 2009 or 2010. 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. Yields were generally not limited by moisture stress, however sporadic high temperature events during spring may have shortened flowering length and led to some level of flower and pod abortion, complicating interpretation of variety performance.

1. Stage 3 PBA breeding trial

The grain yield of the PBA Stage 3 trial averaged 1.88 t/ha in 2011 (Table 1). As in 2010 there was little variation in yield between the majority of lines, and yield of Kaspa was similar to the site mean. Of the other 121 lines in this trial, only 14 lines yielded lower than Kaspa (including Parafield), and 3 higher (including OZP0804 which yielded 2.44 t/ha – 30% above site mean). All commercial cultivars performed similarly to the site mean.

Grain yield of Kaspa was 17% higher than Parafield (Table 1), similar to other recent wetter than average seasons (6% in 2010 and 17% in 2009). Early flowering and maturing recent releases PBA Gunyah, PBA Twilight and PBA Oura were outyielded by several later maturing advanced breeding lines. The 2011 released very early flowering and maturing conventional leafed type dun pea, PBA Percy, showed reasonable yields in 2011, but will generally be better suited to the shorter seasons in this area.

The earlier flowering and maturing types, such as PBA Gunyah and PBA Twilight, have performed better than Kaspa in the drier years of 2006-2007 (Table 2) and at the later sowing dates in sowing time experiments. However they have had similar yields in the more favourable seasons (2009-2011). These recent releases have consistently performed equal or better than Parafield and Kaspa in these seasons, offering more reliable yield across variable seasons.

A mixture of Kaspa, PBA Gunyah and PBA Twilight of equal proportions was trialled in 2011 to observe the effect of variable flowering window on yield. Start flower date (when 50% of plants have flowers) was similar to PBA Gunyah, buffered by the Kaspa (late) and Twilight (early) flowering patterns. Yield of this mixture (94% of Kaspa) was not significantly different from any of the components, but was moderated to between Kaspa yield and PBA Gunyah and PBA Twilight yield (85% of Kaspa). This mixture would allow producers to grow varieties with similar seed and plant types concurrently, but different flowering patterns and performance across variable seasons.

The advanced breeding line 04H069P-05HO2014 was the highest yielding entry in the trial, yielding 25% higher than Kaspa in this trial. This line is a semi-leafless dun pea with powdery mildew resistance and Kaspa type grain and shattering resistance. Another advanced breeding line (04H343P-05HO2004) performed similarly, outyielding Kaspa by 21%. This variety has dual powdery mildew and bacterial blight resistance, but does not have the Kaspa type grain or non-shattering sugar pod trait. These lines will be further evaluated across more sites and seasons.

Table 1 Grain yield (% Kaspa), flowering date and number of flowering days of selected field pea lines in the 2011 Minnipa Stage 3A PBA trial, mean yield across 5 SA 2011 Stage 3 PBA sites and long term predicted yield at Minnipa

Variety	Plant Type	Start Flower	Grain Yield (% Kaspa)		
			Minnipa	**Mean 5 SA sites 2011**	**Minnipa 2005-2011**
Kaspa	SL	25 Aug	2.02 t/ha	2.55 t/ha	1.73 t/ha
Parafield	C	18 Aug	83	90	97
PBA Gunyah	SL	17 Aug	85	93	101
PBA Oura	SL	20 Aug	86	92	104
PBA Percy	C	13 Aug	94	94	104
PBA Twilight	SL	13 Aug	85	94	102
Sturt	C	15 Aug	96	98	107
Yarrum	SL	27 Aug	102	95	104
Kaspa/Gunyah/Twilight Mixture	SL	17 Aug	94	97	100
OZP0819	SL	18 Aug	95	105	109
OZP1003	SL	25 Aug	105	103	106
OZP1101	SL	25 Aug	101	102	106
04H069P-05HO2014	SL	24 Aug	125	112	112
04H0343P-05HO2004	SL	25 Aug	121	110	106
Site Mean (t/ha)			**1.88**	**2.48**	**1.74**
CV (%)			9.86	6.62	
LSD % (P=0.05)			*15.8*		

SL=Semi-leafless, C=Conventional

Table 2 Grain yields (t/ha) of Parafield, Kaspa, and recently released PBA field peas compared with rainfall and sowing date at Minnipa in advanced pea breeding trials, 2005-2011

Line/Year	2005	2006	2007	2008	2009	2010	2011	2005-11
Parafield	0.92	0.61	0.99	<0.2	2.24	2.76	1.67	1.62
Kaspa	0.86	0.54	1.04	<0.2	2.61	2.93	2.02	1.73
PBA Gunyah	-	0.68	1.12	<0.2	2.20	2.91	1.72	1.69
PBA Twilight	-	0.80	1.13	<0.2	2.19	2.94	1.72	1.70
PBA Oura	-	-	1.02	<0.2	2.51	2.97	1.73	1.74
PBA Percy	-	-	-	<0.2	2.39	2.92	1.90	1.74
GSR (mm)	264	111	141	139	333	345	252	226
AR (mm)	334	236	286	251	421	410	404	335
Date sown	24 May	15 May	8 May	20 May	4 May	31 May	18 May	

SL=Semi-leafless, C=Conventional

2. Sowing date x stubble management agronomy trial

Effects of stubble treatment were apparent early in the season through differences in standing plant height and growth habit, however these did not translate to differences in grain yield or disease infection in 2011.

A significant sowing date by variety interaction was observed for grain yield (Table 3). All varieties yielded higher sown early (average 2.72 t/ha) than sown late (average 1.85 t/ha), averaging 32% (30 kg/ha/day) higher when sown early. This is higher than in previous years, where the average yield loss from delayed sowing at Minnipa previous to 2010 (which showed no sowing date response) was 26 kg/ha/day.

The high yielding white pea line OZP0819 was the highest yielding variety sown early, yielding 31% higher than Kaspa, while PBA Oura also outyielded Kaspa by 10% when sown early. Parafield was outyielded by all other varieties at the early sowing date.

At the later sowing date all varieties generally performed similarly, except that OZP0819 and PBA Twilight outyielded Kaspa (21 and 16%, respectively). OZP0819 showed the greatest penalty from delaying sowing (40%, or 46 kg/ha/day delay in sowing), while Parafield showed the least (21%, or 16 kg/ha/day sowing delay) (Table 3).

Early vegetative standing height measurements (taken late July) showed that standing height of peas sown into standing stubbles was higher at both sowing dates (11-13 cm) than those in slashed stubbles (Table 4). Standing height of late sown peas was also higher than early sown peas, due to greater vegetative lodging in early sown peas. Visual observations showed the peas tendrils "netting" onto the standing stubble, which provided a trellis for the peas to grow up, leading to more erect plants (Figure 1).

Mature standing height showed a similar trend to vegetative standing height. Peas sown into standing stubbles averaged 12 cm higher than those sown into slashed stubbles (Table 4).

Table 3 Effect of sowing date on yield (t/ha) and yield loss (kg/ha/day) of 6 field pea lines, Minnipa 2011

	Sowing Date	Kaspa	Parafield	Gunyah	Twilight	Oura	OZP0819	*LSD (P<0.05)*
Yield (t/ha)	Early	2.55	2.33	2.68	2.64	2.79	3.33	*0.276*
	Late	1.65	1.85	1.84	1.92	1.83	2.00	*(0.21 same TOS)*
Yield loss (kg/ha/day)		31	17	29	25	33	46	*4.2*

Table 4 Effect of sowing date and stubble treatment on vegetative standing height (cm), and stubble management on mature standing height (cm) of field peas, Minnipa 2011

Measurement	TOS	Crop Stage	Slashed Stubble	Standing Stubble	*LSD (P<0.05)*
Vegetative Standing Height (cm)	Early	17-18 node	26	34	*6.2*
	Late	9-10 node	37	47	*(1.4 same TOS)*
Mature Standing Height (cm)		maturity	27.5	39.6	*2.07*

Figure 1 Kaspa peas sown into slashed stubble (left) and standing stubble treatment (right)

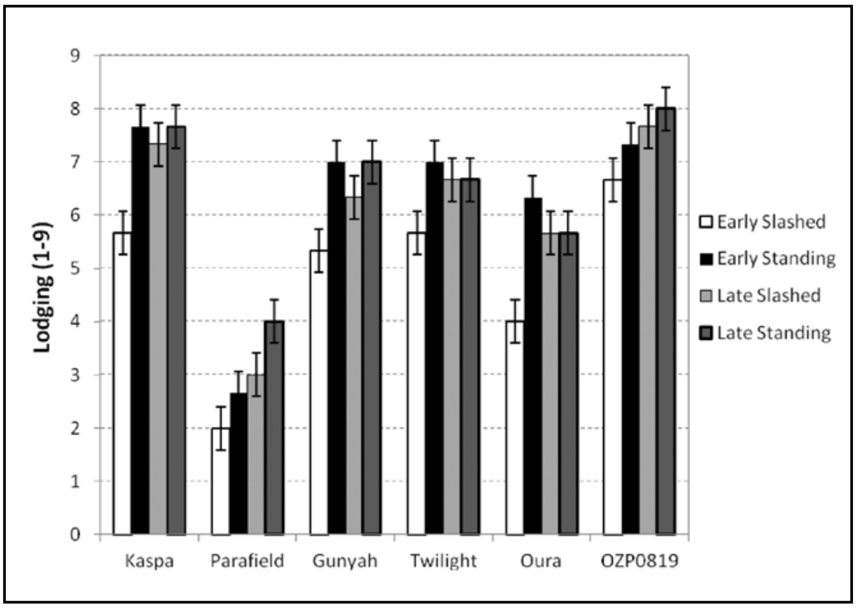

Figure 2 Lodging scores (1-9 score) of six field pea varieties sown at different sowing dates and stubble management methods, Minnipa 2011 (1 = flat, 9 = upright)

Lodging scores showed a significant three-way interaction between sowing date, variety and stubble treatment. Early sown peas were more erect at maturity when sown into standing stubble, except for Parafield which showed no difference between stubble management methods (Figure 2). However standing stubble did reduce lodging in Parafield at the late sowing date.

What does this mean?

High yields were observed in 2011, with little variation between varieties, most likely due to the favourable conditions and minimal yield limiting factors. However the benefit of early sowing was again highlighted by a 32% yield loss from delayed sowing.

A number of new varieties exist for growers to select, based on their particular needs. Long term yield analysis showed most commercial varieties and NVT lines performing similarly to Kaspa at Minnipa for the years 2005-2011. Kaspa has performed well long term at Minnipa, buoyed by recent favourable seasons, but earlier flowering and maturing varieties may maximise yield reliability across variable seasons in this environment. Parafield performed 6% below Kaspa at Minnipa and at a state level over the long term, indicating that upgrading to a variety with better yield reliability across seasons should be considered.

Recent releases PBA Gunyah, PBA Twilight, PBA Oura and PBA Percy all performed similarly to Kaspa in 2011, a season which again favoured later maturing types like Kaspa. These also show similar long term yields to Kaspa. However, their earlier maturities, together with generally broad adaptation, make them an ideal choice for lower rainfall environments such as Minnipa, especially when early sowing cannot be practiced or where spring conditions are not favourable for later flowering varieties.

PBA Gunyah and PBA Twilight have the additional benefits of similar plant and seed type as Kaspa, which are favoured for their high milling quality due to round seed with an absence of dimpling compared to standard dun seed types and also due to improved harvestability over conventional plant types. PBA and the Southern Region Pulse Agronomy project will be further looking at the effect of growing seed mixtures of these varieties on yield and yield stability across variable seasons.

Whilst there is currently no market segregation for white peas in South Australia, the advanced breeding line OZP0819 is being considered for potential release due to its consistent high yield and superior agronomic and disease profile compared to many other commercial varieties. Its long term yield shows a 5% yield advantage over Kaspa at Minnipa, and 11% higher across the state. Growers contemplating growing white pea types will be best advised to secure markets for this seed type prior to sowing.

Stubble treatments showed no yield difference in 2011, however differences in plant height and lodging were observed throughout the season which may aid harvestability, particularly in shorter seasons with less biomass. Retaining anchored standing cereal stubble throughout the year field peas are grown is also seen as having benefits in reducing damage from wind erosion in regions characterised by light textured soils. With good quality cereal stubbles again in 2011, this agronomic trial will be continued with the new varieties to aim to validate these findings under variable seasonal conditions.

SARDI
GRDC Grains Research & Development Corporation
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE
Southern PULSE Agronomy
PBA PULSE BREEDING AUSTRALIA

Improving yield and reliability of field peas under water deficit

RESEARCH

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

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Searching for answers

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 2.43 t/ha (Pulses)
Actual: 1.50 t/ha (site av)

Paddock History
2010: Barley
2009: Wheat
2008: Wheat

Soil Type
Brown loam

Plot Size
10 m x 1.5 m x 3 reps

Yield Limiting Factors
Anthesis heat and moisture stress

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 from the second season and summary of first season experiments are presented with more detailed trait data currently being analysed, with one more year to follow.**
- **Correlations between yield and canopy traits such as greenness and growth rate have been identified.**
- **We have also used APSIM to model the seasonal soil moisture stress for all environments.**

Why do the trials?

Grain legumes are generally more sensitive to periods of drought than cereals and consequently their yield is more variable (Figure 1) 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 (PBA) 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?

Thirty 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 were sown in 2010 across four different sites and in 2011 across five different sites that differed in average rainfall.

Table 1 Mean, minimum and maximum yield (t/ha) of field peas in 2010 and 2011

Environment	Mean	Standard Error	Minimum	Maximum
Minnipa 2011	1.5	0.37	0.45	2.2
Minnipa 2010	2.5	0.43	1.80	3.2
Roseworthy 2011	2.3	0.46	0.76	3.1
Roseworthy 2010	2.9	0.52	1.80	4.0
Mallala early sowing 2010	3.1	0.46	2.10	3.9
Pinery early sowing 2011	2.5	0.46	0.95	3.4
Mallala late sowing 2010	3.0	0.44	1.80	3.8
Pinery late sowing 2011	1.9	0.39	0.86	2.6
Turretfield 2010	3.1	0.55	2.10	4.1
Turretfield 2011	2.5	0.52	0.93	3.2
Willamulka 2011	2.7	0.42	1.60	3.6
Total across all environments	**2.5**	**0.21**	**0.45**	**4.1**

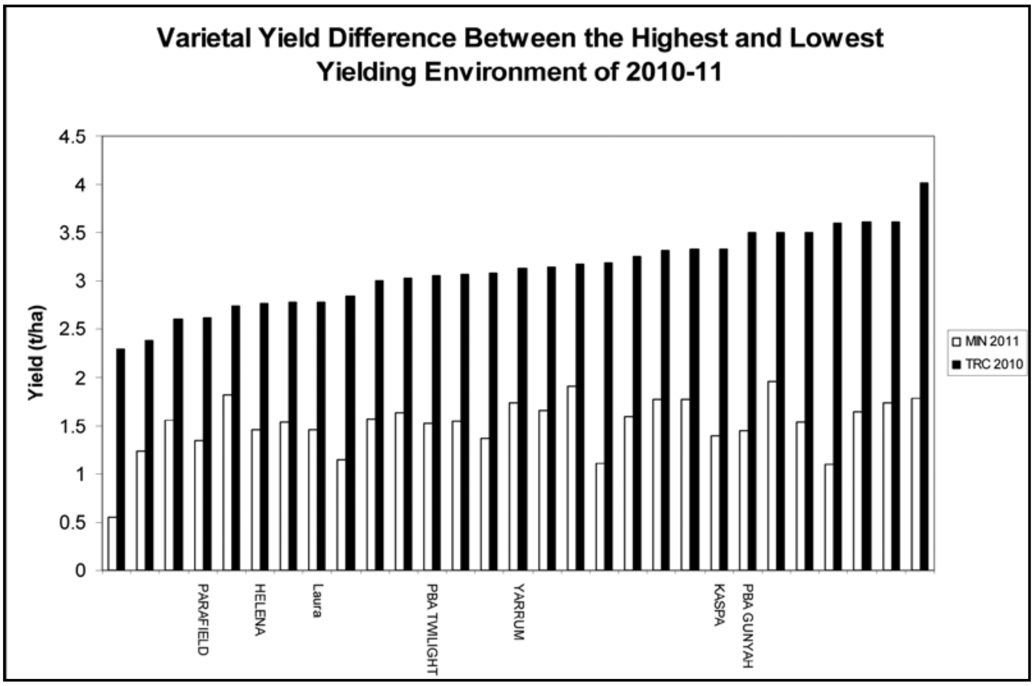

Figure 1 Difference in varietal yield between environments (MIN = Minnipa, TRC = Turretfield)

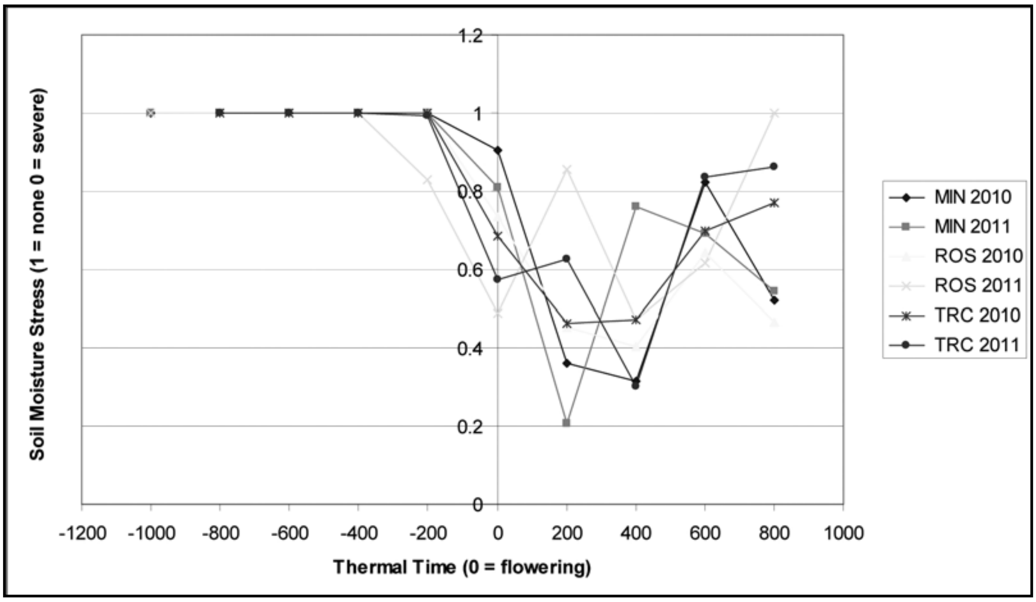

Figure 2 Soil water stress levels and thermal time to flowering (0 = flowering) (MIN = Minnipa, ROS = Roseworthy, TRC = Turretfield)

2010 sowing was Minnipa (1 June), Mallala (8 and 22 June), Roseworthy (8 June) and Turretfield (15 June). Sowing in 2011 included Turretfield (8 June), Roseworthy (3 June), Pinery (early sown 23 May and late sown 22 June), Minnipa (23 May) and Willamulka (19 May). These sites were chosen for their rainfall gradient with expectations of Minnipa being at the driest and Turretfield the wettest end of the scale. We also had two times of sowing at Mallala (2010) and Pinery (2011) to increase the effects of terminal moisture stress.

Sowing density was 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 flower, fifty percent flowering, and last flower
- Canopy traits – temperature, chlorophyll content (SPAD), NDVI (biomass)
- Yield and yield components – yield, harvest index, pods per plant, seed per plant, seed per pod, pods per peduncle, 100 seed weight, and pod weight proportion.

APSIM was used to model crop water use and soil moisture stress (Figure 2).

What happened?

The 2011 season was drier than the 2010 season and as a result all sites yielded less than 3 t/ha. Minnipa had some very low yields but all other sites yielded between 2 and 2.8 t/ha. Yield was affected, as expected, by location, variety and variety x location interaction. The differences between the environments and years are shown in Table 1.

The differences in performance of field pea varieties in the best and worst yielding environments are illustrated in Figure 1.

We are currently analysing the results from the 2011 plant and yield component measurements to identify further links between consistently high yielding varieties and plant and crop traits. Data from 2010 indicates that higher yielding lines have; higher SPAD (greenness), higher NDVI (biomass), lower pod weight proportion, more seed per pod and a higher harvest index.

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.

After validation of our measuring techniques, traits of interest can 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 and Leigh Davis for coordinating the trial at Minnipa, the SARDI New Variety Agronomy team at Clare for management of Turretfield, Pinery and Roseworthy trials, and Tony Leonforte DPI Victoria for providing us with seed and advice on germplasm.

Better medics update

RESEARCH

Jake Howie, Ross Ballard and David Peck
SARDI, Waite

Searching for answers

Location: Arthurton
Neville and Ashleigh Rowe
Rainfall
Av. Annual: 475 mm
Av. GSR: 363 mm
2011 Total: 453 mm
2011 GSR: 262 mm
Yield
Actual: 5 t/ha (estimated by rising plate meter)
Paddock History
2010: Cereals (various)
2009: Canola
2008: Lathyrus
Soil Type
Clay loam, pH 8.2
Soil Test
Colwell P, 68 ppm; organic carbon, 3.4%
Diseases
P. neglectus (RLN)
Plot Size
2 x 1.2 m x 4 reps
Yield Limiting Factors
RLN, unidentified root rot

Location: Netherton
Lester & Kay Cattle
Rainfall
Av. Annual: 396 mm
Av. GSR: 290 mm
2011 Total: 380 mm
2011 GSR: 194 mm
Yield
Actual: 4 t/ha (rising plate meter est. 7/10/10)
Paddock History
2010: Pastures
2009: Wheat
Soil Type
Loamy sand, pH 6.3
Soil Test
Colwell P, 26 ppm; 241 ppm; sulphur, 3.3 ppm; organic carbon, 0.67%
Plot Size
4 x 1.2 m x 3 reps
Yield Limiting Factors
Powdery mildew, low pH/poor nodulation, low sulphur (& trace elements?)

Key messages

- **We have identified a small group of material with excellent agronomic performance exceeding our benchmark strand medic cultivars, Herald and Angel, by up to and over 30% for dry matter production and seed yield.**
- **The lines are bred from a cross between Angel strand medic and a line originally selected for powdery mildew resistance. They also have SU herbicide tolerance, aphid resistance and larger seed size.**
- **If the level of agronomic improvement can be confirmed at regenerating sites, there are good prospects for a future commercial release.**
- **Unexpected responses to Rhizobium inoculation confirm some grower observations of poor medic nodulation in the Mallee, but the reasons for this remain unclear.**
- **Root lesion nematode number was substantially reduced following a season of medic growth.**

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.

In 2010 we evaluated in the field for the first time, the agronomic performance of 27 strand medic hybrids possessing various combinations of new traits (EPFS Summary 2010, pg 61-62). In 2011 we sowed three more field evaluation sites with a shortlist of the best lines identified from 2010 including seven "PM" lines with powdery mildew resistance, SU tolerance, aphid resistance and large seeds.

In separate trials we are also trying to determine the benefit that *Pratylenchus neglectus* root lesion nematode (RLN) tolerance has on medic production and to measure the change in nematode populations after growing these medic lines.

How was it done?

Trial sites were selected on Yorke Peninsula (Arthurton) and the Murray Mallee (Karoonda, Lameroo and Netherton).

The Arthurton site was specifically selected for its variable levels of RLN (2 – 68/g soil) and used to compare the root health and growth of *Pratylenchus neglectus* tolerant and intolerant medic lines and assess nematode multiplication. At the Mallee sites, the short-listed strand medic entries plus a range of cultivar controls were assessed for dry matter production, seed yield and powdery mildew resistance (where it occurred) at Netherton and Karoonda. In response to farmer feedback at field days and measures of poor nodulation in 2010 field trials, we also included some additional rhizobial treatments (including 10 fold rate of inoculation).

What happened?

2011 sown trials – agronomic evaluation

Two trials were successfully established in the Murray Mallee at Netherton and Lameroo enabling further evaluation of dry matter production, disease tolerance and seed yield. The site at Karoonda had variable plant establishment as a result of non-wetting sands failing to wet up sufficiently with the opening rains.

Location: Lameroo
Trevor & Cath Pocock
Rainfall
Av. Annual: 330 mm
Av. GSR: 235 mm
2011 Total: 558 mm
2011 GSR: 197 mm
Paddock History
2010: Pasture
2009: Cereal rye
Soil Type
Loamy sand, pH 6.3
Soil Test
Colwell P, 20 ppm; potassium, 125 ppm; sulphur, 2.9 ppm; organic carbon, 0.89%
Plot Size
4 x 1.2 m x 3 reps
Yield Limiting Factors
Difficult establishment due to clay spreading and rough terrain, low pH/poor nodulation, low soil P, K, S (& trace elements)

Once again we were very encouraged with the agronomic performance of the PM lines with respect to growing season dry matter (DM) production and seed yield (Netherton data only - Lameroo still being processed). As a group the early DM production at Netherton was 20–40% greater than the benchmark commercial cultivars, Herald and Angel (Figure 1). A feature of the hybrids was increased early season vigour, probably a benefit of the larger seed size of the original PM resistant donor parent. Seed yields, which provide a critical measure of potential pasture persistence, were also excellent (average 1100 kg/ha) for the PM hybrids and 30% greater than for Herald and Angel (Figure 1).

2011 regeneration of 2010 Karoonda site

Despite severe predation of pods and seeds by mice over summer, rains in March resulted in a very early germination which survived in sufficient numbers to the onset of winter rains for the best plots to produce > 3 t/ha by the end of July. By the time of the MSF field day (31 August) the best plots had produced an estimated 4 t/ha of dry matter and although there were no differences between entries at this stage, the PM hybrids all demonstrated adequate regeneration and good dry matter production.

Powdery mildew resistance – field observations

Netherton - a natural powdery mildew infection occurred which affected > 80% of leaves of most lines except the PM lines which displayed negligible powdery mildew symptoms. Premature leaf senescence resulting in severe defoliation is a typical expression of severe mildew infection and we observed significantly less leaf drop on the PM lines (12-24%) than Herald and Angel (54-70%).

Karoonda - a natural powdery mildew infection occurred on the 2010/11 regeneration in early spring and the shortlisted PM lines showed much lower levels of infection (12-34% leaf infection) than Herald and Angel (52-66%). Naturalised Harbinger medic at the site showed severe infection and defoliation and this may have implications for pasture rotations still reliant on old cultivars.

This is the first opportunity we have had to observe the impact of powdery mildew on the PM lines in the field and we are very encouraged in that so far they support our results from greenhouse studies and field observations at the Waite Campus. However it is important to note that research is needed to identify the severity and prevalence of different races of powdery mildew (if more than one) in SA. At this stage we don't know how strain specific our PM resistance is.

Nodulation

Assessments of nodulation were made at Netherton, Lameroo and Karoonda where several additional rhizobia inoculation treatments were applied. Large responses to inoculation in terms of nodule number (2-fold increase) and early shoot growth (+67%) were measured and improvements in legume vigour was generally observed at the sites.

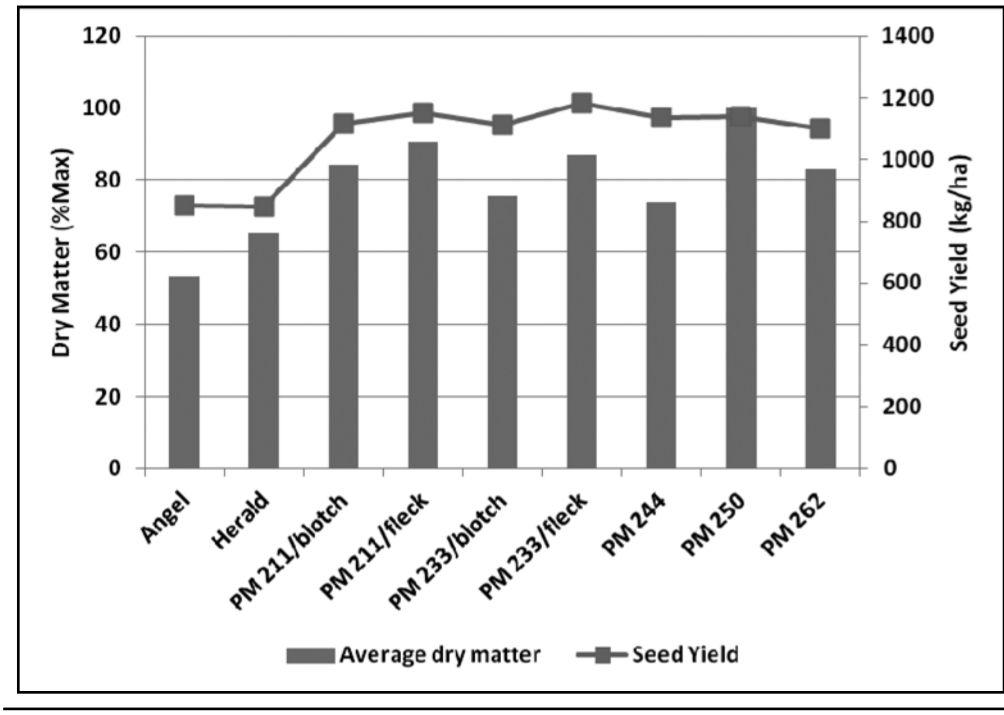

***Figure 1** Relative dry matter production (3 scores from winter to spring - average % site maximum) and seed yield (kg/ha) of advanced "PM" lines compared with Herald and Angel strand medic at Netherton, SA, 2011. LSD (P=0.05) for seed yield = 164 kg/ha.*

The work has confirmed that frequent grower reports of poor nodulation in the Mallee should be taken seriously and more effort is needed to understand why this is occurring. Contrary to general practice, the findings show that medic should be inoculated to ensure good establishment and early vigour when sown on Mallee soils, even where there has been a recent history of medic in the paddock. Further work is planned for 2012.

Multiplication of Root Lesion Nematode *(Pratylenchus neglectus)*

Effects of medic growth on nematode number were made where nematode level at sowing was low (2), medium (16) or high (42). The different nematode levels had been manipulated the previous year using different cereals as part of a GRDC project on P. neglectus supervised by Dr Alan McKay (SARDI). Changes in nematode number after the medic pasture were insignificant where nematode number was initially low. However, where numbers were moderate or high at sowing, they were reduced by 45% and 70% respectively after the medic pasture (Figure 2). Both medics (Herald and RH1) resulted in a similar level of reduction. Medics being developed using RH1 as the nematode tolerant donor parent (based on reduced root damage in the presence of nematodes) should also continue to reduce nematode levels in the farming system.

Root rot at the site prevented differences in root damage and growth between Pratylenchus tolerant and intolerant medic lines being measured.

A similar trial will be established in 2012 at another site where nematode levels have been manipulated.

What does this mean?

The second year of field evaluation has so far confirmed our initial findings.

- We have identified a small group of material which exceed our benchmark strand medic cultivars, Herald and Angel, by up to 30% for dry matter and seed yield.
- The hybrid lines have powdery mildew resistance, SU herbicide tolerance, aphid resistance and larger seeds.
- Further selections have been made and there are good prospects for a future commercial release as a result of this project.
- Unexpected responses to inoculation confirm some grower observations of poor medic nodulation in the Mallee, but the reasons for this remain unclear.
- Root lesion number was substantially reduced after medic growth.

Subject to the final analyses of the 2011 data, we intend to sow a further shortlisted selection of the best lines at additional sites in 2012, as well as monitoring regenerating sites from 2010 and 2011 for hardseed breakdown data and additional agronomic performance data.

Acknowledgements

We gratefully acknowledge the funding by South Australian Grains Industry Trust; technical assistance from Jeff Hill, SARDI; and collaborators: Neville Rowe, Arthurton; Peter & Hannah Loller, Karoonda; Lester & Kaye Cattle, Netherton and Trevor Pocock, Lameroo.

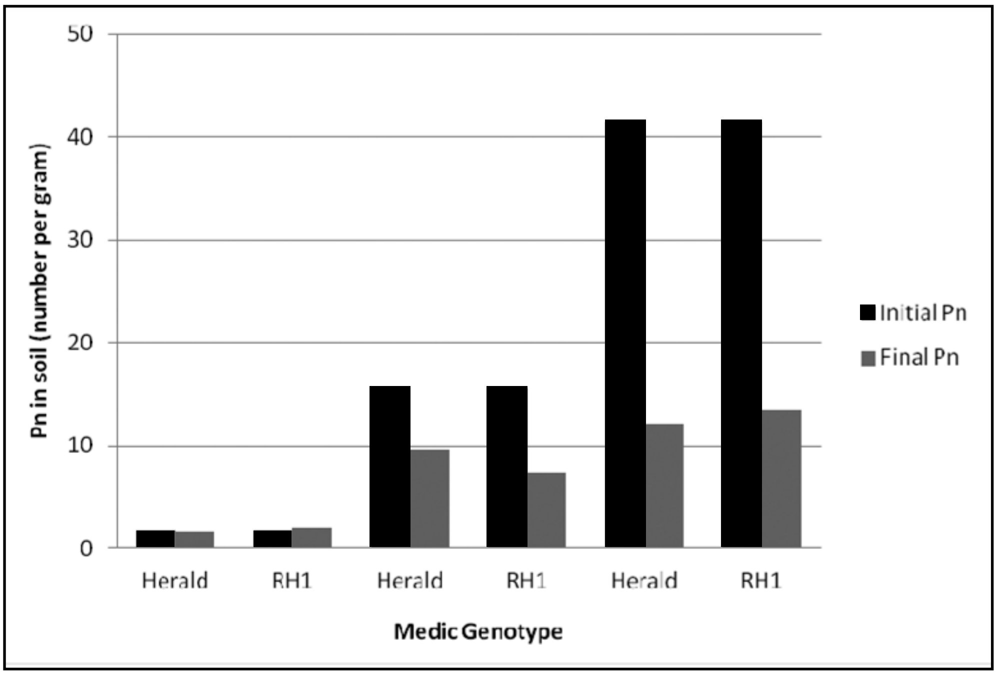

Figure 2 Root lesion nematode (P. neglectus) number measured before sowing (initial Pn) and after a season of medic growth (final Pn) by medic lines Herald and RH1

Vetch in Australian farming systems

Stuart Nagel, Rade Matic and Gregg Kirby
SARDI, Waite

RESEARCH

Searching for Answers

Key messages

- **Vetch is a versatile crop that can be used for grain, pasture, hay/silage or green manure.**
- **Common vetches can be successfully grown in lower to mid rainfall areas of southern Australia where no other legume crops perform consistently well.**
- **It offers disease and weed breaks in rotation and also returns significant amounts of nitrogen to the soil.**
- **New vetch species are showing potential in very low rainfall areas, with trials to be conducted on Eyre Peninsula in 2012.**

Background, the National Vetch Breeding Program

Since it began in 1992 the National Vetch Breeding Program (NVBP) funded by the Grains Research and Development Corporation (GRDC) has focused on breeding common vetch *(Vicia sativa)* varieties for Australian farmers for use as hay/silage, grazing, grain and green manuring. In 2005 the program also included the breeding/selection of woolly pod vetches *(Vicia villosa)* for grazing, hay/silage and green manuring. A South Australian Grains Industry Trust Fund (SAGIT) project was added to the program in 2008, investigating the potential of new vetch species/varieties for very low rainfall areas in Southern Australia. This program is investigating *Vicia palaestina* (leaf dense vetch – LDV), *V. macrocarpa* (big leaf vetch – BLV), *V. articulate* (Bard vetch) and *V. obicularis* (small erect vetch). From this SAGIT project Leaf dense vetch *(V. palaestina)* has shown the best results in areas <300 mm average annual rainfall and the program will concentrate on this species to deliver varieties to farmers for grazing, hay/silage, green manuring and further investigate its potential for grain use.

Vetch uses and benefits

Vetch is a significant component of cereal farming rotations in Australia's low and medium rainfall zones. Its versatility has allowed it to spread into areas where no other legume crops perform well (G. Castleman, 2000). As a legume component in these farming systems, vetch can provide assistance in managing diseases and weed resistance in subsequent crops.

Vetch crops are well adapted to no-till, standing stubble systems aimed at improving soil sustainability. It is a multi-purpose crop grown mostly as a disease break crop in a rotation with cereals in a wide range of soil types from light sands to heavier clay soils. Vetches *(Vicia spp.)* are classified broadly as either grain or forage. The versatility of vetch allows it to be used for: cropping intended for grain or hay production, early grazing as green pasture or for dry grazing, or green manure.

Grain vetches (common vetches) can be successfully grown in lower to mid rainfall cereal areas of southern Australia, vetch crops needs less water per tonne of production than peas, faba beans, medics or clovers (International Centre for Agricultural Research in the Dry Areas – ICARDA, 2000). They do however have poor tolerance to water logging.

Vetches fit well in cereal and canola rotations. Grass-free crops reduce cereal root diseases and provide the added option of crop topping to clean up grass-problem paddocks and prevent herbicide-resistant weeds setting seed.

Previously, the primary constaints for production included diseases such as rust, ascochyta and grey mould. But these constraints have eased with the release of Morava and Rasina, both resistant to rust and tolerant of ascochyta. These varieties can be successfully grown without chemical/fungicide use. Another potential limiting factor is the perceived weediness of vetches, although this has again been overcome by the release of Morava and Rasina which have 98-100% soft seeds together with the availability of herbicides to control volunteer vetch in cereal crops.

An important benefit derived from vetch production is the significant amounts of nitrogen returned back into the soil and the improved levels of organic matter and microbial activity in the soil. Depending on end use, it can return 57, 97, and 136 kg/ha of nitrogen after the production of grain, hay/grazing and green manuring respectively (NVBP data from 5 sites over 3 years), reducing on-farm reliance on chemicals and mineral fertilisers which has both environmental and economic benefits.

Table 1 Grain and dry matter yields for three vetch varieties and advanced lines, from a minimum of 4 sites/year in South Australia in t/ha

Variety/Line	2009		2010		2011	
	Grain	Hay	Grain	Hay	Grain	Hay
Blanchefleur	1.5	3.4	2.7	5.3	2.1	na
Morava	1.0	3.5	2.4	5.5	2.6	4.0
Rasina	1.5	2.9	2.4	5.2	2.9	3.9
SA-34823	2.0	3.7	2.9	5.6	3.2	4.8
SA-34748	2.3	3.7	2.4	5.3	2.9	4.7
SA-35103	1.7	3.4	2.8	5.3	2.9	4.2
SA-34883	na	na	2.8	6.0	3.2	5.1
SA-34884	1.8	3.6	2.6	5.6	3.2	4.8

Importantly common vetch is also an excellent fodder source for ruminants as green grazing, hay or even grain. The grain can be fed ad lib to ruminants and can also be included as up to 25% of the diet in rations for pigs (for details of these trials please contact the NVBP).

In 2012 the NVBP will be conductiong experiments on Eyre Peninsula investigating the performance of advanced breeding lines, which are competing for release as new varieties, with exsisting varieties. As well as trialling the new vetch species for the first time in this area, their perfomance under Eyre Peninsula farming conditions will be evaluated.

For recent results of released varieties compared to advanced lines see Table 1.

Acknowledgements

The National Vetch Breeding Program would like to acknowledge the ongoing support and funding provided to the breeding program by the GRDC which has provided funding for research into vetch since 1992, as well as the support of SAGIT which has been actively funding research into new vetch species for low rainfall regions of southern Australia since 2008.

Section Editor:
Dr Annie McNeill
University of Adelaide

Section 3

Disease

Management of soilborne Rhizoctonia disease risk in cereal crops

RESEARCH

Vadakattu Gupta[2], Amanda Cook[1], Alan McKay[3], Nady Harris[2], Daniel Smith[3], Wade Shepperd[1], Ian Richter[1], Kathy Ophel-Keller[3] and David Roget[4]

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Searching for answers

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

Rainfall
Av. Annual: 340 mm
Av. GSR: 274 mm
2011 Total: 358 mm
2011 GSR: 235 mm

Yield
Potential: 3.1 t/ha, 2.3 t/ha (C), 8.8 t/ha (pasture)
Actual: 1.7 t/ha (W), 1.45 t/ha (C)

Paddock History
2008-11: Trial treatments
2007: Barley
2006: Wheat
2005: Pasture

Soil
Highly calcareous grey loamy sand

Plot size
60 m x 1.48 x 4 reps

Other Factors
Yellow leaf spot and snails

Key messages

- **Grass free canola and pasture reduce Rhizoctonia inoculum levels and can provide effective control of Rhizoctonia for a following cereal crop.**
- **The cereal yield benefits from previous rotation crops were higher in 2011 compared to 2010 as a result of higher Rhizoctonia inoculum levels at sowing in 2011.**
- **Cereals (and grasses) are the main hosts for Rhizoctonia and result in the rapid build up of inoculum.**
- **Rhizoctonia inoculum is reduced following rainfall after crop maturity but levels can recover during dry periods over summer/ autumn.**
- **Following a wet summer (multiple rainfall events), levels of Rhizoctonia inoculum can be reduced from high risk to low risk.**
- **Rhizoctonia inoculum levels at sowing were significantly lower in cultivation treatments compared to no-till however in the trials to date, the decline in inoculum with cultivation has not been sufficient to provide a yield benefit.**

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 first year of a second round of funding of a national GRDC project 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 the 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. Treatment details for 2011 include; conventional cultivation (22 March - wide sweeps; 12 April - narrow points), strategic cultivation (12 April - narrow points), no-till and with several rotations. The trial was sown on 19 May 2011 into reasonable moisture.

Correll wheat was sown 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 with MAP @ 35 kg/ha. Both the canola and medic had excellent establishment in 2011. The trial area received 1.5 L/ha of glyphosate, 1.5 L/ha of trifluralin and 10 ml/ha Hammer® pre-seeding; on 21 June the trial received 30 ml/ha Karate Zeon® for diamond back moth control. Post sowing 1.5 L/ha of Hoegrass® was used for grass control in all plots and 1.1 L/ha of Amicide 625® in the wheat plots for broadleaf control. The medic plots received Broadstrike® at 25 g/ha.

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

What happened?

Wheat grain yields were significantly higher following rotation crops and fallow in both 2010 and 2011 seasons compared to the continuous wheat (Figure 1). In general, wheat yields in continuous wheat rotations were lower in 2011 compared to 2010 season and the rotation effect was greater in 2011 season. Wheat yield after pasture - no-till were higher in 2010 compared to 2011. The yield reduction from cultivation of pasture could be due to a higher mineral N level measured in the surface soil which may have influenced the suppressive effect of native soil microbial communities.

The effect of crop rotation on Rhizoctonia inoculum levels at sowing were similar in both 2010 and 2011 seasons (Figure 2) and similar results were also observed in the Murray Mallee soils at Waikerie and Karoonda and at Galong in NSW over 3 seasons (2009-2011). Rhizoctonia inoculum levels were lowest immediately after grass free canola, medic pasture and fallow, and highest following cereal. However the reduction in the inoculum level lasts only for one year as inoculum builds up on the following cereal crop. In general, the rotation effect on inoculum was greater than the effect of summer cultivation in continuous wheat rotation (Figure 2). Among the different continuous wheat treatments, no-till and strategic cultivation treatments generally showed highest levels of inoculum and conventional cultivation the lowest (Figure 2). In continuous wheat rotations inoculum levels were higher in 2011 season (average 265 pg DNA/g soil) compared to that in 2010 season (165 pg DNA/g soil) and this reflected in the grain yield differences between seasons (1.44 and 1.80 t/ha during 2011 and 2010 seasons, respectively). The final disease impact on yield is due to a combination of inoculum level, and many other factors including the level of soil microbial activity at seeding, the amount of soil disturbance below seeding depth, N levels at seeding and constraints to root growth (e.g. compaction layers, low temperatures, soil moisture etc.).

Inoculum levels of Rhizoctonia have been significantly lower following cultivation compared to no-till systems. This effect is more pronounced on Eyre Peninsula than in the Mallee or NSW. However the cultivation effect on inoculum in the trials to date has only dropped the disease risk from very high to high and there has been no yield benefit observed.

Research over 3 seasons has confirmed that Rhizoctonia can infect wheat crop roots throughout the growing season but the type of symptoms seen above-ground in the field can vary depending upon the time of infection and the severity of disease. Severe damage during the seedling stage (up to 6-8 weeks after germination) generally results in the characteristic patches.

However, when crops are sown early into warm soils, seminal roots can escape severe Rhizoctonia damage, but as the temperature drops below 10°C, the crown roots and seminal roots can still be infected resulting in above-ground symptoms appearing as a general unevenness of the crop instead of distinct patches. If the damage to crop roots continues throughout the spring, it can result in reductions in plant tiller number and grain yield (Figure 3).

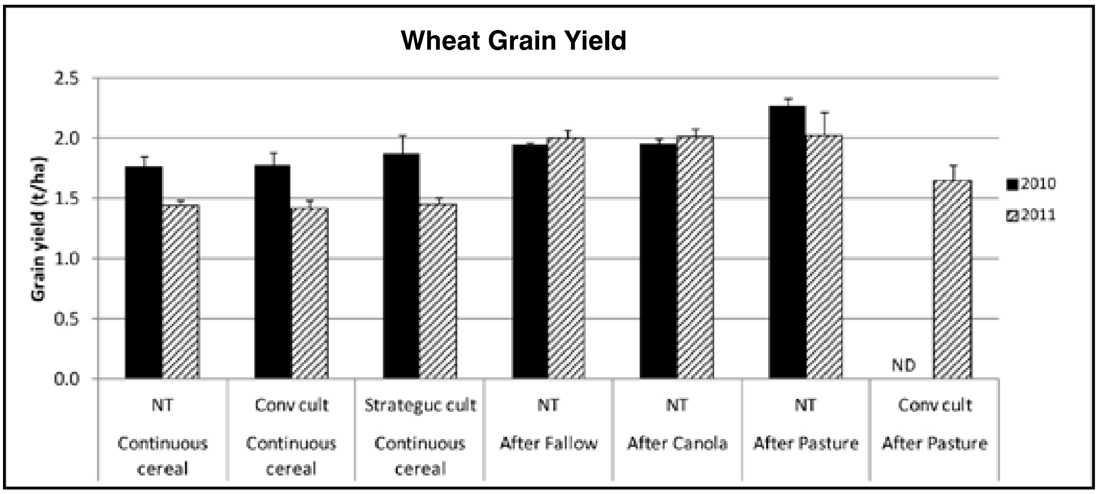


Figure 1 Crop rotation and cultivation effects on wheat grain yield at Streaky Bay during 2010 and 2011 seasons. ND = not determined

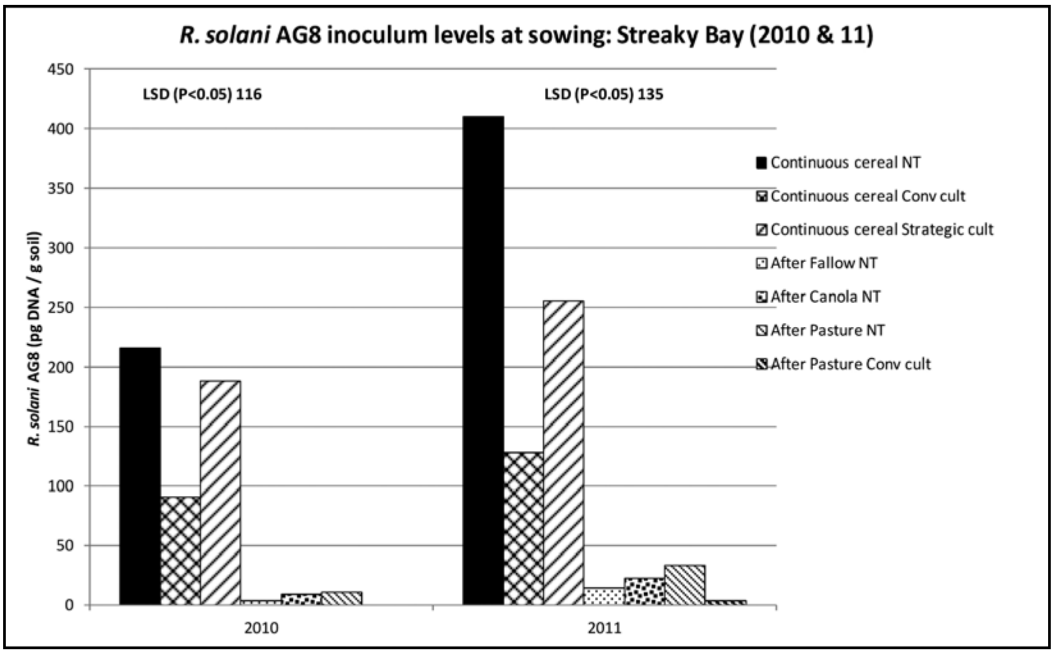


Figure 2 Crop rotation and cultivation effects on the* Rhizoctonia solani AG8 *inoculum levels in soil at sowing of wheat crop during 2010 and 2011

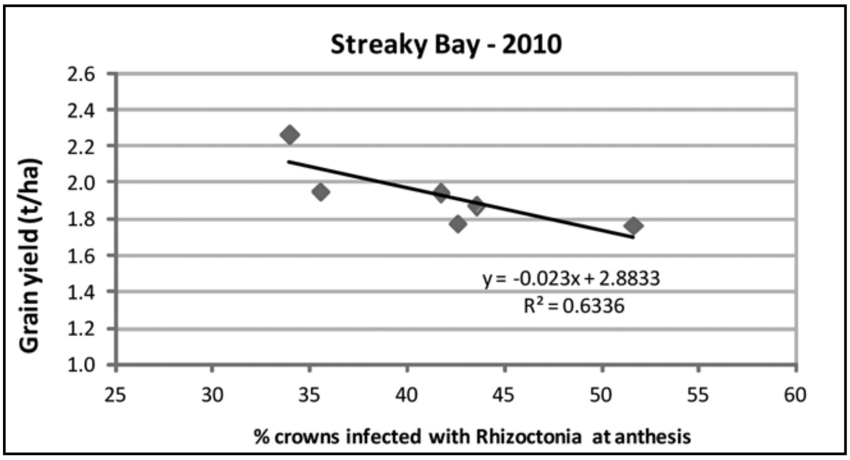


Figure 3 The impact of Rhizoctonia disease incidence on wheat grain yield in 2010

What does this mean?

1. Grass free canola and medic pastures provide a very useful reduction in the Rhizoctonia inoculum level which can result in significant increases in yield. The effect of rotation crops is similar to that after a weed free fallow.
2. Cereals are the key host and inoculum builds up late into the crop season resulting in the rapid build-up of *Rhizoctonia solani AG8* inoculum.
3. Rhizoctonia inoculum levels generally peak at crop maturity and rain post maturity of a crop causes a decline in inoculum, and major rainfall events over summer can reduce inoculum from a high to low risk situation.
4. Multiple significant summer rainfall events that keep soil moist cause Rhizoctonia to decline, but prolonged dry periods that allow the soil to dry out would result in the recovery of inoculum levels.
5. Rhizoctonia damage to crown roots can result in significant loss to wheat grain yield.

Future research will:

- Improve our understanding of the role of summer weeds and other rotation crops.
- Develop more reliable disease prediction based on Rhizoctonia inoculum levels and possibly tests for microbial community structure that affect disease risk.
- Develop techniques to band fungicides to improve disease control (Fungicide project – SARDI).

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.

Amicide 625 - registered trademark of Nufarm, Broadstrike - registered trademark of Dow Agrosciences, Hammer - registered trademark of Crop Care, Karate Zeon - registered trademark of Syngenta, Hoegrass - registered trademark of Bayer Crop Science

Long term disease suppression at Streaky Bay

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

RESEARCH

Searching for answers

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

Rainfall
Av. Annual: 298 mm
Av. GSR: 243 mm
2011 Total: 373 mm
2011 GSR: 238 mm

Yield
Potential: 2.6 t/ha (W) 1.9t/ha (C)
Actual: 0.8-1.8 t/ha (W), 1.1-1.6 (C)

Paddock History
See table 1

Soil
Highly calcareous grey loamy sand

Plot Size
60 m x 1.48 m x 4 reps

Other Factors

Disease
Take all and Rhizoctonia

Livestock
Trial has not been grazed since established in 2004

Economic
Cost of adoption risk: No income from livestock enterprise

Key messages

- **Disease suppression has not developed in this soil type after 8 years.**
- **Higher nutrition treatments allowed crops to cope better with high disease levels in both 2010 and 2011.**
- **Canola will reduce Rhizoctonia inoculum but only one year of wheat will result in high levels of Rhizoctonia inoculum again.**
- **In good seasons the high input treatments have shown that district practice performance is limited by poor nutrition.**

Why do the trial?

A 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 also assessed 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 2011 the trial was in the rotation phase (Table 1). The trial was sown on 6 May. The trial received 1.5 L/ha each of Roundup PowerMAX® and Treflan® pre-seeding, 100 ml/ha Hammer® and 300 ml/ha Li700®. On 21 June the trial received 30 ml/ha Karate Zeon® for diamond back moth control. Post sowing the wheat and canola plots received 700 ml/ha Intervix® and the medic plots received Leopard® at 300 ml/ha.

What happened?

At the beginning of 2010 Take-all inoculum was a medium risk in the Intensive Cereal District Practice rotation and Take-all symptoms developed in that season. Inoculum levels are likely to have increased with the wet spring in that year.

The trial was in the rotation phase in 2011 with wheat, canola and medic plots.

The establishment of all crops was fine with the best medic pasture establishment achieved to date. Earlier in the season the canola in the high input systems looked better than the district practice. Some Rhizoctonia patches were visible in the cereal plots and the district practice treatments were not as even as the continuous cereal high input fluid system. Severe Take-all developed in spring with white heads appearing in all intensive cereal plots but the district practice was more severely affected and this was reflected in yields achieved (Table 2).

What does this mean?

In 2010 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, and this occurred again in 2011 with less disease and higher yields achieved in the high input cereal system.

The microbial respiration in 2010 and the catabolic diversity measurements of 2009, show changing rotation and nutrition have changed the microbial population activity and diversity, but disease suppression did not develop. **When disease suppression develops, it should reduce both Rhizoctonia and Take-all. Since severe Take-all was present in the trial in both of the last two seasons, this indicates disease suppression has not developed in any treatments after 8 years.**

In both the cereal and brassica system higher yields were achieved in the high input fertiliser systems compared to district practice indicating nutrition is limiting production in this environment.

Table 1 Rotations and treatments used in the Long Term Disease Suppression trial

Rotation	Fertiliser each season (kg/ha)	Crops/pastures and seeding rates (/ha)							
		2004	2005	2006	2007	2008	2009	2010	2011
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	Wyalkatchem wheat @ 60 kg	Hindmarsh barley @ 60 kg	Caliph medic @ 5 kg
Intensive Cereal - Distict Practice Inputs	16 P and 7 N applied as MAP	Excalibur wheat @ 55 kg	Keel barley @ 60 kg	Ticket triticale @ 60 kg	Clearfield Stiletto wheat @ 60 kg	Clearfield Janz wheat @ 60 kg	Wyalkatchem wheat @ 60 kg	Hindmarsh barley @ 60 kg	Clearfield Kord wheat @ 60 kg
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	Ticket triticale @ 60 kg	Clearfield Stiletto wheat @ 60 kg	Clearfield Janz wheat @ 60 kg	Wyalkatchem wheat @ 60 kg	Hindmarsh barley @ 60 kg	Clearfield Kord wheat @ 60 kg
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	Wyalkatchem wheat @ 60 kg	Hindmarsh barley @ 60 kg	44C80 canola @ 5 kg
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	Wyalkatchem wheat @ 60 kg	Hindmarsh barley @ 60 kg	44C80 canola @ 5 kg

Table 2 Yield and quality data collected from the Long Term Disease Suppression trial, 2011

Rotation	2011 Yield (t/ha)	Protein (%)	Screenings (%)	Test wt (g/hL)
Intensive Cereal Distict Practice Inputs	0.81	12.8	11.5	384
Intensive Cereal High Inputs	1.79	12.5	13.3	387
Brassica Break District Practice Inputs	1.14	-	-	-
Brassica Break High Inputs	1.59	-	-	-
LSD (P=0.05)	*0.14*			

This trial will not be continued because we believe that we have little further to learn from the treatments present.

Acknowledgements

We would like to sincerely thank the Williams family supporting MAC and research by having the trial on their property and being great co-operators for the last 8 years, and the Streaky Bay Ag Bureau for taking a very active interest in this research.

Thanks to Agrichem for suppling fluid fertiliser products used in the trial.

Roundup PowerMAX - registered trademark of Monsanto, Treflan - registered trademark of Dow Agrosciences, Hammer - registered trademark of Crop Care, Li 700 - registered product of Nufarm Karate Zeon - registered trademark of Syngenta, Intervix - registered trademark of Crop Care, Leopard - registered product of FarmOz.

Disease

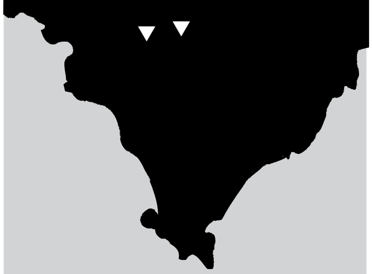
Is disease suppression stimulated by increased dry matter input?

RESEARCH

Amanda Cook, Nigel Wilhelm, Wade Shepperd and Ian Richter

SARDI, Minnipa Agricultural Centre

Searching for answers



Location: Poochera
Ian & J Gosling

Rainfall
Av. Annual: 324 mm
Av. GSR: 245 mm
2011 Total: 320 mm
2011 GSR: 223 mm

Yield
Potential: 2.3 t/ha (W)
Actual: 2.0 t/ha

Paddock history
2011: Pasture/trial treatments
2010: Wheat
2009: Pasture/trial treatments

Soil
Grey calcareous loam

Plot Size
40 m x 4 reps

Location: Minnipa
B & K Heddle

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 374 mm
2011 GSR: 215 mm

Yield
Potential: 2.1 t/ha (W)
Actual: 1.9 - 2.4 t/ha

Paddock history
2011: Wheat
2010: Medic canola hay
2009: Wheat

Soil
Red/brown calcareous sandy loam

Plot Size
40 m x 4 reps

Key messages

- **The fluid fertiliser system increased yield and dry matter production at both sites.**
- **The added carbon treatments with increased microbial activity have not increased grain yield in 2011.**

Why do the trial?

These trials were established on two highly calcareous soils initially to see if disease suppression can be stimulated by increasing organic matter (i.e. carbon) inputs into farming systems under local conditions. The trials have been maintained to monitor the carbon input and breakdown and to determine its impact on grain yield and quality.

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, 2009 and 2010 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) and 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 stubble was added to the soil surface in 2008, 09 and 10 one month before seeding for appropriate treatments. This season both trials were sown with CL Kord @ 60 kg/ha with DAP @ 60 kg/ha following barley in 2010 (also with a standard district practice rate of DAP at seeding across all treatments). The trials were sown on 3 May at Minnipa and on 4 May at Poochera. Both trials received pre sowing 1.5 L/ha Roundup PowerMAX®, 1.5 L/ha Treflan®, 80 ml/ha of Hammer® and 300 ml/ha Li700®, and post sowing 700 ml/ha of Intervix®.

What happened?

The trial sites were chosen for severe Rhizoctonia and low productivity in cereal crops to see if improved production or direct organic matter inputs would make a difference. Soil pH down the profile is similar for both soils but the Minnipa site has higher boron compared to Poochera. Soil organic carbon at the sites is relatively low which is typical for the upper EP. 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) at the start of the trial. Soil Colwell P levels were high for the highly calcareous soils at Minnipa and Poochera (47 P and 50 P (mg/kg) respectively) although are probably still in the deficient range for these soils. These sites have high calcium carbonate (free lime) throughout the profile.

In 2011 all fluid fertiliser treatments increased early plant dry matter and grain yield at Minnipa and Poochera (Table 1 and 2). There were no differences in grain quality at either site.

Screenings were high in all treatments at both sites but this may have been due to grain filling during the dry period in late August through to the end of September.

The greatest amount of added carbon to the system has been through the 10 t/ha stubble treatments (no extra added in 2011 only grown dry matter) with an accumulated total dry matter input of 52 t/ha at Poochera and 49 t/ha at Minnipa over 4 seasons.

Table 1 Soil organic carbon in 2010 and dry matter, grain yield and quality for Poochera in 2011

Treatments in the first 3 years	Total shoot dry matter accumulated 2008-11** (t/ha)	Organic C (%) 2010 0-10 cm	Early dry matter (g/plant)	Late dry matter (t/ha)	Harvest index (%)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	18.3	1.5	0.27	5.2	40	2.0	13.5	8.9
Barley & Vetch	12.0	1.5	0.17	4.0	42	1.5	13.5	7.6
Control wheat	15.0	1.5	0.21	4.5	41	1.3	13.5	7.7
Canola*	19.2	1.4	0.30	5.3	42	1.9	13.8	7.2
Wheat DM*	15.9	1.6	0.26	4.2	43	1.9	13.5	7.9
Stubble 5t	30.8	1.5	0.17	4.3	40	1.4	13.5	8.3
Stubble 10t	52.6	1.6	0.18	4.9	38	1.5	13.5	7.9
LSD (P=0.05)	*2.3*	*0.1*	*0.03*	*ns*	*ns*	*0.2*	*ns*	*ns*

** Fluid Fertiliser system, ** includes added chaff*

Table 2 Soil organic carbon in 2010 and dry matter, grain yield and quality for Minnipa in 2011

Treatment	Total shoot dry matter accumulated 2008-11** (t/ha)	Organic C (%) 2010 0-10 cm	Early dry matter (g/plant)	Late dry matter (t/ha)	Harvest index (%)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	15.9	1.2	0.27	3.7	53	2.5	13.5	8.7
Barley & Vetch	12.0	1.1	0.17	4.1	43	1.9	13.5	8.9
Control wheat	14.2	1.1	0.20	3.7	50	1.9	13.6	9.5
Canola*	15.2	1.1	0.30	3.6	54	2.7	13.7	9.2
Wheat DM*	15.5	1.2	0.26	4.0	50	2.5	13.7	10.5
Stubble 5t	28.7	1.1	0.17	3.4	52	2.0	13.5	10.1
Stubble 10t	49.1	1.3	0.18	3.6	48	2.1	13.5	8.3
LSD (P=0.05)	*2.1*	*0.11*	*0.03*	*ns*	*ns*	*0.1*	*ns*	*ns*

** Fluid Fertiliser system, ** includes added chaff*

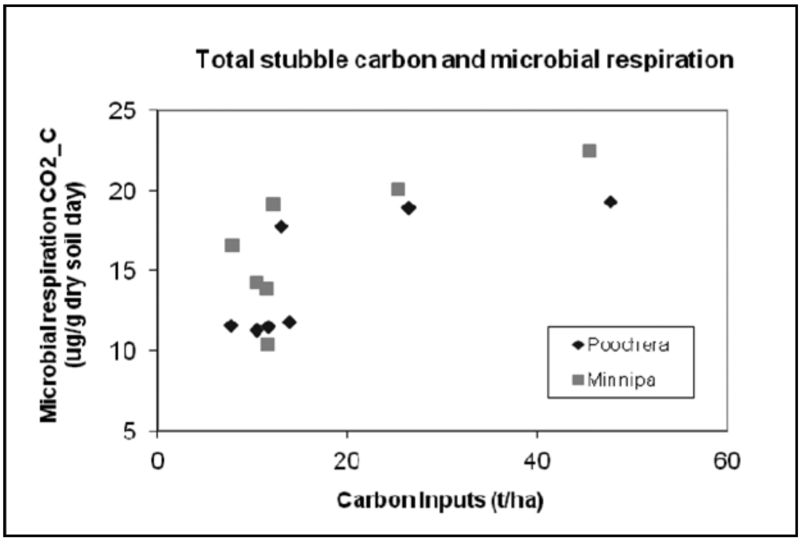


Figure 1 Added carbon inputs (t/ha) and microbial respiration (CO2-C (ug/g dry soil/day) at Poochera and Minnipa sites, 2010

Measurements taken in 2010 showed that added carbon increased soil microbial respiration (Figure 1) but this did not result in increased grain yield for 2011.

What does this mean?

The fluid fertiliser system increased yield and dry matter production at both Poochera and Minnipa for the fourth season in a row. The added carbon treatments have shown increased microbial activity due to the added stubble but this was not enough under standard district practice to support increased grain yields in 2011.

Acknowledgements

Thanks to Goslings and Heddles for allowing us to have trials on their property. Thank you to Jake Pecina for helping with sampling this season.

Roundup PowerMAX - registered trademark of Monsanto, Treflan - registered trademark of Dow Agrosciences, Hammer - registered trademark of Crop Care, Li 700 - registered product of Nufarm, Intervix - registered trademark of Crop Care.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Disease

N12 soil nitrogen and grain yield

Amanda Cook, Nigel Wilhelm, Wade Shepperd and Ian Richter

SARDI, Minnipa Agricultural Centre

RESEARCH

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Searching for answers

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 2.8 t/ha
Actual: 2.3 to 2.8 t/ha

Paddock History
2011: CL Wheat
2010: Wheat
2009: Wheat
2008: Barley

Soil Type
Red sandy loam

Plot Size
40 m x 4 reps

Key messages

- **Only medic based systems from 2008 and 2009 resulted in higher wheat yields in 2011.**

Why do the trial?

This trial was originally established as part of the SAGIT funded project to investigate the impact of soil carbon and nitrogen cycling on disease suppression. The treatments were designed to test whether nitrogen management options typical for upper EP would 'switch off' disease suppression. The trial is in paddock N12 of the Minnipa Agricultural Centre (MAC) which has been continuously cropped for 28 years and has developed disease suppression. The trial has now been continued as part of the National Healthy Soils Project.

How was it done?

The trial was established in 2008 with the initial treatments designed to increase soil mineral nitrogen to different levels. The treatments listed in Table 1 were imposed in 2008 and 2009. The treatments in 2008 and 2009 included nitrogen fertilisers, either urea @ 60 kg/ha or sulphate of ammonia @ 120 kg/ha with application split between sowing and tillering, 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 spray-topped at booting giving an extra treatment.

In 2010, all treatments were sown with Hindmarsh barley @ 60 kg/ha with 60 kg DAP on 31 May. In 2011, all treatments were sown with CL Kord wheat @ 60 kg/ha with 60 kg/ha of DAP on 12 May. A pre-seeding application of 1.5 L/ha Sprayseed® with 200 ml/ha Striker® and 300 ml/ha of Li700® was followed mid season by 750 ml/ha Intervix®. Grain yield and quality were measured at the end of the season.

What happened?

The previous rotations of 2008 and 2009 still influenced grain yield and quality this season. The medic systems had higher yields and protein (Table 1) indicating this system is being driven by soil nitrogen levels. Despite high mineral N reserves at the start of the trial, barley growth and quality in 2010 were also limited by nitrogen. Screenings were high in all treatments but this may have been due to grain filling during the dry period in late August through to the end of September.

What does this mean?

MAC N12 is a low nitrogen system and in 2010 grain yields and quality were influenced by the nitrogen levels imposed in 2008 and 2009. In 2011 some of the medic based systems had slightly higher yield and protein two seasons after the treatments were imposed.

Acknowledgements

Sprayseed – registered trademark of Syngenta, Striker – registered trademark of Nufarm, Li700 – registered trademark of Nufarm, Intervix – registered trademark of Crop Care.

Table 1 Soil mineral nitrogen in autumn of 2010 and grain yields and quality in 2010 and 2011

		2010			2011		
Treatment (2008 and 2009)	**Total mineral N (kg/ha) 0-60 cm**	**Yield (t/ha)**	**Protein (%)**	**Screenings (%)**	**Yield (t/ha)**	**Protein (%)**	**Screenings (%)**
Amm Sulphate	64	5.1	7.6	8.8	2.5	10.4	13.6
Wheat Control 1	66	4.3	7.2	5.5	2.5	10.2	14.7
Wheat Control 2	53	4.4	7.7	6.5	2.5	10.2	14.5
Fallow	74	5.6	9.3	21.0	2.3	10.7	13.1
Fallow/Wheat	56	4.5	7.5	6.7	2.5	10.1	13.5
Medic Fallow	83	5.9	9.1	19.7	2.4	10.8	14.9
Medic Grass	115	5.9	9.1	19.7	2.7	10.8	14.2
Medic mow	98	5.8	9.0	16.8	2.5	10.7	13.5
Medic Spraytop	118	5.8	9.7	23.3	2.9	10.6	12.1
Medic/Wheat	54	4.6	7.3	7.9	2.5	10.3	13.3
Peas	89	6.0	8.8	18.1	2.5	10.4	14.5
Urea	52	5.4	8.0	14.1	2.6	10.4	11.3
Wheat spraytop booting	96	6.0	7.7	6.0	2.5	10.3	14.1
LSD (P=0.05)	*31*	*0.4*	*0.5*	*7.5*	*0.2*	*0.4*	*ns*

White grain on Eyre Peninsula

Hugh Wallwork

Principal Cereal Pathologist, SARDI

RESEARCH

Key messages

- **Spores travel long distances so reducing stubble will only reduce white grain levels if adjacent paddocks are managed in the same way.**
- **Spraying fungicides is unlikely to be the answer to white grain problems.**
- **All the common wheat varieties grown on Eyre Peninsula can be susceptible to white grain.**
- **If growers observe white grain they may be able to reduce contamination by blowing away lighter grain during harvesting.**
- **Trials and monitoring will be ongoing on EP during 2012.**

Background

White grain describes the chalky white appearance of wheat grain infected with a fungus called *Botryosphaeria.* It first appeared in South Australia and Victoria during the 2010 harvest with the highest incidence occurring around Buckleboo, Kimba and Cleve. White grain reappeared in 2011 harvest in the same area on the EP but also more widely downwind in the Mid North and in southern Victoria.

Botryosphaeria zeae was first recorded on wheat in Queensland in 1999 and again in 2000. The disease was not detected again until 2007 and 2008 (also NSW) and then again in 2010. Very little white grain was recorded in Queensland in 2011. The incidence of white grain in the Northern Region appears to have been associated with increased spring rains.

White grain resembles grain infected with *Fusarium graminearum* (head scab) which has been called "tombstone grain" in North America. Grain infected with head scab carries toxins that mean the grain cannot be safely used for consumption by humans or animals. It is for this reason that grain that resembles head scab is a problem for markets.

In 2008 a Queensland study showed that grain infected with *Botryosphaeria zeae* was not toxic to weaner pigs and was therefore unlikely to be toxic to other animals. A survey of white grain of wheat conducted by the Cereal Pathology group in SARDI has shown that none of over 100 white grain samples collected in SA carries head scab and that therefore there are unlikely to be any problems when this grain is fed to animals.

So what can we do?

Monitoring of grain receivals and a survey of growers indicates that all the common varieties grown on Eyre Peninsula can be susceptible to white grain. Some evidence suggests that CLF Stiletto may be less susceptible than other varieties. Assessments of white grain in two variety trials near Booleroo Centre did not correlate very well with each other so the rankings of varieties is still uncertain.

During 2012, specific variety trials are planned for sowing into heavily infected stubbles on eastern EP to try and obtain more reliable assessments of varietal resistance.

Two fungicide trials with a range of treatments applied at two different times were sprayed and harvested at Kimba and Cleve by staff at the Minnipa Agricultural Centre in 2011. The Cleve trial showed no infection with white grain whereas the Kimba trial had white grain levels of 1.3% in the untreated plots. No significant effects or trends were observed for any of the treatments in the Kimba trial.

We now believe that infection occurs when fungal spores infect the emerged heads directly from infected stubbles. Under this scenario the only fungicide treatment that might be effective would be a high rate of chemical applied one or more times post flowering and at a time when there would be no visual evidence that infection was occurring. It is hoped that one or more such spray trials can be run in 2012 to test this hypothesis. Either way spraying of fungicides is unlikely to be the answer to white grain problems.

Given that the inoculum survives in cereal stubbles, reducing stubbles in paddocks will clearly have a beneficial effect on white grain infection levels. The problem is that the fungal spores appear capable of travelling over large distances so reduction of stubbles in one paddock may only provide a small benefit unless stubbles in other nearby paddocks are also reduced.

Infected seed generally will not germinate and infection of seed and soil borne inoculum will not be significant given the high levels of infection in stubbles.

Some grain samples show shrivelled white grain whilst in other samples the white grain is similar in size to uninfected grain. It is likely that these differences relate to the crop growth stage when head infection occurred, with early infection leading to increased shrivelling. When growers observe this prior to harvest then it may be possible to significantly reduce the level of grain contamination during the harvest process by blowing away the lighter grain.

In 2012 we are planning to operate two spore traps in the Kimba area to monitor the release of spores of *Botryosphaeria* as they are produced on the stubble. Along with nearby weather recorders this will help us to better understand the biology of the white grain fungus, including its survival and spread within and between paddocks and to provide better predictions about future infection levels. At the same time we are planning, using GRDC funds, to conduct infection studies on the Waite Campus, to better understand the conditions (humidity period and temperatures) required for infection and to also use controlled environment conditions to assess varietal differences.

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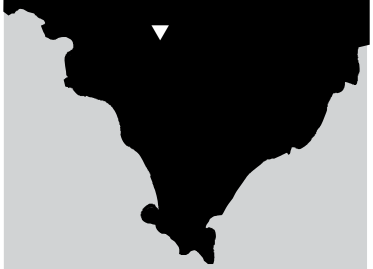
Managing Pratylenchus/root diseases

Alan McKay[1], Sjaan Davey[1], Amanda Cook[2], Wade Shepperd[2] and Ian Richter[2]
[1]SARDI Molecular Diagnostics, Waite, [2]SARDI, Minnipa Agricultural Centre

RESEARCH

Disease

Searching for answers



Location: Minnipa Ag Centre (S4)

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Paddock History
2010: Peas
2009: Wheat

Soil Type
Red sandy loam

Plot Size
12 m x 1.5 x 5 reps

Yield Limiting Factors
None

Key messages

- **Yield losses caused by Pratylenchus are still being defined, in the meantime growers should focus on implementing management strategies to reduce impact of Rhizoctonia; most of these also reduce impact of Pratylenchus.**
- **Cereal cyst nematode (CCN) is a potential risk this year, particularly in continuous cereal paddocks with high frequency of susceptible varieties e.g. Wyalkatchem.**
- **Take-all risk is also increasing in continuous cereal and cereal/grassy pasture rotations; this is driven by above average growing seasons on Eyre Peninsula for the past few seasons.**
- **Field trials are underway to assess the yield losses caused by Pratylenchus in current varieties. Results of the first trials indicate yield losses caused by Pratylenchus in 2011 were relatively small; this program is continuing to determine if losses are higher in different seasons.**
- **Pratylenchus multiplication varies between varieties, check the 2012 Cereal Variety Disease Guide for the latest resistance ratings. Note; some barley varieties are better hosts for *P. neglectus* than previously thought.**

Why do the trial?

The trials on Eyre Peninsula are part of a new larger program funded by GRDC (DAS00116) to develop reliable and efficient field trial protocols to determine the tolerance (nematode effect on yield) of new varieties to *Pratylenchus neglectus*, P. thornei and CCN plus calibrate the bioassays used to screen varieties for resistance (the effect a variety has on nematode levels in soil).

P. thornei usually occurs in the deep self mulching soils in southern Qld, northern NSW and the Wimmera region of Victoria. This nematode can cause substantial yield losses especially in the northen region. On Eyre Peninsula it occurs in soil types that are quite different from the other regions and is spreading. The *P. thornei* trials on Eyre Peninsula are replicated in Victoria near Horsham to determine if the varieties respond the same in both areas.

Background

There are two Pratylenchus species (also known as root lesion nematodes) on Eyre Peninsula, *P. neglectus* and *P. thornei. P. neglectus* is probably native and is widespread while *P. thornei* is most likely introduced and appears to be spreading. *P. thornei* is also considered to be more damaging than *P. neglectus.*

Previous research conducted in the early 2000s found that both Pratylenchus species can cause significant yield losses in the southern region, but the losses were often difficult to repeat across years. The new program aims to use new statistical methods and greater use of soil DNA tests, to develop a more robust field protocol to assess yield losses and define the seasons in which losses are most likely to occur.

How was it done?

DNA assays were used to select trial sites that contained only *P. thornei.* The best sites were then sampled on a grid to help position the sites.

The Minnipa trial was established in 2010 using narbon beans (susceptible) and field peas (resistant) to create paired plots with high and low *P. thornei* levels. These were over sown with 34 wheat and barley varieties in 2011 using a randomised block split plot design with 5 replicates.

P. thornei tolerance was assessed by comparing the difference in yield of each variety in the paired high/low plots. These plots were also sampled at seeding and after harvest to assess the variety effects on the nematode population.

- Wheat was sown on 24 May at 180 plants/m^2 and barley at 145 plants/m^2, with 50 kg/ha DAP.
- Treatments - 29 wheat and 4 barley varieties were sown in split plots with high and low levels of *P. thornei.*
- Measurements – yield plus initial and final nematode numbers per gram of soil.

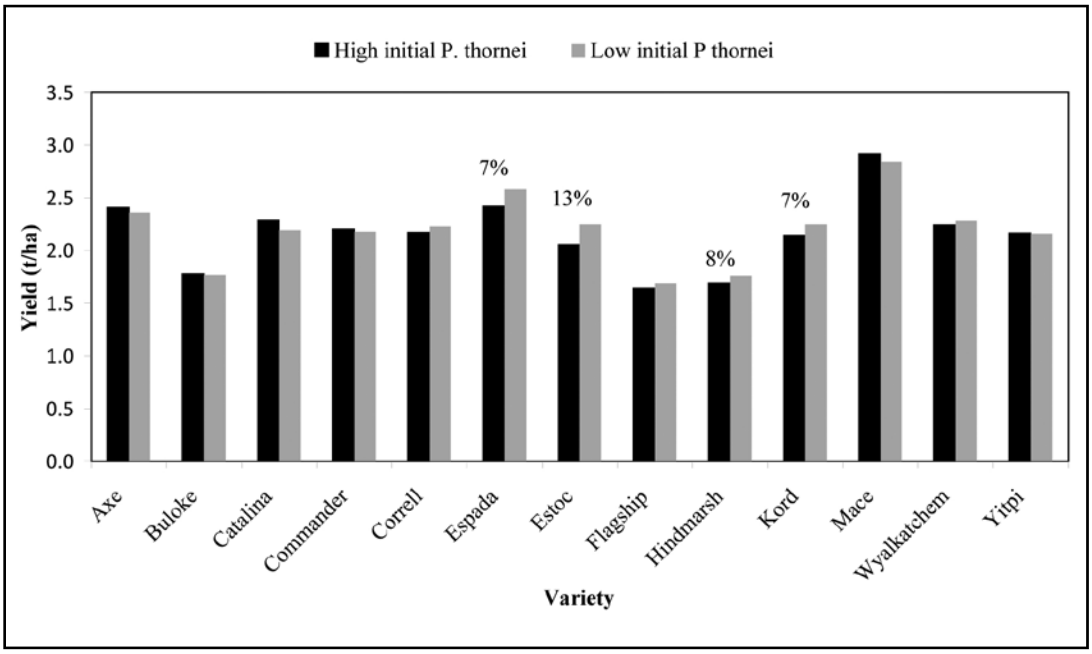


Figure 1 Yield of different wheat and barley varieties in paired plots with low (18) and high (133) levels of* P. thornei*/g soil at seeding at Minnipa 2011. Intolerant varieties lose more yield in the plots with high* P. thornei *level.

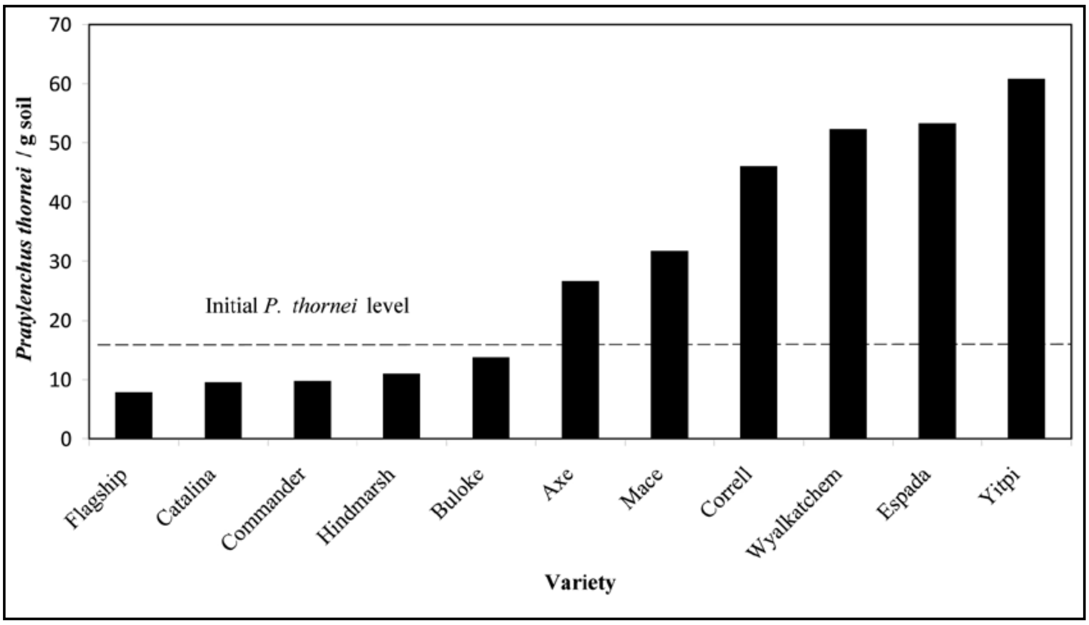


Figure 2 Effect of variety on P. thornei levels after harvest 2011 when levels at seeding were low, 18* P. thornei *per gram soil

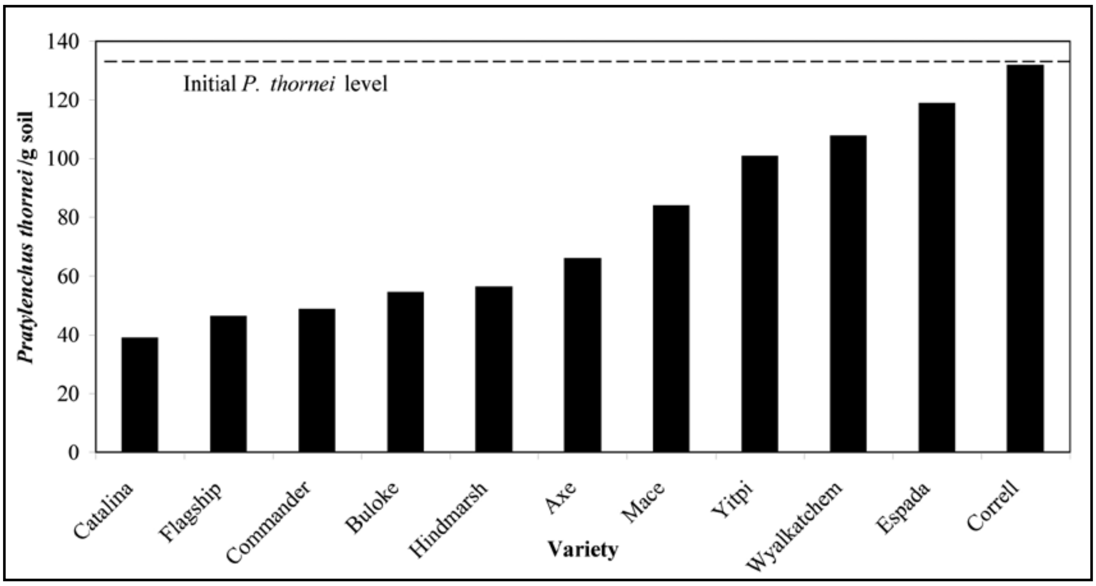


Figure 3 Effect of variety on P. thornei levels after harvest 2011, when levels at seeding were high, 133* P. thornei *per gram soil

What happened?

Yield losses caused by *P. thornei* were small. The varieties affected the most were Estoc (13%), Espada (7%), Kord (7%) and Hindmarsh (8%) (Figure 1).

Varieties varied greatly in their impact on the final nematode levels.

- The varieties that increased the low nematode levels the most were Axe, Correll, Espada, Mace, Wyalkatchem and Yitpi (Figure 2).
- Most varieties, except Correll reduced *P. thornei* levels in the plots that had high levels at seeding (Figure 3). Note; analysis of this data is still proceeding.

What does this mean?

- The levels of resistance in different wheat and barley varieties vary greatly; their resistance ratings are summarised in the latest Cereal Disease Variety Guide.
- Yield losses up to 10% were observed in some varieties in the high *P. thornei* plots which averaged >100 *P. thornei*/g soil at Minnipa in 2011. These losses are much smaller than would be expected in Qld and northern NSW for equivalent levels of *P. thornei.*
- The high *P. thornei* populations in this trial rarely occur in the field.
- Yield losses may be higher under different growing season conditions; this will be investigated in the current project.

How does this relate to previous information?

There is very little yield loss data for *P. thornei* on Eyre Peninsula to compare to. However the losses were slightly lower than in the Victorian trial which had a lot of stored moisture.

Will it require further research or a change in direction?

The trials will be repeated for at least one more season to determine if losses are higher under different growing conditions.

The 2011 results at Minnipa show that "check" varieties used in Qld to classify tolerance of new varieties do not work in the southern region, probably because the magnitude of the losses is smaller. Further work will aim to improve the efficiency of the protocol using split plots.

Can you validate the results with research from other areas?

Similar results have been obtained in parallel trials conducted near Horsham (Vic). However, this work needs to continue for at least one more season to assess impacts under different growing conditions.

Is the issue localised or does it apply elsewhere?

- *P. thornei* is the most important soilborne pathogen constraining yield in northern NSW and southern Qld. It has also been shown to be capable of causing significant losses in Victoria. It occurs in the deep self mulching clays; however it is clearly adapted to the soils on upper Eyre Peninsula and will probably spread further.
- *P. neglectus* is more widespread but it does not appear to be as damaging as *P. thornei.*
- The new research program aims to better understand the magnitude of losses caused by both nematodes and the seasonal conditions under which these are likely to occur.

Recommendations or take home messages

- Until more information is available on Pratylenchus, growers should focus on managing Rhizoctonia, Take-all and CCN. Most management practices to reduce yield losses caused by Rhizoctonia will also help reduce losses caused by Pratylenchus.
- The trial results show P. thornei multiplication varies greatly between varieties. This means crop/variety selection is a useful tool to manage Pratylenchus.
- If Pratylenchus levels are known to be high in a specific paddock, then growing a variety rated MR will help reduce levels, but make sure the variety is well adapted. At this stage, don't risk growing less adapted varieties just because they are more resistant to a specific Pratylenchus species.

Acknowledgements

This work was funded by GRDC. Soil samples were processed by the SARDI Molecular Diagnostic Group, parallel trials in the Victoria were conducted by Dr Grant Hollaway and Seona Casonato (DPI Victoria). MAC for providing trial site and sampling. Tomney's for providing Narbon bean seed.

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Managing Take-all and Crown rot

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EXTENSION

Key messages

- **Incorrect identification could be costly as with Take-all and Crown rot require different management. Check the bases of plants for symptoms, don't rely on whiteheads (which need not even be disease related).**
- **Even where whiteheads are not present, significant yield losses can occur.**
- **Know the risk of yield loss in your paddocks before sowing. For 2012 crops, this will mean sending summer/ autumn soil samples to the Predicta B™ testing service for analysis.**
- **The most effective management tool for both diseases is host-free breaks.**
- **Where old cereal rows have medium to high inoculum levels, sowing between those old rows can reduce yield losses from these diseases, but only if the inter-row has low levels of inoculum.**
- **When Take-all inoculum levels are medium to high, the best option is a 12 month break from hosts. If susceptible cereals must be sown, keep the paddock(s) weed free and sow the at-risk paddock(s) last in the cereal cropping program.**
- **When crown rot inoculum levels are medium to high, the best option is a break from hosts (2-3 years may be needed). If cereals must be sown then barley is least likely to show yield loss, followed by oats and bread wheat. Do not apply excessive nitrogen early in the season.**

Why consider these diseases before the 2012 cropping season?

Take-all has been building up in recent seasons and could pose a significant risk in continuous cereal paddocks in 2012. Take-all inoculum can build to high levels over 2-3 seasons with good spring rains such as those seen on EP during 2010 and 2011. With this in mind, it is timely to consider Take-all again as it could be a serious problem if there are good spring rains in 2012.

Crown rot has been a problem in recent seasons, where dry spring conditions have favoured whitehead development and yield loss from this disease. With little moisture stress during grainfill in 2010 and 2011, whiteheads were unlikely to have been seen. However, there may still be high levels of crown rot inoculum in paddocks and this could pose a risk if there is moisture stress during grainfill in 2012.

Take-all

Paddock symptoms. The most obvious symptom is patches of whiteheads in wheat. However, Take-all may be present and causing significant yield losses even where whiteheads are not seen.

Plant symptoms. Blackening of the root stele (inner core of the root) is characteristic for Take-all and is best seen 6-8 weeks after sowing. In wet springs, the sub-crown internode may be black and this blackening may extend up the tillers to form a "black sock" symptom.

Assessing the risk for the next season. During late summer/ autumn, send soil samples for analysis using the Predicta B™ Root Disease Testing Service.

Inoculum build-up and reduction. Inoculum on infected roots and crowns which means that increased susceptible cereals in the rotation, decreased stubble burning and decreased tillage all favour increase of take-all inoculum. Take-all inoculum builds up on susceptible cereals and grasses over 2-3 seasons with average to above average spring rainfall and can be reduced to a low level by one host-free year.

Inoculum changes over summer/ autumn. Take-all inoculum can reduce by up to 30% after summer rainfall events of 25 mm or more. Multiple rainfall events can have a cumulative effect, particularly where there is low soil mineral N (<10 kg N/ha). Inoculum may increase if a "green bridge" of susceptible volunteer cereals and grasses is allowed to develop in autumn.

Resistance. All wheat and barley cultivars are susceptible to Take-all, cereal rye is moderately resistant, triticale cultivars are generally susceptible and oats are resistant to the wheat attacking variant of Take-all. Barley grass, brome grass and silver grass are all susceptible while most annual ryegrass populations are resistant to the wheat attacking variant of Take-all. Oats are susceptible to a second variant of Take-all, but this variant is rare.

Infection of new plants. Take-all infects plant roots when they come close to infected plant residues.

Managing Take-all. This disease is best controlled by having one year free of hosts (no susceptible cereals or grasses).

If Take-all levels are medium to high and a susceptible cereal must be sown, keep the paddock host-free before sowing and sow the paddock as late as possible in the cereal sowing program. Sow between the rows of the previous cereal if this option is available and the inter-row has low inoculum levels. Ensure adequate nutrition as plants low in P, N and Mn are more susceptible to Take-all. In some areas with neutral to slightly acid soils, using ammonium (not nitrate) forms of nitrogen may reduce the risk – local advice is needed.

Fungicides applied in fertilizer, in furrow or on seed can control Take-all, but this may not be economic.

Crown rot

Paddock symptoms. The most obvious symptom is whiteheads scattered throughout wheat crops. However, Crown rot may be present and causing significant yield losses even where whiteheads are not seen.

Plant symptoms. Honey-brown to dark-brown (but not black) stem bases are characteristic for Crown rot and are easiest to see during grainfill (pull back leaf sheaths to expose the stem). Pink discolouration at nodes or pink fluffy growth inside stems is also diagnostic for Crown rot.

Assessing the risk for the next season. Measure plant infection (brown stem bases) in a current cereal crop, but not oats as they do not show clear symptoms. Collect a minimum of 50 plants across the paddock and inspect each plant for stem browning. General rule of thumb for risk of yield loss in the coming season: low risk – less than 10% of plants infected; medium risk – 10-25% of plants infected; high risk – more than 25% of plants infected.

Alternatively, during summer/autumn, send soil samples for analysis using the Predicta B™ Root Disease Testing Service. This is the best option after a non-cereal or where a cereal crop will be sown between the rows of a previous cereal crop.

Inoculum build-up and reduction. Inoculum carries over on infected plant residues - crowns, stems and leaf material. This means that increased (susceptible) cereals in the rotation, decreased stubble burning and decreased tillage all favour increases in inoculum. Inoculum can increase greatly under one cereal crop and it may take 3 or even 4 years host-free to reduce to low levels.

Inoculum changes over summer. Crown rot inoculum has not been found to change significantly over summer, although information is limited for wet summers.

Resistance. All cereals are susceptible to Crown rot but oats do not show symptoms and barley only rarely develops whiteheads. Many of the grasses found on EP are susceptible to Crown rot, including annual ryegrass, brome grass, wild oats and barley grass.

Infection of new plants. Crown rot infection occurs in sub-crown internodes, leaf sheaths and stem bases when they come close to infected residues.

Managing Crown rot. Reducing inoculum is critical for managing this disease and is best done by having a host-free break - up to a 3 year break maybe needed to reduce inoculum to low levels. The type of break is not critical, so choose the break on economic and agronomic grounds.

If the Crown rot risk is medium to high and cereals must be sown, the following management information may assist in reducing yield loss. Sow between the rows of the previous cereal if this option is available and the inter-row has low inoculum levels. Sow less susceptible cereal types - in order from lowest to highest risk of yield loss are barley, cereal rye, oats, bread wheat, triticale and durum. Do not apply too much nitrogen early as this may produce bulky growth and so increase the risk of moisture stress during grainfill. Ensure trace element levels are good – application will not reduce crown rot, but will assist the plants to cope.

Crown rot is not controlled by commercially available fungicides, nor by resistant/tolerant cultivars currently available in SA.

Burning and cultivation may provide a medium to long-term advantage. However, where inoculum levels are high, they are unlikely to significantly decrease yield losses in a cereal planted in the same season. The best use of burning and/or cultivation (providing they do not cause erosion) is immediately prior to a break crop - this is most likely to provide benefits where the cereal stubble is known to be highly infected with Crown rot.

Cereal variety disease guide 2012

Hugh Wallwork and Pamela Zwer
SARDI, Waite

Summary of 2011 season and implications for 2012

Rain at intervals throughout summer and autumn played a large role in allowing inoculum of powdery mildew and the leaf and stem rusts to build up early in wheat, barley and oat crops leading to widespread occurrences of these pathogens. It was only the timely application of foliar sprays by most growers that prevented serious yield losses. Summer rain also allowed the wheat curl mite *(Aceria tosichella)* to survive on self sown cereals and this led to an outbreak of Wheat streak mosaic virus on the upper EP in October.

The cold winter and dry September conditions greatly reduced the incidence of net and spot forms of net blotch and scald in barley although some early sown crops on Eyre Peninsula still saw some severe infection with NFNB.

Rains from early October onwards are most likely responsible for white grain, caused by the fungus *Botryosphaeria*, returning as a problem in wheat for the second year running. As in 2010 the most serious damage occurred on north eastern Eyre Peninsula, but in 2011 the disease was recorded more widely and in most areas of the state other than the western and southern Eyre Peninsula and southern Yorke Peninsula. Many loads were downgraded or rejected at silos whilst others were not delivered. There seems to have been no clear reason why some paddocks were infected and other similar paddocks alongside were not. Stubble borne inoculum will ensure that the disease remains a threat for 2012 but the severity will likely depend on spring weather conditions. At this stage it appears that all varieties can be affected and there is evidence that some varieties such as Wyalkatchem are worse than others. However the data obtained from two variety trials is not consistent enough to provide reliable ratings at this stage. From a spray trial at Kimba there is evidence that fungicides are not effective in controlling grain infection.

Stripe rust

Fortunately, stripe rust did not appear to survive on summer volunteers in SA and was first observed in crops, mostly Mace between Bute and Wandeerah in the Mid North, in the first week of August. Most of the rust has been the strain 134E16A+17+ which is virulent on the Yr17 gene present in Mace, Gladius and Espada. With a much larger area expected to be sown to Mace in 2012, expect stripe rust to develop much faster and spread much farther than in previous years. Use of in-furrow fungicides should be considered in all prone areas and growers should be prepared to spray at short notice in winter and spring.

Stem and leaf rust in wheat

A new strain of leaf rust emerged in 2011 rendering Wyalkatchem moderately susceptible to leaf rust rather than resistant as before. At the end of the season a number of other varieties (Correll, Gladius, Kord CL Plus, Justica CL Plus and Yitpi) also appeared to be susceptible to leaf rust rather than moderately susceptible as previously rated. It is not known at this stage whether a new strain is involved or whether particularly conducive environmental conditions are responsible for these more severe observations.

With widespread rains in December, volunteer wheat will allow both stem and leaf rusts to survive the early part of the year. If mid-late summer rains occur then a repeat of the threats posed by these diseases in 2011 will recur in 2012. Whilst the area sown to wheat varieties susceptible to stem rust may reduce in 2012, the increased virulence on Wyalkatchem will ensure that a large area will be sown to susceptible wheat and this will increase the risk of this disease in 2012.

Barley leaf rust

Leaf rust was by far the most damaging disease of barley in 2011. Summer rains allowed the rust to survive and spread early far and wide and many crops were seriously affected. Most of the common varieties are now all susceptible or very susceptible with virulence on Buloke and Scope now common everywhere in the state. Virulence on the gene Rph3 has been detected in SA so Yarra is now also susceptible. Oxford and Henley which carry two leaf rust resistance genes, Rph3 and Rph20, have lost some of their resistance and are now rated MR/MS where this strain occurs. Any further summer rains will again create the potential for significant problems with this disease in 2012.

Powdery mildew

The area on the lower Eyre Peninsula that saw severe powdery mildew in wheat in 2010 was mostly treated with in-furrow fungicides in 2011. This proved very effective in controlling the disease until the effect wore off after about 12 weeks. Much of the wheat area surrounding the badly affected southern Eyre Peninsula was infected early in 2011 due to large inoculum loads surviving through summer.

Extensive spraying against powdery mildew took place across the Peninsula. With the area sown to Wyalkatchem being reduced the threat of this disease should recede in coming years, although a significant threat will be present in 2012 and in-furrow fungicides should be considered for all susceptible wheat crops in the affected areas. Serious powdery mildew was also observed in some crops in the Mid North particularly in Gladius, and so this variety should also be considered for in-furrow fungicide treatments in 2012, especially if summer rains allow mildew to survive on volunteers.

Net blotch

Both net blotches in barley were at relatively low levels in 2011. This can be explained partly by the cold winter and dry spring conditions reducing infection efficiency but also by growers monitoring early sown susceptible crops and spraying early to suppress infection where required.

Oats

Stem and leaf rust were the most prevalent oat diseases in 2011. Summer rainfall provided good conditions for both pathogens to survive and increase early on wild oats and volunteer oat crops. Oat crops were infected early in the growing season and by October very susceptible varieties were severely infected with leaf rust and later by stem rust. Monitoring oat crops for leaf and stem rust is essential for effective control by fungicides in years such as 2011.

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 up to 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 for 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 fact sheet supplements other information available including the SARDI Sowing Guide 2011 and Crop Watch email 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

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Wheat	Rust			CCN	Yellow leaf spot	Powdery mildew	*Septoria tritici* blotch	Root lesion nematodes		Crown rot	Common root rot	Flag smut	Black point ‡	Quality in SA
	Stem	Stripe #	Leaf	Resistance				*P. neglectus*	*P. thornei*					
AGT Katana	MS/S	MR/MS	MS	MS	MR/MS	MR/MS	MS	S	S	MS	MS	S	S	AH
Axe	MR/MS	R/MR	MR	S	S	MR/MS	S/VS	MS	MS/S	S	MS/S	S	S	AH
Barham	MR	#MS/S	MR/MS	MS	MS/S	S	MS/S	MR	MS/S	S	MS/S	MR/MS	MS	Soft
Bolac	MR	R/MR	MS	S	MS/S	-	MS	S	MS	S	-	R/MR	MS/S	AH
Brennan	MS	R/MR	R/MR	-	-	-	-	-	-	S	-	-	MS	Feed
Catalina	R/MR	MS	R	R	MS/S	MS/S	MS	S	MR/MS	S	MR/MS	R/MR	S	AH
Chara	MR/MS	MS/S	MR/MS	R	MS/S	-	MS	S	MR/MS	S	S	MR	MS/S	AH
Cobra	R/MR	MS/S	MS	MR/MS	MR/MS	MS/S	MS	S	MR/MS	S	-	S/VS	MS/S	APW α
Corack	MR	MS	MS/S	R/MR	MR/MS	VS	MS/S	MR/MS	MR/MS	S	-	S	MS/S	ASW β
Correll	MR	MR/MS	MS/S	MR	S/VS	MR/MS	MR/MS	S	S	S	MS	R	MS	AH
Derrimut	MR	#MS/S ^	R	R	S	MS	MS/S	S	S	S	S	R	MS/S	AH
Elmore CL Plus	R/MR	MR/MS	R	S	S	MR	MR/MS	-	-	S	-	S/VS	-	APW α
Emu Rock	MR/MS	MR/MS	MS/S	S	MS	MS/S	S	MR/MS	MR/MS	MS/S	-	MS	MS	AH
Espada	R/MR	#MR/MS	R	MS	MS	MS/S	S	MS	MS/S	S	MS/S	MR/MS	MS/S	APW
Estoc	MR	MR/MS	MR/MS	MR	S	MS	S	S/VS	MS	S	MR/MS	MR/MS	MR/MS	APW
Forrest	R/MR	R/MR	MR	S	MR/MS	MS	MR/MS	S	S	S/VS	MS	R/MR	MR	APW
Gladius	MR ^	#MR/MS	MS ξ	MS	MS	S	MS/S	S	MS/S	S	MS	R/MR	MS	AH
Impala	AH	MR	S	S	MS/S	R	S	-	-	S	MS/S	S/VS	MR/MS	Soft
Justice CL Plus	MR	MR/MS	MS/S ξ	MS	S	S	S	S	-	S	-	-	MS	APW
Kord CL Plus	MR	MR/MS	MS ξ	MR	MS/S	MS/S	MS/S	S	-	S	-	-	MR	APW
Lincoln	MR	R	MR	S	MS	-	S	S	S	S	MS	R/MR	MR	AH
Mace	MR/MS ^	#S/VS	MR	MR/MS	MR/MS	MS/S	MR/MS	MR/MS	-	S	MS/S	S	MS	AH
Peake	MR/MS ^	MR/MS ^	R ^	R	S	MS	S	S	MS	S	S	MR/MS	MS/S	AH
Preston	S/VS	R	R	S	MS/S	-	MR	S	MR/MS	S	MS	S/VS	MR/MS	Feed
Pugsley	S	#S ^	MS	MS	S	MS/S	MS	S	-	S	MS	MR	MS	APW
SQP Revenue	R	R	R	S	MS	R	MR	MS	MS	S	S/VS	S	MS	Feed
Scout	MR/MS	MS	R	R	S/VS	MR/MS	MS	S	MS/S	S	S	R/MR	S	APW
Sentinel	R/MR	R/MR	R	S	MR/MS	R	MS/S	S	MS	MS/S	S	MS/S	-	ASW
Wallup	R/MR	MR/MS	MS	MR	MS	S	MS/S	MR/MS	MR/MS	S	-	S/VS	MR/MS	AH
Wyalkatchem	MR/MS	S	MS	S	MR/MS	S/VS	MR	MR/MS	S	S	S	S/VS	MS/S	APW
Yitpi	S	MR/MS	MS ξ	MR	S/VS	MR/MS	MR/MS	MS	MS/S	S	MS	MR	MS	AH

- These ratings are for the WA Yr17 strain. Varieties with a # have the Yr17 resistance and so will be resistant to the other strains α - quality grade under review and may change

^ - Some susceptible plants in mix. α - quality grade under review and may change to AH. β – quality grade under review and may change to APW

ξ – These varieties showed increased susceptibility to leaf rust at the end of 2011.

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

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

The stripe rust ratings for the tritcales are for the WA Tobruk strain present in Eastern Australia in 2011

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.

Disease

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		Black point
										P. neglectus	*P. thornei*	
Barque	MR/MS-S	MS/S	R/MR	S/VS	R	MR	MR	MS/S	S	MS	MR	S
Bass	R-MS	MS/S	MS/S	MR-S	S	MS	-	VS	MS	-	-	-
Buloke	MS-S/VS	MR	MS	MS	S	MR	R	MS	MS	MS/S	-	MS
Commander	MS-S	MS	MS	S	R	MR	R	R	MS/S	MS	-	S
Fathom	MR-S/VS	MS/S	MR	MR	R	MR	-	R/MR	MS/S	-	-	S
Flagship	MR/MS-S	MR	MR/MS	MS	R	MR/MS	MR	MR/MS	S	MS	MR/MS	MS/S
Fleet	MR/MS-S	MR	R/MR	MR/MS	R	MR/MS	MR	MR	MS/S	MS	-	MS
Gairdner	MS-S	MR/MS	S	R-S	S	MR	R	MS/S	MS/S	MS	MR/MS	MR
Grange	MR	MR	MS/S	MS/S	-	-	-	-	S/VS	-	-	MS
Henley	MR-MR/MS	MR	MS/S	R-S/VS	-	-	-	MR	MS	-	-	MS
Hindmarsh	MR/MS-S	MR	S	R-S	R	MS	R	MS	S	MS	-	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	-	MS/S
Navigator	VS	MR	MR	R	R	R	MR	MS/S	MS	-	-	MS/S
Oxford	R-MR/MS	MR	MS/S	MS-S	S	R	-	MR/MS	MS/S	-	-	MR
Schooner	S/VS	MR	MS	MS/S	VS	S	R	MR	S	S	R	MS
Skipper	MS/S-S/VS	MR	MR	S	R	MR	-	S	MS/S	-	-	MS
Scope	MS-S/VS	MR	MS	MS/S	S	MR	R	MR/MS	MS	-	-	MS/S
Sloop SA	S/VS	MR	S/VS	S	R	S	R	R	S	S	R	S
Westminster	R/MR	MR	S	MR	-	MR	-	R	-	-	-	MR/MS
Wimmera	R-MR/MS	MR	MS	MS/S	S	MR	-	MR/MS	MS	-	-	MR

* Due to multiple strains of leaf rust and scald, the table provides a range of reactions that may be observed. Different ratings are separated by a -

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 φ	Resistance	Tolerance	Resistance	Tolerance					
Brusher	MS/S	MR/S	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	MR/MS	MS/S	MS	I	R	T	R	R	S/MR*	MR	-
Kangaroo	MS	S	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	MS/S	MS/S	VS	I	S	I	MR	S	MS/S	S	-
Mulgara	MS	MS/S	R	MT	R	MT	MR	MS	MS	MS	-
Numbat	MS	S	S	I	S	I	S	MS	S	MR	MR
Potoroo	S	S	R	T	S	MI	S	VS	MS	S	MR
Possum	MS/S	S	VS	I	S	I	S	S	S	MS	MR
Quoll	MS/S	MR/MS	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/MS	MR	MT	R	T	MR	R	MS	MR	-
Tungoo	MS	MS/S	R	MT	R	T	MR	R	MR/MS	MR	-
Wallaroo	S	S	R	MT	MS	MI	S	MS	MS	S	MR
Wombat	MS/S	MS/S	R	T		MT	MR/MS	MS	MR	MS	
Wintaroo	S	S	R	MT	R	MT	MR/MS	MR/MS	MR/MS	MR/MS	MR/MS
Yallara	S	MS/S	R	I	S	I	MR/MS	MS	MS	MS	-

Key to symbols used

φ – Depending on which strains are present all current oat varieties can be susceptable to leaf rust

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

Disease

Section Editor:
Roy Latta
SARDI, Minnipa Agriculture Centre

Section 4

Farming Systems

Eyre Peninsula Farming Systems 3 Project – Responsive Farming Systems

Farmers have always had to cope with a wide range of seasonal variables. 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'.

The current five year (2008-2013) GRDC funded project 'Eyre Peninsula Farming Systems 3 – Responsive Farming Systems' is continuing to study the opportunities to tailor inputs to get the most profitable outcomes under a range of conditions. There has been a key research site at the Minnipa Agricultural Centre supported by regional sites at Mudamuckla and Wharminda on red sandy loam, grey calcareous loamy sand and siliceous sand over sodic clay respectively.

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

At the Minnipa Agricultural Centre, the key research site, over the 4 years the project has been operating there has been very low, very high, above average and average growing season rainfall conditions. In studying the opportunities to tailor inputs to maximise profits over that period the major opportunity has been the level of residual phosphorus and total soil N available to maintain crop production. At the completion of a 4 year wheat-wheat-wheat-barley rotation there are examples of no yield difference, on heavier clay based soils, in the 2011 barley, and 3 previous wheat crops, between no applied and applied P and N over that period. This outcome has been repeated at regional focus sites over 3 years. The indications certainly are to tailor inputs to specific needs, not a historical recipe.

The following series of articles are from trials undertaken in 2011 on the three focus sites or funded via the EPFS 3 project:

- Can adjusting zones within N1 paddock at Minnipa improve VRT outcomes?
- Small plot evaluation of the variable rate sowing paddock N1 at Minnipa
- Farming systems WUE survey 2010 – practices
- Responsive farming for soil type at Mudamuckla
- Responsive farming for soil type at Wharminda
- Manganese response in barley at Wharminda
- Can we reduce our phosphorus inputs?
- Crop production using replacement P
- Measuring the effect of residual P

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

Farming systems WUE survey 2010 – practices

Naomi Scholz and Nigel Wilhelm
SARDI, Minnipa Agricultural Centre

Searching for answers

SURVEY INFORMATION
Location
District: Upper Eyre Peninsula
Farmer responses: 49 farmers (90 responses relating to soil type)
Rainfall (annual, averages across upper EP)
2009: 368 mm
2008: 269 mm
2007: 277 mm
Yield (wheat, averaged across upper EP)
2009: 2.1 t/ha
2008: 0.8 t/ha
2007: 0.7 t/ha

Key messages

- **A survey was conducted in early 2010 to determine the current management practices of farmers and the average water use efficiency of farms on upper Eyre Peninsula.**
- **The survey will be repeated in 2013 to see if there are changes in the management practices and water use efficiency.**

Why do the survey?

The Minnipa Agricultural Centre (MAC) has been funded by Grains Research and Development Corporation (GRDC) to run a research and extension program (Eyre Peninsula Farming Systems 3 – Responsive Farming Systems) to improve water use efficiency on farms by 10% on upper Eyre Peninsula (EP). This is seen as one of the main ways to improve profit and manage risk for farm businesses.

An essential part of this program is to determine on farm water use efficiency (WUE) and what practices farmers are using which are thought to improve WUE. A survey was deemed the most efficient method to collect this information from a sample of all farmers across upper EP.

Farmers will be surveyed again in 2013, to see if there have been any changes in practices and subsequent changes in overall water use efficiency on EP farms.

How was it done?

In early 2010 a comprehensive survey of 50 questions was emailed or posted as an excel spreadsheet to 200 farmers across upper EP. 90 responses were considered necessary to obtain a representative sample. Farmers then had the option of completing the survey electronically, via mail, over the phone or in person.

Farmers were asked to consider their responses to the questionnaire in relation to the land zone/s:

- **grey calcareous sands,**
- **redder soils and/or**
- **sand over poorly structured clay.**

Information was collected on demographics of people employed on farms; income from different enterprises, changes to farm businesses being made or planned, yields, methods used to increase WUE of cropping and livestock enterprises, barriers to improving yield, management over summer, time of sowing, in-crop management, break crops, using technology, managing risk and future challenges to farming systems on EP.

Individual information is being kept strictly confidential.

The survey was also conducted with farmers in other low rainfall regions across southern Australia; BCG (Vic), Upper North (SA), Mallee Sustainable Farming (SA/Vic) and Central West (NSW).

What happened?

49 farmers out of 200 responded to the survey, giving a response rate of 25%. Many of the 49 farmers gave answers to more than one soil type, giving a total of 90 responses by soil type. Figure 1 shows the location (nearest town) of respondents, with different shapes indicating different soil type responses

Demographics and enterprise mix

The average time respondents had been farming in their area was 29 years, with 2.5 family members and 1 in 3 with extra labour working on the farm. In 2009, wheat contributed to 65% of their income and most of the rest came from barley (13%) and sheep (16%). On average, farmers are cropping approximately 2,000 ha each year.

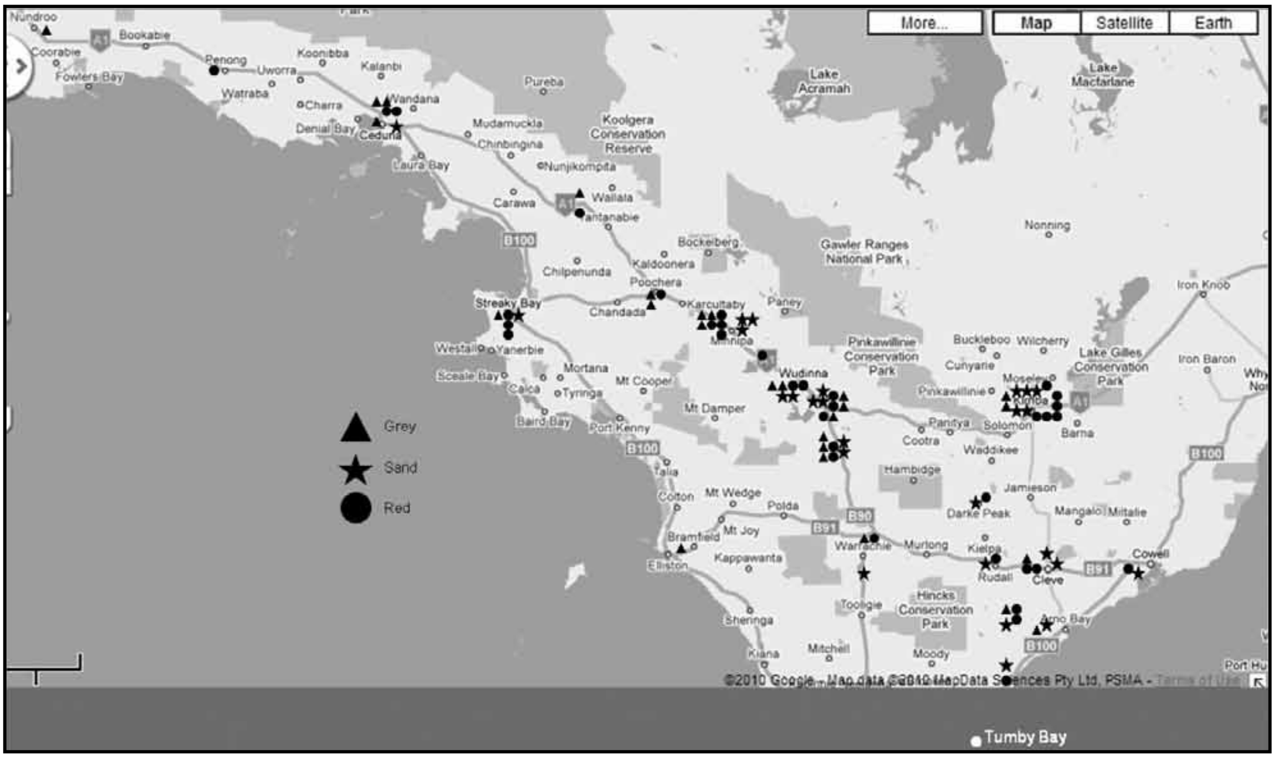


Figure 1 Location (nearest town) and soil types represented

Managing risk

In order to manage risk, farmers said that they use only higher value, lower risk crops – wheat and barley, sow early, reduce expenditure on fertiliser and defer machinery purchases.

Barriers to increasing WUE

In recent years, lack of moisture has prevented farmers from getting the best crop yields possible from the rainfall on the redder soils; farmers with sandy soils blame a shortage of nitrogen and non-wetting soils for not achieving optimum yields and those with grey calcareous soil stated that Rhizoctonia and Take-all were the main constraints to yield. In terms of livestock production, the top three constraints across all soil types were seen as medic pastures performing poorly in autumn (feed gap), lack of moisture (seasonal variation), and insufficient/inadequate fencing for animals.

Practices to increase WUE

Farmers thought the following three practices are the most important practices for increasing water use efficiency of crops:

- Seed early if season allows – before mid May
- Keeping ground free of weeds over summer to store moisture
- Use no till methods

Farmers think the most important practices for increasing WUE of livestock enterprises are dry sowing feed crops, improved grazing management e.g. reducing early season grazing pressure and pasture improvement. The conflict between fencing requirements for stock grazing efficiency and cropping efficiency has been one of the main things in recent years that has prevented farmers from getting the best livestock production possible from the rainfall received. Other commonly listed barriers included seasonal variation and poor performance of pure medic pastures in autumn resulting in a feed gap.

Summer weeds

The main reasons farmers controlled their summer weeds were to conserve moisture to allow earlier sowing (rather than providing a better moisture buffer in spring), avoid livestock poisoning and prevent seed set of problem weeds. None of the respondents selected disease control (removing summer 'green bridge') in their top 3 reasons to control summer weeds. All farmers except one control summer weeds, but the level of control varies from 20% controlling weeds on less than 50% of their land, and 80% controlling weeds on more than 50% of their land over summer. Herbicides and livestock used in combination were the most common method of summer weed control. In balancing WUE and cost risk the majority of farmers would normally spray summer weeds which germinated on a rain before 1 February.

Break crops

Medic pasture was the preferred break crop option overall (50% of respondents), and the main reasons for using break crops were cited as grass clean up, root disease management and increasing nitrogen to subsequent crops. Peas were the next preferred option for farmers with redder soils, while lupins were used by farmers with sand over clay soils. All farmers with grey calcareous soils said medic pastures were the preferred option.

Sowing

Canola (long growing season) and wheat (for the potential return) were normally sown first. About half of the respondents sowed their best paddocks first, and just over half matched sowing date to variety to reduce frost risk and cope with a dry finish. Sowing systems were dominated by no till (no pre-drilling, no cultivation, narrow point opener) and reduced till (one/two cultivations pre-sowing). Generally the only time any paddock is worked is to manage a weed problem that has escaped and needs working to allow sowing.

Varieties

Yield (26%), disease (26%), quality (19%) and drought tolerance (7%) were the main factors determining the choice of a new variety, with other factors listed including CCN resistance, boron tolerance, matching one's system, sprouting resistance and early vigour.

Nutrition

75 per cent of respondents reduced their phosphorus rates between 2007-09 by an average of 30%, as a result of the sharp increase in phosphorus fertiliser prices. Extra nitrogen application was limited on red soils, more common on grey soils at seeding and mid season, and common practice on sands mid season.

Disease

Cultivation and rotation were the most cited methods of managing root disease, with nutrition, grass free medic, summer weed control, autumn weed control and varieties also commonly used. Using fungicide sprays, different varieties and rotations were used to manage leaf diseases.

Rotations

Cereal on cereal is believed to be fine on red soils and sands for at least 3 years by many, but on grey soils most respondents said only one year was suitable for cereals. The majority of farmers do not use two break crops (from cereals) in a row.

Precision agriculture technology

Nearly half the farmers surveyed manage their paddocks by zones, but mostly do this manually. Guidance is not uncommon but the use of yield mapping and variable rate are rare.

Wheat yields

The survey asked farmers to provide their average wheat yields on their different soil types in 2007, 2008 and 2009. 2007 and 2008 had below average growing season rainfall and 2009 had above average growing season rainfall across upper Eyre Peninsula. Redder soils performed slightly better averaged across 'all years' due to their high performance in the wet year of 2009, whereas sandy soils were better in the dry years (Figure 2).

The average yields for the three years was 1.2 t/ha and there was not much difference between soil types in yield in the 2 dry years of 2007 and 2008. The red soil yielded the highest and the sandy soil yielded the lowest in the wet year of 2009.

Changes to farming systems

Some of the main changes farmers had made to their farming programs over the past 5 years were to fine tune tillage practices, utilise liquid fertilisers, pay more attention to sheep management, intensify livestock and cropping programs, grow cross bred lambs, refine agronomic practices, increase feedlotting, move towards precision sowing and reduce fertiliser inputs.

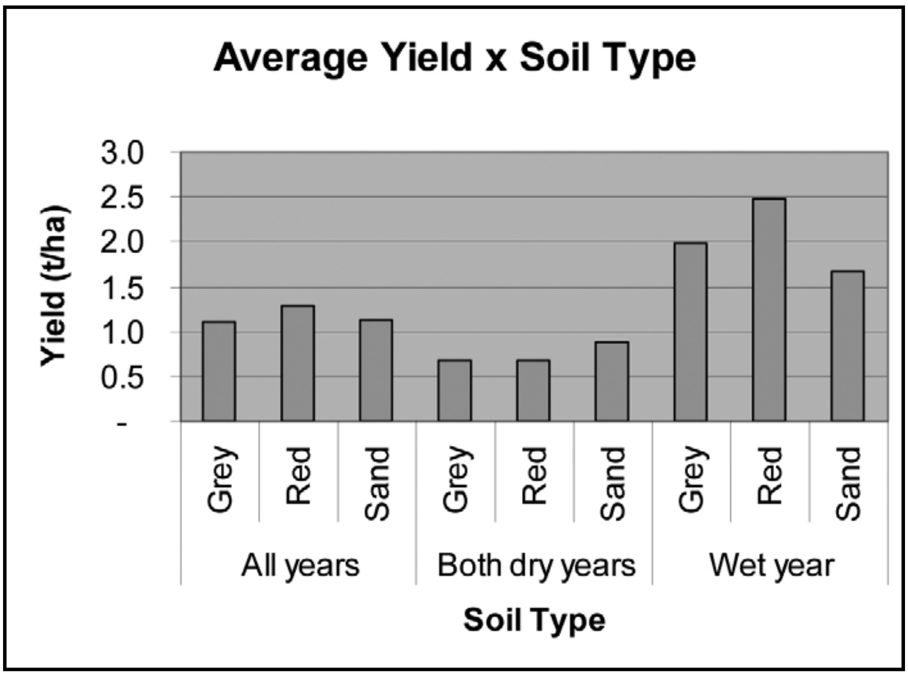


Figure 2 Average yield (t/ha) across different soil types (grey, red and sand) across different years. All years = 2007, 2008, 2009. Both dry years = 2007, 2008. Wet year = 2009.

In 5 years time (2014), 44% of farmers expected their farm business to be similar in mix of enterprises and farm size, to the present; 42% expected to have more sheep, the majority of whom do not want to reduce their cropping area and so would increase intensity of the sheep enterprise; 38% would have more sown pasture; 38% would have purchased more land and 14% hoped to have sold or leased their farms.

Future challenges

Farmers considered the main challenges of their current farming systems as being location and social and community structure. Other challenges listed included mining, climate change, work-life balance, reduced investment into agricultural research and development, and “getting it all to come together for the best overall outcome for the farm, in short and long term”.

What does this mean?

The information gained from this survey also provides a ‘test’ of the relevance of the work being carried out by Minnipa Agricultural Centre and highlights potential areas of research in the future.

The survey shows that farmers are looking to focus more on their sheep enterprises without sacrificing cropping, but sheep infrastructure is generally dilapidated and paddocks are too large for efficiency – the GRDC funded Eyre Peninsula Grain & Graze project is addressing these issues by working with 4 Sheep Groups across EP to make livestock in mixed farming systems easier.

Issues are arising with cereal on cereal rotations (weeds, disease, pests, etc.). The survey shows that 2 year break phases are uncommon on EP. The GRDC funded Crop Sequencing project is investigating the agronomic and economic impacts of 2 year break phases compared to continuous cropping and 1 year break phases.

Zone management is widespread but implemented manually – it may be that farmers find precision agriculture too complicated, or that people are satisfied that what they are doing manually is adequate. The use of guidance is common but yield mapping and variable rate are rare – the advantages are yet to be proven economically over a range of seasons; the GRDC funded EP Farming Systems project is quantifying the costs and benefits of variable rate technology. The project is also investigating the impacts of the conservative approach to fertilisers being used as a result of poor years and the increase in fertiliser prices - how long can you run down reserves before impacting yield?

A follow up survey will be undertaken in 2013 with the farmers that participated initially, to see if there have been improvements in water use efficiency over time. Meanwhile, research into farming systems to improve water use efficiency continues to be carried out on the three focus sites across EP, at Mudamuckla, Minnipa Agricultural Centre and Wharminda.

Acknowledgements

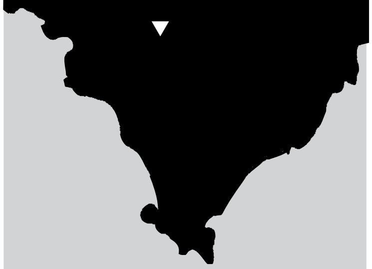
Thanks very much to the farmers that took the time to fill in the survey, your efforts are vital to the success of this project. Thanks to Nigel Wilhelm, Chris Dyson, Anthony Whitbread and Geoff Thomas and Michael Moodie for survey design and analysis. The Low Rainfall Collaboration project, GRDC and EP Farming Systems 3 (UA00107) have provided support for this evaluation.

Small plot evaluation of the variable rate sowing paddock N1 at Minnipa

Cathy Paterson, Roy Latta, Wade Shepperd and Ian Richter

SARDI, Minnipa Agricultural Centre

Searching for answers



Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 4.1 t/ha (B)
Actual: 3.1 t/ha (good and medium zone - high input)

Paddock History
2011: Barley
2010: Wheat
2009: Wheat
2008: Wheat

Soil Type
Sandy loam to sandy clay loam

Soil Test
Outlined in article

Diseases
Rhizoctonia

Plot Size
Paddock trial, sowing widths 9 m

Yield Limiting Factors
Rhizoctonia
Dry spell in spring

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

RESEARCH

Key messages

- **Grain yields reached 80% of their potential water use efficiency in a decile 5 growing season.**
- **Variable rate strategies did not result in improved yields over blanket strategies and the costs of the inputs ensured the blanket nil fertiliser treatment was at least economically comparable to the other options evaluated.**

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 soils zoned as of poor, medium and good production potential from a pre-2008 yield monitor, EM38 and elevation maps. YieldProphet® is 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. To further evaluate variable rate sowing as a tool to improve profitability in low rainfall upper EP farming systems, this trial began in 2008 and has continued through to 2011.

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 each year of the project to date, 2008 to 2011, low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder rows across the paddock. Wheat was sown in 2008, 2009 and 2010, Hindmarsh barley on 4 May 2011 (Table 1). The 3 rates of seed and fertiliser were applied in the same seeder rows in each of the 4 years. In 2011 foliar N was applied as recommended by Yield Prophet® on 4 July at growth stage (GS) 31 to the high input treatment and to the high and standard input treatments on 4 August at GS37 (Table 1). Inputs in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.The paddock received standard weed control across all zones in all years.

The results are a continuation of the 2008, 2009 and 2010 data collection from 4 permanent sample points within each of the 3 zones, encompassing the high, standard and low inputs. The trial design is 3 zones (good, medium and poor) x 3 sub plots (high, standard and low inputs) x 4 replicates.

Measurements collected were soil chemical analysis, plant establishment, early tillering and anthesis dry matter, grain yield and quality, and soil water content at seeding and harvest and the estimated water use efficiency figures based on growing season rainfall plus in-season decline in soil water contents.

Table 1 Area of each zone within paddock, seed and fertiliser rates, and mid season foliar N applications in paddock N1 at Minnipa, 2011

Paddock Zone	Paddock Area (%)	Input strategy	Barley seed rate (kg/ha)	DAP (kg/ha)	Foliar N 4 July 2011 (kg/ha of N)	Foliar N 4 August 2011 (kg/ha of N)
Good	55	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Medium	20	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Poor	25	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0

Table 2 2011 soil P and N levels in 3 zones following fertiliser inputs in 2008, 2009 and 2010

Zone	Colwell P 0-10cm (mg/kg)			Total Mineral N 0-60 (kg/ha)		
	High	Standard	Low	High	Standard	Low
Good	30	37	29	46	53	37
Medium	28	39	28	124	93	78
Poor	33	35	37	54[1]	78	52[1]

[1] 0-40 cm only due to rocks

Table 3 Plant density, dry matter at tillering and anthesis, and soil water contents pre sowing and post harvest (mm) from the 3 paddock zones for each 2011 seed and fertiliser input strategy

Paddock zone	Inputs	Plant density (plants/m^2)	Dry matter *(t/ha)		Soil water content* (mm)	
			Tillering	Anthesis	May	December
Good	High	133	1.3	3.1		63
	Standard	122	1.2	2.9	107	57
	Low	110	0.9	2.2		74
Medium	High	132	1.8	3.7		58
	Standard	122	1.7	3.7	123	73
	Low	106	1.2	2.8		82
Poor	High	116	1.1	3.5		26
	Standard	113	1.0	3.2	52	29
	Low	89	0.9	1.8		31
LSD (P=0.05)		*22*	*0.39*	*0.65*		
Good		122	1.1	2.8	107	65
Medium		120	1.6	3.4	123	71
Poor		106	1.0	2.6	52	29
LSD (P=0.05)		12.6	0.23	0.37		
	High	127	1.4	3.4		49
	Standard	119	1.3	3.2		53
	Low	101	1.0	2.3		62
LSD (P=0.05)		*12.6*	*0.23*	*0.37*		

**Restricted rooting depth, 100 cm in the good zone, 80–100 cm in the medium zone and 20–60 cm in the poor zone*

What happened?

Phosphorus levels measured prior to seeding in 2011 were similar in the poor zone sampling points irrespective of previous high, standard and low (2008 – 2010) inputs, but higher in the good and medium zones with standard inputs compared to low and high inputs (Table 2). Total nitrogen tended to be higher in the medium and poor zone compared to the good zone. Measured pre-seeding P and N levels from the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.

The plant density reflected the comparative seeding rates, 89-110 plants/m^2 (40 kg/ha) for the low input and 113-133 plants/m^2 (50 kg/ha) for the standard and high input treatments (Table 3). However, there were fewer plants established in the poor zone than the good and medium zones.

The low input system produced the least dry matter at both tillering and anthesis (Table 3). The medium zone produced the highest dry matter at both sampling times.

Soil water contents measured at sowing showed the medium and good zones had greater volumetric soil water content in the root profile than the poor zone. Post harvest soil water contents were less than the pre-seeding contents by approximately 40% in all zones. There was correlation between reduced harvest soil water content and increased crop inputs.

Table 4 Grain yield, protein content, screenings and estimated water use efficiency from the 3 paddock zones for each 2011 seed and fertiliser input strategy

Zones	Inputs	Grain yield (t/ha)	Grain protein (%)	Screenings (%)	WUE (kg/ha/mm H_2O)
Good	High	2.6	11.9	4.7	14
	Standard	2.4	11.9	4.1	12
	Low	2.4	11.5	2.8	14
Medium	High	3.0	13.4	6.2	15
	Standard	3.0	12.8	4.3	15
	Low	3.0	12.1	3.7	17
Poor	High	2.5	11.8	3.9	15
	Standard	2.3	11.2	2.6	14
	Low	1.8	11.0	1.8	11
LSD (P=0.05)		*0.36*	*0.63*	*1.15*	
Good		2.5	11.8	3.9	13
Medium		3.0	12.8	4.7	16
Poor		2.2	11.3	2.7	13
LSD (P=0.05)		*0.21*	*0.36*	*0.66*	
	High	2.7	12.3	4.9	15
	Standard	2.6	12.0	3.7	14
	Low	2.4	11.5	2.7	14
LSD (P=0.05)		*0.21*	*0.36*	*0.66*	

Table 5 Yield Prophet® dry matter and grain yield projections (from 90-10% probability) at tillering and anthesis, rainfall decile ranking and measured dry matter and grain yields on the 3 soil zones in 2011

Date	Zone	Dry matter projections (t/ha)	Grain yield projections (t/ha)	Measured dry matter (t/ha)	Measured grain yield (t/ha)	Decile ranking
1 July (early tillering)	Good	0.3	0.5-2.5	1.3	2.6	5
	Medium	0.3	0.5-3.5	1.7	3.0	
	Poor	0.08	0.1-3.0	0.9	1.8	
16 August (anthesis)	Good	2.6	1.0-3.5	3.1	2.8	5
	Medium	2.6	1.0-3.5	3.7	3.0	
	Poor	1.9	0.5-2.5	1.8	1.8	

Grain yields and protein content were higher in the medium zone than the good or poor zones. Proteins were higher in response to increased fertiliser inputs. Test weights from all treatments were similar at 62 to 63 kg/hL. Screenings percentages increased in line with higher yields and inputs. Water use efficiency figures were variable, but generally higher in the medium zone.

Yield Prophet® reports were run for the 3 soil zones on 2 dates over the growing season, 1 July (early tillering) and 16 August (anthesis) (Table 5). The projected dry matter production was underestimated in all zones at early tillering and in the good and medium zone at anthesis. The yield predictions for the good zone were similar at 10% probability, underestimated for the medium zone and overestimated for the poor zone at early tillering. The reports run at anthesis accurately estimated the yields in the good and poor zones at 10% probability. In 2011 the projected crop growth stage was 1-2 weeks ahead of the actual field growth stage.

What does this mean?

In 2011, a decile 5 growing season, grain yields reached a maximum 80% of the potential water use efficiency (WUE) in the medium zone without fertiliser applied. This means there was no WUE benefit to applied P and N or from crops grown in the good zone.

Estimating the benefit of using variable rates as opposed to blanket seed and fertiliser applications was assessed on a per hectare basis (52% of the paddock being good, 22% medium and 26% poor soil) as presented in Table 1. A high input strategy would have resulted in 2.7 t/ha, standard 2.6 t/ha and low (nil fertiliser) 2.4 t/ha. A variable rate strategy of high inputs on the good zone, standard on the medium and low on the poor zone gave 2.5 t/ha. If a more conservative approach was used based on the adequate levels of P measured pre-seeding then a standard input over both good and medium zones, low on the poor zone would give a yield of 2.4 t/ha, similar to the blanket low (nil fertiliser) treatment.

The costs of the inputs ensure the blanket nil fertiliser treatment was at least economically comparable to the high and medium blanket and variable rate options.

Yield Prophet® accurately projected the yield in the good and poor zone at anthesis, however the range of predicted yields was too wide at early tillering to be of value in terms of crop response to additional N at the recommended application time.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Special thanks to Mark Klante, Brett McEvoy and Trent Brace for their assistance sowing and managing the trial.

Can adjusting zones within N1 paddock at Minnipa improve VRT outcomes?

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RESEARCH

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 4.1 t/ha (B)
Actual: 3.1 t/ha (good and medium zone - high input)

Paddock History
2011: Barley
2010: Wheat
2009: Wheat
2008: Wheat

Soil Type
Sandy loam to sandy clay loam

Soil Test
Outlined in article

Diseases
Rhizoctonia

Plot Size
Paddock trial, sowing widths 9 m

Yield Limiting Factors
Rhizoctonia
Dry spell in spring

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 messages

- **Compared to 2008 map, rezoning based on 2009 yield monitor map improved variable rate technology (VRT) performance in 2009, 2010 and 2011 seasons.**
- **The highest gross margin was returned from paddock N1 as a result of zoning whereby no fertiliser was being applied to 89% of the paddock.**
- **A limited yield response to applied fertiliser has restricted any gross margin benefit from the VRT technology from this paddock with high soil P reserves.**

Why do the trial?

Variable rate technology (VRT) offers farmers the ability to adjust sowing and fertiliser rates during the seeding process, in order to change inputs according to the production capability of different paddock zones or soil types. At Minnipa Agricultural Centre (MAC) on paddock N1, the opportunities to increase profits through the use of VRT has been studied through zoning the paddock based on pre-2008 yield monitor maps, and incorporating EM38 and elevation maps.

The initial results have shown little benefit being derived using VRT technology based on the 2008 zone map. Thus the question was raised as to the opportunity to rezone the paddock, by altering the relative proportions of each zone, in an attempt to increase the relative yield differences between the zones and associated fertiliser inputs.

With 4 years of yield monitor data from the variable rate case study paddock N1 at MAC we thought it timely to evaluate the performance of our variable rate strategy by asking the following questions:

1. How well did the original zone map perform over the 4 years?
2. Is there evidence to suggest that the paddock needs rezoning?
3. What is the economic impact of the current paddock zoning compared to rezoning?
4. What is the capital investment of PA and the estimated return on investment?
5. What is the annual cost associated with using PA?

How was it done?

Paddock N1, at MAC, 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). In each year, 2008 to 2011, low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder rows across the paddock.

Wheat was sown in 2008, 2009 and 2010, Hindmarsh barley on 4 May 2011 (Table 1). The 3 rates of seed and fertiliser were applied in the same seeder rows in each of the 4 years. In 2011 foliar N was applied as recommended by Yield Prophet® on 4 July at growth stage (GS) 31 to the high input treatment and to the high and standard input treatments on 4 August at GS37 (Table 1). Inputs in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010. The paddock received standard weed control across all zones in all years.

Table 1 The percentage of paddock within each 2008 zone map, seed and fertiliser rates, and mid season foliar N applications

Paddock Zone	Paddock Area (%)	Input strategy	Barley seed rate (kg/ha)	DAP (kg/ha)	Foliar N 4 July 2011 (kg/ha of N)	Foliar N 4 August 2011 (kg/ha of N)
Good	52	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Medium	22	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Poor	26	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0

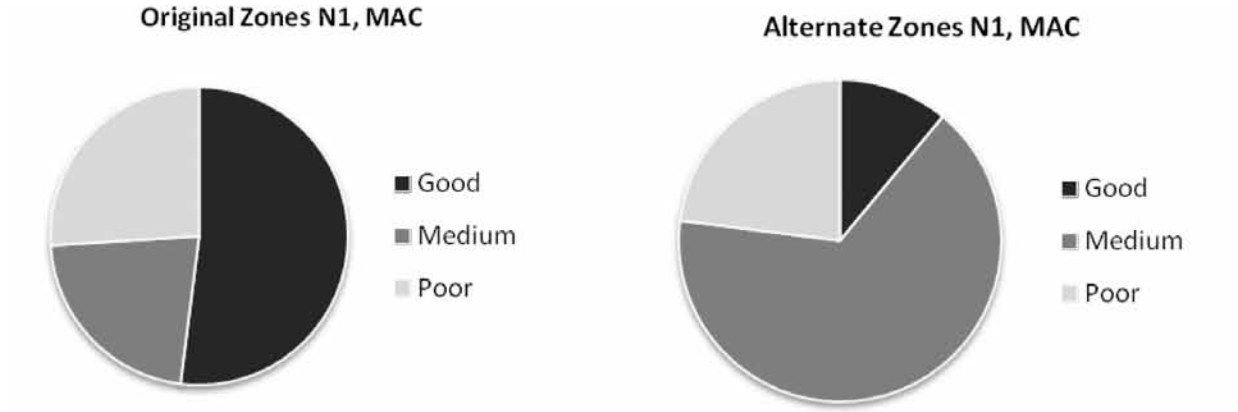

Figure 1a & b Paddock percentage represented by the 3 production zones in the original zone map (left) and the alternate zone map (right)

Table 2 2011 soil P and N levels in 3 original zones following fertiliser inputs in 2008, 2009 and 2010

Zone	Colwell P 0-10 cm (mg/kg)			Total mineral N 0-60 cm (kg/ha)		
	High	Standard	Low	High	Standard	Low
Good	30	37	29	46	53	37
Medium	28	39	28	124	93	78
Poor	33	35	37	54*	78	52*

** 0-40 cm only due to rocks*

To compare the original zoning, and evaluate if farmers could commence using VRT without the expense of EM38 mapping, an alternative second zone map was created from the 2009 yield monitor map. The header has a 9 m front that harvests each alternate 9 m sown strip independently, allowing accurate data in relation to the 3 treatments applied across each zone. The yield monitor readings were calibrated to align with total paddock tonnages delivered to the receival point to ensure accuracy.

The original map had 52% zoned "good", 22% "medium" and 26% "poor" of the 64 hectare N1 paddock (Table 1 and Figure 1a). The alternate zone maps created by using the 2009 yield monitor zoned 11%, 66% and 23% as "good", "medium" and "poor" respectively (Figure 1b.).

What happened?

Phosphorus levels measured prior to seeding in 2011, within the original map zones, were similar in the poor zone irrespective of previous high, medium and low (2008 – 2010) inputs (Table 2). Phosphorus levels were higher in the good and medium zones with standard inputs compared to low and high inputs (Table 2).

Total nitrogen tended to be higher in the medium and poor zone compared to the good zone. P and N levels in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.

In a dry year, 2008, the original zone map has calculated the medium zone producing yields similar to the poor zone; however in an average, 2011, and above average growing season rainfall years, 2009 and 2010, the medium zone produced yields similar to the good zone (Table 3).

Compared to the original zone map, the alternate map calculated less variation in yield between zones in 2008, with an increase in yield for the medium and poor zone in 2008 (Table 3). In the following three years it calculated an increased variation between zones with higher yields in the good zone and lower in the poor zone.

Table 3 Grain yield (t/ha) from the 3 paddock zones with low, medium and high inputs using the original (Orig) and 2009 alternate (Alt) zone maps

Zones	Input strategy	2008 Yield (t/ha)		2009 Yield (t/ha)		2010 Yield (t/ha)		2011 Yield (t/ha)	
		Orig	Alt	Orig	Alt	Orig	Alt	Orig	Alt
Good	High	0.65	0.65	4.1	**4.8**	3.6	**3.8**	3.1	**3.3**
	Standard	0.64	0.61	4.1	**4.9**	3.5	**3.7**	2.9	**3.1**
	Low	0.59	0.59	3.7	**4.8**	3.2	**3.5**	2.9	**3.1**
Medium	High	0.40	**0.54**	4.0	4.1	3.6	3.6	3.1	3.1
	Standard	0.34	**0.53**	4.1	4.1	3.6	3.5	3.1	3.0
	Low	0.38	**0.50**	4.0	3.9	3.4	3.3	3.0	3.0
Poor	High	0.39	**0.47**	3.6	**3.1**	3.0	**2.7**	3.0	**2.6**
	Standard	0.40	**0.47**	3.6	**3.1**	2.9	**2.6**	2.6	**2.4**
	Low	0.36	**0.45**	3.4	**3.0**	2.7	**2.5**	2.8	**2.2**

***Bold values** indicate a significant yield difference from the original to the alternate zone map.*

Gross margins followed the yield trends with the alternate zone map increasing returns from the "good" zone and reducing returns from the "poor" zone, but there was little variation in the "medium" zone (the exception for the medium zone being 2008, where the higher yields are reflected in the improved returns). The low (nil) fertiliser input treatment generally maintained a similar or higher gross margin in all zones (Table 4).

To explore what, if any, advantages can be gained by applying VRT a number of combinations of input level by production zone, and the effect of these combinations on gross margins are outlined in Table 5. The combinations used in calculations are presented in Table 5 as 'Go for Gold!' and 'Hold the Gold!'

The VRT -'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 (Figure 2), taking into consideration the percentages of each zone within the paddock as summarised earlier in this article (Figure 1). The low, standard and high inputs for 2011 are presented in Table 1.

Table 4 Gross margins (GM) ($/ha) from the 3 paddock zones with low, medium and high inputs using the original (Orig) and 2009 alternate (Alt) zone maps

Zones	Inputs	2008		2009		2010		2011	
		GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)
		Orig	Alt	Orig	Alt	Orig	Alt	Orig	Alt
Good	High	25	28	688	**842**	605	**742**	335	**375**
	Standard	48	40	725	**899**	693	**755**	354	**398**
	Low	62	62	735	**948**	643	**724**	418	**464**
Medium	High	-41	-12	679	686	616	618	352	352
	Standard	-15	19	727	721	650	638	394	377
	Low	0	29	675	747	794	767	439	437
Poor	High	-32	-19	563	**462**	468	**401**	324	**253**
	Standard	-10	3	602	**497**	487	**407**	310	**256**
	Low	13	26	637	**546**	466	**401**	393	**290**

Gross income is yield x price delivered cash 1 December 2008, 2009, 2010 and 2011, Pt Lincoln less all input costs. $350/t used for seed value for wheat and $220/t used for seed value for barley.
***Bold values** indicate where the alternate zone map has made potential improvements in the value of the VRT through increasing the yield variations between zones.*

Table 5 Treatments applied to VRT gross income analysis

Paddock Zone	VRT - Go for Gold!	VRT - Hold the 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

What does this mean?

1. **On returning to the original questions:**

How well did the original zone map perform over the 4 years?

The original zone map correctly projected a good zone in 2008 as opposed to medium and poor zones that had similar yields (Table 3). In 2009 and 2010 the good and medium zones had similar yields, the poor zone generally lower yields. In 2011 there was little variation between zones. Therefore, the original zone map correctly identified the opportunity to apply extra inputs to the good zone in 2008 and lower inputs in the poor production zone in 2008, 2009 and 2010 (Table 3).

2. **Is there evidence to suggest that the paddock needs rezoning?**

The value of the VRT is controlled by identifying zones within paddocks of significantly different production potential whereby inputs can be tailored to the potential yield. The medium zone produced similar yields to the good zone over the 2009 to 2011 period in the original zone map irrespective of the level of input (Table 3). Therefore there was the opportunity to alter the zone structure to reduce inputs on a least a proportion of the good zone in line with the medium zone in those seasons of average and above average rainfall. In the dry 2008 season the zone map never differentiated between the yields of the medium and poor zones providing a further indication of potential for rezoning improvement between those 2 zones to reduce inputs on at least a proportion of the medium zone.

It is important to ensure that the zones are correctly identified, as reducing inputs and drawing on nutritional reserves in paddocks with high P reserves is an easy way for farmers to reduce risk while not losing any crop potential, and matching zone inputs to early seasonal conditions may be of benefit in the future. Rezoning the paddock by using a yield map only was also explored to see if farmers could commence using VRT without the expense of EM38 mapping, which is an option.

3. **What is the economic impact of the current paddock zoning compared to rezoning?**

Using the original zone map the "Hold the Gold" approach resulted in a return $84/ha more than the standard input blanket approach over 4 years, 2008-2011. This increased to $210/ha with the alternate 2009 map. This improvement in gross margins is due to more hectares being included in the medium zone in the alternate zone map and therefore a larger proportion of the paddock has not received any fertiliser over the 4 years. By using the alternate zone map there was a slight reduction in profitability using the "Go for Gold" approach compared to the original zone map, but remains similar to the standard input blanket approach.

In N1 over the 4 years of data collection the most profitable treatments were the "Hold the Gold" alternate zone map and the low (nil fertiliser) input regime over all zones (Figure 1). Given the excellent fertiliser history at MAC, the lack of response to no fertiliser is not typical of many farms across the upper EP, so undertaking this approach on other paddocks would require soil testing of nutritional reserves.

4. **What is the capital investment of PA and the estimated return on investment?**

To enable the application of variable rate, a capital investment in GPS guidance and a variable rate controller on the seeder is required. The cost of GPS guidance ranges from $14,000 for a sub metre guidance system (this can also include an annual subscription cost to access satellites) to $20,000 for RTK for 2 cm accuracy (with no additional annual costs). The cost of the variable rate controller starts at approximately $9,000 for a hydraulically driven 2 tank seeder box and $15,000 for uni-electric drive 2 tank seeder box. Software to communicate between the variable rate controller and the zone map is approximately $1000. The total cost of investment is approximately $40,000.

The return on investment if the comparison is made between a conservative (standard) blanket fertiliser approach and the alternate "Hold the Gold" strategy was approximately $50/ha/year. If this increase was spread over 1000 hectares, the figures look good in a paddock with high P reserves.

However it must be highlighted that the "Hold the Gold" strategy projected fertiliser on only 11% of the total good area and should only be used in a situation where there are high levels of soil fertility, and if used would need to be monitored carefully to ensure nutrient reserves do not run down to deficient levels.

The other comparison may be the "Go for Gold" strategy which has high, standard and low (nil) fertiliser inputs applied to the good, medium and poor zones respectively with the high and standard blanket treatments. Given the lack of response to higher fertiliser rates in this paddock there was no advantage in using this approach over the standard blanket approach, but due to the reduced input costs there is an advantage using this approach over the high input blanket approach.

5. **What are the annual costs of using PA?**

There is an annual expense of roughly $2/ha to employ a consultant to ensure the business is gaining full benefit from the system by running any analysis on trials and potentially fine tuning of zones.

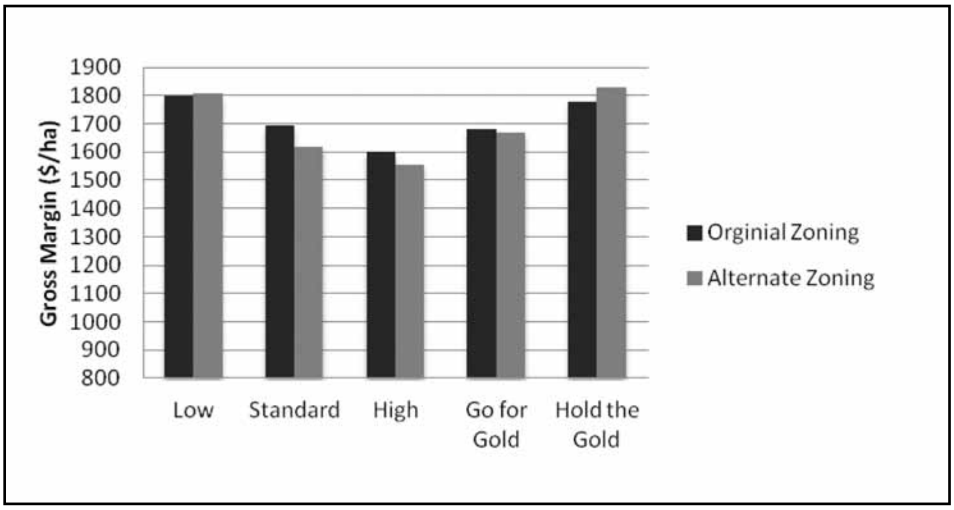

Figure 2 Comparison of the cumulative gross margins of different sowing regimes 2008-11 using the original 2008 zone map and the alternate 2009 yield zone map. Note: Y axis scale starts at $800.

The difference in gross margins under the blanket input treatments is due to the variation in mean yields and the difference in zone area represented under the different maps; when multiplying out these values to calculate the gross margins any differences are accentuated.

Over the 4 years of evaluation the lack of response to applied P irrespective of zone has limited any gross margin benefit from separating production areas. This could be due to the Colwell P levels in this paddock continuing to be maintained at greater than a 27 mg/kg "critical" response to applied P level (Holloway, pers. com.). Reducing the "good" area with the 2009 alternate zone map to 11% of total area as opposed to 55% in the original zone map has supported a slightly higher gross margin to a low (nil) blanket fertiliser strategy; however the benefit may not warrant the capital and ongoing cost associated with the technology.

Acknowledgements

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Responsive farming for soil type at Mudamuckla

RESEARCH

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Location: Mudamuckla
Muddy/Nunji/Wirrulla Ag Bureau

Rainfall
Av. Annual: 291 mm
Av. GSR: 219 mm
2011 Total: 348 mm
2011 GSR: 220 mm

Yield
Potential: 2.8 t/ha (W)
Actual: 2.1 t/ha

Paddock History
2010: Canola
2009: Wheat
2008: Wheat
2006: Self sown barley

Soil Test
Outlined in article

Diseases
Rhizoctonia

Plot Size
Paddock trial, sowing widths 18 m

Yield Limiting Factors
Rhizoctonia
Dry spell in spring

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 messages

- **Wheat yields in the poor, medium and good zones in response to low, medium and high inputs respectively did not differ significantly in 2011.**
- **Over a 3 year wheat-canola-wheat rotation there has been no measured production benefit from applying 6 kg/ha of P on the good soil type as opposed to nil P on a shallow constrained soil.**

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.

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 Mudabie Farm was segregated into zones of good (grey calcareous sandy loam), medium (sandier hills) and poor (magnesia flats) production zones in 2009 using 5 years of yield maps and an elevation map (EPFS Summary 2009, pp 97-103). The area represented by these zones are summarised in Table 1.

The paddock was sown to Mace wheat on 14 May 2011 using variable rate technology (VRT) to apply the different seed and fertiliser rates following 29 mm of rain for the month. The seeding and fertiliser rates are summarised in Table 1. Four permanent sampling points in each of the good, medium and poor zones were established in 2009 enabling soil chemical analysis, plant establishment, dry matter at anthesis, soil water measurements (sowing and harvest) and grain yield to be monitored.

What happened?

Pre-seeding Colwell P levels tended to be lower in the good zone as compared to the other zones. There was more total mineral N measured in the poor zone than the good or medium zones (Table 2). The 2008 analysis of the depth to chemical plant root constraints is shown in Table 2.

Plant establishment was lower in the poor zone than the medium and good zones, reflecting the lower seeding rate, however grain yields were similar and with good grain quality in all 3 zones (Table 3).

Table 1 Paddock zone areas and seed and fertiliser inputs

Paddock zone	Paddock area (%)	Input strategy	Seed rate (kg/ha)	Phos. acid (P kg/ha)
Good	40	High	50	6
Medium	45	Medium	50	4
Poor	15	Low	35	0

Farming Systems

Table 2 Soil chemical analysis for Mudamuckla in 2011

Zone	Colwell P 0-10 cm (mg/kg)	Total Mineral N 0-60 cm (kg/ha)	*Depth to B > 15 mg/kg (cm)	*Depth to Cl > 1000 mg/kg (cm)
Good	37	88	n/a	n/a
Medium	43	79	n/a	n/a
Poor	41	142	60	40

** 2009 data*

Table 3 Wheat establishment, grain yield and quality and calculated gross income from the 3 paddock zones at Mudamuckla, 2011

Zones	Wheat (plants/m^2)	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)	Gross income[1] ($/ha)
Good	133	2.1	11.8	0.8	76.8	460
Medium	130	1.9	12.0	0.9	76.3	419
Poor	96	1.8	12.1	1.0	76.6	431
LSD (P < 5%)	*13*	*ns*	*ns*	*0.1*	*ns*	

[1] Gross income is yield x price of H2 less seed and fertiliser costs delivered cash on 1 December 2011, Pt Lincoln. $350/t used for seed value.

What does this mean?

Three years of study at this site (2009-11) has shown no measured loss in production from deleting P inputs into the shallow constrained soils. Near average (200 mm) growing season rainfall, in all 3 seasons, coupled with high total soil N and Colwell P figures has given confidence in the option to reduce inputs in line with soil chemical assessments. The more constrained the soil the greater the opportunity to reduce inputs, as in 2011 where Colwell P and total nitrogen figures have remained high in the poor zone (having had no P applied over the study period) and trended lower on the good zone in line with wheat grain yields trending higher on those soils with 6 kg/ha of P applied annually. However there is no measure of the impact of putting 6 kg of P on the good soil as opposed to nil P or no comparison of the nil and 6 kg of P on the poor zone.

The benefits of variable rate sowing at Mudabie will continue to be investigated for at least the 2012 season.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Thanks to Peter Kuhlmann for the opportunity to use this paddock as part of EPFS 3, Andre Eylward and Paulus Viljone for sowing the paddock and all their help during the year.

Responsive farming for soil type at Wharminda

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

RESEARCH

Searching for answers

Location: Wharminda
Ed Hunt
Wharminda/Arno Bay Ag Bureau

Rainfall
Av. Annual: 322 mm
Av. GSR: 222 mm
2009 Total: 348 mm
2009 GSR: 189 mm

Yield
Potential: 4.9 t DM/ha (at maturity)
Actual: 1.7 t DM/ha (at flowering)

Paddock History
2010: Barley
2009: Wheat
2008: Pasture

Yield Limiting Factors
Low medic plant numbers
P deficiency

Key messages

- **Annual medic plant establishment density limited by 2008 drought, mice and possibly a false break.**
- **Pasture production restricted by low plant numbers but increased by 2010 P applications.**

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 Wharminda a paddock, one of three focus paddocks in the current farming systems project, was chosen as representative of eastern Eyre Peninsula soils varying from deep sand to shallow clay loam. The emphasis in 2009 and 2010 was on managing risk through tailoring inputs to the different production zones potential by using variable rate technology. In 2011 the Wharminda focus paddock was in the pasture phase of a pasture-wheat-barley-pasture rotation with the response in pasture production from the variable fertiliser rates applied on the 3 zones in 2010 to be assessed.

How was it done?

A paddock at 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.

In 2010 the paddock was sown with Fleet barley with three fertiliser treatments of low 0, standard 8 and high 16 kg P/ha applied to the paddock in alternating strips across the paddock.

In 2011 the paddock was in the annual medic phase of the rotation. This was a self regenerating pasture, established from the soil seed reserve, with no applied fertiliser. Soil samples were taken at 4 permanent sample points for chemical analysis (Table 1) on 27 April from the standard input treatments. The measurements taken during the growing season were plant establishment and dry matter at flowering, both measured on 5 July from within sheep exclusion cages. Quadrants of 0.1m^2 were counted at each of these 12 permanent sample points from the low, standard and high 2010 fertiliser treatments.

What happened?

All zones had Colwell P levels at or below levels considered adequate to meet plant growth requirements.

The was no difference across the zones or inputs in terms of plant establishment (Table 2), however the dry matter production was higher in the good and medium zones in response to the 2010 standard and high P applications.

Table 1 April Colwell P levels (mg P/kg) at Wharminda in 2009, 2010 and 2011

Zone	Colwell P 0-10cm (mg/kg)		
	2009	2010	2011
Good	24	32	21
Medium	22	23	24
Poor	34	26	15

Table 2 Annual medic plant establishment (plants/m²) and dry matter production (t DM/ha), 7 July 2011

Zones	Inputs	Plant establishment (plant/m²)	Dry matter anthesis (t DM/ha)
Good	High	120	1.5
	Standard	122	1.7
	Low	110	1.1
Medium	High	116	1.4
	Standard	128	1.4
	Low	116	1.0
Poor	High	116	1.1
	Standard	116	1.1
	Low	112	1.1

What does this mean?

Similar numbers of annual medic plants established across all zones and 2010 P application treatments. However 100–120 plants/m² is lower than the required 300-400 plants/m² required to optimise early biomass production. There are several possible reasons why the annual medic seed resource did not support a higher density;

- 2011 rainfall of 338 mm included more than 100 mm in February and early March, early germinating medic may have died over the late March, April dry period,
- the previous medic phase in the rotation was during the very dry 2008, limiting seed production and,
- mice reduced seed reserves.

The measured biomass in July reflected the P application in 2010 coupled with soil type. It could be assumed that the heavier clay based soils retained more available P from 2010 applications along with stored soil water from the February/March rainfall events. The result of this was an increased biomass in response to previous P applications on the heavier soils, but no benefit on the deep sands.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Thanks to the Hunt family for the opportunity to use this paddock as part of EPFS 3.

GRDC Grains Research & Development Corporation

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Adapting to climate change with crop sequences

RESEARCH

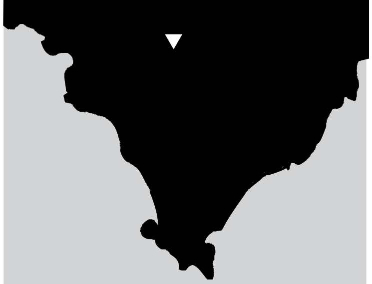
Roy Latta and Ian Richter
SARDI, Minnipa Agricultural Centre

Australian Government Department of Agriculture, Fisheries and Forestry

GRDC Grains Research & Development Corporation

SARDI South Australian Research and Development Institute

Searching for answers



Location: Minnipa Ag Centre
Rainfall
Av. Annual: 333 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 3.8 t/ha (W)
Actual: 3.6 t/ha
Paddock History
2010: Wheat
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam over light clay
Soil Test
Total N (0-60 cm) <40 kg/ha
Colwell P 22 mg/kg
Pest and Diseases
Project key outcome: control grass weeds and cereal borne root diseases
Plot Size
40 m x 1.5 m x 3 reps
Yield limiting factors
Powdery mildew on annual medics
Environmental Impacts
Soil Health
Project aims to recommend options to improve;
- soil nutrients and groundcover
- reduce disease levels and chemical use

Key messages

- **Well managed continuous wheat produced a yield of 3.6 t/ha in 2011, a decile 5 year.**
- **Oats produced up to 9 t dry matter (DM)/ha as a hay crop.**

Why do the trial?

To determine the comparative performance of alternative crops and pastures as pest and disease breaks in an intensive cereal phase.

In low rainfall regions of south-eastern Australia broad-leaf crops make up only a very small proportion of the total area of sown crops. In light of increasing climate variability farmers have adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to greater yield and price fluctuations. However, there is an identified need for non-cereal options to provide profitable rotational crops, disease breaks and weed control opportunities to sustain cereal production. The current "break crop" is often a poor performing volunteer annual grass dominant pasture. They are often havens for cereal pests and disease and seen as having a negative impact on subsequent cereal grain yield and quality.

How was it done?

2011 was the first year of a 4 year rotation trial, comparing a 2 year phase of alternative break crops followed by 2 years of wheat with a continuous wheat phase. The site is described as a red sandy loam over light clay pH 7.9 ($CaCl_2$). Boron and chloride levels were measured as providing a constraint to root development at 70-80 cm. Total soil N (0-60 cm) was less than 40 kg/ha, Colwell P 22 mg/kg (0-10 cm) was assessed from soil collected on 22 March 2011.

The break crops were sown on 2 May, apart from an earlier simulated regenerating medic pasture sown on 1 April, in plots of 40 x 1.5 m replicated 3 times. The 40 m plots were split into 2 x 20 m sub plots where the treatment was considered a dual purpose option, i.e. grazing or hay production, hay or grain production or graze and grain production. The continuous wheat treatment was sown on 13 May. To prepare the site broad spectrum knockdown sprays were applied on 24 December 2010, 2 March and 2 May 2011. Table 1 presents the crop type and species sown, seeding and fertiliser rates along with in-crop management.

There was no broad-leaf herbicide applied, all broadleaf crops and pastures received a bare earth insecticide treatment at the time of sowing, 2 May.

Measurements collected included; site soil chemistry analysis, plant establishment, biomass production at times selected for grazing and hay production (both simulated with mowing) and the grain yields from field crops. Samples were collected from 8 x 0.5 m rows = 1 m^2 within each field crop plot and 5 x 0.1m^2 quadrats = 0.5 m^2 within each pasture plot. Grain yields were measured with a Kingaroy plot harvester with grain samples retained for quality testing. Comparative soil water contents were also collected post harvest.

Plant establishment was satisfactory and representative of sowing rates. The oats and pea and canola mixture had produced adequate food on offer for grazing by 1 July following the May seasonal break and 2 May sowing. The simulated regenerated medic treatment also produced adequate biomass by July but was sown too late to take full advantage of the March rainfall events and only commenced germination in mid April.

The oats, with 50 kg/ha of applied urea, achieved a growth rate of 73 kg DM/ha/day from 1 July to 11 August, vetch and oats 45, medic 36. Total cumulative figures of 4.9 t/ha (oats) 3.7 (annual medic) and 3.6 (vetch & oats) were less than the measured hay production of 9.4, 4.5, 5.9 and 7.2 t/ha respectively.

Table 1 Crop type and species, seeding rate (kg/ha), fertiliser (units N & P/ha) and in-crop herbicides for grass control

	Cultivar	Seeding rate	Fertiliser	Herbicide
Wheat	Mace	60	35 & 13	Pre-em Treflan® Post-em Hoegrass®
Annual medic	Jaguar/Angel	5	12 & 13	Pre-em Treflan® Post-em Leopard®
Regen. medic	Angel	5		Post-em Leopard®
Oats	Winteroo	40	35 & 13	[1]Broad spectrum 26 September
Vetch & Oats	Rasina & Winteroo	10 & 15	12 & 13	Broad spectrum 26 September
Fallow				Broad spectrum 7 July, 19 October
Field pea	Twilight/Morgan[2]	80	12 & 13	Pre-em Treflan® Post-em Leopard®
Canola	Tarcoola	2	35 & 13	Pre-em Treflan® Post-em Leopard®
Pea & canola	Morgan & Tarcoola	40 & 1	12 & 13	Pre-em Treflan® Post-em Leopard®
Hedysarum	Wilpena	5	12 & 13	Pre-em Treflan® Post-em Leopard®

[1] The broad spectrum treatment includes glyphosate. [2] Forage type field pea

Table 2 Plant establishment (plants/m²) biomass (t DM/ha) grain yields (t/ha) and volumetric soil water contents (mm, 0-1 m) in 2011

	Establish-ment (plts/m²)	Biomass (t DM/ha) Grazing				Hay	Grain (t/ha)	H_2O (mm)
	27 May	1 July	11 Aug	19 Sept	31 Oct	19 Sept	28 Oct	15 Nov
Mace	119[1]						3.6[3]	139
Jaguar	123		2.8	[2]	0.9	4.5	0.1	134
Angel	123		2.1	[2]	0.1	2.9	<0.1	134
Regen. medic	111	0.7	2.2	[2]	0.2	3.8		162
Winteroo	95	0.6	3.6	0.5	0.2	9.4		164
Vetch & oats	111	0.4	2.3	0.6	0.4	7.2		163
Twilight	36					6.1	1.8	157
Morgan	33					5.4	1.3	163
Tarcoola	31	0.4					1.4[4]	151
Pea & canola	49	0.6		5.1	0.1	5.9		162
Wilpena	26			3	1.8			130
Fallow								184
Annual Rye grass	50							
Barley grass	7							

[1] Establishment count delayed until 10 June due to later sowing date. [2] Infestation of powdery mildew limited annual medic spring biomass production. [3] Wheat harvest delayed until maturity, 14 November .[4] Grain yield for crops both mown (on 1 July) and unmown were 1.4 t/ha

The 5.5 t/ha (pea & canola) from mowing was similar to the 5.9 t/ha hay cut. The mown medic pastures did not recover well after 11 August with levels of powdery mildew evident.

Wheat yield at 3.6 t/ha achieved an estimated water use efficiency (WUE) of 19 kg/ha/mm of plant available water, a protein content of 10.6% but with 12% screenings. Pea yields of 1.3-1.8 measured a WUE for 7.5 to 11 for the Morgan and Twilight pea respectively. Canola yielded <0.5 t/ha, 43% oil and a 24% harvest index. The Jaguar medic produced 0.1 t/ha of medic seed harvestable with open front header as opposed to the Angel with <10 kg/ha.

Indications were that the biennial pasture Sulla (Wilpena), the late sown medics and the wheat had less soil water in the 0-1 m soil profile than the other crops with the fallow treatment having the most water present in the profile.

What does this mean?

2011 was a decile 5 year with the continuous wheat producing excellent water use efficiency figures. In year 1 of the 4 year study the alternative "break crops" showed their specific attributes; the biomass production from oats and the early production of regenerating annual medic, when coupled with an early break.

The other opportunities measured were:

- The potential to harvest worthwhile amounts of Jaguar medic pod from an ungrazed pasture.
- Canola as an early feed resource with no grain yield loss resulting from the defoliation.
- Sulla with a green feedbase at the pre stubble November/ December period of feed deficit.
- No measured benefit in the use of mixtures as opposed to the monocultures.
- Twilight out yielded Morgan in grain produced, and although an earlier maturing cultivar, Twilight produced similar biomass in 2011.

The relative benefits of the crops for cereal weed and disease control will be measured through emerging weed numbers and soil borne disease levels in 2012, 2013 and 2014.

Acknowledgements

DAFF Climate Change adaptation project BWD00019, GRDC "Profitable crop sequencing in low rainfall areas of south eastern Australia" DAS00119.

Treflan – registered trademark of Dow Agrosciences, Hoegrass – registered trademark of Bayer Cropscience, Leopard – registered trademark of Farmoz.

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: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 3.65 t/ha (W)
Actual: 2.04 t/ha (B)
Paddock History
2010: Medic pasture
2009: Wheat
2008: Wheat
2007: Wheat
Soil Type
Red sandy loam
Soil Test
Organic C%: 0.77
Phosphorus: 12.54 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)
Water use
Runoff potential: Low
Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2,NO_2, Methane): Cropping and livestock

Key messages

- **Grain yields increased with higher crop inputs and following grazing, they were further improved following a sown legume pasture and a more intensive grazing system.**
- **There has been no measured change in soil organic carbon over the 4 year project as a result of varying crop and pasture inputs or grazing compared to not grazing crop stubbles or pastures.**

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 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. However, in an environment where biomass production, soil moisture and microbial activity levels are lower, a clear relationship between stubble retention and soil health is still to be established. Value adding to stubbles by grazing is usually regarded to be of greater economic value.

A trial was established on Minnipa Agricultural Centre in 2008 to test whether soil fertility and health could be improved under a higher input system compared to a lower input and more traditional system. The four year (2008-2011) wheat, wheat, pasture (annual medic), wheat rotation was also split for plus and minus grazing in both the high and low input systems to establish the impact of grazing between the two treatments.

How was it done?

In 2008 a 14 ha, red sandy loam (pH 7.7, CaCl) portion of a paddock on Minnipa Agricultural Centre was divided into 4 x 3.5 ha sections. Each section represented a system treatment:

- Traditional - grazed
- Traditional - ungrazed
- High input - ungrazed
- High input - grazed

Four sampling points were selected and marked as permanent sampling points in each section. Data presented for each treatment are a mean of the four selected permanent points in each section. Table 1 presents the seed and fertiliser inputs over the 4 years. Weed control was imposed on all treatments as required in both summer and during growing season; broad-leaved weed control in the wheat, selective grass control in the medic.

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

What happened?

Soil for chemical analysis by CSBP soil testing laboratory was collected prior to seeding at five sites surrounding the four selected permanent points in each section. Table 2 presents the initial 2008 and subsequent 2010 and 2011 phosphorous, total nitrogen and soil organic carbon results.

2010 soil analysis figures indicate there has been a declining trend in residual P or N contents over the 2008 and 2009 seasons. However the 2011 results suggest increased total N contents in response to the 2010 medic pasture, with increased additions in response to the 2010 high input grazed medic treatment. Soil organic carbon levels have remained constant in study to date.

Table 1 Crop and pasture variety, seeding rate (kg/ha), phosphorus and nitrogen (units N & P/ha) applied to the traditional and high input systems, sowing dates and annual and growing season rainfall totals (mm) over the 4 year rotation

Variable	Systems	2008	2009	2010	2011
Crop variety		Wyalkatchem wheat	Angel medic	Wyalkatchem wheat	Wyalkatchem wheat
Rainfall (mm)	Annual	251	421	410	402
	Growing season	139	333	346	252
Sowing date	All treatments	19 May	7 May	22 April	9 May
Seeding rate (kg/ha)	Traditional	50	50	0	50
	High Input	70	70	5	70
N & P (kg/ha)	Traditional	7N, 8P	7N, 8P	0	7N, 8P
	High Input	25N, 12P	25N, 12P	6N, 7P	13N, 15P

Table 2 Colwell P (mg/kg 0-10 cm), total mineral nitrogen (kg N/ha 0-60 cm) and soil organic carbon (SOC%, 0-10 cm) in 2008, 2010 and 2011

System	Colwell (mg/kg)			Total mineral nitrogen (kg/ha)			Soil organic carbon (%)		
	2008	2010	2011	2008	2010	2011	2008	2010	2011
Traditional - grazed	32	25	41	83	93	134	1.2	1.1	1.2
Traditional - ungrazed	32	25	29	109	51	99	1.2	1.0	1.1
High input - ungrazed	29	25	34	107	50	84	1.2	1.0	1.1
High input - grazed	22	17	23	92	54	119	1.1	1.2	1.1

Table 3 Grain yield (t/ha) in the cereal phases of the wheat-wheat-pasture-wheat rotation and water use efficiency (kg/ha/mm of plant available water) in 2011

Grain Yield* (t/ha)				WUE (kg/ha/mm of H_20)
System	2008	2009	2011	2011
Traditional - grazed	0.2	4.0	2.0[b]	13.5
Traditional - ungrazed	0.2	4.1	1.7[c]	11.9
High input - ungrazed	0.3	4.4	2.1[b]	14.4
High input - grazed	0.3	4.5	2.4[a*]	16.2
LSD (P=0.05)			*0.24*	

**Different letters indicate significant differences LSD P=0.05*

In 2008 and 2009 grain yields were collected by yield monitor data from a 9 m commercial harvester at the four selected points in each section. In 2011 an experimental plot harvester harvested two 1.8 x 9 m plots at the four permanent points in each section. Table 3 presents the grain yield data for the 2008, 2009 and 2011 wheat crops and the estimated water use efficiency figures for 2011.

Grain yields were higher in response to increased seeding rates and/or fertiliser inputs in 2008, 2009 and 2011, grazing in 2010 also increased 2011 yields. Estimated water use efficiency in 2011 was directly correlated with higher yields with each treatment having similar available water. Wheat grain protein content did not differ significantly between treatments; the averages were 14.3, 9.7 and 10.2% respectively in 2008, 2009 and 2011.

Pasture biomass was collected in 2010 from 5 x 0.1 m^2 quadrats sited at each of the 4 permanent points in each section. Table 4 presents the annual pasture biomass, grazing pressure and stocking rate on the 2010 medic pasture.

Table 4 Annual pasture biomass in September following August grazing, grazing days imposed in March, August and November and total annual stocking rate (DSE/ha) in 2010

System	Biomass (t DM/ha)	March (DSE)	August (DSE)	November (DSE)	Annual DSE/ha
Traditional - grazed	1.8	200[1]	120[3]	750[5]	3
Traditional - ungrazed	3.9				
High input - ungrazed	4.9				
High input - grazed	3.8	200[2]	1200[4]	1500[6]	8

[1]40 days grazing with 5 sheep @ 1 DSE, [2]7 days grazing with 28 sheep @ 1DSE, [3]14 days grazing with 7 sheep @ 1.2 DSE, [4]14 days grazing with 70 sheep @ 1.2 DSE, [5]21 days grazing with 24 sheep @ 1.5 DSE and [6]21 days grazing with 48 sheep @ 1.5 DSE

The food on offer in September represents the utilisation through grazing and the comparative recovery capability of the volunteer self-regenerating (traditional) and sown (high input) medic pastures. The sown medic pasture carried more than double the stocking rate of the volunteer self-regenerating medic pasture.

What does this mean?

Higher grain yields were measured in 2008 and 2009 in response to a higher seeding rate and phosphorus and nitrogen applications. In 2011 there was a wheat yield benefit measured as a result of the grazing of both the sown and self regenerated medic based pastures in 2010, when compared to their ungrazed sown and self regenerated medics. This benefit was considered to be due to the increased total soil N levels measured pre-seeding in 2011. It could not be attributed to increased water access as soil water content measurements taken before seeding were similar in each section. There has been no measured change across sections in soil organic carbon levels after 3 seasons of below (1 year) and above (2 years) average growing season and annual rainfall.

Acknowledgements

We gratefully acknowledge the help of Mark Klante, Brett McEvoy, Trent Brace, Jake Pecina, Wade Shepperd and Ian Richter for their technical assistance and site management. We also thank GRDC for funding this trial work (UA00117).

CARING FOR OUR COUNTRY

Grain & Graze Profit through knowledge EYRE PENINSULA

GRDC Grains Research & Development Corporation

Conserving moisture during summer

Claire Browne[1], Dr James Hunt[2] and Dr Therese McBeath[2]

[1]BCG (Birchip Cropping Group), [2]CSIRO, Adelaide

RESEARCH

Location
Hopetoun NW Vic Mallee
Farmer: Warrakirrin Pty Ltd
Rainfall
2011 GSR: 198 mm
Summer rainfall 2010/11: 387 mm
Paddock History
2011: Wheat
2010: Canola
2009: Barley
Soil Type
Mallee sand dune swale
Plot Size
12 m x 4 m x 4 reps

Key messages

- **Controlling summer weeds conserved both water and nitrogen and almost doubled wheat yields in 2011 on both sand and clay soil types.**
- **Retaining or removing stubble had only minor effects on wheat yield.**
- **Complete control of summer weeds pays, and there is no excuse for weedy paddocks during summer in the Victorian Mallee!**

Background

Capturing, storing and making best use of summer rainfall is one of the most effective ways of improving crop yields in low to medium rainfall environments. The value of storing summer soil moisture has been proven in recent years through various Birchip Cropping Group (BCG) trials (1999 to 2010). Results have consistently shown the value of controlling summer weeds in terms of increased yield of the following crop.

Why do the trial?

To quantify how paddock stubble load and weed burden during summer can affect available soil water, nutrients and subsequent crop yield.

How was it done?

This field experiment was established 13 km south-east of Hopetoun, Victoria on Warrakirri's Bullarto Downs property on two soil types typical to the region. The sand site lay on top of an east-west dune with sandy topsoil and clay subsoil. The clay site was located on a low-lying flat with clay loam topsoil and moderate subsoil constraints.

At each field site, six stubble treatments were established on 2 December 2010 into existing canola stubble loads: 5.3 t/ha at the sand site and 4.8 t/ha at the clay site. The treatments were:

1. standing stubble
2. standing stubble and summer weeds
3. slashed stubble
4. bare earth
5. bare earth and summer weeds
6. cultivation

Stubble on treatments 3, 4 and 5 was slashed with a whipper-snipper; stubble was then removed from the plots in treatments 4 and 5.

Two soil cores per plot (to a depth of 1.3 m) were taken on 14 December 2010, 28 March 2011 and 2 December 2011. Plant available water (PAW) and mineral nitrogen were determined from the samples.

Following rain in December 2010 and January 2011, summer weeds (volunteer cereals, melons and heliotrope) emerged in all treatments. On 25 January 2011, treatments 1, 3 and 4 were sprayed with Amicide® 625 600 ml/ha and Companion® 1%. On 9 February and 11 March treatments 1, 3 and 4 were sprayed again with Roundup® 1.5 L/ha, Goal® 75 ml/ha and Hasten® 1%. Treatment 6 was cultivated on 25 January at both sites and the sand site was cultivated again on 3 March due to subsequent weed emergence. Weeds in treatments 2 and 5 were allowed to continue growing throughout the summer.

All treatments were inter-row sown with 30 cm row spacing using knife points and press wheels with Correll wheat on 29 April 2011 @ 70 kg/ha, with 55 kg/ha MAP at sowing and 21 kg/ha N top-dressed as ammonium sulfate on 1 July. Plots were kept weed-free throughout the season. Crop biomass was measured as Normalised Difference Vegetation Index (NDVI) at growth stage (GS) 30 with a hand-held GreenSeeker® crop sensor (NTech Industries Inc., Ukiah, California). Grain yield was measured with a plot harvester and grain quality analysed (protein, moisture, screenings and test weight).

What happened?

At both sites, crop establishment was better when summer weeds were controlled (Table 1). Stubble retention also improved establishment at the sand site, but made no difference at the clay site (Table 2). Early growth was better where weeds were controlled over summer, at GS30 NDVI was higher in these treatments (Table 3).

Table 1 Wheat plant density for weedy and weed control treatments

Treatment	Plant density (plants/m²)	
	Sand	Clay
Weeds (treatments 2 & 5)	104	91
No weeds (treatments 1, 3, 4, & 6)	139	113
LSD (P=0.05)	*13*	*16*

Table 2 Wheat plant density for stubble retained and no stubble treatments

Treatment	Plant density (plants/m²)	
	Sand	Clay
Stubble (treatments 1, 2 & 3)	141	105
No stubble (treatments 4, 5, & 6)	115	107
LSD (P=0.05)	*12*	*ns*

Table 3 Wheat NDVI at GS30 on 4 August 2011 for weedy and weed control treatments

Treatment	Sand	Clay
Weeds (treatments 2 & 5)	0.07	0.12
No weeds (treatments 1, 3, 4, & 6)	0.12	0.26
LSD (P=0.05)	*0.03*	*0.05*

Farming Systems

Table 4 Sand site plant available water (PAW) and mineral nitrogen (0-130 cm), yield, protein and gross margin in 2011

Treatment	PAW 28 March (mm)	Mineral N 28 March (kg/ha)	Yield (t/ha)	Protein (%)	Gross Margin ($/ha)
Standing stubble	97	131	3.7	9.9	298
Standing stubble + summer weeds	78	77	2.2	10.2	126
Slashed stubble	113	123	4.2	9.8	346
Bare earth	101	105	3.7	9.6	304
Bare earth + summer weeds	67	70	2.1	9.9	84
Cultivation	96	101	3.7	9.2	305
LSD (P=<0.05)	*27*	*29*	*0.3*	*ns*	*46*

Table 5 Clay site plant available water (PAW) and mineral nitrogen (0-130cm), yield, protein and gross margin in 2011

Treatment	PAW 28 March (mm)	Mineral N 28 March (kg/ha)	Yield (t/ha)	Protein (%)	Gross Margin ($/ha)
Standing stubble	145	145	2.6	12.1	296
Standing stubble + summer weeds	99	97	1.4	12.9	58
Slashed stubble	133	123	2.8	11.8	321
Bare earth	125	149	2.9	11.9	351
Bare earth + summer weeds	97	111	1.4	12.2	55
Cultivation	133	145	3.0	12.0	369
LSD (P=<0.05)	*ns*	*30*	*0.2*	*0.5*	*70*

Table 6 Additional PAW, nitrogen, yield and return on $ investment (ROI %) from controlling summer weeds at both sites 2009-2011

Site	Year	Mean additional PAW at sowing (mm)	Mean additional Nitrogen (kg N/ha)	Mean additional grain yield (t/ha)	RO (%)
Sand	2009*	26	-5	0.1	170
	2010	40	45	0.4	205
	2011	29	41	1.6	662
Clay	2009	10	10	0.0	6.6
	2010	52	44	0.6	308
	2011	36	53	1.4	909

**Crop type in 2009 was barley, 2010 canola and 2011 wheat*

Increased yields were measured at both sites in response to controlling summer weeds. PAW and mineral N prior to sowing were also generally higher as a result of the weed control (Table 4 & 5). Compared to retaining standing stubble, slashing increased grain yields at the sand site and the bare earth and cultivation treatments had higher yields at the clay site.

What does this mean?

The results of this trial in 2011 have once again clearly demonstrated that controlling summer weeds has a much bigger impact on plant available water, nitrogen and crop yield than retaining stubble. This is the first season in which a small but significant effect of stubble management on yield has been found. The slashed stubble treatment yielded more than standing stubble and the cultivation and bare earth treatments yielded more than the stubble retention treatments at the clay site. The increased yield due to stubble at the sand site may have been due to higher established plant numbers. Reasons for the yield decrease at the clay site are less obvious and less significant.

Return on investment in summer weed control in 2011 was excellent; this has been the case for two of the three years that the trial has run (Table 6). Modelling over 120 years of climate data has shown that years such as 2009, in which there is no return on investment from controlling summer weeds, are not common, occurring in only 29% and 3% of years at Hopetoun on clay and sand soil types respectively.

Because controlling summer weeds results in more soil water and nitrogen, yield responses are very reliable. In seasons with high growing season rainfall (e.g. 2010), the yield increase was driven by additional nitrogen. In seasons with low growing season rainfall, the yield increase is driven by additional water, and in average seasons the yield increase is driven by both water and nitrogen.

Commercial practice: what this means for the farmer

- Growers and consultants are right to focus attention on summer weed control. Complete control of summer weeds is highly profitable and one of the safest input investments in broad-acre grain farming.
- In north-west Victoria, there is no excuse for weedy paddocks over summer. Research by NSW DPI has shown that whilst complete control of summer weeds is preferable, delayed control is better than no control.
- Weed control by cultivation is as effective at storing water and increasing yields as are herbicides. It should not be ruled out as an option, particularly on heavy soils and on bare paddocks (e.g. pulse stubbles etc.) where it is likely to reduce rather than exacerbate wind erosion. Weed control by cultivation can be undertaken within a few days of rainfall (longer is required for herbicides), and can be done when weather conditions prevent spraying. Because of this, it may have a role on farms where timely summer weed control with herbicides is difficult.
- Retaining or removing stubble has only minor implications for yield. The best reason for retaining stubble is to prevent wind and water erosion, and 70% cover (~2 t/ha) of cereal stubble is required to achieve this. Stubble levels should be managed on a paddock-by-paddock basis to ensure system benefits (prevent erosion, reduce labour, facilitate faster sowing, and improve establishment) and avoid system penalties (increased labour, delayed sowing, reduced pre-emergent herbicide efficacy, increased disease e.g. crown rot, yellow leaf spot).

Acknowledgments

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Grains Research & Development Corporation

Section 5

Section Editor:
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Nutrition

Crop production using replacement P

Cathy Paterson[1], Wade Shepperd[1], Ian Richter[1], Sean Mason[2] and Therese McBeath[3]

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RESEARCH

Almost ready

Location:
Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 4.0 t/ha
Actual: 2.9 t/ha

Paddock History
2010: Wheat
2009: Wheat
2008: Wheat

Soil Type
Red sandy loam

Plot Size
1.4 x 9 m x 4 reps

Yield Limiting Factors
Leaf rust and dry spell in spring

Environmental Impacts
Water Use
Water use efficiency: 11.5 kg/ha/mm
Runoff potential: Low

Resource Efficency
Greenhouse gas emmisions (CO_2, NO_2, methane): Changed fertiliser input

Social/Practice
Time (hrs): No extra
Clash with other farming operations: Standard practice

Economic
Infrastructure/operating inputs: No change
Cost of adoption risk: Medium

Key message

- **Over 3 years of crop production (2009-2011) applying replacement phosphorus (P) rates have been the most economic.**

Why do the trial?

There has been an accumulation of P reserves in many cropping soils as a result of application rates in excess of crop demand over a run of poor seasons prior to 2009. To better match the import and export of P, replacement P application rates are being investigated. A replacement P rate is based on the estimated P exported from the paddock as product (grain, hay or livestock) calculated using a grain P concentration of 3 kg P/ha/t of cereal grain harvested the previous year.

The aim of this study is to assess the crop production and economic outcomes from applying P at nil, replacement, 10 kg P/ha (district practice, DP) and 20 kg P/ha (double district practice, DDP) rates on 2 soil types at Minnipa. This work follows on from articles in the 2009 (pg 154-155) and 2010 (pg 110-111) EPFS Summaries.

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) and the second on a shallow, heavy soil (poor zone). In 2009, Colwell P levels were 25 and 35 mg/kg on the good and poor zones respectively, prior to establishing the trials.

There are four treatments which have been tested for three consecutive years on the same plot (Table 1). P was applied as DAP banded at sowing, with N balanced with urea to give a total of 18 kg N/ha on all treatments. In 2011, both trials were sown with Scope barley on 3 May.

Table 1 shows 2010 yields, the P and DAP applied to each treatment. Measurements during 2011 included dry matter at late tillering, grain yield and quality (Table 2).

What happened?

Soil tests taken before sowing in the 2011 season in the good zone showed that the Colwell P levels had fallen from the 2009 and 2010 levels in all treatments, with the exception of the 20 kg/ha P treatment which remained the same (Figure 1). In the poor zone, the Colwell P levels have dropped in 2011 compared to 2010, except for the 20 kg/ha P treatment, but are similar to the initial 2009 levels. However soil test values from both sites were estimated to be above the critical Collwell P value suggesting little or no response to applied P in 2011 (Figure 1).

Nutrition

Table 1 2010 wheat yields, phosphorus (P kg/ha) and DAP (kg/ha) applied in 2011

P applied	Yield 2010 (t/ha)	P applied in 2011 (kg/ha)	DAP applied in 2010 (kg/ha)
Good zone, deep sandy loam			
0	3.9	0	0
10 (DP)	4.0	10	50
20 (DDP)	4.4	20	100
Replacement P	4.3	12.9	65
Poor zone, shallow constrained soil			
0	3.5	0	0
10 (DP)	3.7	10	50
20 (DDP)	3.9	20	100
Replacement P	3.9	11.7	53

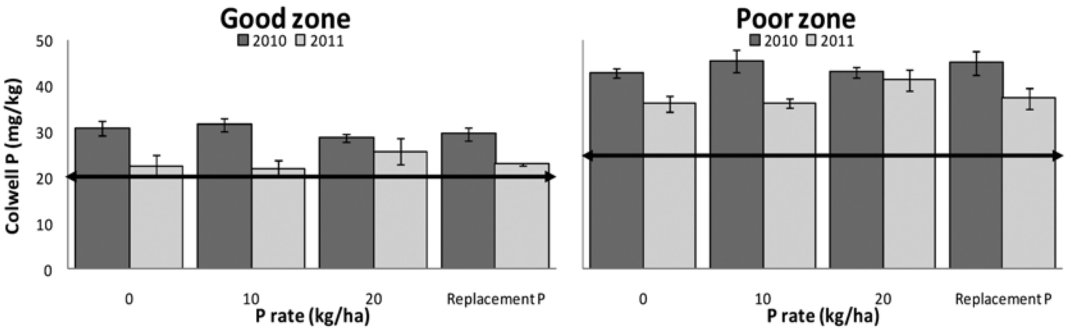

Figure 1 Colwell P values with P treatments prior to sowing in 2010 and 2011. Arrow represents the critical Colwell P value calculated from PBI values at each site. Standard error bars are given on each column.

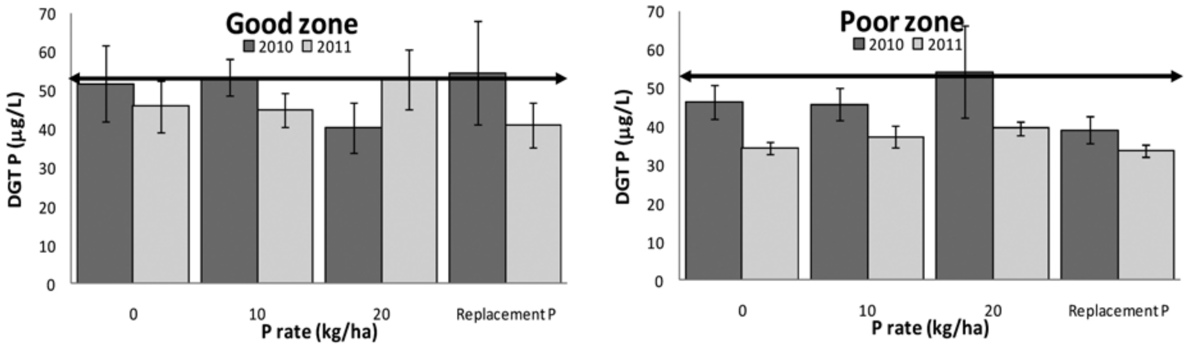

Figure 2 DGT P values measured prior to sowing in 2010 and 2011. Arrow represents the critical DGT P value. Standard error bars are given on each column.

Analysis of the same soil samples using DGT revealed a similar pattern with respect to P treatments and the maintenance of P levels with replacement application rates (Figure 2). The major benefit of using DGT in this circumstance was that it correctly predicted the response seen at both sites with values at or below the critical DGT value. This finding was a repeat of 2010 with DGT values estimated as at or below the critical level and yield increases were measured in response to P applications (Table 3).

As predicted in Figure 2 there was higher grain yield with applied P in both zones. This was reflected in increased dry matter production at tillering in the good zone. The addition of P in the good zone resulted in a lower screening percentage and higher test weight. However the generally low test weights and high screenings percentage is likely to be a result of a late leaf rust infection and the 6 week dry period experienced by the crop in the mid August to late September period.

A gross income analysis on all treatments showed that the Nil P strategy had a similar gross income in 2011as the replacement and 20 kg P (DPP) on good and poor zone respectively, but less on all others. The highest total gross income in 2011 from both zones was produced by the 10 kg/ha P treatment, followed by the replacement P strategy (Table 2). However after 3 years of this trial the cumulative gross income analysis has shown that in 2 out of 3 years a replacement P strategy has performed better than the district practice of 10 kg P/ha in both zones. This has resulted in a higher accumulated gross income for the replacement P strategy.

Table 2 Barley 2011 dry matter (DM) at tillering, grain yield, test weight, protein and screenings in response to P treatments from the 2 zones

P applied (kg/ha)	DM late tillering (t/ha)	Yield 2011 (t/ha)	Test Weight (kg/hL)	Protein (%)	Screenings (%)	Gross Income *($/ha)
Good zone, deep sandy loam						
0	1.4	2.4	58.0	12.0	32.4	386
10 (DP)	2.4	2.9	59.0	11.8	27.3	443
20 (DDP)	2.5	2.9	59.4	11.9	23.8	415
Replacement P	2.1	2.9	59.0	12.2	28.5	434
LSD (P<0.05)	*0.38*	*0.24*	*0.60*	*ns*	*5.8*	
Poor zone, shallow constrained soil						
0	1.5	1.8	58.5	11.9	25.6	226
10 (DP)	1.7	2.1	59.2	11.7	21.5	317
20 (DDP)	1.8	2.0	59.5	11.9	21.5	279
Replacement P	1.9	2.1	59.2	11.7	26.4	306
LSD (P<0.05)	*ns*	*0.14*	*ns*	*ns*	*ns*	

Table 3 Grain yield and gross income in response to P treatments in 2009, 2010, 2011 and the accumulated 2009-11 gross income from the 2 zones

P applied (kg/ha)	2009		2010		2011		Accumulated Gross Income* 2009-11 ($/ha)
	Yield (t/ha)	Gross Income *($/ha)	Yield (t/ha)	Gross Income *($/ha)	Yield (t/ha)	Gross Income * ($/ha)	
Good zone, deep sandy loam							
0	3.9	848	3.9	1025	2.4	386	2259
10 (DP)	4.4	906	4.0	1025	2.9	443	2374
20 (DDP)	4.6	941	4.4	1106	2.9	415	2462
Replacement P	4.3 (2)**	966	4.3 (13.3)	1085	2.7 (12.9)	434	2485
Poor zone, shallow constrained soil							
0	2.9	573	3.5	873	1.8	226	1672
10 (DP)	2.8	548	3.7	944	2.1	317	1809
20 (DDP)	3.1	606	3.9	972	2.0	279	1857
Replacement P	2.7 (1.2)	570	3.9 (8.4)	995	2.1 (11.9)	306	1871

Gross income is yield x price less fertiliser costs delivered cash on 1 December each year
**In the yield column, a number in brackets represents the amount of kg P/ha added.*

What does this mean?

In 2009 and 2010 there was an economic benefit gained from using the replacement P strategy compared to the 10 kg P/ha strategy, especially in 2009 when the level of fertiliser required to replace the P exported the previous 2008 harvest was low (Table 3). In 2011 there was no extra yield from the higher replacement P rates when compared with the district practice rate of 10 kg P/ha in both the poor zone and the good zone of the paddock. However, there was a yield increase from adding 10 kg P/ha compared to the nil P treatment and this yield increase provided a 10% increase in gross income in the good zone and a 9% increase in the poor zone. Due to the slightly higher fertiliser cost for the replacement P strategy, there was a 2% decrease in gross income in the good zone and 4% decrease in the poor zone for replacement P compared to the 10 kg/ha P treatment. Overall in the 3 years of this trial the replacement P strategy has been the most economic.

The Colwell P values suggest that the replacement and 10 kg P/ha treatments are decreasing the P status in both zones while the 20 kg/ha application rate is maintaining P reserves. However at both sites Colwell P critical value estimates from the textbooks suggested sufficient P was present to maintain yields without further P; this was shown to be incorrect with a yield response from P added at both sites, so another example perhaps of industry standards needing to be tweaked for the upper EP environment.

DGT results produce a specific site measure whereby a grain yield response is expected when P values fall below that measure or level, this method is more accurate than using Colwell P which can tend to overestimate P reserves on calcareous soils. In both 2010 and 2011 there was a grain yield response to applied P when DGT values were either at or below that critical level. There were no levels above the critical level to assess a yield response or a lack of a yield response. Please refer to the P management article for the economic implications of incorrectly predicting P soil levels and also an update on the DGT as a commercial service.

This trial will continue in 2012 with appropriate soil analysis carried out to measure any further 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 after the end of the 2012 season.

Acknowledgements

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Measuring the effect of residual P

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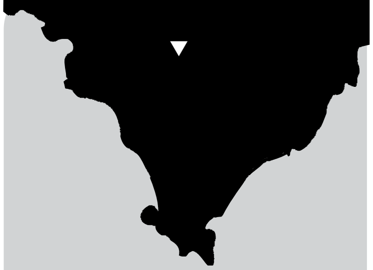
RESEARCH

Searching for answers



Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 4.0 t/ha (B)
Actual: 2.3 t/ha
Paddock History
2010: Wheat
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Plot Size
1.4 m x 12 m x 4 reps

Key message

- **Despite three years of above average rainfall, a red calcareous sandy loam at Minnipa with soil phosphorus reserves of 27 mg/kg of Colwell P has not required any added P fertiliser for maximum cereal grain yields.**

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 relative value of current and previous fertiliser applications, we are measuring crop response in a field trial at Minnipa to different fertiliser rates over time, with soil P levels measured annually as Colwell P. Since 2010 DGT (EPFS Summary 2009, pg 150) has also been used to measure soil P levels.

How was it done?

To measure comparative wheat yields in response to different P rates and years of application, a 4 year replicated trial was established in Paddock South 1, Minnipa Agricultural Centre in 2009. Table 1 shows the P application rates on each of the 10 treatments over the 4 years of the study. The site had an initial Colwell P level of 27 mg/kg (0-10 cm). Deep banded DAP is used as the P supply with the N balanced using urea to give a total of 18 kg N/ha. In 2011 the trial was sown on 23 May with Scope barley at 50 kg/ha.

Soil samples (0-10 cm) were taken before sowing in 2011 between the rows in a zigzag pattern from each plot to assess the effect of the treatments on soil P fertility. Dry matter production was sampled on 23 August (end of tillering). Grain yield and grain quality were measured at maturity. All plots were kept weed free.

What happened?

Colwell P measurements taken before sowing in 2011 ranged from 27-31 mg/kg, and were less than the 2010 Colwell P levels of 36-37 mg/kg, but similar to the 2009 measured 27 mg/kg. The increase in Colwell P from 2009 to 2010 was similar between all treatments. By 2011 Colwell P had declined back to the 2009 measured level (27 mg/kg) providing no or only 5 kg/h of P had been previously added. For all the other treatments Colwell P has fallen from the 2010 levels but were still higher than the original measured amount (Figures 1a and 1c).

Similar trends were seen using the DGT-P soil test (Figure 1b and 1d). There has been a reduction in P levels to near critical value levels in 2011and therefore the results from the final year of this trial (2012) will be extremely interesting in terms of soil analysis and crop response.

Table 1 Phosphorus (kg/ha) to be 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

Nutrition

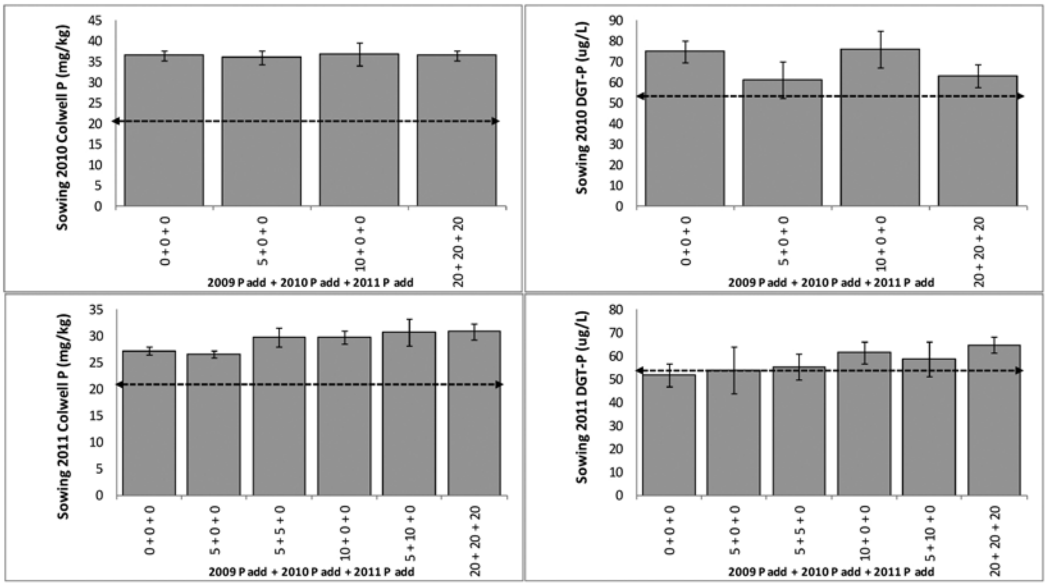


Figure 1a (top left) Colwell P and 1b (top right) DGT-P values measured at sowing in 2010. 1c (bottom left) Colwell P and 1d (bottom right) DGT-P values measured at sowing in 2011. The dashed line represents the critical soil test value.

Table 2 Biomass and grain yield response to P fertiliser applied in 2009+2010+2011

P applied (kg/ha)	Dry matter 23/8/2011	2009 Wheat yield (t/ha)	2010 Wheat yield (t/ha)	2011 Wheat yield (t/ha)
0+0+0	2.3	4.0	2.7	2.1
20+20+20	2.7	4.0	2.8	2.3
2009 applied fertiliser				
5+0+0	2.2	3.9	2.7	2.1
10+0+0	2.3	4.0	2.7	2.1
2010 applied fertiliser				
5+5+0	2.3		2.8	2.2
5+10+10	2.5		2.8	2.1
2011 applied fertiliser				
5+5+5	2.6			2.2
5+5+10	2.8			2.3
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*

Despite a trend for higher biomass production with applied P in 2011 there were no grain yield or quality responses to applied P measured in 2011 (Table 2). Test weights were 62-65 kg/hL, screenings 5.1-7.3% and protein 10.8-11.4%. Due to the lack of response to added P in this soil it is not yet possible to assess the residual value of P fertiliser as all treatments have had the same yield in every season of the experiment.

What does this mean?

Although there was a trend towards increased biomass in response to applied P in 2011 for the third year in a row, there was no yield response to P in this trial, indicating that the measured P was sufficient to grow a productive crop in each of those years. Similar results were previously reported in this trial (EPFS 2009, pg 156-157 and EPFS 2010, pg 112-113) and in trials done by Sean Mason (EPFS 2009, pg 150-153).

Both the Colwell P and DGT soil P tests had values close to or greater than their respective critical values and therefore both these tests correctly predicted a marginal to nil response to P applications. Starting P levels using DGT-P were higher for this paddock compared to the paddock North 1 (see P replacement trials) explaining why this paddock continues not to respond to P application compared to responses seen with the replacement trial. Soil analysis will continue for the final year of this trial to measure any changes in soil P and if there is any impact of differing regimes on crop performance.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Thanks to Nigel Wilhelm and Roy Latta for their advice throughout the year and Sue Budarick and Jack Pecina for their technical assistance during the year.

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Can we reduce our phosphorus inputs?

Therese McBeath[1], Sean Mason[2] and Cathy Paterson[3]
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RESEARCH

Key messages

- **Reducing P inputs has a risk attached to it, but excessive use of P fertiliser is also a risk to profit making.**
- **After several seasons with high crop yields, reduced P inputs are not maintaining soil P fertility.**
- **Monitoring soil P fertility can be a cost-effective method to manage the risk associated with reduced P inputs.**

Background

Many cropping paddocks across EP are currently recording high soil test phosphorus (P) values. This suggests that there may be an opportunity to reduce P fertiliser rates in those paddocks.

To manage P more efficiently, we have asked the question 'Can we reduce our P inputs?' To investigate this, we have tested the merits of using a replacement P strategy by adding the amount of P that was removed in the previous crop and we have evaluated the residual value of previously applied fertiliser P (previous two articles). In this article we consider the risks associated with reduced P inputs and evaluate strategies that help us to manage this risk.

P fertilisers underpin productive farming systems in southern Australia. There are two main risks to the bottom line when it comes to fertiliser management, the first being loss of profit through loss of yield from too little fertiliser and second being loss of profit through use of fertiliser above crop and pasture requirements. There are several ways to monitor whether fertiliser management is at optimal efficiency and they include fertiliser response trials, modelling of the interaction between soil nutrient reserves and crop production, and the use of soil testing to monitor soil fertility. Fertiliser response trials tend to be quite accurate, but are intensive in cost and labour, and are specific to the site and season of the testing. Modelling enables consideration of response to different management strategies over a longer timeframe, but when it comes to phosphorus, it is very much a work in progress and not ready for use of on-farm prediction of soil nutrient reserves. Soil testing is a monitoring tool that predicts the responsiveness of the paddock to P addition based on the soil test value, although Colwell P on calcareous soils has some extra problems. In Figure 1 we consider the likely behaviour of P reserves in a cropping soil over time under different P management strategies. The soil P status is presented relative to a critical P level as determined by a soil test. In the figure it is assumed that starting P levels are adequate which has been a common occurrence in many paddocks in recent years. The status of P reserves can then fluctuate in response to the P management strategy. Three scenarios are presented in Figure 1 as an example:

- **Fertiliser Strategy 1** - a P fertiliser program that maintains soil P levels at a point well above the soil test critical value by taking into account P removal and fertiliser efficiencies for a particular soil. The management risk is associated with using more P than is required to optimise yield.
- **Fertiliser Strategy 2** - a P fertiliser program that is resulting in a rundown in soil P fertility. This can occur when the tie up and fertiliser contribution to the plant is underestimated and the soil P fertility will eventually fall below the soil test critical value. As for the use of no P, the management risk is knowing when the soil test value falls below the critical value and yield is being lost due to inadequate P.
- **No fertiliser** application for a period of time which will run down P reserves, to below critical levels if continued for a sufficiently long period – then production losses will start to occur. The pattern of run down will be determined by the amount of P removed by crops and the ability of the particular soil to supply P to crops. The management risk is knowing when the soil test value falls below the critical value and yield is being lost due to inadequate P.

What happened?

The replacement P trials at Minnipa Agricultural Centre on two soil types are comparing district practice fertiliser rates with replacement P rates (replacing the amount of P removed in the previous grain harvest). Both sites had starting soil P levels well above the adequate range and in the first year there was no response to P, however this was following three years of drought where the fertiliser inputs over the whole paddock would have exceeded crop requirements, resulting in a build up of residual phosphorus. In the above average rainfall seasons of 2010 and 2011, there was a response to added P but due to high yields the replacement P rate was similar to or higher than the district practice of 10 kg P/ha at 8-13 kg P/ha.

As there was no yield advantage from a replacement P rate compared to the district practice rate, the district practice rate of 10 kg P/ha was more economic.

Nutrition

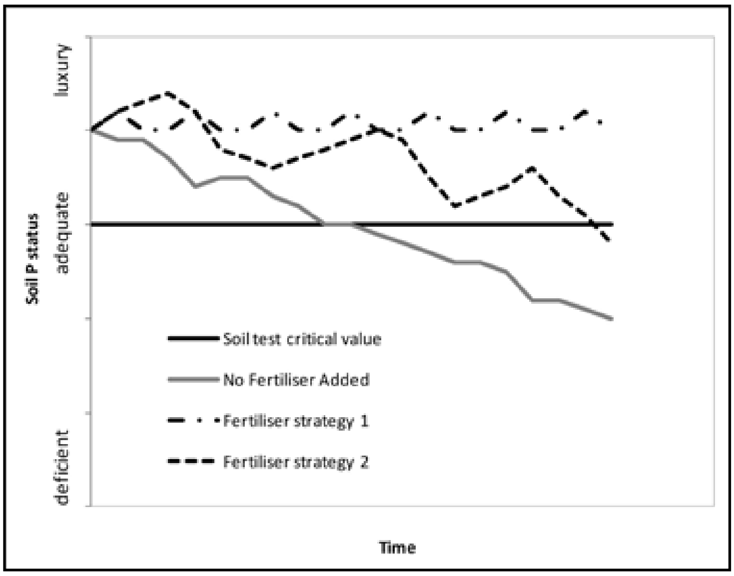

Figure 1. A theoretical outline of the behaviour of soil test P over time in response to different P management strategies. The black bold line shows the soil test critical value. When the soil test is above this line the soil P aat least 90% of maximum yield and when below extra P addition is required in order to achieve maximum yield. The grey line shows the decline in soil test P over time when no fertiliser is added. The black broken lines represent the change in soil test values in response to different fertiliser addition strategies. Strategy 1 maintains the soil test value well above adequate while strategy 2 is a system that is slowly running it down.

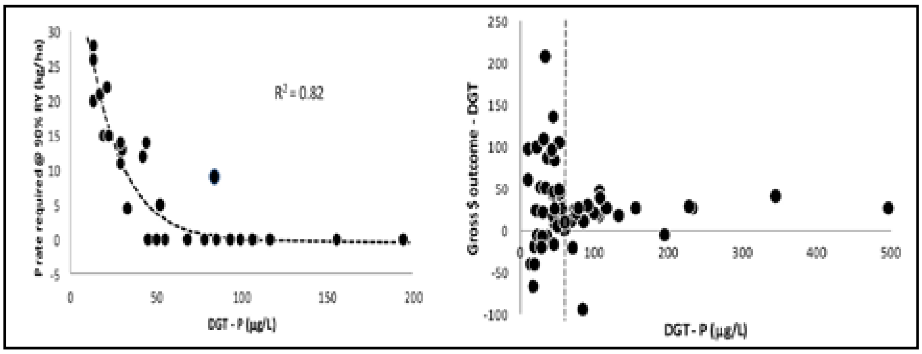

Figure 2a. (left) Relationship of DGT P soil test measurements with the P rate required to maximise yields. Data is obtained from replicated field trials performed during 2006-2010 across Southern Australia and 2b. (right) potential returns using the DGT-P soil test under both deficient and sufficient conditions (dashed vertical line represents the critical value). Data used is from a replicated P response field trial database generated 2006-2010. Parameters used – Wheat @ $200/t, DAP/MAP @ $750/t, Colwell P/PBI @ $15/test, DGT @ $22/test.

While it was possible to achieve equivalent yields for the first year following drought with no P inputs, the high yields of 2009 and 2010 resulted in a decline in soil P fertility and a response to added P fertiliser in 2011. Adjusting fertiliser inputs in response to changes in soil fertility would be of benefit to productivity and profitability.

The residual P site is not yet showing any yield increases with added P suggesting that some sites have sufficient P reserves to grow several crops before inputs are required. The soil P levels are now near soil test critical values for response to P addition so the season of 2012 may provide the answer as to the amount of grain removal that is possible before further P addition is necessary.

What does this mean?

In all trials measuring the sustainability of reducing P inputs, the monitoring of soil fertility is providing clues as to the rundown or maintenance of soil P fertility relative to the critical value. A well calibrated soil test can be used to develop a relationship between soil test value and P addition required to achieve maximum yield (see Figure 2a. as an example with DGT P). When this relationship works well, there is a significant pay-off from investment in soil testing, because soil testing provides reliable information to guide the selection of P rates which will keep soil P reserves at or above the critical value as described in Figure 1. A well calibrated soil test can provide significant economic savings as illustrated in Figure 2b. In this example, returns were calculated using the following:

- If a soil test correctly predicted a site is deficient in P – the positive $ return is the yield gained with P addition minus the cost of the P input; and
- If a soil test correctly predicted the site is sufficient in P – the positive $ return is the savings in not applying P above a starter rate of 5 kg P/ha.

The return made on the extra yield obtained with P application in a deficient soil is of greater $/ha benefit than the cost savings of not applying P in a sufficient soil. The counter balance is that getting the P rate right when managing a responsive situation requires investment up front whereas for a sufficient situation, the $$ can stay in the bank. Getting these costs, benefits and risks in the right balance for you, or your client, is the key. Soil testing can get you closer to that balance.

At the time of writing the commercialisation of DGT is imminent and every attempt is being made in consultation with two soil laboratories to offer a trial service for the 2012 growing season.

Acknowledgements

Thanks to the GRDC projects UA0017, UA00103 and CSA020 for funding this work and to Nigel Wilhelm for helpful comments on this article.

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE GRDC Grains Research & Development Corporation CSIRO

Phosphorus responses in wheat and barley

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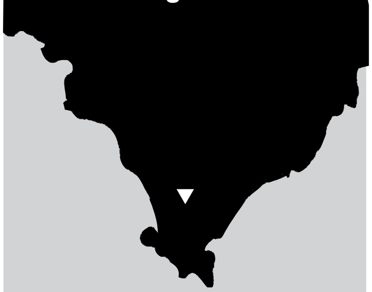
[1] University of Adelaide School of Agriculture, Food and Wine; [2]SARDI New Varieties Agronomy, Waite

Searching for Answers



Location:
Yallunda Flat, Lower Eyre Peninsula
Steve, Val and Adam Briese
Rainfall
2011 GSR: 373 mm
Yield
Potential: 5.26 t/ha (Wheat)
Potential: 5.66 t/ha (Barley)
Actual: 4.40 t/ha (Wheat)
Actual: 4.69 t/ha (Barley)
Paddock History
2010: Pasture
2009: Wheat
Soil Type
Acid loam
Soil Test
pH(H_2O): 5.6
Colwell P: 15 mg/kg (PBI=43.9)
Nitrate N: 13 mg/kg
Organic C: 0.7%
Disease
Rhizoctonia
Plot Size
1.4 m x 10 m x 3 reps
Yield Limiting Factors
Available soil P, root disease
Environmental Impacts
Water use
Water use efficiency: (based on GSR and highest yield achieved)
Wheat: 11.8 kg/ha/mm
Barley: 12.6 kg/ha/mm

Key messages

- **There is considerable variation in the responsiveness to P among varieties of wheat and barley.**
- **Seasonal conditions can influence the extent of this variation but there are varieties that show consistent responses to P on different soil types.**
- **Increases in vegetative growth from added P were reflected in higher yields.**
- **Plants that were P deficient tended to show greater sensitivity to root diseases and flowered later.**

Why do the trial?

Aim: To characterise the response to phosphorus (P) in a range of wheat and barley varieties.

The inexorable increase in fertiliser prices means there is a need to improve efficiency of on-farm nutrient use. Adequate P nutrition is the basis of profitable crop production but crops only use a small proportion of the P fertiliser that is applied in that year; the rest of the crop's P requirements needs to be met from soil reserves. Breeding to improve the ability of crops to use soil P reserves and to take up fertiliser will improve P use efficiency. However, as a first step we need to characterise how much variation there is among varieties in response to P fertiliser.

How was it done?

The experiments were conducted at Yallunda Flat on lower Eyre Peninsula. The soil was an acid (surface pH = 5.6) sandy loam which was low in available P (Colwell P = 15 mg/kg; DGT P = 40 g/L). The experiments were sown after a pasture in 2010.

Fifty varieties of wheat and 50 varieties of barley were grown at two rates of P, 0 and 30 kg P/ha, in separate experiments. The varieties grown included a range of current commercial varieties and some old varieties that have been reported to show differences in P responses. Among the wheat varieties we also grew four Brazilian varieties that show greater tolerance to acid soils: it is thought that the mechanisms of their greater tolerance will also contribute to greater P uptake. The P was applied as triple superphosphate, drilled with the seed at sowing. Target plant populations were 210 plants/m^2 for wheat and 145 plants/m^2 for barley. The experiments were sown on 2 June 2011 and harvested on 28 November (barley) and 7 December (wheat).

Crop biomass was assessed as NDVI measured using a Greenseeker on 18 August and 21 September. Crop development was assessed by noting the Zadok's growth stage on 21 September. Patches of root disease, largely Rhizoctonia, developed in some plots and the severity of this was assessed by a visual rating of the proportion of plot area affected. Prior to harvest, samples of plants were taken from each plot to estimate the harvest index (HI = plant grain yield/total plant biomass). The plots were harvested at maturity. Phosphorus use efficiency (PUE) was estimated as the relative yield at the two rates of P:

PUE = [(yield at 0 kg P/ha)/(yield at 30 kg P/ha)] x 100%

What happened?

The Colwell P and the DGT P results suggested that the site would be responsive to P and this was confirmed by the large increase in vegetative growth and in grain yield with the addition of P fertiliser. Measurements of NDVI early in the season were correlated with grain yield at both P treatments suggesting the amount of early crop vigour was a strong contributor to grain yield.

Table 1 The grain yield of selected wheat and barley varieties at 0 and 30 kg P/ha and their corresponding phosphorus use efficiency (PUE) at Yallunda Flat in 2011. The varieties are ordered according to their PUE.

Wheat				Barley			
Variety	Grain Yield (t/ha)		PUE (%)	Variety	Grain Yield (t/ha)		PUE (%)
	0 kg P	30 kg P			0 kg P	30 kg P	
Halberd	2.93	3.71	79	Scope	1.46	3.25	45
Trident	2.54	3.24	78	WI4259	1.83	4.28	43
Toropi	2.05	2.68	77	Navigator	0.77	1.90	40
Trintecenco	1.93	2.57	75	Hindmarsh	1.44	3.68	39
Carazhino	2.08	2.81	74	Vlamingh	1.15	2.93	39
Carnamah	2.58	3.53	73	Forrest	1.28	3.36	38
Gladius	2.58	3.55	73	Barque73	1.44	3.79	38
Yitpi	2.81	4.11	68	Oxford	1.77	4.69	38
Maringo	2.27	3.36	67	Chebec	0.89	2.45	36
Frame	2.74	4.08	67	Baudin	0.82	2.29	36
Gamenya	2.40	3.65	66	Franklin	1.00	2.91	34
Kukri	2.13	3.29	65	Commander	1.31	3.88	34
Spear	2.74	4.24	65	SloopSA	0.73	2.21	33
RAC875	2.03	3.19	64	Gairdner	1.08	3.30	33
Condor	2.06	3.25	63	Skiff	1.14	3.48	33
Annuello	2.39	3.92	61	Galleon	1.18	3.59	33
Magenta	2.48	4.08	61	Fleet	1.35	4.34	31
Wyalkatchem	2.27	3.77	60	Flagship	1.03	3.45	30
Janz	1.85	3.17	58	Tantangarra	1.20	4.04	30
Scout	2.09	3.60	58	Arapiles	0.80	2.78	29
Excalibur	1.57	2.75	57	Yarra	1.11	4.01	28
Espada	1.92	3.43	56	Maritime	0.87	3.46	25
Mace	2.34	4.20	56	Yagan	0.74	3.05	24
Strezelecki	1.88	3.39	55	Hannan	0.88	3.66	24
AGT Scythe	2.31	4.40	52	Roe	0.61	2.77	22
Krichauff	1.83	3.53	52	Mundah	0.77	3.62	21
Axe	1.55	3.15	49				

Table 2 Comparison of ranking for PUE of wheat varieties grown at Yallunda Flat in 2011 with previous work on PUE on calcareous soils on the Eyre Peninsula reported in EPFS Summary 2008, p 37-38

Rank for PUE	Yallunda Flat (2011)	Minnipa (2008)	Streaky Bay (2008)	Piednippie (2008)
1 (highest)	Gladius	Gladius	Gladius	Krichauff
2	Yitpi	Excalibur	Kukri	Kukri
3	Kukri	Axe	Krichauff	Gladius
4	Wyalkatchem	Kukri	Excalibur	Yitpi
5	Excalibur	Yitpi	Wyalkatchem	Excalibur
6	Krichauff	Wyalkatchem	Axe	Wyalkatchem
7 (lowest)	Axe	Krichauff	Yitpi	Axe

On average, wheat yield increased from 2.21 t/ha to 3.62 t/ha (PUE = 61%) and barley yield increased from 1.00 t/ha to 3.08 t/ha (PUE = 32%). Low P supply slowed crop development and delayed leaf emergence. Another notable feature was that the severity of root disease was more severe under low P. Adequate P also increased HI, due to higher grain set and/or grain size. What this shows is that despite the large increase in biomass from the addition of P, there was no evidence that crops 'hayed off' from the greater bulk of crop growth with added P.

There was a considerable range in the responsiveness among the wheat and barley varieties (Table 1). Axe and Krichauff were the least P efficient varieties. In past trial work on the Eyre Peninsula and in some of our other experiments Axe has also shown low PUE. The older varieties Halberd, Trident and the Brazilian lines, Carazinho, Trinticenco, Toropi and Maringa, all showed high PUE. The Brazilian lines are tall and not adapted to Australian conditions, but they may provide a useful source of high PUE. At this acid soil site barley yielded less and had a lower PUE than wheat. There was more than a two-fold variation in PUE among the barley varieties, with the most P efficient varieties including Scope, Hindmarsh, Vlamingh and Forrest and the least efficient including Maritime, Roe and Mundah.

In both wheat and barley, the PUE was related more strongly to the yield at 0 kg P/ha than at 30 kg P/ha, which suggests that traits that enable a variety to extract P from the soil are key in determining the PUE of a cereal variety. This effect was more strongly expressed in barley, which is consistent with its lower PUE on this soil. Variation in yield at low P may be related to the size and distribution of the root system in the soil, the ability to release root exudates to help solubilise soil P or the ability to form associations with mycorrhizal fungi. Our current work is looking at these mechanisms in more detail to understand their importance to P uptake among different varieties.

Despite the variation observed in 2011, our other trial work has shown that soil type and growing season can affect PUE. In this current trial for example, later flowering varieties of wheat tended to be more P efficient than early flowering varieties, whereas in 2010 later flowering varieties tended to be slightly less P efficient. However when the results for wheat are compared with previous work on calcareous soils on the Eyre Peninsula there are some consistent results. Among the seven varieties that were common in the two sets of trials, Gladius and Kukri showed consistently high PUE while Axe and Wyalkatchem had consistently low PUE. This means that adequate levels of soil available P are more critical for a variety like Axe compared to Gladius.

What does this mean?

- There is considerable variation in the ability of varieties of wheat and barley to yield well under low levels of P which means there is potential to breed varieties with high PUE.
- There is some consistency in P responsiveness over different soil types.
- Brazilian wheat varieties appear to offer a useful source of PUE related traits.
- Further work is examining mechanisms of PUE in selected varieties.
- Adequate P nutrition improves a plant's ability to cope with root disease.

Acknowledgements

We thank Andrew Ware and team at Port Lincoln for managing the trials and Steve, Val and Adam Briese for allowing the trial to be conducted on their farm. The experiments were run with the financial support of the GRDC.

Nutrition

Are farmers in low rainfall cropping regions under-fertilising with nitrogen? A Mallee risk analysis.

RESEARCH

Marta Monjardino, Therese McBeath, Lisa Brennan and Rick Llewellyn
CSIRO Ecosystem Sciences

Key messages

- **There are opportunities to increase profit with increased N input in sandy Mallee soils. However, the risk aversion of the land manager is an important consideration. The use of probability graphs at different levels of risk aversion can support decision making and practice change.**

Background

Fertiliser is a major variable cereal production cost in Australia (ABARE, 2010) and costs are expected to increase in the future (FAO, 2010). In the face of high climatic and spatial variability, low nutrient use efficiency and market volatility, identifying the most profitable rate of nitrogen (N) fertiliser presents a challenge to dryland farmers. N deficiency is one of the main causes of a gap between actual and potential yields in the wetter seasons, but because N is such a significant investment, farmers often seek to minimize the risk of a loss in poor seasons by applying low standard rates of N to their cereal crops. In doing so, their fertiliser management reflects recommendations for average seasons. Part of the reason for the conservatism in this management strategy is the perception that excess N supply in dry seasons increases their exposure to risk. We ask the question: could those farmers in the Australian wheat belt who adopt a low-input strategy to minimize economic risk in fact be missing out on greater returns overall because of under-fertilising with N in the more favourable seasons ?

We used simulation modelling to test wheat response to a range of N management strategies at sites that are the location of field based N management trials. The output of the crop simulation modelling was used in economic modelling to evaluate the combined impact of yield and price risk on long-term performance of N fertiliser strategies, including tactical N application within the growing season. We then considered the best profit and risk scenarios according to the risk aversion preference of the land manager.

How was it done?

A combination of agronomic and economic tools were used to evaluate the combined impact of yield and price risk on long-term performance of N fertiliser strategies on 3 different soil types, including the application of extra in-season N when growing season conditions are favourable. The results were then re-scaled according to the farmer's level of risk aversion. The main outcome is a response scale associated with adding N which is intended to help inform farmers in their fertiliser decisions.

To test N response for a given site we applied 0-90 kg N/ha at sowing with a further 0-90 kg N/ha applied in-season at GS31-39 (applied if simulated soil N was less than 100 kg N/ha at the time and a >10 mm rainfall event occurred) on three soil types common in the Karoonda district of the SA mallee (av annual rainfall 342 mm); the dune (starting N 103 kg/ha), mid-slope (starting N 72 kg/ha) and flats (starting N 36 kg/ha). Outputs were modelled over 60 different growing seasons using the climate data of 1950-2010. Due to co-location of our modelling with sites where N response trials have been undertaken we were able to closely monitor the model output with field data.

In addition to the 60-year time-series wheat yield data sets generated in APSIM, two farm-gate-price datasets were also created, one for Australian Standard White (ASW) wheat and the other for N fertiliser (urea, 46% N) from a range of data sources including historical pool returns (AWB 2010), commodity statistics (ABARE, 2010) and farm budget guides (Rural Solutions SA, 2009; 2010; 2011). To quantify variability in net returns for each scenario, we used @RISK (Palisade Corporation, 2002) to generate outputs of net returns based on the probability density functions for yields and the price parameters based on the distributions of prices over the defined period.

A number of economic and risk performance indicators were used to rank the best performing N management strategies including:

- Net return greater than district average practice.
- A co-efficient of variation of less than 30%.
- A greater than 50% probability of a net profit and a net return greater than district practice.
- A net return better than a loss of $150/ha in the bottom 10% of seasons.
- A net return of greater than $1 per $1 invested N fertiliser.

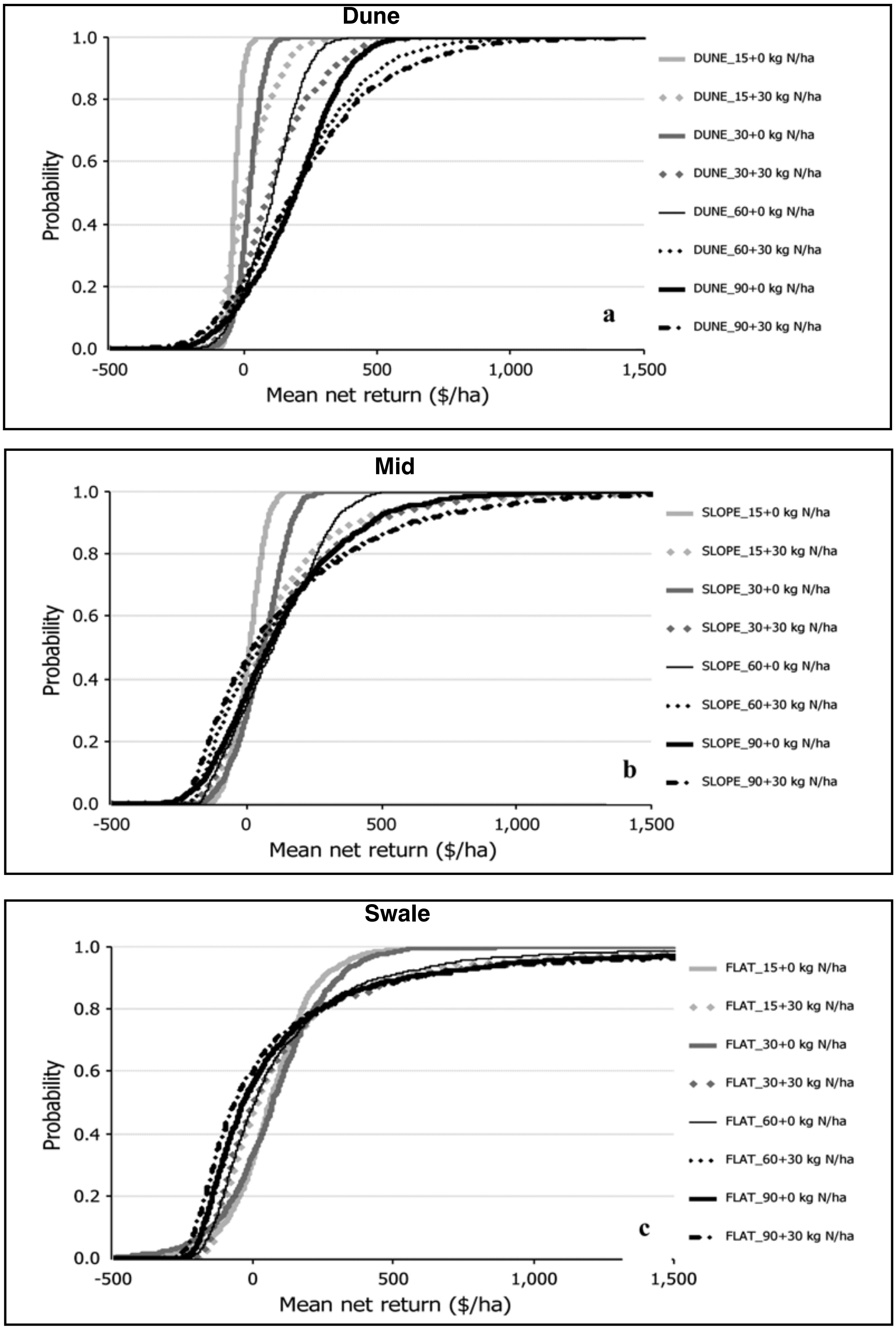


Figure 1. The probability of a mean net return ($/ha) on a. Dune, b. Mid-slope and c. Swale in response to a subset of the treatments evaluated. *To read the graph, a mean net return of $0/ha with a probability of 0.2 means that in 80% of seasons a net return of >$0/ha will be achieved.

What happened?

District practice at Karoonda is 10-20 kg N/ha at sowing. A comparison of district practice with alternative N management strategies on the three soil types of dune, mid-slope and swale suggested that net returns may be improved through altering N input strategies. District practice had a mean net loss of $30/ha in the dune, a low net return of $7/ha in the mid-slope, and a relatively higher net return of $66/ha in the flat over the 60 year simulation runs. While the mean net return on the flats is high, this value has a high standard deviation due to variable performance. The upside of this soil is that due to a relatively deep soil profile it can produce very good yields in high rainfall seasons and this outcome is reflected in the mean value.

The analysis indicated that there is scope to use more N within the dune and the slope zones of a Mallee paddock. The best strategies included mid to high N rates applied at sowing, with low rates of additional N applied in-season when required on both the dune and slope (Figure 1a. and b.). The best performing upfront rates are lower for the more fertile mid-slope (starting N 72 kg/ha) zone compared to the poorer dune (starting N 36 kg/ha) soil.

For the swale (starting N 103 kg/ha), very few management strategies offered an economic-risk better than district practice (Figure 1c.).

Whilst a range of tactical N applications performed well across the dune and slope, those including a sowing input of 30 to 90 kg N/ha in the dune and 15 to 60 kg N/ha in the mid-slope, with in-season application of 0 to 30 kg/N ha in both zones, were the best treatments.

One of the best net returns on the dune was in response to a sowing application of 90 kg N/ha, which, compared to the standard 15 kg N/ha, increased mean net return by $213/ha, while reducing some of the risk by increasing break-even probabilities by 73%, increasing the return in the bottom 10% of seasons by $56/ha and increasing net return on fertiliser investment $0.7 per $ of invested N fertilizer (but also increased the coefficient of variation by 1.74). A similar, though slightly higher risk strategy was applying the same total N but with 60 kg N/ha at sowing followed by 30 kg N/ha tactical N.

In the mid-slope and compared to district practice, 30 kg N/ha at sowing followed by 30 kg/N ha in-season when required tactically, increased mean net returns by $130/ha, reduced the coefficient of variation of mean net returns by 6.54, increased the probability of breaking even by 8%, increased the mean return in the worst 10% of seasons by $52/ha, increased the return on total N fertilizer investment by $0.5 and increased the return on tactical N fertilizer invested by $1.8.

The least attractive management options (measured as a combination of economics and risk) were under-fertilising with zero/low N inputs in the dune and mid-slopes and over-fertilising in the swale (especially in-season).

The analysis was extended to include a specialised form of analysis (SERF-stochastic Stochastic Efficiency with Respect to a Function) that alters the ranking of different N management strategies using a range of risk aversion preferences from very risk averse through to neutral risk aversion (where risk does not control decision making). As expected the analysis suggested a more risk-averse farmer would be more likely to select an upfront N application strategy due to the lower risk on return when compared to tactical fertilisation with mid to high N rates (i.e. 60 + 30 kg N/ha in the dune), despite a lower net return for this practice. In general, risk-averse farmers prefer consistent returns and are thus willing to take a somewhat lower, but less variable, expected payoff (Kingwell, 2011).

What does this mean?

The most useful aspect of this analysis is to provide a picture of the range of outcomes for a given N management strategy at a given site. When this study is complete, the analysis will include three South Australian sites (Hart, Tarlee and Karoonda), and other sites from all of the Australian grain growing regions. The analysis will be completed at each site to include a range of starting (deep soil test N) conditions so that the analysis includes the likely range of starting soil N conditions for the soil type, and the analysis will be incorporated in a framework that considers the risk preference of the land manager. Given that the model can only predict the response to N addition by soil water conditions with variation in prices accounted for it is not designed to be a perfect predictor of the outcome in a given season but rather to provide an opportunity to compare a range of treatments and potential outcomes, with risk aversion preference incorporated.

Acknowledgements

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GRDC Grains Research & Development Corporation

CSIRO

Manganese response in barley at Wharminda

RESEARCH

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
2011 Total: 338 mm
2011 GSR: 189 mm
Yield
Potential: 2.7 t/ha (B)
Actual: 1.2 t/ha
Paddock History
2010: Wheat
2009: Pasture
Disease
Nil
Yield Limiting Factors
Mice damage early in the growing season
Below average rainfall June-Sept

Key message

- **In a below average rainfall year there was no response to manganese (Mn) in barley on a deep sand at Wharminda.**

Why do the trial?

During the 2010 growing season the Wharminda Ag Bureau questioned the value of applying manganese with nitrogen as this practice is common with some farmers in the area. As a result unreplicated treatment strips of foliar Mn were applied to barley in a small area in the 2010 EPFS 3 Wharminda Focus Paddock. There appeared to be a yield increase in response to added Mn in combination with N in an above average growing season rainfall year.

In 2011 it was decided to establish a trial looking at Mn application only to unravel this issue.

How it was done?

A trial was sown with Scope barley @ 55 kg/ha and DAP @ 50 kg/ha at Wharminda on 13 May 2011 with 15 treatments applied (Table 1). These treatments were established to begin investigating the benefit in applying Mn at different rates, different timings of application, method of application as well as Mn sulphate vs. Mn chelate.

Soil chemical analysis performed before sowing indicated that the Colwell P level (0-10 cm) was 21 mg/kg, mineral N (0-60 cm) was 81 mg/kg and DTPA Mn (0-10 cm) was 2 mg/kg. Measurements taken during the year included plant establishment (not reported), dry matter at early tillering and anthesis, grain yield and grain quality.

What happened?

Mice damage early in the growing season meant that it would have not been possible to detect a response to added Mn at early tillering. However, by anthesis there was a dry matter response to all of the split applications of Mn sulphate compared to the nil Mn (Table 2). There was no response to Mn added in terms of yield or grain quality, the low test weights are most likely due to the below average growing season rainfall.

Table 1 Mn treatments applied to Scope barley, Wharminda 2011

Treatment 1	3 L/ha MaxiMang 2-3 leaf stage
Treatment 2	1.1 kg/ha Mn Sulphate 2-3 leaf stage
Treatment 3	1.1 kg/ha Mn Sulphate 2-3 leaf stage + early tillering
Treatment 4	0.55 kg/ha Mn Sulphate 2-3 leaf stage + early tillering
Treatment 5	1 kg/ha Mn Sulphate banded with seed
Treatment 6	1 kg/ha Mn Sulphate banded with seed + 0.55 kg/ha late tillering
Treatment 7	Mn seed dressing 3 L/t seed
Treatment 8	Mn Seed dressing 3 L/t Seed + late foliar spray 0.55 kg/ha Mn Sulphate
Treatment 9	Nil Mn
Treatment 10	1.1 kg/ha Mn Chelate 2-3 leaf stage
Treatment 11	2 L/ha Mn Chelate 2-3 leaf stage
Treatment 12	1.5 L/ha Mn Sulphate 2-3 leaf stage + Mn Chelate at 3 L/ha end of tillering
Treatment 13	1.5 L/ha Mn Sulphate 2-3 leaf stage + Mn Sulphate at 3 L/ha end of tillering
Treatment 14	Mn Seed dressing 6 L/t seed
Treatment 15	Mn Seed dressing 6 L/t Seed + late foliar spray 0.55 kg/ha Mn Sulphate

Table 2 Barley dry matter, yield and grain quality response to Mn, Wharminda 2011

Treatment	Anthesis DM (t/ha)	Yield (t/ha)	Test Wt (kg/hL)	Protein (%)	Screenings (%)
Nil Mn	5.4	1.1	59.6	11.9	9.9
Mn seed dressing 3 L/t seed	5.5	1.2	59.2	11.5	10.8
Mn Seed dressing 6 L/t seed	5.8	1.1	58.8	11.3	10.8
1 kg/ha Mn Sulphate banded with seed	5.8	1.1	59.9	12.3	10.1
3 L/ha MaxiMang 2-3 leaf stage	5.6	1.0	58.3	11.8	12.0
2 L/ha Mn Chelate 2-3 leaf stage	5.6	1.1	59.7	11.6	10.0
1.1 kg/ha Mn Chelate 2-3 leaf stage	5.9	1.0	58.6	11.3	10.9
1.1 kg/ha Mn Sulphate 2-3 leaf stage	4.7	1.1	57.7	11.7	11.2
0.55 kg/ha Mn Sulphate 2-3 leaf stage + early tillering	6.1	1.2	59.7	11.5	11.9
1.1 kg/ha Mn Sulphate 2-3 leaf stage + early tillering	6.3	1.0	59.4	11.6	10.6
1.5 L/ha Mn Sulphate 2-3 leaf stage + Mn Chelate at 3L/ha end of tillering	5.0	1.0	58.8	11.5	11.9
1.5 L/ha Mn Sulphate 2-3 leaf stage + Mn Sulphate at 3L/ha end of tillering	6.0	1.1	58.0	12.3	11.7
1 kg/ha Mn Sulphate banded with seed + 0.55 kg/ha late tillering	6.0	1.1	59.8	11.5	10.3
Mn Seed dressing 3 L/t Seed + late foliar spray 0.55 kg/ha Mn Sulphate	4.8	1.0	58.9	11.6	11.9
Mn Seed dressing 6 L/t Seed + late foliar spray 0.55 kg/ha Mn Sulphate	6.0	1.1	59.9	11.5	10.1
LSD (P=0.05)	*0.6*	*ns*	*ns*	*ns*	*ns*

What does this mean?

Although this site appears to be on the borderline of Mn deficiency at 2 mg/ka Mn (The Wheat Book-Principles and Practice), there was no yield response to Mn in 2011 and responses in dry matter growth seemed variable and showed no clear pattern. This could be due to the below average rainfall at this site from June to September in 2011 resulting in the crop being unable to fully utilise any additional nutrients.

The response in barley to added Mn needs further investigation over a range of seasons in the Wharminda area. In 2012 we will also determine whether the addition of Mn to N applications increases yield.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Thanks to Nigel Wilhelm for advice on this trial. Thanks also to Sue Budarick for her technical assistance during the year.

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Section Editor:
Cathy Paterson
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Section 6

Livestock

Enrich – Incorporating a perennial shrub feedbase into mixed farming systems on Eyre Peninsula

RESEARCH

Jessica Crettenden and Roy Latta
SARDI, Minnipa Agricultural Centre

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Soil Type
Red sandy loam
Location: Piednippie
Tim and Trecina Hollitt
Rainfall
Av Annual: 379 mm
Av GSR: 305 mm
2011 Total: 464 mm
2011 GSR: 302 mm
Soil Type
Grey calcareous sandy loam

BOTH SITES
Plot Size
Plant spacing 2 meters within rows and 3 meters between rows
Livestock
Enterprise type: Self replacing merinos
Stocking rate: Rotational grazing and district practice
Environmental Impacts
Soil Health
Soil structure: Stable
Compaction risk: Grazing
Ground cover or plants/m^2: Forage shrubs

Key messages

- **Farmscapes can be redesigned to incorporate a mixture of perennial shrubs as an addition to the existing feedbase, offering multiple benefits for mixed farming systems in low rainfall areas.**
- **Perennial shrubs complement rather than compete with cropping and can contribute to whole-farm profitability and sustainability.**
- **Developing a mixed stand of perennial shrubs is the best way of balancing establishment risk, survival, growth and livestock utilisation.**

Why do the trial?

Eyre Peninsula low rainfall mixed farming systems have the potential to incorporate a mixture of shrubs as a perennial feedbase for innovative, profitable and more sustainable grazing enterprises that are based on sound resource management principles.

There are opportunities to utilise unproductive and underutilised land to redesign farmscapes in the livestock-cropping zone to achieve multiple benefits for the animal, the farmer and the environment. In most cases, perennial shrubs complement rather than compete with cropping and furthermore do not compete with pasture but are an addition to the existing feedbase.

Producers can gain major advantages by incorporating perennial shrubs into their system through improved livestock production and health, providing green feed over summer/autumn, making use of unseasonal rain and providing shade and shelter for livestock. In addition, there is a suite of other natural resource management benefits such as reducing salinity through more effective water use, controlling erosion and soil degradation through better land cover and improving biodiversity in farming systems. By developing productive use of land that is unsuitable, or becoming unsuitable for profitable grain/pasture production, farmers can contribute to whole-farm profitability and sustainability.

How was it done?

With the support of the Eyre Peninsula Grain & Graze 2 project, the Future Farm Industries Cooperative Research Centre (FFI CRC) research project 'Enrich' has been established to investigate the potential to incorporate a mixture of perennial species into farming systems in low-rainfall areas across southern Australia.

Perennial or annual plants: Perennial
Grazing Pressure: Piednippie (148 DSE/ha), Minnipa (90 DSE/ha)
Water use
Runoff potential: Low
Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emmissions (CO_2, NO_2, methane): Livestock
Social/Practice
Time (hrs): Extra livestock management
Clash with other farming operations: Standard practice
Labour requirements: Livestock may require supplementary feeding and regular checking
Economic
Infrastructure/operating inputs: High cost of establishment
Cost of adoption risk: Low

Two Enrich perennial shrub sites at the Minnipa Agricultural Centre (MAC) and Piednippie were planted on upper Eyre Peninsula as tubestock in 2009, each with 4 replicates of 15 species with 36 plants in each replicate.

Refer to the EPFS Summary 2010, pg 139 for a list of the botanical and common names of the forage shrub species planted at the Minnipa and Piednippie Enrich field trials.

Ongoing measurements in autumn and spring have monitored plant survival, growth, plant health, flowering/fruiting, recruitment, edible biomass, as well as defoliation (palatability) and recovery after the first grazing period in autumn 2011.

The 4 replicates at the Minnipa site were fenced separately and grazed individually, whereas the Piednippie site was not fenced, thus all replicates were grazed at the same time. Grazing information for both sites is given in Table. 1.

What happened?

Measurements taken at both sites have shown that there are a selection of perennial shrub species that have adapted well to the regions and have favourable survival and growth characteristics, compared to other species that have very few remaining shrubs on both sites. Figure 1 shows the survival characteristics of the shrubs since their establishment of 36 plants in 2009.

Table 1 Grazing method, grazing period, days grazed, sheep numbers and stocking rate for both Minnipa and Piednippie Enrich sites, 2011

Site	Grazing method	Grazing period	Days grazed	Sheep number	Stocking rate
Minnipa	Rotational	15 March - 23 May	15, 22, 16, 18 days/replicate	22 wethers	90 DSE/ha
Piednippie	Set-stocked	25 March - 5 April	12 Days	120 dry ewes	148 DSE/ha

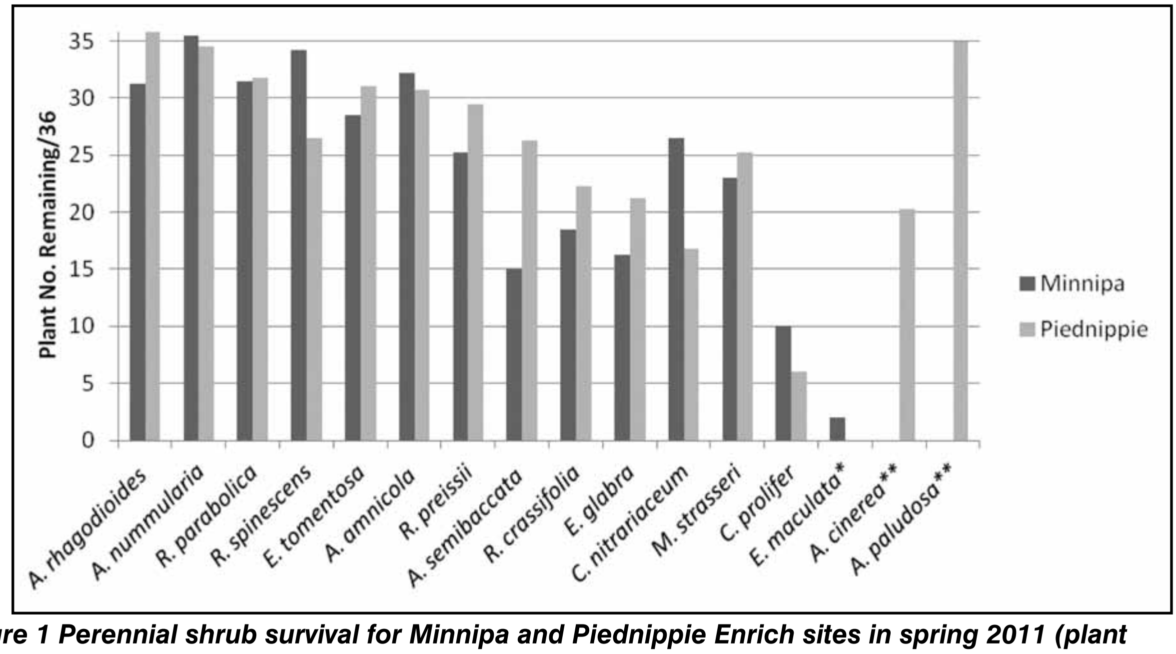

Figure 1 Perennial shrub survival for Minnipa and Piednippie Enrich sites in spring 2011 (plant numbers remaining out of 36 established in 2009)

**Species at Minnipa site only, **Species at Piednippie site only*

Biomass production measurements were taken for each shrub (excluding the outside shrubs in each species for edge effect for a total of 24 plants for each species) using two different techniques in the autumn and spring sampling periods. The first method used height x width x depth calculated measurements of each shrub, which can give an advantage to the taller shrubs, or those that have long branches. The 'Adelaide Technique' was also used for better accuracy, which was calculated by choosing a representative individual plant 'unit' of each shrub species, measuring this 'unit' objectively, through sampling a portion of the shrub for dry matter and the shrub given a corresponding score. The sampled 'unit' was then separated for edible and inedible proportions dried and weighed.

Table 2 Average edible biomass (grams of dry matter/ plant) and average biomass (height x width x depth in m³) for Minnipa and Piednippie sites pre and post grazing 2011 (autumn and spring measurements)

Scientific name of shrub	Minnipa			Piednippie	
	Average Biomass*			Average Biomass*	
	Edible (g/plant) Pre-grazing	Edible (g/plant) Post-grazing	HxWxD (m^3) Post-grazing	Edible (g/plant) Pre-grazing	HxWxD (m^3) Post grazing
C. prolifer	4	7	0.01	40	0.07
R. parabolica	1736	2095	2.87	1425	2.98
A. nummularia	2349	1526	4.19	2831	4.81
R. crassifolia	369	673	0.79	666	1.38
R. spinescens	1231	843	1.45	581	0.93
C. nitrariaceum	133	130	0.68	48	0.47
M. strasseri	27	22	0.02	103	0.15
C. remotus/ A. nummularia	0/1730	0/1218	0.32/3.73	n/a	n/a
E. tomentosa	1001	297	0.32	1178	0.47
E. glabra	187	72	0.05	600	0.44
A. amnicola	720	335	0.39	1357	0.49
A .rhagodioides	2606	1074	3.45	1582	1.64
A. semibaccata	390	153	0.14	2068	0.25
R. preissii	662	809	1.33	1864	3.66
E. maculata	2	6	0.01	n/a	n/a
A. cinerea	n/a	n/a	n/a	770	1.37
A. paludosa	n/a	n/a	n/a	1427	1.05

**Averages are calculated from the plants surviving on each site*

Table 3 Average defoliation percentages over the grazing periods at Minnipa and Piednippie Enrich sites (i.e. 10% defoliation refers to 10% of shrub edible biomass)

Scientific name of shrub	Minnipa Defoliation %				Piednippie Defoliation	
	Rep 1**	Rep 2**	Rep 3**	Rep 4**	@ 5 days	@ 12 days
*C. prolifer**	-	100	100	100	100	100
R. parabolica	0	0	5	5	0	0
A. nummularia	95	30	100	100	50	100
R. crassifolia	5	90	100	100	5	5
R. spinescens	5	60	100	100	20	65
*C. nitrariaceum**	100	100	100	100	95	100
*M. strasseri**	100	100	100	100	100	100
C. remotus/ A. nummularia	-/95	-/30	-/100	-/100	n/a	n/a
E. tomentosa	100	95	100	100	50	100
*E. glabra**	100	100	100	100	85	100
A. amnicola	100	95	95	100	10	85
A .rhagodioides	50	50	90	90	50	100
A. semibaccata	100	100	100	100	65	95
R. preissii	5	90	100	100	0	0
*E. maculata**	-	100	-	-	n/a	n/a
A. cinerea	n/a	n/a	n/a	n/a	20	100
A. paludosa	n/a	n/a	n/a	n/a	0	10

** Please note some of the species had minimal survival and biomass recordings at the commencement of grazing*
*** Please note that sheep grazed each replicate (1-4) for different periods, at 15, 22, 16 and 18 days respectively*

Each plant within the species was given a comparative score to the sampled shrub and the individual plant biomass calculated by multiplying the sampled biomass by the given score of each shrub. Table 2 presents both the biomass measurements and the averages for each species over both sites.

The sheep grazed one replicate at a time at the Minnipa site, changing dietary preference with each area and becoming more adventurous with species selection. Although the entire site was grazed at one time at Piednippie with a different livestock class, selection trends were very similar.

At the beginning of the trial the sheep targeted 9 species for the majority of their feed intake with defoliation percentage ranging from 95-100 and other species ranging from 0-50 percent. Favoured species with 100 percent defoliation throughout the trial included the *M. strasseri*, *A. semibaccata* and *C. nitrariaceum*, which were always the shrubs selected first by the sheep. Although the shrub commonly known as the *R. parabolica* had plenty of edible biomass and was similar in structure and texture to other very palatable shrubs, the sheep would not graze this particular species. By the end of the trial period this changed significantly and sheep were grazing the entire palatable component of the shrub in 14 out of the 15 species on site.

The changing pattern of grazing behaviour in the Enrich trial is shown in Table 3, which portrays one of the interesting learning experiences observed in livestock in the forage shrub grazing system research.

What does this mean?

Obtaining an ideal balance of desirable properties in a perennial shrub feedbase can be quite difficult as survival, growth and palatability properties can often vary greatly within species. On the Minnipa and Piednippie sites *R. parabolica* and *A. paludosa* had excellent survival and growth characteristics but were not eaten by the sheep. Conversely the *M. strasseri* and *E. glabra* species were quite palatable; however they had low growth and survival statistics. This highlights the significance of having a range of perennial shrub species in a feedbase to offset desirable and non-desirable properties of other species.

It is obvious from the data presented in Table 3 that once livestock familiarised themselves with a particular new feed, they learnt to incorporate it into their diet and did not hesitate the next time the feed was offered. Understanding the behavioural phenomenon of livestock diet selection in these grazing systems is a fascinating area of study, yet is one that still has some grey areas that need to be explored further. A mixture of forage shrub species in a grazing system can provide the best opportunity for livestock to do well on perennial shrub stands as it provides a better balance in livestock diet compared with single species shrub stands, and also allows for equilibrium of species with advantageous properties in different areas. Furthermore, livestock would be more productive if a perennial shrub feedbase was offered to complement existing annual pasture, rather than providing the animals with shrubs alone.

Selecting a range of perennial shrub species and subsequently incorporating the feedbase into farming systems can be extremely beneficial for a variety of reasons benefiting both the livestock and the land, thus contributing to whole-farm profitability and sustainability.

Acknowledgements

We gratefully acknowledge the help of Trent Brace, Ian Richter and Jake Pecina for their technical assistance and site management. We also thank Tim and Trecina Hollitt for the opportunity to use their property for an Enrich site, the Phillips Family for the loan of their wethers, and the Eyre Peninsula Natural Resources Management Board staff for their assistance. This project is funded by GRDC, Caring for Our Country and Future Farm Industries CRC (UA00117).

Evaluation of perennial forage legumes on Eyre Peninsula

Roy Latta and Jessica Crettenden
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Key messages

Fifteen months after establishment the study has shown:

- **Lucerne to be well adapted to good Eyre Peninsula cropping soils.**
- **Cullen and Tedera to be more persistent and productive than lucerne on shallow calcareous and highly acidic soils respectively.**
- **Sulla to be highly productive on good lower EP cropping soils in the growing season following establishment.**

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 at least 3 options potentially 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, which is 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 South Australian 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 continuing evaluation to compare to lucerne at a range of Eyre Peninsula sites. To review 2010 results see EPFS Summary 2010, pg 141.

How was it done?

Six lines of forage perennials; Lucerne, Sulla, Cullen and three Tedera lines 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 red sandy loam (Minnipa, ph 7.7 -7.8 $CaCl_2$) calcareous sand (Rudall pH, 7.7-8.1 $CaCl_2$) slightly acidic, shallow duplex (Edillilie, pH 6.4-7.5 $CaCl_2$) to acidic sand over clay (Greenpatch pH 4-5.1 $CaCl_2$) in the 0-0.6 m soil profile.

In 2010 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. The Minnipa site was desiccated with an unplanned broad spectrum summer herbicide spray in March 2011. A replacement site was established at Minnipa on 2 May 2011, 5 x 2 m plots with 2 replicates handsown into seeder rows at 0.5 m row spacings. Five of the lines from the 2010 entries were sown, Sulla was not included.

What happened?

Rainfall in 2011 was similar at Minnipa (400 mm) to 2010. The perennials established successfully and were sampled for biomass on 18 September (lucerne only) and 18 October (Table 1). At Rudall rainfall was 380 mm, there were 4 biomass measurements taken, 19 January, 15 March, 7 May and 17 September. Higher than average annual rainfall of 475 mm at Edillilie allowed 6 samplings, 19 January, 4 March (Cullen only, Lucerne grazed by rabbits) 9 April, 26 May, 1 August and 15 October. Three samplings on 7 May, 1 August and 14 October were completed at Greenpatch with average rainfall (<500 mm).

Table 1 Plant establishment in 2010 (Minnipa 2011) and plant survival in November 2011

	Minnipa	Rudall (plant/m²)		Edillilie (plants/m²)		Greenpatch (plants/m²)	
	2011	2010	2011	2010	2011	2010	2011
Tedera 27	17	5	5	9	9	9	8
Tedera 37	13	4	2	5	7	8	7
Tedera 42	11	4	6	6	7	7	9
Lucerene	17	3	2	8	6	6	5
Cullen	40	7	6	5	6	18	4
Sulla	-	4	2	21	5	17	7

Table 2 November to April 2010/11 and May to October (growing season) 2011 biomass production (t DM/ha) at the 4 evaluation sites

	Minnipa	Rudall		Edillilie		Greenpatch	
	May-Oct	Nov-April	May-Oct	Nov-April	May-Oct	Nov-April	May-Oct
Tedera 27	0.9	1.2	2.0	4.6	6.9	1.3	3.4
Tedera 37	0.3	0.5	0.2	3.5	4.0	0.3	0.8
Tedera 42	1.0	1.1	2.3	4.9	6.3	0.7	2.1
Lucerene	1.8	1.6	1.3	6.1	5.1	0.1	0.9
Cullen	0.9	3.1	3.8	4.3	7.0	1.0	0.5
Sulla		1.0	0.8	5.0	12.5	0.5	0.9

Table 3 November 2011 volumetric soil water contents (mm)

	Minnipa	Rudall	Edillilie	Greenpatch
	0-0.8 m	0-0.4 m	0-0.6 m	0-0.6 m
Tedera 27	95	23	131	32
Tedera 37	106	41	143	36
Tedera 42	101	25	143	35
Lucerene	78	28	126	30
Cullen	93	25	149	59
Sulla		28	141	33

Biomass samplings were undertaken at the time of one or more lines flowering. Plant counts were carried out at each time of biomass sampling. Soil water content measurements were collected in November 2011 to compare water use of species evaluated.

The biennial Sulla plant densities declined over the second growing season at all 3 sites. Cullen numbers declined at the more acidic higher rainfall Greenpatch site. Lucerne plant numbers trended lower at all 3 sites. The Tedera line 27 densities were maintained at the 3 sites, line 37 numbers varied and line 42 had higher numbers at all 3 sites over the 12 to 18 month period.

The entries that produced more biomass in 2010 and 2011 than the site mean were Lucerne at Minnipa, Cullen at Rudall, Lucerne and Sulla at Edillilie and Tedera lines 27 and 42 at Greenpatch. Tedera line 37 produced less than the site mean at all 4 sites.

Soil water content was lower under Lucerne at Minnipa and Lucerne and Tedera line 27 at Edillilie. It was higher with Tedera line 37 at Rudall and Cullen at Greenpatch.

What does it mean?

The major change in plant populations has been the decline in Sulla, which is to be expected with a biennial following the second growing season. Secondly the poor adaptation of Cullen to the highly acidic soil at Greenpatch has resulted in a significant plant loss. The Tedera line 42 had higher numbers present in November 2011 than were counted in 2010. This may have been due to hard seed at the initial 2010 sowing as plants that have continually been defoliated at flowering providing little or no opportunity for seed set. The reducing trend in densities of Lucerne present 12-18 months after establishment would meet expectations with normal levels of attrition of a low input Lucerne stand.

In support of the previous 2010 report, Lucerne was highly productive on the better soil types represented by the Minnipa and Edillilie sites. Sulla produced large amounts of biomass during the spring period in suitable soils as measured at the Edillilie site in 2011. However the adaptation of Cullen and Tedera to the range of soil types and environmental variables encountered on Eyre Peninsula is less well documented. Cullen has been comparatively productive and persistent on the shallow sandy calcareous soil at Rudall, which has been a very low input site with no pest or weed control applied. The Tedera lines have persisted satisfactorily, and while its production and growth has been low, compared to Lucerne, on the good soils at Minnipa and Edillilie it has been more productive on the constrained soils at Rudall and Greenpatch, once again in the absence of insect control.

The soil water content figures collected in November 2011 reflected the plant numbers and/or the comparative biomass production of the tested lines over the 2011 growing season.

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 are giving an indication as to the potential role of "improved" lines of these pasture species in the EP environment and farming systems.

Acknowledgements

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Minnipa farming systems competition - grain and graze barley

Jessica Crettenden and Roy Latta
SARDI, Minnipa Agricultural Centre

RESEARCH

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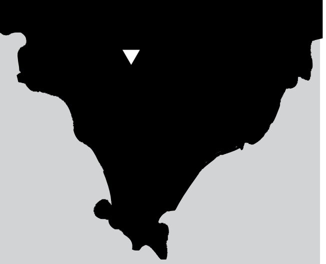

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 4.05 t/ha (B)
Paddock History
2010: Canola
Pre - 2010: Varied
Soil Type
Red sandy loam
Soil Test
Organic C%: 0.4-1
Plot Size
2.7 ha (split in half for grazed versus ungrazed treatments)
Yield Limiting Factors
Grazing
Livestock
Enterprise type: Self replacing merinos
Stocking rate: High (37 DSE/ha), low (27 DSE/ha)
Environmental Impacts
Soil Health
Soil structure: Stable
Compaction risk: Plus and minus grazing treatments
Perennial or annual plants: annual
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
Labour requirements: Livestock may require supplementary feeding and regular checking
Economic
Cost of adoption risk: Low

Key messages

- **Depending on seasonal influence, stored soil moisture, soil nutrition, stocking rate management and correct timing (early tillering at growth stage (GS) 18-22, rather than later tillering at GS 24-28), grazing can be done with no detriment to crop yield.**
- **However, preceding paddock history had a significant impact on subsequent crop success and needs to be considered when planning future rotations.**

Why do the trial?

The Farming Systems Competition began in 2000 to compare the impact of four different management strategies on production, profitability and sustainability at the Minnipa Agricultural Centre. Comparative production and profitability were measured annually (EPFS Summary 2009, pg 120) and the soil health and sustainability after 10 years of competition were reported last year (EPFS Summary 2010, pg 103) at the completion of management from the 4 teams including; farmers, farm consultants, MAC research staff and district practice, each group being responsible for one paddock.

In 2010 we commenced the restoration of the competition paddocks to a common nutrition and disease level by sowing canola across all 4 paddocks. In 2011 barley was sown for the same purpose, which also provided the opportunity to measure the impact of early grazing with livestock as opposed to previous studies that have simulated grazing by mowing (EPFS Summary 2010, pg 136). This decision was based on comparing feed and sacrificial grain and graze opportunities (see below) of a 'dual purpose' crop with solely a grain crop that had no intent to introduce livestock for grazing.

- FEED: Sowing the cereal early as a pasture with the potential to remove stock and harvest grain if late winter and spring conditions are favourable (grazing is the main paddock use, grain harvest is the bonus) or;
- DUAL PURPOSE: Sowing the cereal with the full intention of harvesting grain but utilising it for livestock during early growth stages. The crop can put extra growth into its reproductive phase as there is reduced plant canopy during vegetative growth, reducing the impact of grazing (grain harvest is the main paddock use, grazing is the bonus) or;
- SACRIFICIAL: During the mid to late reproductive phase of the crop where there is a decreased likelihood of reaping a significant yield, the crop is grazed after maturity to fill the feed gap or short supply over summer.

How was it done?

Each 2.7 ha paddock was sown with Hindmarsh barley on 3 May 2011 @ 55 kg/ha with 60 kg/ha DAP. Each paddock had a grazed versus ungrazed section and a 'high' and 'low' stocking rate treatment was imposed on the grazed section with 2 replicates for each.

Figure 1 presents the trial design which shows the treatments and previous managers of the paddocks for reference to management history. For previous management histories see EPFS Summary 2009, pg 120. In this report, paddocks will be referred to as their corresponding letter i.e. A, B, C and D.

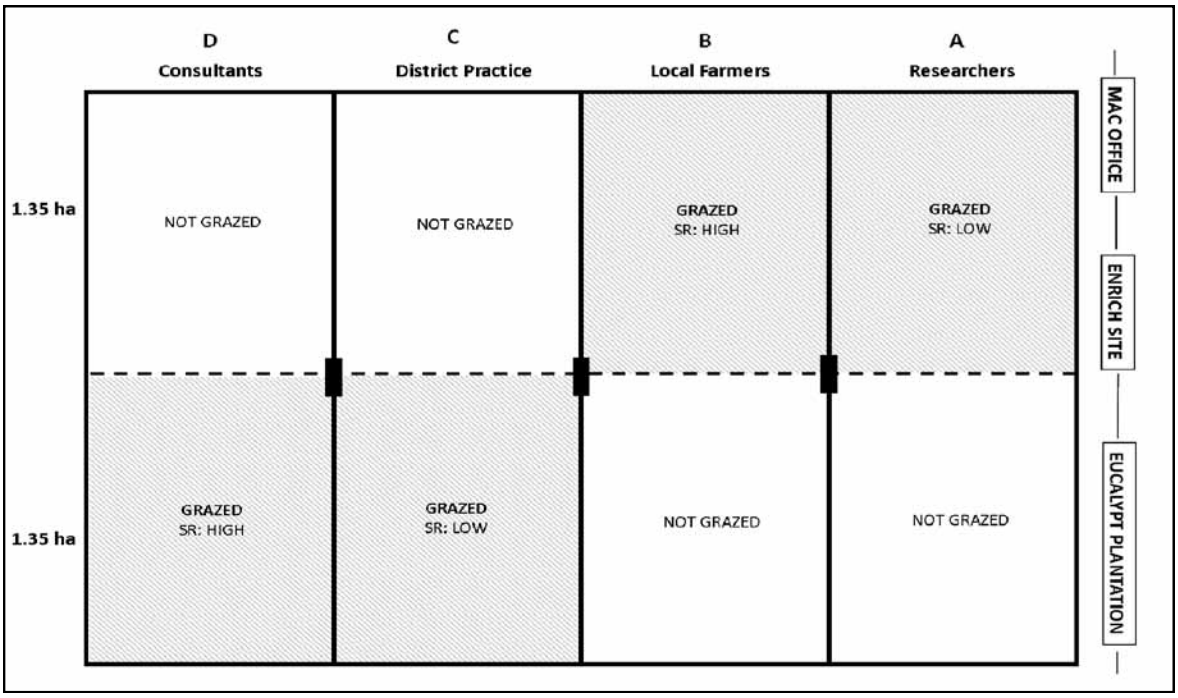

Figure 1 Competition paddock trial design for 2011 with names of the previous managers for paddock history

Plant counts and biomass samples (dry matter, DM) were taken from 12 x 0.1 m^2 quadrats across each section and dried at 70°C for 48 hours on 6 June and biomass was also measured on 28 June, just prior to the commencement of grazing. From the second biomass measurement, a feed test was taken to assist with calculating stocking rates for grazing. Ground cover measurements using a 1 x 1 m^2 quadrat were also conducted prior to grazing.

On the 28 June approximately 1 year old ewe hoggets began grazing the 1.35 ha section of each paddock that was split in half using an electric fence, as shown in Figure 1, at a 'high' stocking rate of 37 DSE/ha and at a 'low' stocking rate of 27 DSE/ha. To clarify, the 'high' and 'low' stocking rate treatments in the grazed sections of the paddock were thus named to simplify the treatment titles; it needs to be noted that both stocking rates are high for the Minnipa district.

These stocking rates were calculated according to feed on offer, crop growth rate, feed allowance for the stock class and crop to be left at the end of grazing using the MLA Stocking Rate Calculator http://www.mla.com.au/Publications-tools-and-events/Tools-and-calculators/Stocking-rate-calculator which is presented in Table 2 along with the total grazing days for each section. Sheep were removed from the paddock after approximately a week of grazing on 6 July and post-grazing ground cover and biomass measurements were taken.

Harvest occurred on 10 November and 10 x 0.1 m^2 cuts were taken in each section to measure dry matter, harvest index and a variety of grain properties including yield, test weight, screenings, protein, moisture and 1000 grain weight at each sampling point.

What happened?

The feed test reported acceptable levels for grazing young ewe hoggets with 14% dry matter, 34.2% crude protein (target is 16% for growing lambs), 38.3% neutral detergent fibre (target over 30%), 75% DOMD (digestibility) (75% required for production feeding) and 13.4 MJ ME/kg DM (11 MJ ME/kg DM required for young, quick growing lambs).

During the week of grazing, Minnipa had 17 mm of rain, which caused some slight damage in the paddocks with a high stocking rate as the sheep were trampling some of the crop. After grazing, Minnipa had 158 mm of growing season rainfall, which helped in the recovery of the barley. No fertiliser was applied post-grazing.

Table 2 Grazing calculations for high and low stocking rates in competition paddocks 2011

Treatment	HIGH	LOW
Paddock size	1.35 ha (2.7 ha split by electric fence x 4)	1.35 ha (2.7 ha split by electric fence x 4)
Crop daily growth rate	10 kg DM/ha/day	10 kg DM/ha/day
Feed allowance	1 kg DM/hd/day (10 MJ ME/kg DM)	1 kg DM/hd/day (10 MJ ME/kg DM)
Grazing period (15% spoilage)	7.04 (retaining 800 kg DM/ha)	9.65 (retaining 800 kg DM/ha)
Stock class and number	50 x 1 year old ewe hoggets	37 x 1 year old ewe hoggets
Stocking rate	37 DSE/ha	27 DSE/ha
Number of actual grazed days	7 days	8 days

ME = metabolisable energy

Table 3 Dry matter (DM kg/ha) for the competition paddock throughout the 2011 season

	Early DM	Pre-grazing DM	Post-grazing DM	Harvest DM
A (grazed)	562	1667	1211	7905
A (ungrazed)	423	1194	2042	8223
B (grazed)	398	1250	376	3414
B (ungrazed)	482	1083	1791	6159
C (grazed)	894	1146	748	7280
C (ungrazed)	786	832	1475	5794
D (grazed)	631	1079	558	4803
D (ungrazed)	697	1096	1946	6309

The biomass measurements that were taken throughout the period of crop growth are presented in Table 3. Paddock C had 2 sowing times due to a missed seeder width, which resulted in higher early biomass measurements, therefore grazing occurred at an earlier growth stage. The differences between the grazed and ungrazed sections were measureable at harvest with the grazed sections in paddocks A, B and D measuring less biomass than the ungrazed sections. Paddock C had an increase in biomass at harvest time in the grazed section, which is directly related to the yield results for the paddock also.

The previous variation in management strategies became a catalyst for diverse results between the paddocks after deciding to plant barley in the 2011 season. It soon became obvious that previous paddock history prevented the comparison between paddocks, therefore each of the four paddocks have been analysed separately.

Paddock A

Paddock yield in the grazed section measured only 0.5 t/ha lower than the ungrazed with the test weight also measuring slightly lower. Screenings were over 5% higher in the grazed section and protein was 0.2% higher.

Paddock B

The high stocking rate during grazing had a detrimental effect on yield and there was a 1.5 t/ha loss in yield in the grazed versus ungrazed section. Test weight was lower by over 4 kg/hL, screenings were almost 7% higher and protein was 0.3% lower in the ungrazed section.

Paddock C

Grazing at a 'low' stocking rate was favourable for paddock C, measuring a 1 t/ha higher yield in the grazed compared to the ungrazed section. Test weight was 2.4 kg/hL higher and there was 1.6% less screenings in the grazed section. The only unfavourable result from the grain sample in the grazed area was a 1% decline in protein.

Paddock D

There was a 0.7 t/ha yield loss in the grazed compared to the ungrazed section in paddock D from the high stocking rate. Test weight was 0.8 kg/hL lower and protein was 0.4% lower after grazing, with screenings 0.8% higher in the ungrazed area.

What does this mean?

Paddock history had a big impact on yield differences across paddocks and was a contributing factor to treating each paddock as a separate trial.

Paddock A

This paddock has a history of good soil nutrition due to both sown and self-regenerating medic in 3 out of the past 6 years of rotation, resulting in higher levels of soil N. This is represented in the higher protein percentage in the sample than other paddocks and may have contributed to lower grain weight and higher screenings. The reasonable levels of N in the soil assisted plant recovery after grazing, resulting in minimal yield loss in the grazed section of the paddock. The 'low' stocking rate and even grazing minimised crop damage and allowed the barley to compete well against emerging weeds.

Lodging in the ungrazed section was a major issue at harvest time and resulted in significant loss of barley heads; visually the grazing helped overcome this problem and the barley was standing more upright in the grazed section of the paddock.

Table 4 Grain sample figures for the competition paddock in the 2011 season

	Yield (t/ha)	Test weight (kg/hL)	Screenings (%)	Protein (%)	1000 Grain weight (g)
A (grazed)	3.2	62.3	16	12.8	34.0
A (ungrazed)	3.7	64.5	10.9	12.6	36.4
B (grazed)	1.7	62.7	7.6	10.4	36.1
B (ungrazed)	3.2	66.9	0.7	10.1	43.1
C (grazed)	3.9	67.4	3.6	10.3	39.0
C (ungrazed)	2.9	65.0	5.2	11.3	39.0
D (grazed)	2.7	66.6	1.3	9.8	40.6
D (ungrazed)	3.4	67.4	2.1	10.2	41.9

Paddock B

After a cereal rotation in this paddock in 4 out of the last 5 years, the grass weed burden became a significant issue in the 2011 crop. A wet period during the week of grazing exacerbated the problem due to the 'high' stocking rate on the grazed section of the paddock, which led to vast crop damage caused by sheep trampling the crop. Following grazing, the competition from the weeds impacted considerably on plant growth, resulting in a substantial yield penalty. The size and weight of the grain was also negatively impacted by the grazing and weed burden. Again, lodging was an issue for the ungrazed section of the crop.

Paddock C

The dissimilar results from the grazed section of Paddock C compared to the other paddocks were due to a combination of grazing at an earlier crop stage due to a missed pass at sowing time, a lower stocking rate and a conservative rotation history. Unlike the other paddocks, the grain yield was higher in the grazed section and test weight and screenings were also more favourable after grazing. Almost half of the crop (the missed seeder pass) was grazed at a more recommended growth stage during early tillering with the other half of the barley and other paddocks closer to late tillering. The 'low' stocking rate of the paddock caused less trampling than the higher stocking rate and allowed time for a vigorous crop recovery before weeds could become an issue. A conservative approach in 'district practice' rotations created a catalyst for sound soil nutrition. The lodging issue in the ungrazed section of the paddock added to the lower yield in the ungrazed section of the paddock.

Paddock D

The loss in yield in the grazed section of Paddock D can be attributed such a high stocking rate and grazing at a later growth stage than originally anticipated. Competition from weeds after grazing also caused the barley to struggle during recovery. A variety of past paddock rotations meant that soil nutrition was stable, resulting in an average yield in the ungrazed section with lodging again presenting itself as an issue with the loss of grain heads on the ground, especially at harvest.

Acknowledgements

We gratefully acknowledge the help of Mark Klante, Trent Brace, Cathy Paterson and Ian Richter for their technical assistance and site management. This project is funded by GRDC and Caring for Our Country (UA00117).

Extending best practice wool innovations on Eyre Peninsula

Roy Latta, Jessica Crettenden and Mark Klante
SARDI, Minnipa Agricultural Centre

RESEARCH

Why do the trial?

Eyre Peninsula (EP) has the proven capacity to produce fast growing sheep as a valuable component of the mixed farming system. However, adverse seasonal conditions coupled with social and depressed market forces have reduced sheep numbers from 2.5 million to less than 2 million over the past decade.

Current positive market forces and a longer term consideration of climate change and the likely systems adaptations provide a real opportunity to reinvigorate the livestock component of the EP farming system.

The livestock component of the mixed farming enterprises on EP has had very limited uptake of technology developments in recent decades. The challenge is to provide a package incorporating the latest technology from AWI and the Sheep CRC that improves production, without increasing management input.

How was it done?

In 2010 we commenced, with the Minnipa Agricultural Centre (MAC) sheep flock, to establish a focal point for Eyre Peninsula mixed farmers 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, fleece weight 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, fleece weight and fibre diameter. Wether progeny will be sold at 10-12 months of age. Ewe hoggets will be visually and objectively classed before being admitted into the breeding flock.

The progeny from the first 2 matings in February 2010 and 2011 were used to benchmark the flock and assess traits that may need improving. In both years existing rams were used, supplemented with 2 rams from the Turretfield Research Centre (SARDI) flock to provide genetic linkage.

In subsequent years rams will be purchased from local EP studs on the basis of visual assessment and Australian Sheep Breeding Values (ASBV) concentrating on traits identified as important in the flock’s breeding objective.

Once the genetic potential of the MAC 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 EP.

Previous results for comparison are presented in EPFS Summary 2010, pg 143.

What happened?

The 2010 drop hoggets were assessed both visually and through objective measurement to assist selection and 23% were culled, the results are presented in Table 1.

In 2011 the MAC flock of 333 ewes were single sire mated in 7 randomly selected groups of approximately 45 ewes from 5 February for 7 weeks. The performance of the 7 rams in respect to lambing percentage weaned (mid-November) and weaning weights is presented in Table 2.

Table 1 Maximum, minimum and average greasy fleece weight (kg), fibre diameter (μm) and body weight (kg) of 2010 hoggets at 11 months of age with 7 months wool growth

	Greasy fleece weight (kg)	Fibre diameter (μm)	Body weight (kg)	Eye muscle depth (mm)	Fat depth (mm)	Breech wrinkle (score 1-5)
Maximum	6.4	21.9	75.0	36.6	4.9	5.0
Minimum	1.8	14.5	32.2	21.6	1.0	1.0
Average	3.4	18.1	50.0	30.8	2.9	2.6

Table 2 Percentage lambs weaned (%) from the eight single sire mating groups

Group	Weaned percentage (%)
1	146
2	146
3	153
4	133
5	97
6	68
7	122
Average	**124**

What does it mean?

There was a wide variation in the production performance of the 2010 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 2011 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

Darryl Smith and Forbes Brien, SARDI Roseworthy, Brian Ashton, Sheep Consultancy Service Pty Ltd and Ian Bradtke, Lazerline for project development and delivery. Trent Brace for his livestock management support and MAC staff Brett McEvoy for support in the shed and sheep yards.

australian wool innovation limited

MERINOSELECT ASBV

LAMBPLAN ASBV

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Practical ram selection

EXTENSION

Brian Ashton[1] and Darryl Smith[2]

[1]Sheep Consultancy Service Pty Ltd, Port Lincoln, [2]SARDI, Breeding and Genetics Group, Roseworthy

Key messages

- **Ram selection is important.**
- **A ram must be structurally sound and his progeny must be able to thrive in a tough environment.**
- **Measurement of the big dollar traits is also important to increase profit.**
- **For Merinos MERINOSELECT adjusts the raw measurements so that the figures produced give a better indication of the genetic merit of the animal.**
- **LAMBPLAN does the same thing for the meat breeds.**

Why do the work?

Farmers know that ram selection will affect their profit but many are unsure of how to select their rams and are keen to know what the Australian Standard Breeding Values (ASBVs) presented on rams mean.

Some farmers just select the biggest ram, or the cheapest, or the finest, or the plainest. However, the best choice will not be found by selecting on one trait only or just on how good the ram looks. To make the best decision you will need to use a balance of visual assessment and the key breeding value figures.

The best animal needs to be visually acceptable and also have good genes for the key production traits.

How was it done?

On Eyre Peninsula we ran five workshops on stud breeder's farms. They covered Merino and Terminal Sire ram selection. These workshops were a chance for both breeders and commercial sheep producers to discuss selection options and also to learn more about the ASBVs provided by MERINOSELECT and LAMBPLAN.

What happened?

Four workshops were successful with an average of 10 people attending and lots of questions asked. One workshop was cancelled due to lack of numbers.

Participants gave very high scores indicating that they would recommend the workshop to others and would implement changes to how they select rams. There was a large increase in their confidence to use ASBVs to select rams. One producer said "That was the best sheep industry event I've been to for 40 years!"

A key part of the workshop was for participants to decide their breeding objectives. They listed the things in their sheep that could be improved. These were ranked on their dollar impact and then on their heritability (some are largely influenced by genetics (e.g. micron) and others are mostly affected by management, e.g. reproduction). This process made it easier to decide what they really needed to improve to make more money or to reduce their workload (easy care sheep).

At the workshops the breeders penned sheep for inspection and discussed the important areas of key visual traits to watch out for.

What does this mean?

Commercial sheep producers who attended the workshops will have more understanding of ASBVs and how to use them. This will reward the breeders who provide good figures and who also have visually good rams.

The long term objective is to increase the genetic gain in sheep on Eyre Peninsula and therefore create more profit for producers.

It was stressed at the workshop that it is not desirable to focus only on the figures. They are a very useful tool to help select rams that will make more money. However, they need to be used in conjunction with good visual assessment.

Further work will be needed to see widespread adoption of ASBVs. The demonstration project involving the Minnipa flock will contribute to this (see article 'Extending best practice wool innovations on Eyre Peninsula' in this section).

Acknowledgements

The workshops were funded by the SA Sheep Advisory Group and the Making More from Sheep program.

Workshop locations		
Wharminda	Nantoura Stud	Merino
Poochera	White River Stud	Merino
Yallunda Flat	Teakle Hill Stud	White Suffolk
Cleve	Uralba Stud	White Suffolk
Koppio	Kurrabi Park Stud	Suffolk & Romney

Grazing systems management into 2030

Melissa Rebbeck
SARDI Climate Applications

Key messages

The main impacts of climate change by 2030 on grazing livestock enterprises is likely to be shorter growing seasons, greater variability in pasture growth, reduced pasture quality, less available pasture, reduced wool quality and increased variability in farm gross margins. Possible adaptations to alleviate some of these impacts are;

- **Minimising the need for supplementary feed by reviewing lambing and calving times, age at first joining, stocking rates and sale times,**
- **Increase flexibility in systems by varying sale times/rules, confinement feeding, movement, more animal trading (core breeding), agistment , matching feed demand to pasture production, and**
- **Improved pasture utilisation by grazing management.**

Why do the trial

Livestock managers have been challenged in recent years by many weather extremes including heat waves, drought, floods, late breaks, dry springs, and more. As a result livestock producers have been innovative in how they manage their systems. They have increased the flexibility in their systems by being able to adjust animal numbers more easily in response to seasonal conditions. During a suite of workshops across SA, 150 livestock producers said that they wanted a tool or process to review their stocking rates, lambing or calving dates, weaning rates and other management practices. The computer model Grass Gro (Moore et al, 1997) allows livestock managers to review these and other management decisions under a changing and variable climate without actually having to physically implement them on farm and then wait for the result.

In response to livestock producers needs the Department of Agriculture Forestry and Fisheries (DAFF) and Meat and Livestock Australia (MLA) funded a project which combined the use of sophisticated biophysical models such as Grass Gro with localised rainfall, temperature and carbon dioxide levels predicted from various climate models out to 2030. This allowed SARDI staff to work closely with livestock managers in order to analyse and test the most viable farm management adaptation options to meet a range of climate scenarios in the future.

How was it done?

Climate change projections were made using four Global Circulation Models (GCM's). Rainfall and temperature data was downscaled using the "Weather Maker, 2009". Simulations were run within Grass Gro for the period 2016-2045 (for 2030) and for the periods 1970-1994, and 1995-2005 for comparative purposes for many locations in South Australia. Rainfall is shown using Tod River in the Eyre Peninsula below (Figure 1). We assumed 450 ppm carbon dioxide across the 2030 time period. Various locations were selected in the high, medium and low rainfall areas across SA. On the Eyre Peninsula, Pillaworta station Merino ewe x Suffolk enterprise and a self replacing Merino ewe enterprise were used with Tod River rainfall to investigate a range of management decisions including optimum pasture species, lambing dates, weaning dates and stocking rates. The pasture compared was an improved pasture of annual ryegrass, Seaton Park sub clover, cocksfoot and annual grass on a moderately high soil fertility with 9300 kg/ha average annual pasture production versus a native grass pasture of annual ryegrass, Dalkeith sub clover, *Danthonia sp*, *Austrostipa sp* and early annual grasses on a moderately low soil fertility with 6750 kg/ha average annual pasture production. Pasture growth simulations using the improved pasture base is shown in Figure 2.

Measurements taken

Using these livestock systems we used the Grass Gro model to investigate the impact of climate change and climate variability on pasture and livestock production and then analysed the effects on supplementary feed requirements, gross margins, ground cover and animal sale weight. Various climate change projections and comparative time periods were used in order to promote discussion about alternative management options and adaptations for their livestock enterprises under a variable and changing climate by 2030. During workshops producers were shown these outputs and then asked to suggest adaptation options for testing within Grass Gro. The data shown here is a representation of what was demonstrated on Eyre Peninsula.

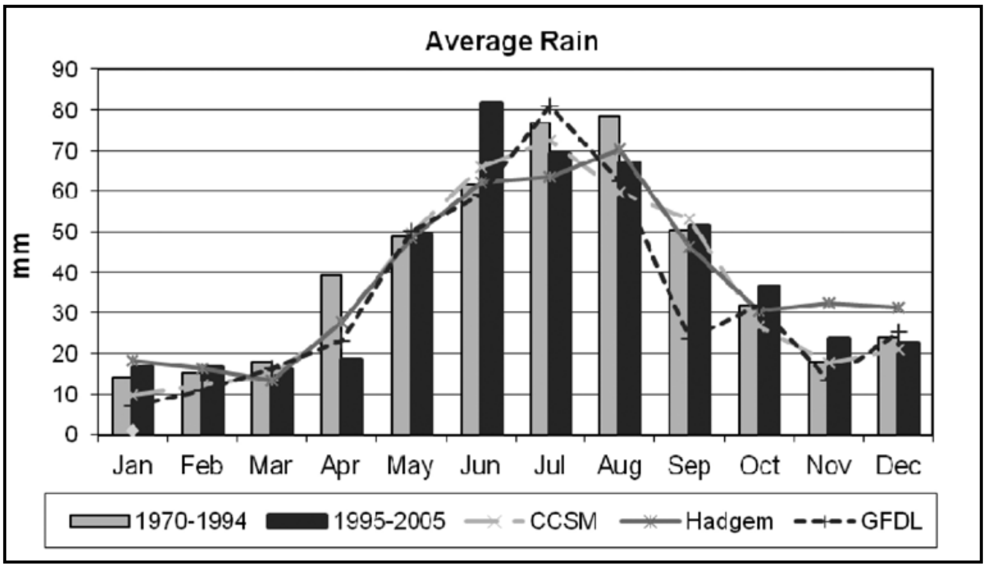

Figure 1 Actual average rainfall for 1970-1994 and 1995-2005 vs simulated rainfall averages for 2030 at Tod River on the Eyre Peninsula. The simulated rainfall for 2030 uses 3 Global Climate models (CCSM, Hadgem and GFDL)

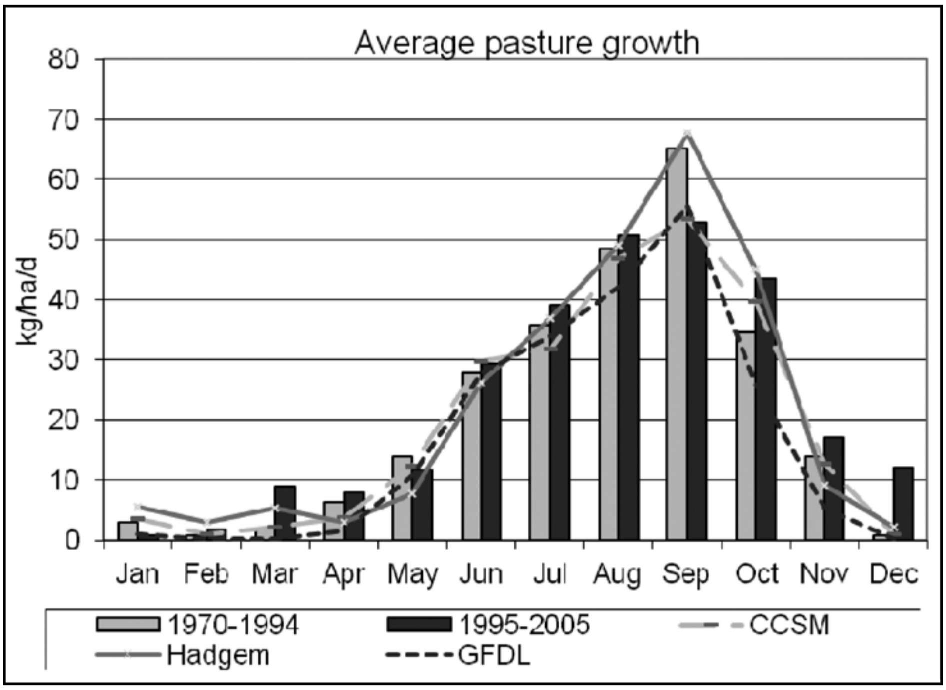

Figure 2 The improved pasture using Tod River rainfall at Pillaworta station simulated using Grass Gro for 1970-1994, 1995-2005 and comparing 3 different rainfall scenarios for 2030 using generated data from Global climate models (CCSM, Hadgem and GFDL)

Livestock

What happened?

Rainfall at Tod River for 1995-2005 was 5% lower than the long term average. The projections for both rainfall and pasture growth for 2030 using the CCSM and Hadgem climate scenarios for 2030 were similar to that of 1995-2005, however the 2030 projections show that the pasture growth begins later in the season and cuts off earlier (Figure 2). Similarly, tests over the remainder of the state using Grass Gro show that by 2030 the main impact of climate change to South Australian livestock managers is likely to be increased climate variability and a shortened growing season. This has flow-on affects to livestock systems such as more variable gross margins. Below is the comparison of gross margins for a Merino ewe x Suffolk enterprise using the improved cocksfoot pasture for 1995 to 2005 rainfall (Figure 3) compared with the 2030 CCSM model projections (Figure 4).

The best gross margins for the improved cocksfoot pasture using 1995 to 2005 rainfall is an April lambing at 6.5 DSE/ha. Using the 2030 rainfall a May lambing on improved cocksfoot pasture has slightly improved average gross margins with the 6.5 DSE/ha. The CCSM model projections for 2030 show a greater range in gross margins with greater opportunities for gain but also for loss. This is partially due to the uncertainty of rainfall projections into the future but also due to the fact that the seasons may cut off earlier. The same April lambing with 6.5 DSE/ha seemed best under a native pasture situation. Under the set up we had in Grass Gro at times the native pasture produced higher gross margins, however native pasture also has many more opportunities for loss and there was greater variability with the native grass based pastures (Figure 5). The gross margin for improved pastures included an additional $70/ha for establishing and maintaining these pastures compared to native pastures.

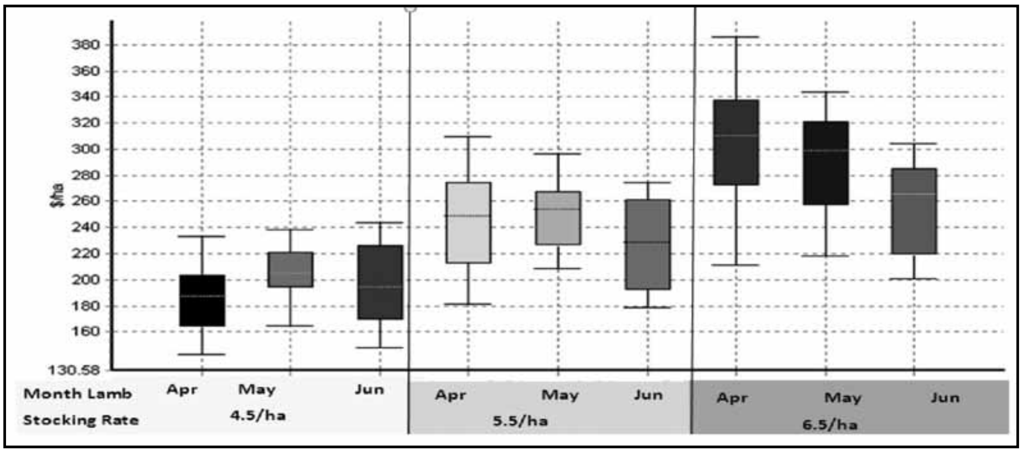

Figure 3 Gross margins for a Merino ewe x Suffolk enterprise on improved cocksfoot pasture using 1995-2005 rainfall at Pillaworta. Looking for optimum lambing time and stocking rate (DSE/ha). See 'Understanding box plots' for assistance in understanding Figures 3, 4 and 5

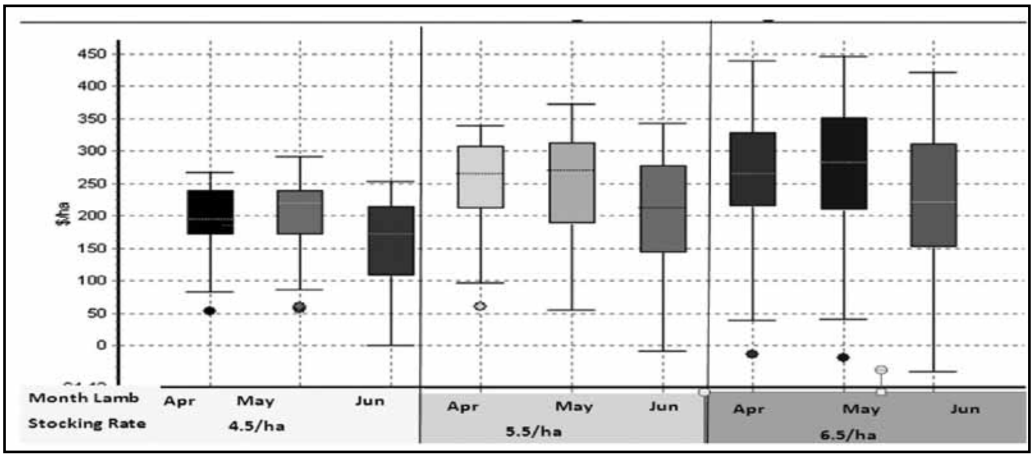

Figure 4 Gross margins for a Merino ewe x Suffolk enterprise on improved cocksfoot pasture using 2030 projected rainfall with the CCSM model at Pillaworta. Looking at optimum lambing time and stocking rate (DSE/ha).

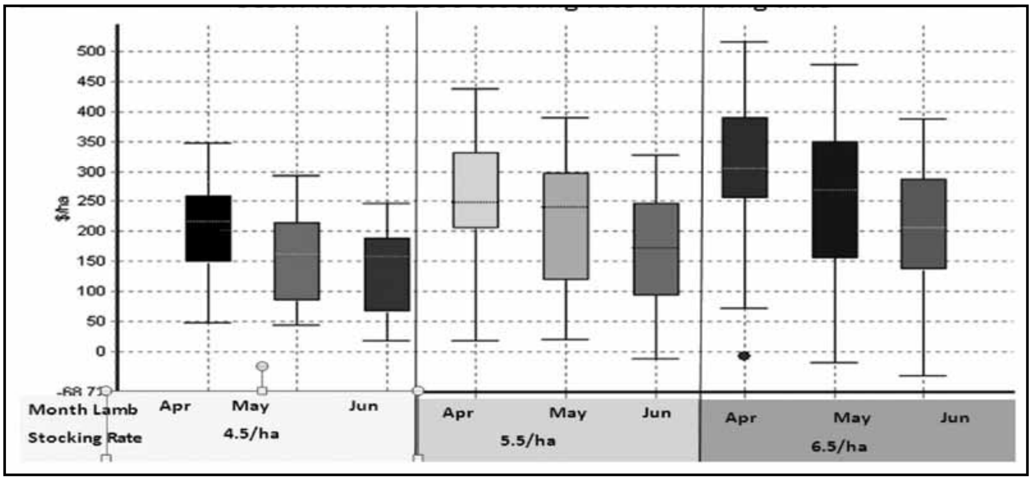

Figure 5 Gross margins for a Merino ewe x Suffolk enterprise on improved native pasture using 2030 projected rainfall with the CCSM model at Pillaworta. Looking at optimum lambing time and stocking rate (DSE/ha).

What does this mean?

The Grass Gro model is a powerful tool providing an opportunity to run many simulations. This shows its power to interrogate various management strategies for any enterprise. These gross margin results and more comparisons of supplementary feed, sale weight of lambs, and ground cover were shown to a group of 15 livestock managers and 3 consultants at the Pillowarta station. We also compared these same graphs with a self replacing Merino ewe enterprise. The results were discussed and producers were then asked what they may do differently to manage their enterprises both in the short and longer term. Responses were as follows;

- Early lambing created more profit.
- Cocksfoot pasture more productive (sow some more).
- Ensure adequate nutrition to pregnant ewes to ensure secondary fibre production.
- Improved pasture the way to go.
- Feed crop to stock.
- Consider the practicality of early lambing.
- Grazing management timing is important to gain better pasture utilisation.
- Plan your pasture and management of stock.
- Soil test for nutrition.
- Tactically manage the variability in the season.
- Don't compromise ground cover (management).
- Keep 1000 kg/ha feed ahead of stock.
- Rest paddocks (plan for stock nutrition).

Over the last 3 years in SA we have run 10 other farmer workshops across a wide range of geographical locations representing over 20 different livestock enterprises. Across these locations we have tested many management changes and discussed these with over 150 producers. These producers said the main impacts of climate change by 2030 on their livestock enterprises would be; generally shorter growing seasons, greater variability in growth, reduced pasture quality, feed available for less time, less pasture, high heat days reducing livestock production, wool quality reduced and more variable and potentially lower farm gross margins.

The adaptations tested and accepted by these livestock producers included;

- Minimise the need for supplementary feed by reviewing lambing and calving times, age at first joining, stocking rates, sale times.
- Increase flexibility in their systems to respond to seasonal conditions by varying sale times/rules, confinement feeding, stock movement, more animal trading (core breeding), self replacing system, agistment and matching livestock feed demand to pasture production.
- Improve pasture utilisation by grazing management systems including controlled, cell, rotational, confinement, or movement of stock and maintaining pasture growth in phase II (Figure 6).

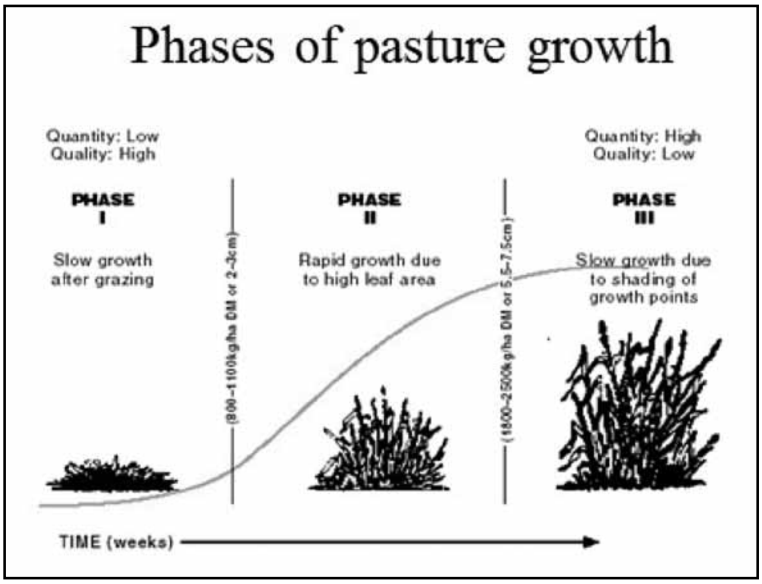

Figure 6 Phases of pasture growth [Source: MLA Prograze SA manual, editor T Prance]

Future Directions

There are many more simulations possible with Grass Gro and it can be used as a powerful tool to help plan into the future and also make decisions about the current season. There could be endless analyses performed in all areas, however we need funding to do this and capability. So far there are not more than 2 people that can adequately run Grass Gro in SA.

In the future we have proposed to do some work coupling Grass Gro with a model called Ausfarm. This will allow us to provide numbers on methane and nitrous oxide emissions for the case study scenarios already set up.

Acknowledgements

Tim Prance, T Prance Rural Consulting for setting up case study scenarios on Eyre Peninsula and all over SA and for reviewing this article.

Mary Crawford and Daniel Schuppan from Rural Solutions, SA for checking simulations and to Mary for setting up Pillaworta workshop. Russell Pattinson the project coordinator for reviewing this article.

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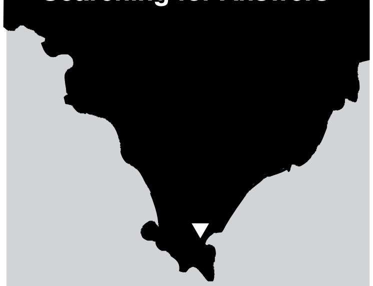
Potential use of fertilisers and trace elements on Tumby Bay Hills SheepConnect SA focus farm

Mary Crawford
Rural Solutions SA, Port Lincoln

DEMO

Searching for Answers



Location:
Tumby Bay
Emie Borthwick and sharefarmer Andrew Cabot
SheepConnect Focus Farm
Rainfall
Av. Annual: 500 mm
Paddock History
Perennial pastures
- Cocksfoot/clover
- Native and annual grasses

Soil Type
Variable from non wetting sandy loam with high gravel content to light sandy loam over gravelly clay loam
Soil Test
Soil chemical analysis
Plot Size
High and low P demonstration plots (20 m x 8 m)
Control demonstration plot (20 m x 4 m)
Yield Limiting Factors
Demonstration sites not grazed during growing season
Copper spray not applied at the optimum time due to season
Livestock
Enterprise type: Sheep and cropping
Type of stock/breed: 1800 merino ewes (37% joined to a terminal state)

Key messages

- **Soil testing is the most accurate and beneficial way to determine soil deficiencies and limitations.**
- **Demonstration showed reduced cocksfoot/pasture growth when zinc was applied at 2 kg/ha.**
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- **Applying phosphorus to perennial pastures will increase pasture production and carrying capacity.**

Why do the trial?

A fertiliser demonstration site was established on the property Pillaworta, Tumby Bay as part of the SheepConnect SA focus farm project. Initial soil tests undertaken from the property indicated that soils were deficient in phosphorous, zinc and copper.

Pillaworta did not have a strong history of fertiliser use and therefore provided the ideal opportunity to demonstrate the response of pasture and native grasses to different rates of fertiliser and trace element application.

How was it done?

Two paddock demonstration sites were selected, one consisting of cocksfoot/clover pasture the other native and annual grasses. Each site was established to determine pasture response to high phosphorus application @ 30 kg/ha, low phosphorus @ 10 kg/ha and three trace elements, sulphur @ 10 kg/ha, zinc @ 1 and 2 kg/ha and copper @ 100 gm/ha. The type of phosphorus used was 18:20 and zinc and copper were applied as foliar sprays.

Pasture cuts were taken throughout the demonstration period to measure pasture response to fertiliser application through the production of dry matter. Visual assessments were made regarding changes in pasture composition. Feed tests were also taken to determine the nutritional benefit of dry matter produced to grazing livestock.

What happened?

Cocksfoot/clover results

Phosphorus and sulphur were applied to the demonstration site on 17 June, zinc on 27 June and copper on 7 September. Visual observations were noted over August, September and October and are summarised in Table 1.

The application of high phosphorus, copper and zinc applied @ 1 kg/ha recorded the highest dry matter result of 3.2 kg DM/ha. The application of copper and zinc @ 2 kg/ha had a significant reduction in the amount of dry matter produced. On the high phosphorus site, copper and zinc applied @ 2 kg/ha reduced the amount of dry matter produced to 2.4 kg DM/ha.

The cocksfoot and clover demonstration site had not been grazed since 17 June. Grazing pressure can influence pasture composition and density during the growing season. Had the site been grazed over the winter/spring grazing season, an increase in the amount of dry matter produced would have resulted.

All demonstration sites recorded an average of 20% crude protein and an average of 9 ME (MJ/kg). 20% protein is adequate for grazing sheep but 9 ME may be limiting for lactating ewes and further supplementation may be required.

Table 1 Visual observations of cocksfoot/clover pasture after application of high phosphorus, low phosphorus and three trace elements

Date of observation	Observation Noted
25 August	Pasture has responded to high and low P application with the high P demonstration site showing denser pasture growth. There was a small response in density and composition to zinc at 1 kg/ha but a negative response to zinc @ 2 kg/ha with less dense, shorter growth of pasture. Clover and capeweed appeared to have poor growth. The lack of response was evident across high, low and no P plots. There appeared to be a response from the clover and capeweed to sulphur @ 10 kg/ha across all demonstration plots.
7 September	Appeared to be a lack of capeweed flowering on the zinc @ 2 kg/ha demonstrations plots. On inspection, there was noticeably less biomass – capeweed and clover was missing, cocksfoot had less growth and more bare ground between plants. The capeweed was well advanced and flowering across the rest of the site.
10 October	A response to both high and low P with no trace elements was noted. The plots with sulphur @ 10 kg/ha still appeared fresher and denser. As the site had not been grazed the Haresfoot clover, Cape weed and Salvation Jane were out-competing the clover. Density of Haresfoot clover varied across the site. The plots with zinc @ 2 kg/ha continued to show less biomass. There appeared no results from copper @ 100 gm/ha however that could be due to the warm dry conditions immediately after application.

Table 2 Visual observations of native grasses/annual grass pasture after application of high phosphorus, low phosphorus and three trace elements

Date of observation	Observation Noted
25 August	There appeared to be more clover and capeweed on the high P (30 kg/ha) site compared to other demonstration sites. Sulphur @ 10 kg/ha had a slightly better response compared to no sulphur across the site.
7 September	Capeweed and clover were more evident in the high P plots. Sheep have selectively grazed the clover and capeweed on the site but they were not putting enough pressure to have any impact the grasses. The grasses across the site have started to go to head. The sheep were excluded again from the site from 7 September.
10 October	Although significant visual responses were hard to observe, in walking through the site it was evident that the capeweed and clover in the high P and sulphur plot were still fresh.

Native grasses/annual grass pasture results

Phosphorus and sulphur was applied to the demonstration site on 17 June, zinc on 27 June. By September grasses such as wild oats, silver grass and *Austrostipa sp* had already started to go to seed therefore applying a copper foliar spray would have little impact. Visual observations were noted over August, September and October (Table 2).

The application of high phosphorus, copper and zinc applied @ 1 kg/ha recorded the highest dry matter result of 3.4 kg DM/ha. The application of copper and zinc @ 2 kg/ha had a significant reduction in the amount of dry matter produced. On the high phosphorus site, copper @ 100 mg/ha and zinc applied @ 2 kg/ha reduced the amount of dry matter produced to 2.5 kg DM/ha.

The demonstration site had limited grazing from 25 August to 7 September. High grazing pressure would need to be applied early in the season to reduce the annual grasses when they are more palatable. Palatability dramatically reduces once silver grass, soft brome and wild oats go to head. *Austrostipa sp* (spear grass) a perennial native grass needs to be grazed before it goes to head to reduce seed contamination. To increase the percentage of native grasses, grazing pressure needs to occur in early - mid spring to reduce competition and seed set from annual grasses.

The crude protein from the native grasses/annual grasses site varied from 13-20% and recorded an average of 8 ME (MJ/kg). 8 ME may be limiting for lactating ewes and further supplementation may be required. The native grasses/ annual grass site also lacked sufficient calcium and magnesium to maintain lactating ewes.

What does this mean?

This work was undertaken purely for demonstration purposes, but some conclusions can be made about the results. A soil test is the best way of determining soil deficiencies and therefore fertiliser application rates. Over the long term, this can save money by only applying what is required by the plants.

All demonstration sites showed a response in pasture growth to low or high phosphorus application. This was not surprising due to the limited fertiliser application history of the demonstration sites.

High rates of zinc (2 kg/ha) resulted in significant reduction in the growth of cocksfoot pasture and burnt the leaves of clovers. It was also noted the area of bare ground was increased. We could conclude that this level of application can limit pasture production.

Zinc foliar sprays were used in the trial to determine an instant response to zinc in pasture growth, as we have seen a direct response to zinc pellets, which are a more traditional and effective way of applying zinc to pastures.

The fertiliser demonstration will continue in 2012. It is intended that grazing pressure will be increased to get a better indication of pasture response and to determine the amount of dry matter which can be produced during the growing season.

Results from the demonstration will be discussed during the SheepConnect sheep groups which meet regularly throughout the year on Eyre Peninsula.

Acknowledgements

We would like to acknowledge Emie Borthwick for her participation as a focus farm for the SheepConnect SA project and allowing us to conduct this trial on her property. We would also like to acknowledge and thank Australian Wool Innovation (AWI), Eyre Peninsula NRM Board for their funding assistance and Cummins Ag Services.

Early winter grazing of crops intended for grain

Alison Frischke
Birchip Cropping Group (BCG)

RESEARCH

Key messages

- **An early sown cereal crop provides a green paddock of feed when regenerating or sown legume pastures are establishing, and avoids the cost and labour of handfeeding.**
- **In low to medium rainfall areas, barley and oat crops best tolerate grazing. They have better forage value and their ability to recover lessens production penalties. Grazed wheat varieties are likely to suffer grain yield and quality penalties. Dual purpose winter varieties are generally not suitable.**
- **In low rainfall areas, it is best to graze well before stem elongation to ensure better crop recovery.**

Why do the trial?

An early rainfall event, coupled with good soil moisture levels, presents an opportunity to sow a cereal crop, have it established quickly and cover the ground. Within 6-8 weeks, cereal crops can provide nutritious feed to livestock at a time of the year when stubbles are depleted and regenerating legume pastures are slow-growing.

The ability of the crop to recover dry matter and grain yield after grazing is dependent on variety, the stage of growth of the crop when grazed, soil moisture levels and subsequent growing season rainfall. In higher rainfall areas, dual purpose winter wheats can be grazed between GS13 and GS30 with little risk to grain production. However, winter wheats are generally not suitable for low rainfall areas because the growing season is too short and springs are variable. Early- to mid-maturing spring cereals are much better adapted to low rainfall areas. Rules-of-thumb developed in higher rainfall areas for avoiding or reducing crop grain yield and quality penalties associated with grazing need to be reviewed for low rainfall varieties.

Aim

To evaluate the suitability of different wheat and barley varieties for both grazing and grain production, when sown early in the cropping program in low rainfall western Victoria.

To evaluate how the stage at which the crop is grazed affects its recovery.

This is the third season of trialling grazing spring cereals intended for grain recovery. Previous variety evaluation has occurred at Woomelang (BCG 2009 Research Results, pp 46-51) and Culgoa (BCG 2010 Research Results, pp 168-173).

How was it done?

Location: Corack

Replicates: 4

Sowing date: 29 April 2011

Seeding density: 150 plants/m^2

Crop variety (maturity): wheat: Axe (early), Scout (mid-late), barley: Hindmarsh (very early), Commander (mid-late), Buloke (early-mid), Urambie (late), Oxford (mid-late), oats: Matika (early)

Fertiliser: Granulock®(11:22:0:4, 4% Zn) @ 50 kg/ha, urea topdressed @ 90 kg/ha (17 June) and @ 60 kg/ha (15 July)

Seeding equipment: knife point, press wheels (30 cm row spacing)

A replicated plot trial evaluating wheat, barley and oat varieties with different maturities and grazing times was established in barley stubble at Corack in the southern Mallee. Grazing occurred at growth stage GS14 (4-leaf) on all varieties for varietal evaluation, and at GS30 (stem elongation) for two wheat and barley varieties: an early maturing and a mid-late maturing type, to evaluate time of grazing on crop recovery and production. Plots were mown to simulate grazing on 11 July (grazed at GS14) and 1 August (grazed at GS30). Mowing instead of using animals enabled randomising of grazing treatments.

Dry matter (DM) production was measured at GS14 or GS30 on respective grazing treatments just prior to 'grazing'. Tissue samples were also taken at GS14 and GS30 and bulked for each crop type for feed testing; nutritional value between varieties has not varied greatly in previous years.

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

DSE grazing days = DM (kg/ha) – 30 (kg/ha; physically unavailable DM) x feedtest metabolisable energy (ME) / 8 MJ, which assumes that each DSE requires 8 MJ/day.

Table 1 Nutritional value of grazed crops at GS14 and GS30, Corack 2011

Crop	Crude protein (% of DM)		Neutral detergent fibre (% of DM)		Metabolisable energy (MJ kg/DM)		Digestibility (% of DM)		Magnesium (mg/kg of DM)
	GS14	GS30	GS14	GS30	GS14	GS30	GS14	GS30	GS14
Wheat	28.3	25.4	44.6	41.1	12.4	11.6	81.5	76.9	1300
Barley	32.5	29.8	35.6	38.8	13.8	13.5	89.7	87.9	1400
Oats	32.1		31.5		14.3		92.4		1300
Min. req. for lactating ewes and lambs	*>16%*		*>30%*		*> 11 MJ kg/DM*		*> 75%*		*1200 mg/kg DM*

Crops were left to recover and were grown through to harvest. Dry matter was measured at maturity (barley on 10 November, wheat on 2 December) to measure recovery and standing crop value.

Grain yield was measured using a small plot harvester (barley and oats on 15 November, wheat on 2 December), and grain quality analysed. Grain yields were adjusted to 11.5% moisture for barley and oats and 12% for wheat.

Gross margins were calculated for every plot of each treatment; grazing gross margin was added to crop gross margin for grazed treatments. Crop gross margins were calculated using:

Crop gross margin ($/ha) = crop income - variable costs (input + operational costs).

Grazing gross margins were calculated using DSE grazing days (accounting for DM production and nutritional value), and 2012 RSSA Farm Gross Margin Guide for self-replacing merino flock gross margin of $40/DSE/year (Bruce Hancock, Rural Solutions SA):

Grazing gross margin ($/ha) = DSE grazing days x 40/365

What happened?

There was plentiful subsoil moisture after 186 mm in January and 79 mm in February. Following sowing, 18 mm rainfall fell on 20 May, but further significant rainfall did not fall until 6-11 August. This decile 2 period resulted in patchy crop emergence, which was more advanced where stubble lay. Timely rains between early August and early October recovered grain yields.

Tissue tests indicated that all crops had adequate nutrition to meet the minimum requirements of lactating ewes and lambs (Table 1).

*Table 2 Dry matter production (kg/ha) of and grazing value of crops grazed at GS14 and GS30, Corack 2011**

Crop	Variety	GS14 DM (kg/ha)*	GS14 DSE grazing days	GS13 Grazing gross margin ($/ha)	GS30 DM (kg/ha)*	GS30 DSE grazing days	GS30 Grazing gross margin ($/ha)
Wheat	Axe	164[bc]	208	23	393[b]	526	62
	Scout	134[cd]	161	18	325[b]	428	50
Barley	Hindmarsh	109[de]	136	15	373[b]	579	65
	Commander	207[a]	305	34	489[a]	775	87
	Buloke	203[a]	298	33	-	-	
	Urambie	85[e]	95	10	-	-	
	Oxford	194[ab]	283	31	-	-	
Oats	Matika	135[cd]	188	21	-	-	
	LSD (P=<0.05)	*35.9*			*75.1*		

** Results that are not statistically significant from one another are followed by the same letter.*

Table 3 Dry matter at maturity, grain yield, quality and gross margin of wheat grazed at GS14, GS30 and un-grazed, Corack 2011

Variety	Quality Maturity	Grazing treatment	Maturity DM (t/ha)	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Total gross margin* ($/ha)
Axe	APW Early	GS14	4.62^{b}	2.51^{c}	10.5	3.47^{abc}	142
		GS30	4.11^{b}	2.07^{d}	10.6	3.25^{bc}	117
		Ungrazed	6.42^{a}	2.72^{bc}	10.6	2.81^{c}	172
Scout	ASW Mid-late	GS14	4.69^{b}	2.82^{b}	9.7	4.63^{a}	153
		GS30	3.91^{b}	2.16^{d}	10.0	4.46ab	95
		Ungrazed	6.71^{a}	3.10^{a}	9.8	2.88^{c}	174
		LSD (P=<0.05)	*0.93*	*0.26*	*ns*	*1.30*	*ns*
		LSD (P=0.05) Variety	*ns*	*0.14*	*0.4*	*0.75*	*ns*
		LSD (P=0.05) Grazing	*0.69*	*0.17*	*ns*	*0.92*	*49*
		***LSD (P=0.05) Variety x Grazing*	*ns*	*ns*	*ns*	*ns*	*ns*

**Total gross margin includes crop gross margin, plus grazing gross margin for grazed treatments.*
***Interaction (variety x grazing) analysis: LSD (variety x grazing) can be used to compare table values. LSD Variety and LSD Grazing can be used to compare averages for each variety or grazing treatment respectively.*

At GS14, plot unevenness resulted in plant growth stage varying up to GS22 in the header row where there was more moisture. As a result high CVs occurred for dry matter. This lessened by GS30 and crops levelled out as they progressed through the season. Feed value (DSE grazing days) at GS14 was greatest for Commander, Buloke and Oxford barley (Table 2). Commander also had the highest feed value at GS30 (Table 2).

In 2009, Hindmarsh performed well at Woomelang, but as in 2010 at Culgoa, Hindmarsh was of poorer feed production value. Urambie, a dual purpose, feed quality barley with winter habit was included after success during drought conditions at Temora, NSW (pers. comm., J. Hunt, CSIRO Canberra), but it too performed very poorly.

Maturity dry matter production, grain yield, quality and gross income of crops are presented in Tables 3, 4 and 5.

For wheat, dry matter at maturity was reduced in grazing treatments (Table 3). Grain yield in turn was also reduced, significantly more the later it was grazed, regardless of crop maturity type. Although, on average, protein was 10.5% or above for Axe, it varied between plots with some low readings for grazed plots, which led to downgrading to AGP1. Screenings increased for grazed Scout but not enough to affect quality. Test weights were adequate and did not vary between grazing treatments.

Table 4 Dry matter at maturity, grain yield, quality and gross margin of barley grazed at GS14, GS30 and ungrazed, Corack 2011

Variety	Quality Maturity	Grazing treatment	Maturity DM (t/ha)	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Total gross margin* ($/ha)
Hindmarsh	Malt Very early	GS14	6.29^{de}	3.18^{ef}	11.0^{a}	1.2^{d}	276^{b}
		GS30	5.37^{e}	2.86^{fg}	10.8^{ab}	1.5^{cd}	273^{b}
		Ungrazed	7.74^{bc}	3.30^{e}	10.2^{bc}	1.3^{d}	278^{b}
Commander	Malt Mid-late	GS14	7.59^{bc}	4.01^{abc}	9.0^{e}	2.0^{bc}	421^{a}
		GS30	6.29^{de}	3.72^{cd}	8.7^{ef}	2.0^{bc}	422^{a}
		Ungrazed	9.15^{a}	4.13^{ab}	9.3^{de}	1.5^{cd}	414^{a}
Burloke	Malt Mid-late	GS14	6.46^{cde}	3.57^{de}	9.8^{cd}	1.4^{cd}	390^{a}
		Ungrazed	8.38^{ab}	3.74^{bcd}	10.6^{ab}	1.4^{cd}	386^{a}
Urambie	Feed Late	GS14	5.39^{e}	2.77^{g}	10.4^{abc}	2.5^{ab}	192^{c}
		Ungrazed	6.55^{cde}	2.88^{fg}	10.7^{ab}	2.9^{a}	184^{c}
Oxford	Feed Mid-late	GS14	7.18^{bcd}	3.91^{abcd}	8.1^{f}	1.3^{d}	388^{a}
		Ungrazed	8.41^{ab}	4.30^{a}	8.8^{ef}	1.3^{d}	417^{a}
		LSD (P=<0.05)	*1.28*	*0.41*	*0.8*	*0.7*	*68*
		LSD (P=0.05) Variety	*0.59*	*0.26*	*0.3*	*0.5*	*ns*
		LSD (P=0.05) Grazing	*0.73*	*ns*	*ns*	*ns*	*ns*
		***LSD (P=0.05) Variety x Grazing*	*ns*	*ns*	*ns*	*ns*	*ns*

**Total gross margin includes crop gross margin, plus grazing gross margin for grazed treatments.*
***Interaction (variety x grazing) analysis: analysis on Hindmarsh and Commander treatments only. LSD (variety x grazing) can be used to compare table values. LSD Variety and LSD Grazing can be used to compare averages for each treatment.*

Table 5. Grain yield, quality and gross margin of oats grazed at GS14 or ungrazed, Corack 2011

Variety	Maturity	Stage of growth grazed	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Total gross margin* ($/ha)
Hindmarsh	Malt Very early	GS14	3.44	10.8	5.3	325
		Ungrazed	3.32	11.5	4.2	286
		LSD (P=<0.05)	*ns*	*ns*	*ns*	*ns*

**Total gross margin includes crop gross margin, plus grazing gross margin for grazed treatments.*

Late (GS30) grazing caused lower grain yields, higher screenings (although still below 5%) and lower gross margins compared with ungrazed plots, despite the value of grazing to the livestock enterprise. Grazing at GS14 also caused reductions but to a lesser extent.

For barley, grazing reduced dry matter production at maturity for Hindmarsh, Commander and Buloke, but not for longer season varieties Urambie and Oxford (Table 4). Grain production, however, was not affected by grazing at GS14, but was reduced by grazing at GS30.

Grain quality was good: retention was above 91% for all varieties (CV 0.4). All varieties had test weights adequate for their receival grade (to achieve malt or feed 1). Protein and screening differences occurred between varieties but not grazing treatments.

In contrast to wheat, barley gross margins were not affected by grazing; the grazing value to the livestock enterprise made up for any crop income losses caused.

For Mitika oats, grazing early had no affect on grain production or quality (Table 5). Test weight was adequate and not affected by grazing (CV 2.1).

The grazed Mitika crop sustained its gross margin compared with the ungrazed crop.

What does this mean?

All crops and varieties proved to be nutritious feed sources for lactating ewes and lambs. Barley provided the most forage, with Commander a standout variety in 2011.

Dry matter production at maturity, which becomes available for forage use as stubbles or even a standing crop, was reduced by grazing the growing crop. However, final dry matter production for grazed crops was generally 4.0-4.5 t/ha for wheat (compared with 6.7 t/ha ungrazed Scout) and 5.4-7.6 t/ha for barley (compared with > 9 t/ha ungrazed Commander). These crops provide substantial forage banks for use during times of particular need such as lambing once stubbles are consumed. Lodging in barley would need to be considered to avoid wastage. Oats would not be suitable for this purpose, due to shattering. Alternatively, grazed crops could be cut for hay in spring; those varieties with more DM at maturity would be likely to have the greatest hay yield at cutting time.

Growth stage at grazing was more important than maturity characteristics on final grain yield. Crops grazed at GS14 incurred little yield penalty, whereas crops grazed at GS30 had reduced yields compared with ungrazed crops.

The grain quality of wheat was affected by grazing, reducing grazed crop gross margins due to a reduction of receival category. Grain quality for barley and oats, however, was not affected by grazing. Gross margins were maintained in barley and oat grazed crops, with the value of grazing counteracting any grain income losses due to grain penalties.

Commercial practice: what this means for the farmer

- Consider growing a barley or oat crop for stockfeed. An early (April, first week May) established crop can provide a nutritious feed source for stock when regenerating or sown legume pastures are still establishing, and avoids the cost and labour of handfeeding.
- In low rainfall areas, early (April) sowing is critical; grain recovery after grazing is more likely to be successful in years with stored subsoil moisture and good spring conditions.
- In low rainfall areas, it is best to graze well before stem elongation for better crop recovery. Barley and oat grain crops will tolerate grazing the best, having better forage value and ability to recover and lessen grain production penalties. Grazed grain wheat varieties are likely to suffer grain yield and quality penalties.
- Dual purpose winter cereal varieties are generally not adapted to low rainfall areas.
- The alternative to risking production and grain quality of a crop is to sow an area of crop specifically for forage use: this may be either with a traditional grain cereal, or with a variety bred specifically for forage production. Refer to article 'Choice of forage crops for winter feed' in this publication.

Acknowledgments

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Granulock® is a registered product of Incitec Pivot LTD.

Choice of forage crops for winter feed

Alison Frischke
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RESEARCH

Key messages

- **The choice of vigorous, leafy, nutritious forage crops available for low to medium rainfall environments to supply nutritious green feed to sheep during the winter and spring months continues to expand.**
- **Forage cereal crops provide feed during winter; vetch is useful from late winter into spring and forage brassicas provide from late spring into summer.**
- **To help decide which forage to grow from the broad range available, first plan the time of greatest need (time of year, duration), intention to harvest silage, hay or grain and the rotational requirements of the paddock in which forage is to be planted.**

Why do the trial?

Higher prices for meat and fibre in recent years have driven a resurgence of interest in livestock. A livestock enterprise in the farm business acts as a risk management tool for leaner years and works at the same time as a lower risk, profitable enterprise in its own right.

Livestock production is no longer a case of just accepting what is turned off the paddock. Healthy ewes, increased numbers of lambs weaned and faster growth rates drive production and overall profitability. Meeting nutritional requirements according to age, pregnancy or lactation throughout the year is imperative if optimal production is to be reached. Achieving this only with regenerating pastures and stubbles is difficult; hand feeding grain or hay is necessary in most seasons and with higher stocking rates. Alternatively, sown forage crops may be used to fill the gaps.

Aim

To evaluate different commercially available forage crop varieties for their feed value and capacity to recover during winter and spring in a low rainfall Mallee-Wimmera environment.

How was it done?

Location: Corack

Replicates: 4

Sowing date: 29 April 2011

Crop types and seeding density: outlined in Table 1.

Fertiliser: Granulock® (11:22:0:4, 4% Zn) @ 50 kg/ha

A replicated plot trial evaluating forage wheat, barley and oat varieties, oaten hay varieties, vetch and vetch/oat mixes and a forage brassica was established in barley stubble at Corack in the southern Mallee. Variety details are given in Table 1, treatments listed in Tables 3 and 4. Some varieties are usually recommended for higher rainfall areas, but were included to assess early forage production given the large soil moisture reserve available after exceptional summer rainfall: 186 mm in January and 79 mm in February.

Dry matter production (DM) was measured when crops were at least 20 cm high. A cut (First Graze) was taken for cereal varieties and oat/vetch mix on 19 July and a regrowth cut on these areas was taken on 29 September. The First Graze and regrowth cuts were totalled to measure the cumulative grazing value (Two Grazes). A separate fresh cut (Later Winter Graze) was taken from these plots on 22 August to measure forage value if it had been allowed to grow for another month before its first graze.

Similar cuts for pure vetch and forage brassica were each taken one month later (when they too had reached 20 cm high); 'First Graze' on 19 August, the regrowth cut for 'Two Grazes' on 26 October and 'Later Winter Graze' on 20 September.

Tissue samples were collected at the time of 'First Graze' and bulked for each crop type for feed testing.

The crops remaining in plots (uncut areas) were grown through to harvest. Dry matter was measured at anthesis to measure total ungrazed dry matter production, which is equivalent to hay yield. Grain yield of cereals and vetch was measured using a small plot harvester (barley 18 November, oats and oats/vetch 24 November, wheat 2 December).

Table 1 Crop variety, use, maturity traits and sowing rates in Forage Crop trial, Corack 2011

Crop	Variety	Use	Maturity	Sowing Rate (kg/ha)
Barley	Hindmarsh	Feed grain	very early	80
	Moby	Forage	early	80
	Moby - half SR *	Forage	early	40
	Dictotor	Forage	early-mid	60
	White Stallion	Forage	early	100
Triticale	Tuckerbox	Forage	mid	80
	Crackerjack	Forage	late	60
Wheat	Wrangler	Forage	mid	80
Oats	Tammar	Hay/feed grain	late	80
	Kangaroo	Hay/feed grain	mid-late	80
	Winteroo	Forage/hay/feed grain	early-mid	80
	Outback	Forage	mid-late	80
	Galieo	Forage/hay	late	60
	Mulgara	Hay/feed grain	early-mid	80
	Brusher	Forage/hay/feed grain	early-mid	80
Oats/Vetch Mix	Winteroo/Rasina	See individual variety descriptions		40/20
	Winteroo/Morava			40/20
Vetch	Morava	Forage/hay	late	45
	Rasina	Forage/hay	early	45
Forage brassica	Winfred	Grazing	early	3

*Variety details and recommended sowing rates obtained from NVT and seed merchant documents. *SR – sowing rate*

Table 2 Nutritional value of forage cereals, vetch and forage brassica when 20 cm high, Corack 2011

Crop	Crude protein (% of DM)	Neutral Detergent Fibre (% of DM)	Metabolisable Energy (Calculated) (MJ/kg DM)	Digestibility (DOMD) (Calculated) (% of DM)	Nitrate (mg/kg of DM)
Barley	25.7	41.9	12.9	78.1	-
Triticale	26.7	40.7	12.9	78.1	-
Wheat	27.4	40.3	13.1	79.5	-
Oats	25.1	39.3	12.9	78.1	-
Oats/Vetch mix	26.3	36.9	13.0	78.9	-
Vetch	32.6	38.7	11.6	72.0	1400
Forage Brassica	29.6	24.4	13.3	80.2	2900
Min. reg. for lactacting ewes and lambs	*> 16%*	*> 30%*	*> 11 MJ kg/DM >*	*75%*	*> 4-5000 mg/kg is toxic*

What happened?

Despite the wet start to the season, the period after sowing became quite dry. After 18 mm of rain fell on 20 May, rainfall remained at decile 2 until timely rain fell between the second week of August and early October which recovered dry matter and grain production.

At the first time of sampling (First Graze July: cereals, August: vetch and forage brassica), the nutritional value of all the forages met the minimum requirements for production (i.e. lactating ewes and lambs); although digestibility (DOMD) of vetch was adequate for maintenance (55%) but borderline for production. The vetch and forage brassica were both well within safe limits for nitrate levels (Table 2).

The production of the forage crops at different grazing times are presented in Table 3.

Brusher, Mulgara and Galileo oats as well as White Stallion barley had all produced at least 350 kg DM/ha by mid July, seven weeks after sowing. These varieties were closely followed by Tuckerbox triticale, Moby barley, Outback and Winteroo oats exceeding 300 kg DM/ha, with Dictator barley and Kangaroo oats not far behind.

A delay of one month before grazing, Later Winter Graze, enabled many varieties to produce over 1000 kg DM/ha in a similar order, again with Brusher oats as the outstanding variety.

The Two Grazes treatment measured the crop's ability to recover from grazing and once again produce forage. White Stallion and Moby barley, Mulgara oats and Tuckerbox triticale had combined grazing values of over 3100 kg DM/ha. Brusher oats, Moby barley at half sowing rate and Hindmarsh barley all produced over 2850 kg DM/ha. This was 800-1000 kg DM/ha more than some varieties such as Winteroo, Outback and Galileo oats which had performed well early.

Moby barley sown at half the recommended sowing rate performed very well in the low rainfall environment, producing as much dry matter and grain as the full-rate crop.

The Two Grazes grazing value of the oat/vetch mixes Winteroo/Rasina and Winteroo/Morava, produced over 2400 kg DM/ha. The oats dominated these forage mixes: production was largely a reflection of Winteroo performance. However, the vetch still had a presence which would hold rotation value with the legume break crop benefits. Nearby Rasina and Morava plots were producing as much forage without the oats.

The Rasina and Morava vetch and Winfred forage brassica had similar production levels to the forage cereals, but production was occurring one month later compared with the forage cereals, shifting the feed curve to later in the season.

Hay value (measured as dry matter at anthesis on ungrazed plots) and grain yield for ungrazed forage crops are presented in Table 4. Note that not all varieties are recommended for hay (see Table 1). Where not recommended for hay, they have been included to demonstrate their dry matter production capability. Grain yield has been presented to indicate grain harvest if you were keeping an area excluded from grazing for seed production. For this reason, yields are not discussed.

Of the hay types, Galileo, Kangaroo, and Winteroo oats produced over 6600 kg DM/ha at anthesis. Moby barley and Outback oats are not recommended for hay, but at anthesis had produced over 6000 kg DM/ha, indicating their usefulness as silage options had they been cut earlier.

Winfred forage brassica was still green when all the other crops had matured.

What does this mean?

Despite the decile 2 rainfall conditions experienced during winter, the stored soil moisture from summer and the return of regular rain from August onwards enabled crops to produce lush stands of growth and yield well in 2011.

Crops had different growth rates as the season progressed, varying the forage available at different times of the year. Only a couple of varieties performed below the others: probably as a result of inadequate rainfall or because the grazing timing of the treatment did not match recommended grazing management, e.g. grazed after first node (GS30).

Table 3 Forage value of forage cereals, vetch and brassica, Corack 2011

Crop	Variety	Maturity	First Graze* (kg/ha)	Later Winter Graze** (kg/ha)	Two Grazes (cummulative value) *** (kg/ha)
Barley	Hindmarsh	very early	217^{f}	914^{def}	2884^{bcde}
	Moby	early	334^{abcde}	1099^{bcd}	3439^{ab}
	Moby - half SR	early	267^{cdef}	968^{cdef}	2938^{bcd}
	Dictator	early-mid	294^{abcdef}	798^{f}	2767^{bcdef}
	White Stallion	early	364^{ab}	1031^{bcde}	3822^{a}
Triticale	Tuckerbox	mid	335^{abcde}	967^{cdef}	3112^{abcd}
	Crackerjack	late	279^{bcdef}	809^{ef}	2688^{cdef}
	Wrangler	mid	274^{bcdef}	430^{g}	2146^{f}
	Tammar	late	263^{ef}	829^{ef}	2537^{def}
	Kangaroo	mid-late	294^{abcdef}	1202^{ab}	2689^{cdef}
	Winteroo	early-mid	$305^{abcfdef}$	1209^{ab}	2187^{ef}
	Outback	mid-late	306^{abcdef}	999^{bcdef}	2140^{f}
	Galileo	late	351^{abcd}	1091^{bcd}	2115^{f}
	Mulgera	early-mid	354^{abc}	1186^{abc}	3310^{abc}
	Brusher	early-mid	382^{a}	1340^{a}	2907^{bcde}
Oat/Vetch Mix	Winteroo/Rasina	*See individual variety descriptions*	255^{ef}	1169^{abc}	2676^{cdef}
	Winteroo/Morava		324^{abcde}	118^{abcd}	2468^{def}
		LSD (P=<0.05)	*91*	*229*	*721*
#Vetch	Morava	late	703	2130	2623
	Rasina	early	737	1669	3063
#Forage brassica	Winfred	early	1469	3314	2180

 # Not included in analysis as samples were taken in different months to cereals
** First graze: cereals (19 July); vetch & forage brassica (19 August)*
*** Late winter graze: cereals (22 August); vetch & forage brassica (20 September)*
**** Two grazes: cereals (19 July & 26 September); vetch & forage brassica (19 August & 26 October)*

Table 4 Anthesis dry matter production (hay) and grain yield of ungrazed forage cereals, vetch and forage brassica, Corack 2011

Crop	Variety	Maturity	Ungrazed anthesis DM (kg/ha)	Ungrazed grain yield (t/ha)
Barley	Hindmarsh	very early	5685^{bcde}	3.23^{bc}
	Moby	early	6142^{abcd}	2.21^{i}
	Moby - half SR	early	6155^{abcd}	2.06^{i}
	Dictator	early-mid	4992^{ef}	1.98^{ij}
	White Stallion	early	5777^{bcde}	2.06^{ij}
Triticale	Tuckerbox	mid	5581^{bcde}	2.93^{def}
	Crackerjack	late	5976^{bcde}	2.81^{d}
	Wrangler	mid	5864^{abcde}	3.11^{ef}
	Tammar	late	5129^{cdef}	3.06^{cde}
	Kangaroo	mid-late	6631^{ab}	2.98^{cdef}
	Winteroo	early-mid	6234^{abc}	3.05^{cde}
	Outback	mid-late	6626^{ab}	3.16^{cd}
	Galileo	late	7075^{a}	2.73^{fg}
	Mulgera	early-mid	4081^{f}	2.51^{gh}
	Brusher	early-mid	5189^{cdef}	2.24^{hi}
Oat/Vetch Mix	Winteroo/Rasina	*See individual variety descriptions*	5735^{bcde}	na
	Winteroo/Morava		5735^{bcde}	na
Vetch	Morava	late	*4343^{cde}*	*1.85^{j}*
	Rasina	early	*5019^{def}*	*1.87^{j}*
Forage brassica	Winfred	early	*5735^{bcde}*	*ns*
		LSD (P=<0.05)	*1139*	*0.28*

na – not applicable as they would not be harvested for grain.

In 2011, Moby and White Stallion barley, Tuckerbox triticale and Kangaroo, Winteroo, Outback, Mulgara and Brusher oats, were the crops that produced the most feed in July and August. Most of these are early to mid-maturing varieties. Varieties Moby and White Stallion barley, Tuckerbox triticale, Mulgara and Brusher oats and Hindmarsh barley responded best to grazing, creating the most total dry matter in two grazes. Moby barley sown at half rate performed quite well compared with the full sowing rate.

Hay production was highest for suitable hay varieties Kangaroo, Winteroo and Galileo oats.

Pure vetch stands produced over 5 t/ha of hay; while lower than some other cereal crops, the benefits of the high quality hay, cereal rotation break and nitrogen fixation for the following cereal crop would drive the decision to choose a lower producing crop. To bolster early feed production, the addition of oats helped increase forage available.

Commercial practice: what this means for the farmer

- Many forage crops that can produce fast growing, winter feed to support production of lactating ewes and growing lambs are now available. End use options of these crops range from forage, silage and hay, to grain production.
- To help decide which forage might be grown from the broad range available, farmers should take into consideration when the feed is needed (time of year, duration), whether the crop will be harvested for silage, hay or grain, and the rotational needs of the paddock.
- In general, early- to mid-maturing barley and oat varieties were the top performers of winter feed production in 2011, appearing best suited to the low-medium rainfall Mallee and Wimmera.
- Experiment first with a smaller paddock which can be stocked adequately to graze the paddock evenly. This prevents animals grazing the same areas where they keep the regrowth fresh and sweet, while other areas remain ungrazed and risk growing tall and rank.
- The use of electric fencing to create smaller areas and intensify stocking rate is a very good way of managing grazing in larger paddocks, as has been experienced by several growers in the nearby Nullawil Best Wool Best Lamb group.

Acknowledgments

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Grazing wheat crops to reduce supplementary feeding in mixed wheat and sheep farms in southern Australia

Dean Thomas and Katrien Descheemaeker
CSIRO

Key messages

- **Grazing a spring wheat crop reduced the supplementary feeding required from 17.8 to 16.3 % of the seasonal energy intake of sheep on average across the locations that were studied.**
- **This is part of a National Grain & Graze project with a diverse range of locations across WA, SA and Victoria being used in the study in order to identify trends across a number of climate 'transects'.**
- **Grazing crops were used more frequently (in 52% of years) for farms located in drier climates, compared with higher rainfall sites where they were used in 17% of years.**
- **Increased use of grazing crops in drier areas was in part due to the later establishment of pastures, compared with crops, at these sites. Use of winter wheat varieties may increase opportunities to graze crops in higher rainfall areas.**
- **Grazing crops had a relatively small overall contribution to the farm feedbase, however crops tended to be grazed in seasons when pastures were late to establish, so in these years access to grazing crops may help reduce supplementary feeding.**

Why do the trial?

This modelling study was conducted to compare how the use of feed components in a mixed wheat and sheep farm are affected when grazing of immature crops is allowed. A number of studies have shown that grazing crops at early growth stages (prior to stem elongation) has little effect on subsequent crop yields. This grazing window often coincides with a shortage in feed supply in early winter. To date, research on grazing crops has focused on the use of specialist dual-purpose crop varieties in higher rainfall areas, where earlier sowing and delayed crop maturity allows more frequent and longer grazing opportunities during each season. However, in the drier regions in southern Australia the use of dual-purpose crops (crops that are grown for both grain and grazing) has increased because of their potential to increase profitability in mixed farming systems (Kirkegaard, 2008). In this study, we used a mixed farm simulation model to investigate the value of grazing a spring wheat variety opportunistically, where priority is given to preserving crop yields.

How was it done?

A simulation experiment was conducted using the AusFarm biophysical model (Moore, 2007), based on a self-replacing Merino sheep and wheat growing enterprise with or without crop grazing. The simulation study used climate data from 1961-2010 from 15 sites across southern Australia, representing the range of climates that exist in the main grain growing regions of southern Australia. High, medium and low rainfall sites (transects) were selected for each of 5 agricultural regions (WA – Northern Agricultural, Central Wheatbelt, South-east Coast, SA – Eyre Peninsula, Victoria – Mallee). Farm stocking rate was determined according to the total annual rainfall at each location (i.e. dry sheep equivalents (DSE) per winter grazed ha = 0.0225 x annual rainfall (mm) - 2).

Two 4-year rotation sequences were applied within the model, across the 8 paddocks allocated to crop and pasture rotations. A single rotation sequence (pwww) was used in 4 of the paddocks (each 500 ha), and one of two rotation sequences (pwww or pddd) was used in the other 4 paddocks (each 200 ha), where p = annual pasture, w = wheat and d = wheat crops that were allowed to be grazed if certain conditions were met (see section on grazing rules). A further 2 paddocks (each 100 ha) in the model were not cropped and were managed as permanent pastures. The energy intake of green and dry pasture, permanent pasture, crop stubbles, supplementary feed and dual-purpose crop consumed by livestock was determined for 2 scenarios, being (1) with or (2) without sheep having access to grazing crops.

Table 1 Use of grazing spring wheat crops on their effect on level of supplementary feeding in a representative self-replacing Merino ewe and wheat cropping enterprise at a range of locations across southern Australia

	Supplementary feeding (% of energy intake)			
Location	**without wheat grazing**	**with wheat grazing**	**% of years crops are grazed**	**Duration of crops grazing (days)**
Badgingarra, WA	21.7	17.4	46	17
Bendigo, Vic	9.5	9.7	6	33
Binnu, WA	25.2	22.2	80	17
Charlton, Vic	10.6	9.7	16	17
Cleve, SA	16.4	14.3	10	12
Cummins, SA	13.4	12.5	8	12
Esperance, WA	10.9	10.5	14	11
Kojonup, WA	20.4	20.1	12	18
Kyancutta, SA	31.0	28.1	60	18
Merredin, WA	16.6	14.8	56	18
Mingenew, WA	23.2	20.3	78	16
Salmon Gums, WA	16.1	15.2	26	17
Scadden, WA	11.6	11.5	8	17
Swan Hill, Vic	21.3	20.5	38	18
Wickepin, WA	19.0	17.6	36	18
WA - Northern Agricultural	23.4	20.0	68	17
WA - Central Wheatbelt	18.7	17.5	35	18
WA - South-East Coast	12.9	12.4	16	15
SA - Eyre Peninsula	20.3	18.3	26	14
Vic - Mallee	13.8	13.3	20	22
Low rainfall	22.0	20.2	52	18
Medium rainfall	16.1	14.7	30	16
High rainfall	15.2	14.0	17	18
Grand mean	**17.8**	**16.3**	**33**	**17**

Table 2 Percentage change in the use of feed components when grazing of dual-purpose crops is permitted in a representative self-replacing Merino ewe and wheat cropping enterprise at a range of locations across southern Australia

	Feedbase component (%)				
Location	**Annual pasture**	**Permanent pasture**	**Crop stubbles**	**Supplementary feed**	**Dual-purpose wheat**
Badgingarra, WA	0.8	1.5	0.0	-4.3	2.1
Bendigo, Vic	-0.3	-0.3	0.0	0.2	0.4
Binnu, WA	-0.1	-0.2	-0.5	-2.9	3.8
Charlton, Vic	0.0	0.8	-0.6	-0.9	0.7
Cleve, SA	0.0	1.9	-0.1	-2.1	0.3
Cummins, SA	0.7	0.0	0.0	-1.0	0.2
Esperance, WA	0.2	-0.1	-0.1	-0.4	0.4
Kojonup, WA	-.01	-0.1	-0.1	-0.3	0.5
Kyancutta, SA	0.0	0.3	-0.4	-2.8	2.9
Merredin, WA	-0.1	-0.7	0.1	-1.9	2.7
Mingenew, WA	-0.1	-0.1	-0.3	-2.9	3.4
Salmon Gums, WA	0.0	-0.5	0.2	-0.9	1.2
Scadden, WA	-0.3	0.0	0.0	-0.1	0.4
Swan Hill, Vic	0.1	-1.1	0.0	-0.8	1.8
Wickepin, WA	0.1	0.0	-0.4	-1.4	1.7
WA - Northern Agricultural	0.2	0.4	0.3	-3.4	3.1
WA - Central Wheatbelt	-0.1	-0.3	-0.1	-1.2	1.6
WA - South-East Coast	0.0	-0.2	0.1	-0.5	0.7
SA - Eyre Peninsula	0.2	0.7	-0.1	-2.0	1.1
Vic - Mallee	-0.1	-0.2	-0.2	-0.5	1.0
Low rainfall	0.0	-0.5	-0.1	-1.9	2.5
Medium rainfall	-0.1	0.5	-0.3	-1.5	1.3
High rainfall	0.2	0.2	0.0	-1.2	0.7
Grand mean	**0.0**	**0.1**	**-0.1**	**-1.5**	**1.5**

What does this mean?

- Grazing spring variety wheat crops is likely to reduce farm supplementary feeding cost marginally, and may be more important in years with late pasture establishment. Using the crop grazing rules set for this study, the impact on grain yield is likely to be minimal. In particular, farmers in lower rainfall areas should benefit from grazing spring variety wheat crops at a frequency of about every second year.
- The greater effect for lower rainfall sites may be due to a greater difference in the relative availability of crops versus pastures for grazing, as was reported by Thomas (2011). That is, that the time difference between when crops and annual pasture have grown enough to be grazed is longer at lower rainfall sites.
- Grazing crops will be most beneficial and achievable in years where the season break does not occur until early May, or later. This is because crops are more likely to be available for grazing before pasture mass reaches 800 kg/ha.
- To avoid crop yield penalties from grazing, it is critical that crops only be grazed after they have adequately established (typically 4-6 weeks after sowing), and sheep be removed before wheat plants mature to the stem elongation stage (GS30).

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Livestock

Section Editor:

Nigel Wilhelm

SARDI, Minnipa Agricultural Centre/ Waite

Section 7

Soils

Addressing production constraints through the modification of sandy soils

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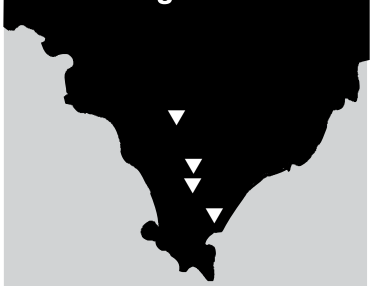
Searching for answers



Location:
Lock, Mt Hill, Wharminda, Ungarra and Pillanna
Farmers: Gus Glover, Chris Will, Ed Hunt, Terry Young & Mick Dahlitz

Soil Type
Variable depth of sand with bleached A2 Horizon over clay

Soil Test
Mid season basic nutrition
Microbial biomass
Crop root DNA

Plot Size
Unreplicated demonstration site with varying plot sizes.

Yield Limiting Factors
Six week dry period in September
Potential competition from summer forage sorghum and ryegrass on spaded treatment at Young's

Key messages

- **Modifying soil using a spader only can give large increases in dry matter without necessarily giving the same increase in yield.**
- **Using the spader to incorporate a delved site can be effective in increasing the benefit of the delving operation, particularly where organic matter is also incorporated.**

Why do the trial?

Past trials and demonstrations have shown that the placement of clay and nutrients into A2 horizons (either by delving or deep incorporation through spading) have resulted in greater production increases than those achieved by modifying the A1 horizon only (clay spreading). The addition of organic material in this process can deliver even more significant results (EPFS Summary 2010, p154) but results have been inconsistent. The demonstrations summarised below have been conducted to improve our understanding of what is driving these responses and how soil modification techniques can be improved on sandy profiles.

How was it done?

A number of large plot demonstration sites were established using the spader prior to sowing in 2011 and monitored during the season. Yield data was also gathered on some existing sites (Table 1).

Sites were sown with farmer equipment and treated the same as the rest of the paddock during the season. Grain yield data was obtained from 6 x 1 metre row cuts at maturity and threshing out the grain. The Edillilie site was harvested using the SARDI plot header with three ten metre strips harvested from each treatment.

What happened?

Glover, Lock

The Glover site compared spading, spading with oaten hay (33 t/ha), spading with canola hay (30 t/ha) against a control of no soil modifications. Spader treatments were applied in early May 2011 with the site being sown to Maritime barley in the first week of June. Strong winds in late June resulted in erosion on the spaded treatment.

Plant emergence counts taken in early July showed little difference between the control and the spaded only treatment. Plant density was 24% higher than the control on the spaded with oaten hay treatment and 200% of the control where canola straw was incorporated by the spader.

Dry matter in the spaded only treatment reflected the impact of erosion. Dry matter in the spader with canola straw treatment was much higher than any other treatment (Figure 1).

Table 1 Summary of demonstration sites

Co-operator	Location	Soil profile description	Plot size	Crop	Measurements	Treatments
Glover	Lock	Fine neutral grey siliceous sandy A1 to 10 cm over a bleached yellow siliceous sand (A2) to 50 cm with orange clay lamella from 30 cm. Orange clayey sand from 50 to 75 cm.	8 m x 20 m	Barley	Plant emergence, dry matter, mid season soil nutrients, root DNA, fungal biomass, yield	Non spaded, spaded only, spaded with oaten hay incorporated and spaded with canola hay incorporated, May 2011
Will	Mt Hill	Grey slightly acid sandy A1 to 10 cm over bleached A2 to 25 cm. Neutral orange/ brown clay B horizon beginning at 25 cm becoming increasingly calcareous and alkaline at depths greater than 35 cm.	4 m x 20 m	Wheat	Plant emergence, dry matter, mid season soil nutrients, root DNA, fungal biomass, yield	Non modified, spaded only, spaded with pelletised lucerne incorporated, delved only, delved and spaded, delved and spaded with pelletised lucerne incorporated, May 2011
Hunt	Wharminda	Shallow sand over clay. Profile not characterised.	12 m x 50 m	Wheat	Plant establishment	Non spaded, pasture green manured spring 2010, damaged by spray drift, no data collected
Young	Ungarra	Grey siliceous sandy A1 to 10 cm with bleached A2 to 25 cm. Yellow brown sodic medium clay B horizon becoming increasingly calcareous with depth.	20 m x 100 m	Wheat	Plant emergence, dry matter, mid season soil nutrients, root DNA, fungal biomass, yield	Delved in 2009, lupin crop green manured using spader in spring 2010, sorghum sown on spaded area, December 2010
Dahlitz	Pillanna	Shallow sand over clay. Profile not characterised.	8 m x 50 m	Wheat	Yield	Delved in December 2010, spaded in May 2011. Spaded with 20 t/ha pea straw incorporated
Treloar	Edillilie	Grey brown loosely structured loamy sand to 15 cm. Pale brown acidic sandy A2e horizon with 20-30% ironstone cobbles to 20 cm. Highly bleached white sandy A2 with 5% ironstone cobbles to 35 cm over a neutral orange/red brown medium clay B1 horizon beginning at 35 cm. Yellow brown sodic B2k horizon from 50 cm with carbonate increasing with depth.	12 m x 8 m	Wheat	Yield	Control, spaded and spaded with 10 t/ha of lucerne hay, March 2009

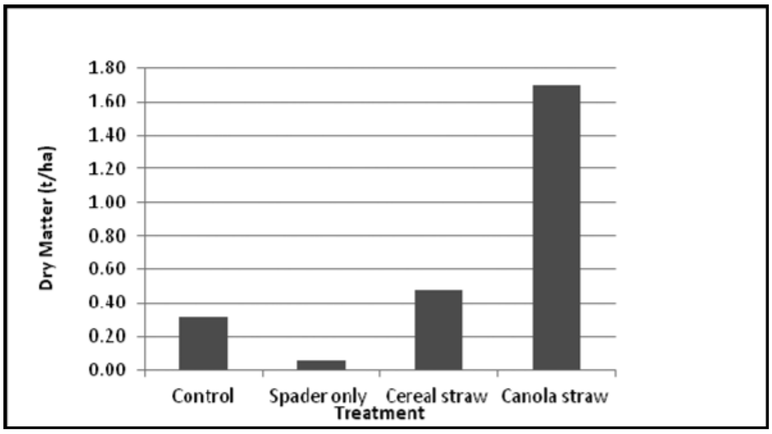


Figure 1 Dry matter from Glover site in August 2011

Soil samples were taken from each treatment at depths of 0-10 and 10-30 cm (the working depth of the spader) in early September and were analysed for basic nutrition, root DNA and fungal biomass. There was little difference in nutrient analysis results between the control, spaded only and incorporated canola hay treatments. Potassium, sulphur and nitrate levels were generally higher on the spaded plus cereal hay treatment.

Root DNA analysis indicated more wheat roots with spading and even more where organic matter was incorporated as well (Table 2). This was most obvious in the 10-30 cm depth.

Differences in dry matter production were also reflected in yield with incorporated hay treatments delivering three to six times greater yield than the control (Figure 2).

This demonstration confirms other work which suggests that incorporation of organic material will provide significant increases in yield. A number of questions were raised including:

- How long does the yield benefit from the incorporation of organic matter last?
- Why has the canola hay treatment provide such significant benefits? There are no obvious nutrition differences between canola hay, spaded only and the control, yet the canola treatment has delivered major dry matter and yield responses. Further investigation is required to determine the effect of different types of organic matter on crop growth response.
- What methods can be employed to reduce erosion risk following spading?

Table 2 Soil root DNA samples taken from Glover site in September 2011

Treatment	**Depth 0-10 cm** (pgDNA/g)	**Depth 10-30 cm** (pgDNA/g)
Control	18	0
Spaded only	67	318
Cereal Straw	118	1367
Canola Straw	4761	2743

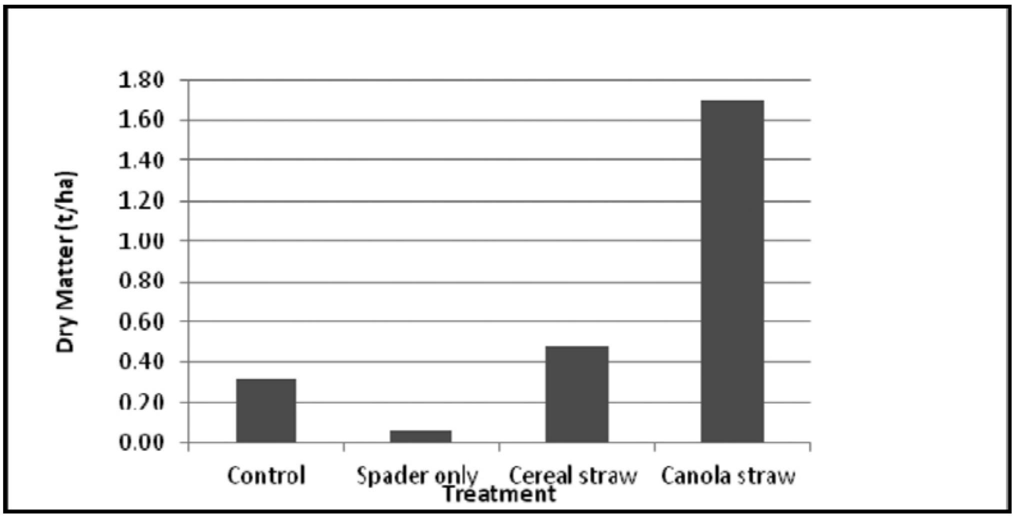


Figure 2 Glover barley yields, December 2011

Will, Mt Hill

A portion of the site was delved to a depth of 60 cm in April with spader and organic matter treatments (pelletised lucerne @ 10 t/ha) applied prior to seeding in May 2011.

Plant numbers in early July were slightly higher on spaded plots (5 to 19%) than the control, except for the delved + spaded treatment which had similar plant numbers to the control. There were 20% fewer plants on the delved only plot compared to the control. This may have been due to uneven germination resulting from poor incorporation of clay after delving.

Dry matter cuts in late July showed that all modified treatments except delved only recorded higher dry matter levels (13 to 32% higher) than the control (Figure 3). When comparing these dry matter weights against the variation in plant numbers there was a 10% increase in the kg/plant on the spaded treatments over the control and a 20% increase on the delved + spaded treatments indicating a growth response to the treatments. In September all soil modification treatments had higher dry matter production than the control.

Soil samples were taken from each treatment at depths of 0-10 and 10-30 cm in early September and were analysed for basic nutrition, root DNA and fungal biomass. Higher levels of sulphur, organic carbon and nitrogen were present in the 0-10 cm layer of the unmodified control and higher levels of potassium in the B horizon at 20-30 cm. The modified treatments had a more even distribution of nutrients throughout the profile than the control. All soil modification treatments had higher soil pH than the control. This is likely to be a result of bringing up alkaline B horizon material through the soil modification treatment. However change in pH was variable for each treatment which is likely to reflect the variability of depth to the B horizon and carbonate layer (pH increases ranged from 0.4 pH unit in the spaded + organic matter treatment to greater than 1 pH units for the delved + spaded treatments). The larger increases where the spader was used post delving could indicate the better ability of the spader to incorporate material brought up by the delver.

Wheat root DNA analysis showed:

- Fewer roots in the delve only treatments and in the 10-30 cm soil levels of the spaded only treatments.
- More roots in the 10-30 cm layer where organic material was incorporated than spading alone.

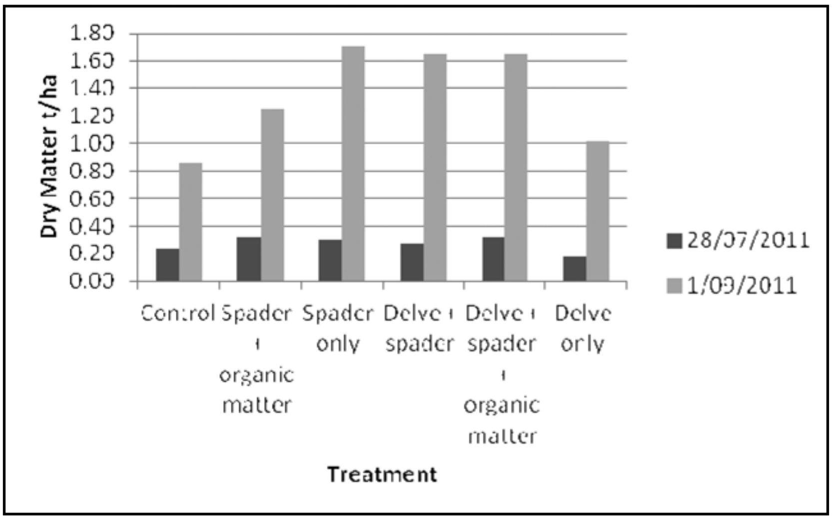


Figure 3 Dry matter from Will site in July and September 2011

Table 4 Wheat root DNA analysis from soil samples taken from Will site in September 2011

Treatment	**Depth 0-10 cm** (pgDNA/g) Sample	**Depth 10-30 cm** (pgDNA/g) Sample
Control	71352	62169
Spaded only	69531	22005
Spaded + OM	83577	34086
Delve only	17590	17634
Delve + Spade	79790	12726
Delve + Spade + OM	79943	71115

Microbial carbon analysis did not identify any particular trends resulting from the soil modification treatments. Further investigation is required to help quantify the impact of soil modification techniques on root development and microbial activity.

The large increases in dry matter production on the soil modification treatments in the middle of the season did not translate to similar increases in grain yields (Figure 4). The only treatments which gave yield increases greater than 10% were a combination of delving and spading.

These results do not accord with other demonstrations showing significant increases in production following incorporation of organic material. This requires further investigation and this site will be monitored in 2012.

Young, Ungarra

The objectives of this demonstration were to;

- Establish surface cover using a summer active pasture (forage sorghum) to reduce wind erosion risk following spading in spring (green manuring).
- Determine the impact of the summer crop on grain yield on the site in the following season.

Sorghum effectively eliminated wind erosion potential and produced approx 15 t/ha of dry matter over the course of the summer. However, it appeared to dry the soil profile (Table 5) with an impact on subsequent production (Figures 5 and 6).

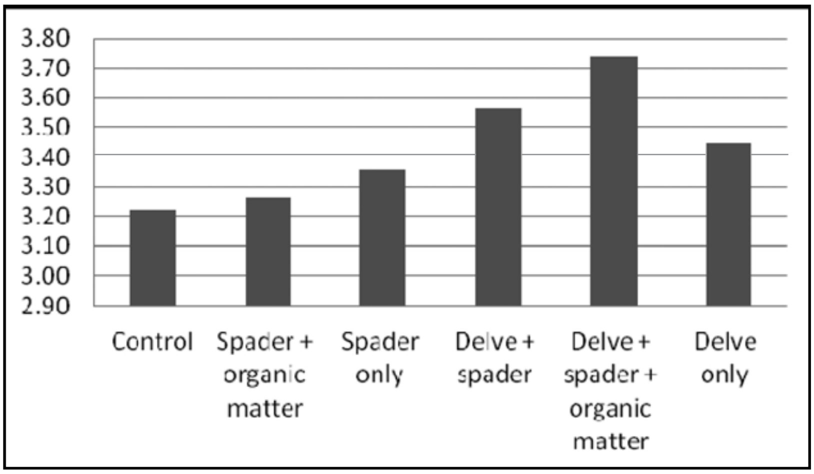


Figure 4 Will wheat yields, December 2011

Table 5 Gravimetric moisture content of Young site, May 2011

Depth	0-10 cm Gravimetric moisture (%)	10-20 cm Gravimetric moisture (%)	20-30 cm Gravimetric moisture (%)
Unspaded	10.33	9.83	14.50
Spaded	9.06	8.97	10.54

The spaded area suffered from a high infestation of ryegrass despite pre and post emergence treatments. Additionally crop emergence appeared be to more variable on the spaded area.

Dry matter in early September was 25% higher on the unspaded control than the spaded treatment. At this time the crop was also observed to be more yellow on the spaded area indicating nitrogen deficiency possibly due to depletion by the summer sorghum crop and ryegrass competition.

Soil samples were from each treatment at depths of 0-10 and 10-30 cm in early September and were analysed for basic nutrition, root DNA and fungal biomass.

The site was generally marginal in phosphorous and sulphur but did not identify any large differences between treatments or depths.

The pH of the unspaded control (pH 5.5 in $CaCl_2$) was 0.9 lower than the spaded areas at 0-10 cm and was 0.7 lower than the spaded areas at 10-30 cm depth (pH 5.7). This may indicate better mixing to 30 cm by the spader of the alkaline clay brought up by the delver.

Soil microbial levels were highest in the 0-10 cm depth in both treatments but were higher in the 10-30 cm layer of the spaded treatment than the control (Table 7). More investigation of plant root growth and microbial activities in modified soils is required to quantify the impact on crop yield.

Grain yields were 44% higher on the unspaded area than the spaded treatments (Figure 6), reflecting the differences in early dry matter production. This could result from the moisture and nutrient use by the summer sorghum crop or possibly from the increased ryegrass competition on the spaded area.

Table 7 Microbial carbon levels in soil samples taken from Young site in September 2011

Treatment	Microbial levels (ugC/g dry soil) Depth 0-10 cm	Microbial levels (ugC/g dry soil) Depth 10-30 cm
Control	141	29
Spaded only	132	67

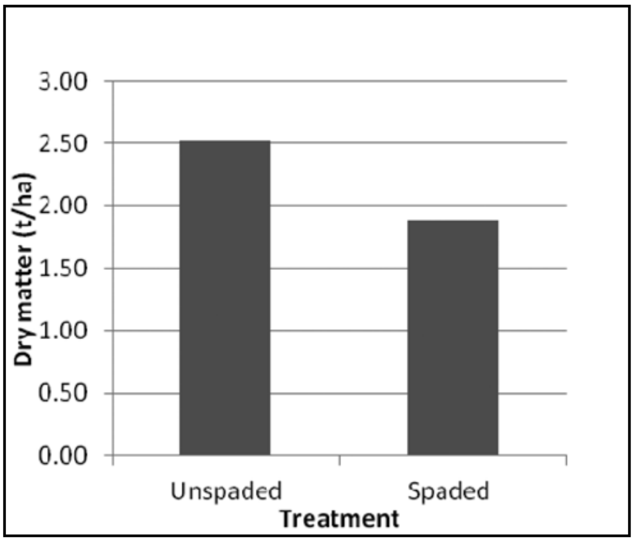


Figure 5 Dry matter at Young site September 2011

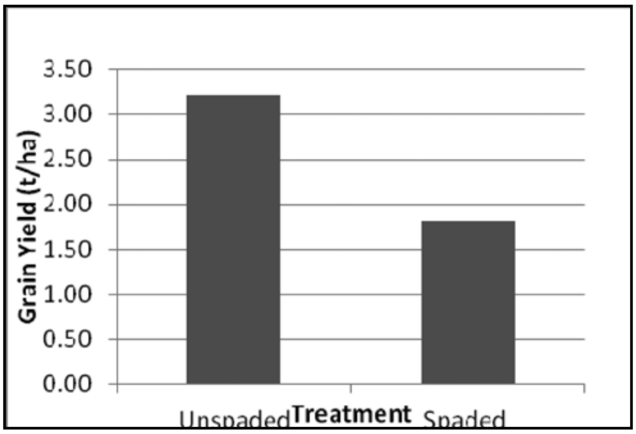


Figure 6 Young wheat yields, December 2011

Dahlitz site

Grain yield was 37% higher where pea straw was incorporated by the spader than on the spaded treatment alone (Figure 7).

Treloar site

This site was established using the spader in 2009. In 2009 the site was sown to lupins with a large yield responded on the spaded + lucerne straw treatment. In 2010 the canola yields were higher on the spaded treatment compared to the control and even higher where lucerne straw was incorporated.

In 2011 yield was 32% higher on the spaded only treatment and 62% higher where lucerne straw was incorporated than the control (Figure 8).

What does this mean?

This series of demonstrations has further illustrated the possibility of using soil modification techniques to increase crop yields on sandy soils. Results from these demonstrations have supported earlier work which suggests that while clay incorporation into sandy topsoils does provide yield benefits, further increases can be realised by incorporation of clay and organic matter. This poses further questions as to the impact of the addition of organic matter on crop growth, particularly root development and microbial activity.

The much greater dry matter and yield response from the incorporated canola straw compared with oaten hay at Glover's site poses further questions as to the best form of organic matter and its impact on soil microbial processes.

Other issues with regard to soil modification that require further investigation include:

- Does additional nitrogen need to be applied where cereal residues are incorporated to prevent the residue decomposition resulting in induced crop nitrogen deficiency?
- How long are the potential gains going to last?
- What are the implications for soil carbon levels? Identification of organic carbon fractions may assist.
- What is the impact of spading on weed management strategies?

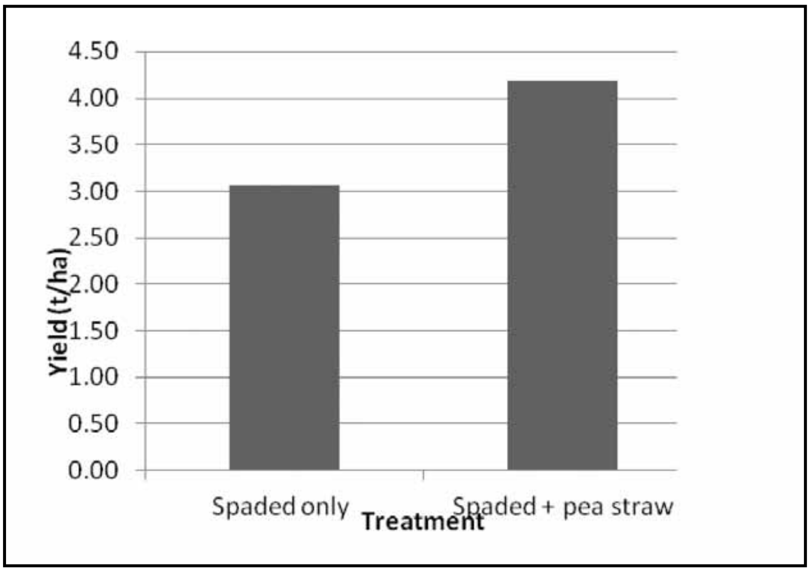


Figure 7 Dahlitz wheat yields, December 2011

Soils

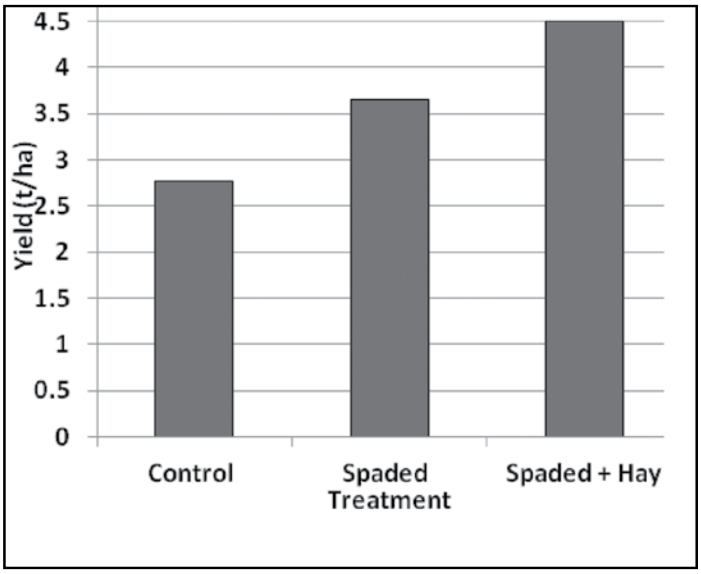


Figure 8 Treloar wheat yields, December 2011

Soil Health

Soil structure: Whilst the initial soil modification treatments involve significant soil disturbance, there is potential for long term structural improvements through the addition of clay and organic matter to the sandy A horizon.

Disease levels: The increased dry matter production resulting from the soil modification treatments may increase fungal disease pressure.

Chemical use: There are a number of effects of soil modification on weed management. The first is more even weed germination by addressing water repellence on sandy soils. This allows for more effective knockdown herbicide applications. The impact of spading on weed germination has been variable with an increased germination of grass weeds on some sites.

Soil nutrients: Increasing the clay and organic matter content in A horizons using these treatments can increase the nutrient and moisture holding capacity. If B horizon material which has high carbonate content is brought up by the treatment it can reduce nutrient availability.

Tillage type: The initial soil modification treatments require full soil disturbance to a depth of at least 15 cm. However by overcoming the water repellence in the A horizon through the addition of clay there is a reduced need for mixing the profile by cultivation.

Ground cover or plants/m^2: The soil modification treatments resulted in large increases in surface cover and crop biomass production. This is very important for reducing wind erosion risk on such fragile sandy soils.

Water Use

Water use efficiency: By increasing effective rooting depth of crops through soil modification there is potential to improve water use efficiency. However these demonstrations support results from earlier work where large increases in biomass production from soil modification treatments have not always been reflected in increased grain yields. Further investigation in required to quantify what is driving the relationship between biomass and yield following soil modification.

Resource Efficiency

Energy/fuel use: In the past incorporation of clay material after clay spreading and delving required multiple workings with a cultivator to be effective. Spaders are able to incorporate clay material and other soil ameliorants effectively to a depth of 30 cm with a single pass, significantly reducing the fuel requirement for modifying soils in this way

Social/Practice

Clash with other farming operations: Soil modification treatments are ideally applied as early as possible before the paddock is sown. This is to ensure effective incorporation of the clay and organic matter and give the modified soil profile the longest possible time to “stabilise” following treatment. Green manuring treatments are costly as the crop is unable to be harvested. However they can increase the nutrient and organic carbon in the soil profile as well as provide another weed control strategy. As the processes involve significant soil disturbance there is a high risk of wind erosion on the sites if adequate surface cover is not established rapidly. This can be difficult to do in late spring and summer.

Labour requirements: Soil modification operations require specialised equipment i.e. delver, spader. For most growers this means contacting out this work which, due to demands on contractors, can make it difficult to get the job done at the optimum time.

Economic

Infrastructure/operating inputs: Soil modification works are expensive. Delving costs between $125 and $185/ha with spading costs around $250/ha. The expected returns need be able to justify the costs of the operation.

Acknowledgements

The authors would like to thank the landholders involved in this trial; Gus Glover, Chris Will, Ed Hunt, Terry Young, Mick Dahlitz and Peter Treloar. Also funding bodies including GRDC, the South Australian NRM program and the Australian Government Caring for our Country Program

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Government of South Australia
Department of Environment and Natural Resources
LEADA Lower Eyre Agricultural Development Association
CARING FOR OUR COUNTRY

Reducing the impact of wind with stubble

BEST PRACTICE

Barry Mudge and Charlton Jeisman
Rural Solutions SA, Jamestown

Try this yourself now

Location:
Upper North
Port Germein
Upper North Farming Systems
Rainfall
Av. Annual: 340 mm
Av. GSR: 230 mm
2011 Total: 387 mm
2011 GSR: 189 mm
Paddock History
2010: Wheat
2009: Vetch
2008: Wheat
Soil Type
Sandy loam
Environmental Impacts
Soil Health
Soil Structure: Good
Tillage type: Direct drill with knife points
Compaction risk: moderate
Water Use
Water use efficiency: N/A
Runoff potential: low

Key messages

- **Standing stubble will reduce the wind erosion potential of soils over summer.**
- **Inter-row sowing into standing stubble is desirable in wind-erosion prone soils.**
- **Sow perpendicular to the prevailing wind direction where possible.**
- **Landholders ought to retain as much surface cover in their paddocks for as long as possible.**

Why do the trial?

Soil erosion by wind is environmentally damaging, results in loss of valuable topsoil and nutrients, and can be a considerable cost to a farmer. The effects of wind erosion are greatest where no physical barriers exist to dissipate the energy before it detaches and transports soil particles. A field experiment was established to demonstrate the effectiveness of stubble height (and row direction) on reducing wind speed close to the ground.

How was it done?

A trial site was located on a wind erosion prone soil (sandy loam) which had been cropped to wheat in 2010. The site had a minimum residual stubble height of 350 mm with a row spacing of 300 mm. Row orientation was north east/ south west on a parallel sowing pattern. The 2010 wheat crop yielded 3.8 t/ ha and residual stubble was measured at 4.5 t/ ha in April 2011. Three stubble treatments were imposed (Table 1).

Wind measurements were taken using a portable wind speed meter (Kestrel 4500 Pocket Weather Tracker). Measurements were recorded for each stubble treatment at 2000 mm and 200 mm above ground level. For each height, wind speed was measured for 30 seconds, with the maximum and average speeds recorded. This process was repeated 10 times for each location. A wind speed ratio was calculated for each stubble treatment.

Table 1 Wheat stubble treatments imposed in April 2011

STUBBLE TREATMENTS		
Treatment	**Stubble Height (mm)**	**Stubble Practice**
1	50	Slashed close to ground level. In practice, this meant that straw was cut at 50 mm above ground level and distributed evenly across the slashed area.
2	200	Slashed at 200 mm above ground level with the straw being distributed evenly across the slashed area.
3	350	No stubble treatment. Average residual stubble height was measured at 350 mm.

** Treatments were located centrally in a field in adjoining plots with no other obstacles within 200 m*

Table 2 Wind speed observations and calculated wind speed ratio at Port Germein showing average maxima and average wind speed of 10 measurements recorded over 30 seconds. A ratio of close to 1.0 indicates wind barriers have very little effect.

WIND SPEED OBSERVATIONS

Wind Speed Observations - 8 April 2011
Wind Conditions - NNW gusting to 35 km/h
Row Direction: SW - NE

	2000 mm		200 mm		Wind Speed Ratio	
Stubble Height (mm)	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**	**Average**
50	30.9	25.3	20.6	16.1	0.67	0.64
200	27.0	20.3	12.3	8.7	0.46	0.43
350	29.0	23.2	6.2	4.0	0.21	0.17

Wind Speed Observations - 11 May 2011
Wind Conditions - SW gusting to 27 km/h
Row Direction: SW - NE

	2000 mm		200 mm		Wind Speed Ratio	
Stubble Height (mm)	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**	**Average**
50	22.0	18.2	14.9	12.0	0.68	0.66
200	21.5	17.1	9.5	6.6	0.44	0.39
350	21.8	16.7	6.2	4.3	0.28	0.26

Wind Speed Ratio = Average wind speed at 200 mm height/ Average wind speed at 2000 mm height

A ratio of close to 1.0 indicates wind barriers have very little effect.

Measurements were taken on two separate relatively windy days when the wind direction was either in line with the sowing rows or at a significant angle (~ 60 degrees).

What happened?

The wind speed ratio showed a linear decline in wind speed as stubble height increased. This result was similar for both measuring times. Stubble slashed near ground level recorded wind speeds at 200 mm above the ground of around 65% of the speed at 2000 mm. Standing stubble at 350 mm (with wind direction across crop row direction) resulted in wind speed at 200 mm height of about 20% of the speed at 2000 mm.

What does this mean?

Stubble retention on erosion prone soils is critical to reduce the impact of soil erosion by wind. Row orientation is also important and where possible landholders should sow in a direction perpendicular to the wind direction that has historically caused most erosion issues. Row direction however is not as essential as stubble height and volume.

Standing cereal stubble (>200 mm) can have a substantial impact on reducing wind speed at lower levels in the canopy even when wind direction is in line with crop row direction. However, the effectiveness of stubble height in slowing wind speeds at lower levels in the canopy was reduced when the wind blew in the same direction as the crop rows. This effect may have been more obvious because of the wide row spacing of 300 mm.

At 4.5 t/ha, the amount of stubble at the trial site was quite high for this district and would have contributed to dissipating the wind energy. Lower volumes of stubble (more likely in average seasons), might not be as effective at reducing wind speed. This must be considered as the amount of stubble present in a paddock has implications for land management practices.

During summer, land managers should limit (or avoid) practices which reduce stubble height or affect its anchorage in soil. For example, livestock grazing stubbles have a compounding effect of removing surface cover by reducing stubble height and loosening stubble from its roots by trampling. While stubble can be a good source of livestock feed, growers should regularly check surface cover levels to ensure paddocks do not become too bare.

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Section Editor:
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Pests & Weeds

Changes in snail management?

Kym Perry
SARDI Entomology, Waite

EXTENSION

Key messages

- **A year-round integrated approach is still the best method to manage snail populations effectively over time.**
- **Summer management including burning should be considered a priority in problem paddocks leading into 2012 to prevent carryover of juvenile snails.**
- **In future, baiting in summer may need to be considered during very wet summers if snails are active for long periods.**

Why have snail populations been so high in the last two seasons?

Rising snail populations over the past two seasons culminated in some of the highest numbers ever experienced in the 2011 winter growing season. The major factor has been wet and cooler summer conditions, the provision of summer weed refuges and high stubble loads favouring snail survival and carryover between growing seasons. This follows a decade of dry conditions through the 2000s which helped keep snails in check. The recent conditions have also provided fewer opportunities for traditional summer management such as stubble bashing on hot days to kill snails.

A major factor in 2011, also relating to weather patterns, were grower reports of unseasonal early egg-laying events sometime in the December-February period, resulting in large juvenile snail populations in paddocks before autumn baiting commenced. These juvenile snails caused significant damage and destruction of some germinating crops. There are currently no effective methods to control juvenile snails hatching in autumn within the same winter season because they will not reach the minimum size for effective baiting (at least 7 mm in length /diameter) until at least late spring after baiting is finished. This means they need to be controlled before and /or during the following season.

A high proportion of the uncontrolled 2011 juveniles could carry into 2012 unless control measures are undertaken. This means careful summer management, monitoring and early baiting before egg-laying will be critical in problem paddocks leading into 2012. The good news is that snails will have grown to a size more likely to take snail baits this season.

Do we need to change our snail management approach?

The short answer is no, although the last two seasons have highlighted the need to closely monitor snail activity to correctly time controls. A year round integrated approach to snail management as outlined in the Bash ‘em, Burn ‘em, Bait ‘em publication is still the best method for reducing snail populations as no single method provides adequate control. A refresher of key points is listed below and more detail is available by downloading the publication free from the GRDC website (see references). The only potential change to management is to consider the timing of baiting during unseasonably wet summers as discussed below. Remember that cultural pest control practices may involve agronomic trade-offs with other crop and soil health factors which need to be carefully balanced when making decisions.

Bash ‘em

Bash stubble (cabling, chaining etc.) on hot days over 35°C ideally when several hot days will follow. This knocks snails onto the hot soil surface resulting in desiccation and death. Control summer weeds to remove snail refuges first.

Burn ‘em

Burning is still the most effective pre-sowing control for snails. This year there is a greater argument for a one-off strategic burn to reduce snail populations in problem paddocks despite the agronomic trade-offs.

A substantially higher snail kill is achieved if summer weeds are desiccated first (see Figure 1) and rocks should also be turned over (by cabling etc.) immediately prior to burning. A hot, even burn is needed across the entire paddock as poor kill is achieved in unburnt patches. An earlier burn is likely to be more effective.

Bait 'em

Monitoring and early baiting before egg-laying commences is the key to minimising the next generation. The time to begin is when moist conditions first trigger snail movement down from their summer dormancy sites to begin feeding, typically in late summer/ early autumn. Baits rely on snail movement and therefore should be applied when moist conditions are likely to continue for several days. Bait efficacy is also improved by baiting before sowing when there are fewer alternative food sources.

The 2011 experience indicates that summer baiting should be considered in situations where prolonged moisture causes extended periods of snail feeding activity and maturating of sexual organs (> 1 week activity as a guide), to prevent early egg-laying. This is the only significant change to snail management outlined in this paper. Baiting under moist and overcast conditions would help reduce UV degradation of baits. The key is regularly monitoring snail activity and the importance of monitoring cannot be over-emphasised.

New research

There are other avenues for potential snail control currently being investigated. Charles Sturt University have commenced a GRDC funded project evaluating parasitic nematodes for biological control of conical and round snails. In 2011, field trials were conducted on Yorke Peninsula in August, later than planned due to initial nematode supply problems. Very preliminary results were somewhat encouraging with nematodes providing control of conical snails that was equivalent to standard commercial baits at one assessment date (14 days after treatment) but generally poor control of round snails. Further field trials are planned for autumn 2012 in South Australia and Victoria.

Some farming groups have been investigating the potential use of caffeine as a snail treatment, as caffeine is known to have toxicant and repellent effects on slugs and snails (Hollingsworth, 2002). Some encouraging initial results have been reported and this could be an area to watch over the next couple of seasons.

Summary & entomology support services

To summarise, until new technologies become available, a fully integrated approach based on summer cultural controls, monitoring and early baiting are still the cornerstones of snail control. This season there is a greater argument for a strategic burn to reduce snail numbers in problem paddocks, despite agronomic trade-offs. The timing of baiting may to be earlier during wet summers if snails are active for extended periods. The key is regularly monitoring snail activity.

SARDI Entomology provides support on pest related issues to growers and advisors in the grains industry through the GRDC-funded National Invertebrate Pest Initiative (NIPI), which is currently funded until 2013. Growers are encouraged to subscribe to PestFacts SA & western Victoria Edition newsletter, a free electronic newsletter that provides timely updates on invertebrate pest issues in broad acre crops through the winter growing season. The service relies on feedback and field observations sent in by subscribers to alert the entire farming community. SARDI Entomology also offers a free insect diagnostic service through NIPI for PestFacts subscribers to assist with correct identification. Please contact the author to subscribe or with any technical enquiries.

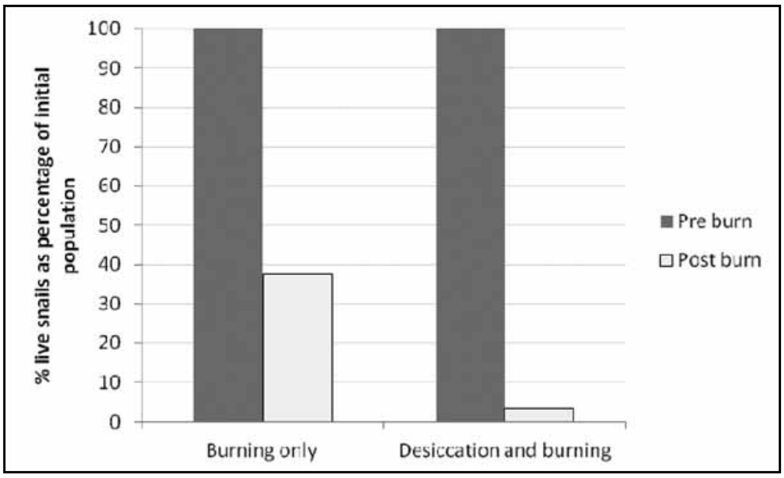

Figure 1 Snail control from burning combined with pre-desiccation of summer weeds, relative to burning only (modified from Bash 'em, Burn, 'em, Bait 'em, 2003). Note: desiccation of summer weeds first substantially increases snail kill.

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SARDI Entomology

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Acknowledgements

Dr Gavin Ash, Charles Sturt University.

Barley grass, an emerging weed threat

Ben Fleet and Gurjeet Gill
University of Adelaide

Searching for answers

Location: Minnipa Ag Centre, N11
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 2.8 t/ha around trial
Actual: see Table 2
Paddock History
2011: Wyalkatchem wheat
2010: Wyalkatchem wheat
2009: Wyalkatchem wheat
2008: Correll wheat (spray topped)
Soil Type
Sandy loam to clay loam
Plot Size
5 m x 9 m x 4 reps
Yield Limiting Factors
Barley grass

Location:
Buckleboo
Rainfall
Av. Annual: 315 mm
Av. GSR: 220 mm
2011 Total: 339 mm
2011 GSR: 215 mm
Yield
Potential: 1.3 t/ha around trial
Actual: see Table 2
Paddock History
2011: Axe wheat
2010: Espada wheat
2009: Chemical fallow
2008: Barley
Soil Type
Clay loam
Plot Size
5 m x 18 m x 4 reps
Yield Limiting Factors
Barley grass, late mice

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?

Research from the last three years has found that barley grass has become a regular problem in crop, not only in pastures as previously believed. This change appears to be due to the development of high levels of seed dormancy in many paddock populations. These dormant barley grass populations were found to require not only moisture, but a period of colder temperatures to germinate. High dormancy and chilling requirements enable these populations to avoid knockdown herbicides and germinate in crop where control options are far more limited.

Herbicides trialled have shown variable levels of control, with Sakura® (pyroxasulfone) providing the highest and most consistent control across all trials. In 2010 herbicide trial results indicated reduced rates of Sakura® could achieve very high levels of barley grass control, but where weed pressure was very high levels of control became less reliable. In 2011 various mix partners were trialled with reduced rates of Sakura® aiming to achieve similar reliability of full rates of Sakura®, but at a lower cost.

How was it done?

Barley grass seed was collected, just prior to harvest in 2010 from a number of sites across Eyre Peninsula. Samples were taken from cropping paddocks both within and along fencelines (Minnipa and Lock) and from both pasture and cropping paddocks at Yaninee. A sample was also taken from a cropping paddock at Buckleboo. Germination patterns of these populations were studied both in the laboratory and trays in the field to compare the change of dormancy at individual locations.

Field trials were set up at two locations on EP in 2011 to investigate pre-emergence herbicide options for barley grass control in wheat.

Location 1, Buckleboo:
Established on 1 June (see Table 1 for herbicide treatments). Sown with Axe wheat @ 65 kg/ha with 70 kg/ha 24:16 fertiliser. Plots were 5 x 18 m in size and herbicides were incorporated with a single pass of an air-seeder. Measurements taken included crop density, weed density at two timings, weed seed head density, weed seed production, crop yield and grain size.

Location 2, Minnipa:
Established on 17 May. Sown with Wyalkatchem wheat @ 50 kg/ha, with 65 kg/ha DAP. Set up similarly to the trial at Buckleboo, but plot size 5 x 9 m. See Table 1 for herbicide treatments.

What happened?

Dormancy studies showed that the barley grass populations from cropping paddocks had much higher levels of seed dormancy at maturity and well into winter than those sampled from either fencelines or pasture paddocks (Figure 1). This was also supported in a tray/field study with the same populations, where dormant populations did germinate readily, but much later than the non-cropping populations. The large difference of germination at both Lock and Minnipa between seed from fencelines and within the paddock is of interest.

Table 1 Herbicide treatments

Herbicide Treatments
1. Control (only knockdown herbicide pre-seeding)
2. Sakura (pyroxasulfone) @ 118 g/ha (incorporated by sowing, IBS)
3. Sakura (pyroxasulfone) @ 89 g/ha (IBS)
4. Sakura (pyroxasulfone) @ 59 g/ha (IBS)
5. Sakura (pyroxasulfone) @ 89 g/ha + Trifluralin (480 g/L) @ 1 L/ha (IBS)
6. Sakura (pyroxasulfone) @ 59 g/ha + Trifluralin (480 g/L) @ 1 L/ha (IBS)
7. Sakura (pyroxasulfone) @ 89 g/ha + Dual Gold (s-metolachlor 960 g/L) @ 500 ml/ha (IBS)
8. Sakura (pyroxasulfone) @ 59 g/ha + Dual Gold (s-metolachlor 960 g/L) @ 500 ml/ha (IBS)
9. Sakura (pyroxasulfone) @ 89 g/ha + Diuron (900 g/kg) @ 350 g/ha (IBS)
10. Sakura (pyroxasulfone) @ 59 g/ha + Diuron (900 g/kg) @ 350 g/ha (IBS)
11. Trifluralin (480 g/L) @ 1 L/ha + Metribuzin (750 g/kg) @ 180 g/ha + Dual Gold (s-metolachlor 960 g/L) @ 500 ml/ha (IBS)
The above herbicide treatments are for research purposes and may not be registered.

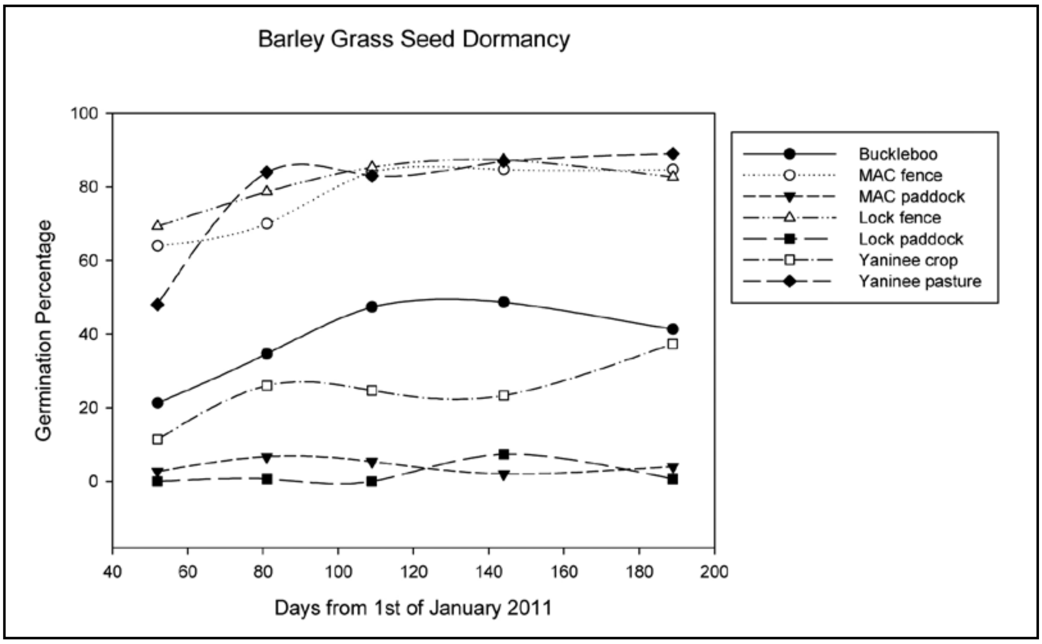

Figure 1 Barley grass seed dormancy

This large difference in germination pattern demonstrates how seed dormancy has developed in barley grass under intensive crop production. This finding clearly indicates that barley grass is becoming a greater problem in crop because it can avoid knockdown herbicide with its dormancy and then germinate in crop where control options at present are relatively ineffective. The Yaninee example comparing seed from a pasture paddock to a cropping paddock shows the result of selection pressure from cropping systems where only the more dormant barley grass is able to set seed and over time becomes the dominant component of the population.

Barley grass control, presented as seed set reduction from the control treatment is shown in Table 2. This has been used to demonstrate reduction in the paddock's barley grass seed bank, and future barley grass infestations. At the two sites, knockdown herbicide alone provided unacceptable barley grass control as shown by seed set/m² in brackets. The two sites chosen were both potentially challenging for pre-emergent herbicide control. At Minnipa the site had been cultivated quite deeply for summer weed control, resulting in a mixing of surface barley grass seed throughout the top 10-15 cm of soil and not being retained in close proximity to the pre-emergent herbicide band.

At Buckleboo the site was on a burnt cereal stubble (just prior to starting trial) which has been known to potentially hinder the performance of some pre-emergent herbicides. It is possible these factors could have reduced the level of control achieved with 118 g of Sakura® in 2011 relative to the control achieved previously on no-till sites where weed seed was predominately near the soil surface. When comparing the performance of herbicide treatments it is clear that the addition of the mix partners to Sakura® made very little difference to its performance, indicating that nearly all the control is from the Sakura® component.

Table 2 Wheat yield and barley grass (BG) control, as a % of control with different pre-emergence herbicide treatments in 2011

Herbicide	Buckleboo			Minnipa	
	Wheat yield (%)	**Grain size (%)**	**BG Control (%)** (reduction in seed set)	**Wheat Yield (%)**	**BG Control (%)** (reduction in seed set)
Control (knockdown herbicide only)	100 ***b*** (1.381 t/ha)	100 ***b*** (38.53g/1000 seeds)	0 ***a*** (1818 seeds/m²)	100 ***c*** (2.180 t/ha)	0 ***c*** (5518 seeds/m²)
Sakura @ 118 g/ha (IBS)	111 ***ab***	104 ***ab***	81 ***c***	113 ***ab***	85 ***c***
Sakura @ 89 g/ha (IBS)	117 ***a***	104 ***ab***	77 ***bc***	111 ***b***	81 ***c***
Sakura @ 59 g/ha (IBS)	115 ***ab***	106 ***a***	69 ***bc***	112 ***b***	78 ***c***
Sakura @ 89 g/ha + Trifluralin @ 1 L/ha (IBS)	109 ***ab***	102 ***b***	34 ***bc***	120 ***a***	82 ***c***
Sakura @ 59 g/ha + Trifluralin @ 1 L/ha (IBS)	111 ***ab***	104 ***ab***	75 ***bc***	116 ***ab***	85 ***c***
Sakura @ 89 g/ha + Dual Gold @ 500 ml/ha (IBS)	106 ***b***	105 ***a***	83 ***c***	115 ***ab***	74 ***c***
Sakura @ 59 g/ha + Dual Gold @ 500 ml/ha (IBS)	102 ***b***	104 ***ab***	60 ***bc***	112 ***b***	80 ***c***
Sakura @ 89 g/ha + Diuron @ 350 g/ha (IBS)	114 ***ab***	104 ***ab***	65 ***bc***	120 ***a***	79 ***c***
Sakura @ 59 g/ha + Diuron @ 350 g/ha (IBS)	114 ***ab***	104 ***ab***	64 ***bc***	111 ***b***	82 ***c***
Trifluralin @ 1 L/ha + Metribuzin @ 180 g/ha + Diuron @ 350 g/ha (IBS)	106 ***b***	105 ***ab***	55 ***b***	101 ***c***	23 ***b***
Statistical (P=<0.05) differences displayed with letters for each site	*P=0.014 LSD=0.1315 (t/ha)*	*P=0.037 LSD=1.165 (g/1000 seeds)*	*P<0.001 LSD=406 (barley grass seeds/m²)*	*P<0.001 LSD=0.1698 (t/ha)*	*P<0.001 LSD=1104.8 (barley grass seeds/m²)*
The above treatments are for research purposes and may not be registered.			*At Minnipa grain size was not statistically different between treatments*		

While the results from 2011 show potential to achieve high levels of barley grass control with Sakura® (even higher in previous years), it is not a complete solution to barley grass management. The highest level of control in 2011 was an 85% reduction of seed set (118 g of Sakura®), this still allowed production of more than 800 barley grass seeds /m² to reinfest the paddock next season. Barley grass needs to be managed in terms of reducing the weed seed population over time not just in a single crop year.

Wheat yields for each herbicide treatment at each site are displayed in Table 2. Increased yields are generally associated with improvements in barley grass control. Lesser increases in crop yield in 2011 than observed previously could be simply related to lower weed densities.

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.

Recommendations from work done in 2009/2010/2011 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 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 Peter & James Woolford, and Mark Klante for providing field sites for this work. Also we would like to thank Malinee Thongmee, Shyamantha Bandara, Brett McEvoy, Leigh Davis and Brenton Spriggs.

Sakura – registered trademark of Bayer Crop Science Pty Ltd.

Controlling flaxleaf fleabane

Simon Craig
Birchip Cropping Group (BCG)

RESEARCH

Almost ready
Try this yourself now

Key messages

- **Roundup® alone will not control Flaxleaf fleabane.**
- **Addition of Surpass® and Ally® to Roundup® provided the most effective control.**
- **To avoid the need to use more expensive chemicals and spray more than twice, control fleabane before it begins to elongate (>40 cm in height).**

Background

Flaxleaf fleabane (*Conyza bonariensis*) is a major weed seen in cropping areas of southern Queensland and northern New South Wales and more recently northern Victoria. The most worrying aspect of fleabane is that it is a prolific seeder: a mature plant can produce over 100,000 seeds. These seeds are air-borne (spread by wind), and can infest large areas in a short period. The relatively cool (25-30°C) wet harvest last year stimulated germination of fleabane along roadsides and in uncropped land in October and November. From these areas it spread to nearby paddocks.

Fleabane is particularly difficult to control in no-till farming systems. No-tilled, glyphosate-based fallows are at greatest risk because populations are not controlled by glyphosate. Seeds prefer to germinate between 20-30°C (optimum 25°C) in moist conditions and only when they are on or close to the soil surface. Fleabane is not capable of emerging when buried beneath the soil surface. This is the principal reason no-till systems are at greater risk than conventional farming systems. Germination is enhanced in no-tilled soils with high stubble levels as the seeds are not deeply incorporated and the farming system relies strongly on glyphosate.

Ideal temperatures for germination are around 25°C, typical of those occurring in autumn and spring. Once germinated, particularly during winter when growth may appear slow above the ground, beneath it is establishing a deep tap root. By spring and early summer, the plants can be two to three months old, at which stage they are extremely difficult to kill. A study has found that when seeds are buried deeper than 10 cm, emergence is significantly reduced, but seed dormancy can be prolonged from 18 months to six years. Generally, the weed seed has a short persistence (18-20 months).

The recently funded GRDC project 'Emerging weeds in southern Australia', led by the University of Adelaide, is investigating new methods and products to control difficult weeds. BCG is collaborating in the Victorian component. This project funded a trial which was conducted in the Mallee during harvest in 2011. The project will also look at other weeds such as windmill grass, hairy panic, couch and brome grass.

Why do the trial?

To determine the most effective herbicides for controlling Flaxleaf fleabane (*Conyza bonariensis*).

How was it done?

Location: Kooloonong (170 km north of Birchip)

Replicates: 3

Spraying date: 4 November 2011

Paddock history: medic fallow (brown manured)

Plot size: main herbicide plots (2.5 m x 40 m), sub-plots (2 m x 2.5 m)

Using a matrix design, 15 herbicide treatments were applied in a randomised block design. On 4 November, the treatments listed in Table 1 were applied, using a gas-pressured five-nozzle shielded sprayer.

The fleabane plants varied in size at the time of spraying, ranging from just 4 cm in height to well branched and beginning to bolt. The population was relatively low; density was recorded at less than 2 plants/m^2. Plants were visually assessed for herbicide efficacy scores at 7, 18 and 25 days after application (DAA). The ratings were based on a scale of 0 (alive) to 100 (dead).

Table 1 List of the products and mixes used in this trial, treatments were sprayed east to west

Description/product	Rate (per hectare)	Cost ($)
Untreated		0
Roundup PowerMax®	1.0 L	5.75
Roundup PowerMax	2.0 L	11.50
Roundup PowerMax	3.0 L	17.25
Roundup PowerMax®	5.0 L	28.75
Roundup PowerMax + Surpass 300®	2.0 L + 1.6 L	16.46
Roundup PowerMax + Surpass 300 + Ally®	2.0 L + 1.6 L + 5 g	16.86
Roundup PowerMax + Ally	2.0 L + 5 g	11.90
Roundup PowerMax + Hammer® (240 g/L)	2.0 L + 75 ml	33.45
Roundup PowerMax + Lontrol®	2.0 L + 150 ml	16.00
Roundup PowerMax + Tordon 75-D®	2.0 L + 700 ml	n/a
Roundup PowerMax + Balance®	2.0 L + 100 g	48.83

Li700 was added to each mixture at 300 ml/ha.

Table 2 Weather conditions at the time of spraying

Spray details	Treatment application
Date	4 November 2011
Implement	Gas Pressure 2.5 m sprayer
Water rate	100 L/ha
Nozzles	AIXR 110-02
Boom height	70 cm
Temperature	27°C
Wind speed	6 km/hr
Direction	Southerly
Humidity	50%
Delta T	8

Table 3 Herbicide efficacy scores (10=alive, 100=dead) at 7, 18 and 25 days after application (DAA)

Treatment	Fleabane control (%)		
	7 DAA	18 DAA	25 DAA
Untreated	10	10	10
Roundup PowerMax (1 L/ha)	40	20	15
Roundup PowerMax (2 L/ha)	40	20	20
Roundup PowerMax (3 L/ha)	45	25	30
Roundup PowerMax (5 L/ha)	45	40	30
RupPMax (2 L/ha) + Surpass (1.6 L/ha)	60	50	80
RupPMax + Surpass + Ally (5 g/ha)	60	50	85
RupPMax + Ally	50	40	50
RupPMax + Hammer (75 ml/ha)	60	30	20
RupPMax + Lontrel (150 ml/ha)	60	45	35
RupPMax + Tordon (700 ml/ha)	65	60	70
RupPMax + Balance (100 g/ha)	60	65	50
LSD (P=<0.05)	*5*	*10*	*20*

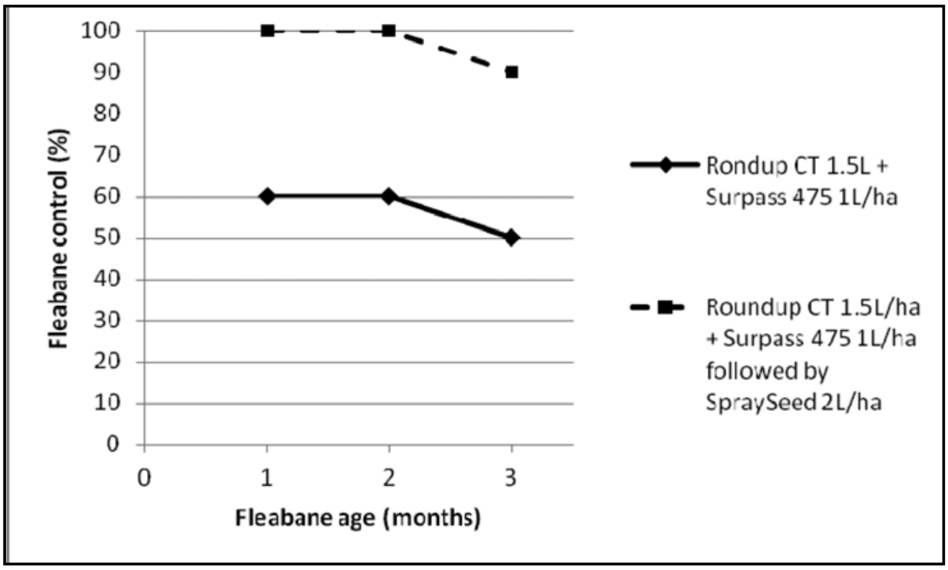

Figure 1 Benefit of double-knock over single herbicide applications on fleabane control (DEEDI 2009). 1st application applied at 75 L/ha, 2nd application at 105 L/ha (applied 7 days after first knock for all timings)

What happened?

Fleabane germination occurred in early October, after late September rainfall. Following the treatment applications on 4 November, herbicide efficacy scores taken at 7, 18 and 25 days after application (DAA) showed that increasing the rate of glyphosate did not improve control of fleabane (Table 3). Glyphosate effects were observed after 7 DAA, but by 25 DAA, the effect was negligible.

The addition of other products with different modes of action significantly improved the effect of glyphosate. Surpass® and Tordon® were the most effective products used in combination with glyphosate. The addition of Ally to the Surpass mix appeared to improve control slightly. Ally alone provided reasonable control up to 25 DAA.

Group G chemicals (e.g. Hammer®) were the least effective herbicides. Typically used as "spikes" to improve control with glyphosate, they were only effective early. The effect of Hammer® was observed with necrotic spots on the leaves, but the plant remained healthy. Given that the glyphosate had failed to kill the weed, the plants subsequently re-grew. By the 25 DAA assessment, those plots were healthy and setting seed.

What does this mean?

Flaxleaf fleabane is a weed we must learn to control. Control is expensive and can be difficult during busy periods of harvest. Given the right conditions, this weed has the potential to be two to three months old before farmers realise that control is required. Figure 1 illustrates the effectiveness of both single and double knock strategies. Control of the second application accounted for 90-100% of the weed plants. If fleabane is found on paddocks and even along fencelines, it warrants control, and higher and more expensive chemicals should be used. Commercially, if less than 80% control results from the first application, then a second application (double knock) is required.

Though the double knock strategy has not been carried out in this trial, studies such as the NSW one presented in Figure 1 have found the practice to be very successful. The findings of the first application in this trial were similar to the NSW experiences in that Roundup® alone provided little control. Higher rates of Surpass® were found to be the most effective and, where the rotation permitted, Ally® provided good residual control. It was also found that if the first application is not effective, then a higher rate of SpraySeed® is required for the second application.

NOTE: SpraySeed® is not currently registered for the control of fleabane, but BCG is in the process of applying for a permit from Victorian DPI to allow members access. Until a permit is issued and provided to members, a use pattern specifically targeting fleabane should NOT be conducted.

References

Widderick, M, Cook T, Daniel R (2011) 'Keeping on top of fleabane - in-crop strategies, the role and impact of residual herbicides, crop competition and double-knock' www.grdc.com.au

Acknowledgments

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BCG shared solutions

GRDC Grains Research & Development Corporation

Section Editor:
Naomi Scholz
SARDI, Minnipa Agricultural Centre

Sharing Info

Should sheep come into my farming business?

RESEARCH

Mike Krause
Applied Economic Solutions P/L, Adelaide

Introduction

The popularity of continuous cropping through the challenging years of the 2000s is coming to an end, due to both the financial rewards from sheep significantly improving, and as a result of the experience of the higher financial risks involved in continuous cropping. However, the decision to add more sheep in the farming system is a complex one, with the final decision being driven by many factors. What will be the correct decision for one farming business, may not necessarily be correct for the next. This paper looks at some of these issues.

Farmers are now considering expanding their flocks and perhaps replacing some break crops with pasture. This could be driven by the issue of resistant ryegrass management in the cropping program, or just wanting to make more money in the drought-affected years. The decision to return to more sheep is a challenging one, in that it's not just about comparing gross margins, but also considering the impact on the 'whole farming business'. The following issues need to be considered:

- The passion of the farmer
- The financial numbers for break crops vs pasture and sheep
- The capital cost of buying in expensive stock, or breeding up
- The skills of sheep husbandry in the business
- The efficiency of the farm cropping plant if less cropping is undertaken
- The property's sheep infrastructure
- The risks to the farming system
- The current financial position of the farming business.
- The market trend of the increasing capital costs of cropping machinery.

These issues all need to be considered when making a decision about expanding the sheep enterprise in the business.

The passion of the farmer

The risks of drought and commodity price variations that farmers have experienced over the last decade means that 'passion for farming' is an essential ingredient for long-term farming success. This is also the case for having sheep in the system. With the profits from sheep being in the doldrums through the 1990s and most of the 2000s, a lot of farmers adopted continuous cropping. Consequently, many younger farmers have not known sheep. Sheep take a different management skills set than cropping and definitely require a different passion. If a farmer who is looking at taking on more sheep doesn't have the passion for sheep, then don't start and remain in cropping. There is a saying that 'Do what you do, do best', which means you generally succeed if you follow your passions.

The financial numbers for break crop vs pasture and sheep

A common quote used in business management says that, 'If it doesn't work on paper then it's unlikely to work in practice'. So, before you start down the track of adopting more sheep, do the budget estimates. A good position is to start looking at the gross margins of break crops against the gross margins from sheep. This is a challenging analysis, but necessary if the decision is to be correct from a profit perspective.

With prime lamb prices hitting $160/hd and wool prices in excess of $1,000/bale, the gross margins for self-replacing sheep have gone from $25/DSE to above $40/DSE. However, it is important to do these numbers for each particular farming situation. If the farm's management doesn't have the skills to do this, then either get training or used a qualified adviser in this area of farm management.

When doing this analysis, it is important that you also consider the expected outcomes given poor, average and good seasons. Also, assess whether it's better to manage self-relacing merinos, prime lambs, or both.

The capital cost of buying in expensive stock, or breeding up

If you have decided that you have a passion for expanding the sheep enterprise, then you can pursue two main strategies: (1) to purchase the additional stock that you require or (2) expand the breeding animals from natural increases using the current sheep numbers in the business. This too can be a challenging analysis, but tools like Plan to Profit (P2P) (www.PlantoProfit.biz) are excellent for doing this calculation.

A lot of farmers elect to grow their sheep numbers by retaining more ewe lambs each year. This is easier on the cash flow, but may take 3 to 4 years to achieve the desired sheep numbers. The potential income lost needs to be also considered in this analysis. Even under current high prices for sheep, in a lot of cases it would be better to purchase the additional sheep and get higher production earlier. However, let the farm specific analysis guide this decision.

The skills of sheep husbandry in the business

Sheep take a special skill set and with cropping dominating the farming business in the last 10 – 15 years, a lot of farmers may have lost or perhaps never gained this livestock management skill set. So, look to improve the necessary skill set through training or using a professional livestock adviser.

In the past, improvements in cropping technology have driven crop yield improvement and hence cropping profits. The technology improvement in sheep management has tended to be slower. However, there are significant improvements in management practices that can improve the financial performance of sheep. These include: improved genetics, time of lambing, pregnancy testing, nutrition management and the type of sheep enterprise selection (self replacing, prime lambs and South African sheep breeds). If sheep are to be managed well, then time needs to be put into learning these improved management methods.

The efficiency of the farming cropping plant if less cropping is undertaken

One of the economic dilemmas of taking on more stock means the cropping area may decrease. If this is the case, then from a business efficiency perspective, the business will have surplus cropping capacity, which will lead to some cropping inefficiencies. Although this may only be a minor cash flow issue, as some farmers say the cropping machinery should now last more seasons as it is being used less, it should still be considered.

The property's sheep infrastructure

The condition of the infrastructure (fencing, water points, shearing shed and yards) for sheep is also an important issue. This infrastructure needs to be at a certain standard to achieve livestock management efficiencies. Any upgrading of necessary infrastructure will require capital investment, which will need to be funded from either cash reserves or borrowings. A financial analysis of taking on more sheep will also need to include this capital expense.

The risks of the farming system

There are two fundamental elements to risk management:

- First, to identify the financial risks of a particular strategy. There is a saying in investment practice that 'high risks bring high rewards', and this is very true when it comes to comparing cropping and sheep returns. Crops provide the higher profits, but also come with the higher risk of seasonal and commodity price performance. Sheep, on the other hand, offer a more steady return regardless of season, and so offer a lower reward for lower risk.
- Secondly, to identify if the decision makers are 'risk takers' or 'risk adverse'. Generally, risk takers will be more attracted to the risk profile of cropping, while risk adverse decision makers will be attracted to the lower risk profit offered by sheep.

The current financial position of the farming business

The decision of taking on more sheep should be taken from a 'whole farm' perspective, which is what P2P can help analyse. A 'whole farm' analysis measures the impact of strategic changes, such as changes to expected business profits, cash flow and balance sheet.

As a general rule, the higher the business equity, the greater the business borrowing capacity. So, if a business currently has a high equity (i.e. 85%), then it can afford to borrow money to increase the sheep enterprise quickly. If the business equity is low, for example at 60% and the sheep enterprise is to be expanded, this may have to be done at a slower pace.

The markets trend of increasing capital costs of cropping machinery

In recent times, the capital cost of machinery has increased significantly, which is a major concern to cropping farmers when it comes to changing over the header, boomspray and main tractor. This is another reason to look at increasing the sheep enterprise, as it tends to be a cheaper enterprise to manage.

Conclusion

Yes, the economic pendulum has swung back toward sheep being a good financial match to break crops in the lower rainfall area of SA. The gross margins of sheep enterprises are now competing very well when compared to the financial performance of crops such as canola, peas and beans. This indicates that it is a good time now to reconsider the role of the sheep enterprise in the low rainfall farming systems. However, the broader issues outlined in this paper need to be considered during the decision making process. The most important consideration is whether the management have a passion for sheep! If the answer is yes, then look further into the capital, profit and cash flow considerations of taking on more sheep.

Improving profits and managing risk – the two keys to the future

EXTENSION

LOW RAINFALL COLLABORATION GROUP

GRDC Grains Research & Development Corporation

Geoff Thomas

Manager, Low Rainfall Collaboration Project

Farmers have been seeking guidance for years on how they can better fit the various components of their farm systems together. That no longer just means improved production - profitability, reduced inputs and management of risk are increasingly recognised by farmers as major factors affecting the performance of their businesses.

Since each farmer's business is different, a "one size fits all" approach to financial analysis does not work. What is needed 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 their businesses. The aim is to better inform decisions through more thorough understanding of the outcomes of each option.

One response by GRDC has been to support a Low Rainfall Collaboration Group project using a whole farm, case study approach which brings together past farmer experiences and activities and involves farm business experts, consultants as well as farmers. The project covers BCG in Vic, Eyre Peninsula and Upper North in SA, the Mallee, and Central West NSW.

While keeping to this principle, the approach used by each group has varied from the use of a case study farmer group at BCG, in the Mallee and in Upper North; teaching young farmers bookkeeping/ simple accounting concepts on Eyre Peninsula, and with an emphasis on grain marketing outcomes in Central West. There have been many experiences to date which are interesting:

- Farmers show less interest in better seasons, despite this being the very time they need to maximise profits to see them through tough times. One of the most important parts of the projects is to increase awareness about the benefits from improved business management, and the ease with which improvements can be achieved.
- All projects have involved farm consultants who are seeing the importance of improved farm business decisions as well as getting the agronomy right.
- There is a lot of value in involving accountants in the farm business projects – their advice needs to take into account the broader issues impacting on profit and risk, as well as manage the tax bill.
- Farmer figures and case studies must be used and KEEP THE MESSAGES SIMPLE. Too much farm business training in the past has not been "real world" and has been overly complicated.
- Simple rules of thumb are the key – most farmers have these but they are sometimes based on bad habits. The aim of the project is to use farmer experience and intuition supported by simple farm business understanding to improve these "rules".
- Having these simple "rules" and the flexibility to adapt especially at the opening of the season and capture the good ones was essential. The purpose of this project is to not just consider the agronomy and the weather but to assess the potential impacts of various options on the business.
- A mix of cropping and livestock enterprises is still important in managing risk, especially during tough years and fluctuating grain prices.
- Lifestyle considerations are becoming increasingly important with farmers seeking systems and business structures which give them more free time. This of course can have an apparent conflict with keeping livestock and highlights the opportunity for better ways of handling stock.
- The balance between labour and farm machinery investment is important and differs from farm to farm. While machinery must be reliable, over expenditure on machinery was a major factor exposing farmers to risk in tough times.
- Most farm businesses are family partnerships and it is essential that all members be involved in these skill building projects. Not only does it increase the quality of the information (often the spouse keeps the books), but it also improves the quality of discussion through having more views. It also shares the responsibility for decisions and highlights the need to plan for both the short and long term future of the business.
- Whilst the Low Rainfall Collaboration Project will conclude in June 2012, the Profit/Risk work will continue for a further two years with current funding, and hopefully beyond.

For further information contact Naomi Scholz, EP Farming Systems, on 8680 6233.

Conservation and production of Sheoak grassy woodlands

Rob Coventry

Eyre Peninsula Natural Resources Management Board, Elliston

Key messages

- **Sheoak grassy woodlands (SGW) are a threatened vegetation community on Eyre Peninsula; they can also be very productive areas for livestock production.**
- **WildEyre initiated a project funded by the Native Vegetation Council SA, which invited landholders to submit, through a conservation auction, bids to undertake management actions to recover SGW over 10 years, whilst establishing long term sustainable grazing practices.**
- **Maintaining the biodiversity values of SGW areas will have positive impacts on both grazing potential at the property level and conservation at the district level.**

Why do the trial?

Sheoak grassy woodlands (SGW) are a threatened vegetation community on Eyre Peninsula. Stock grazing has traditionally been very productive in SGW. The invasion of annual grasses and weeds, combined with a lack of vegetation regeneration opportunities has reduced the grazing and biodiversity value of SGW.

Fire, rabbits and overgrazing by stock and native vertebrates is considered as the cause of the decline in SGW extent. Regeneration of degraded areas is possible through stock and weed management but financial implications make it difficult to achieve. Periods of between 5 and 7 years with significantly reduced grazing and incorporation of appropriate management is considered sufficient to allow natural regeneration of areas with sufficient propagules (seed source).

How was it done?

- SGW landholders indicated through interviews that they wanted individually tailored funding options that incorporated dynamic management options.
- Use of a Market Based Instrument (MBI) conservation auction to determine the allocation of available funding catered for a tailored approached to each landholder.
- February 2011 - two community workshops were held in Elliston and Streaky Bay to give interested land managers the opportunity to obtain information about the SGW conservation auction.
- Land managers were then invited to submit formal expressions of interest for potential project sites.
- Sites were then assessed by project officers to determine the condition, extent and management actions that would be required to achieve long term recovery of SGW on the property scale; this formed the basis of the individual site management plan.
- During March 2011, Land managers who received site management plans were invited to submit bids into the conservation auction detailing the required funds to meet the objectives of their specific site management plan.

What happened?

Eight bids were received from eligible land managers for the conservation auction. Two bids were successfully funded through the auction, being determined as the best value for money in achieving the project objectives. These two land managers are required to undertake annual management actions including, weed control, fence maintenance, stock exclusion and feral animal control.

Monitoring of the sites will be undertaken to assess the recovery of both biodiversity and grazing values, with reintroduction of stock at a mutually agreeable time relative to vegetation growth.

What does this mean?

Over the next 10 years the project will be collecting vegetation and fauna data that will provide information as to the stages of recovery of SGW. The information collected through the project will help inform the management of other areas of SGW. Information from the sites will help establish principles on how to sustainably graze areas of SGW that can be used by broader groups of land managers.

It is anticipated that through participation in the project the land manager will gain an increased awareness of how to manage these highly productive vegetation communities for the benefit of both agriculture and biodiversity.

With an increase in the extent and condition of SGW on the West Coast of Eyre Peninsula, it is anticipated that associated species of flora and fauna will also experience an increase in their population stability.

Acknowledgements

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Eyre Peninsula Natural Resources Management Board

Department of Environment and Natural Resources

Greening Australia

Ecological Evaluation Pty Ltd & Dr Tim Milne

The Native Vegetation Council of South Australia

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 2011 achievements and 2012 focus

2011 had farmers smiling again with average to above average yields being realised. This too was the case for LEADA as trials yielded well and experimental treatments gave us some promising data. Our work with nutrition and fungicides increased cereal yields from 5 t/ha to 8 t/ha at Cummins, leaving the soil profile 25% drier than the controls – a significant increase in water use efficiency (WUE).

There was very positive feedback for our extension efforts also, with the largest attendance at our expo and spring field day. This has resulted in our highest membership base to date.

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.

2012 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 (N) and canopy management
- Canola – blackleg (seed, fertiliser & foliar fungicides), nutrition and pest management
- Wheat – pushing yields economically, disease management and time of sowing for varieties
- WUE – soil classification for APSIM, modifying APSIM/Yield Prophet® for our region
- Soil amelioration – improving efficiencies with precision ag, spading and building soil carbon
- Pastures – discovering best perennial options (establishment, production and recovery)

Future research objectives:

Canola - managing increasing intensities of canola rotations (canola made up 1/4 of all crops grown on LEP and is likely to increase significantly in 2012), growing canola in a low N environment

All crop type management - targeting N use, precision ag for improved variable rate of nutrition and soil amelioration, ryegrass management, increasing soil carbon, snail control, discovering new break crops

Livestock - integrating into our cropping systems, use as weed managers, cell grazing and perennial pasture management

LEADA is key to integrating the latest research into sustainable, practical and profitable farming systems and instigates collaboration between regions, issues and researchers

Committee members:

Daniel Adams, Martin Burns, Shane Nelligan, Mark Modra, Stewart Modra, Bruce Morgan, Luke Moroney, Nigel Myers, Dustin Parker, John Richardson, Tim Richardson, Scott Siviour, Michael Treloar and Jordan Wilksch supported by Neil Ackland (EPNRMB), Roy Latta and Andrew Ware (SARDI)

Contact	Dates for the diary:
David Giddings, Chair - 0429 332 415	LEADA Ag Expo - 17 March 2012
Kieran Wauchope, EO - 0428 761 502	Spring Crop Update - August 2012

Sharing Info

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Acronyms and Abbreviations

ABA	Advisory Board of Agriculture
ABARES	Australian Bureau of Agricultural & Research Economics & Sciences
ABS	Australian Bureau of Statistics
AFPIP	Australian Field Pea Improvement Program
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
CFOC	Caring for our Country
CLL	Crop Lower Limit
DAFF	Department of Agriculture, Forestry and Fisheries
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
DMD	Dry Matter Digestibility
DOMD	Dry Organic Matter Digestibility
DPI	Department of Primary Industries
DSE	Dry Sheep Equivalent
DWLBC	Department of Water, Land Biodiversity Conservation
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
GS	Growth Stage (Zadocks)
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
PEM	*Pantoea agglomerans, Exiguobacterium acetylicum* and *Microbacteria*
pg	Picogram
PIRD	Producers Initiated Research Development
PIRSA	Primary Industries and Regions 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

NOTES:

NOTES:







FEATHER WEIGHTS


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...

CARING FOR OUR COUNTRY

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