Eyre Peninsula Farming Systems Summary 2014

2014

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GRDC Foreword

In an ideal world, “the next big thing” in grains research and development would arrive with great regularity to keep propelling production and profitability forward at a significant rate.

In reality, we know that few if any stones remain unturned in our quest for that elusive breakthrough that will offer a massive leap forward.

And while we should always encourage blue sky thinking, it is even more important to maintain our commitment to improving every aspect of grain production through targeted and consistent industry investment in research, development and extension.

The grains industry on Eyre Peninsula subscribes to the notion that commitment and collaboration is required by all relevant players to ensure gains, no matter how small, continue to be made.
EP’s grain growers operate in an environment that at times can be challenging, to say the least. Constraints and limitations above and below the ground can test the tenacity and resilience of even the most experienced and adaptive grain growers.

The region’s grain growers and the broader industry are therefore indeed fortunate to be well served by organisations such as the South Australian Research and Development Institute, the University of Adelaide, South Australian Grain Industry Trust, CSIRO, EP Agricultural Research Foundation, Lower Eyre Agricultural Development Association, EP Natural Resources Management Board and local agribusinesses which remain determined to see that grain production continues to be a viable and sustainable enterprise.

With support from the Grains Research and Development Corporation (GRDC), organisations on EP continue to address those issues and constraints that matter most to local growers. The GRDC Southern Regional Panel and the Regional Cropping Solutions Networks which support the Panel seek to keep abreast of those issues as well as the need for persistence and perseverance to ensure problems new and old are addressed.

In 2014, the Panel determined that herbicide resistance and nitrogen management were the two key agronomic issues across the entire southern cropping region – EP included.

The GRDC has embarked upon a concerted RD&E effort to better understand and address these challenges, along with others that impact on EP grain production, such as subsoil constraints, water use efficiency, break crops, pest management, disease control, stubble management, mixed farming and skills and capacity.

RD&E activities undertaken in the region over the past year, and outcomes from those, are detailed in this 2014 Eyre Peninsula Farming Systems (EPFS) Summary, which I have great pleasure in presenting to you.

Andrew Rice

Manager – Regional Grower Services (South)

GRDC

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Grains Research & Development Corporation
Your GRDC working with you

Eyre Peninsula Farming Systems Summary 2014

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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.

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IMPORTANT NOTICE

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Minnipa Agricultural Centre Update

Welcome to the sixteenth Eyre Peninsula Farming Systems Summary. This summary of research results from 2014 is proudly supported by the Grains Research & Development Corporation (GRDC) through the Eyre Peninsula Farming Systems project (EPFS 4 Maintaining Profitability in Retained Stubble Systems), and the Crop Sequencing project. We also acknowledge the funding support from the Australian Government through the Community Landcare Grant project ‘Improving management practices of Rhizoctonia ‘bare-patch’ on upper EP soils’.

We would like to thank the sponsors for their contribution to Eyre Peninsula (EP) for research, development and extension and enabling us to extend our results to all farm businesses on EP and beyond in other low rainfall areas.

Staff news

It has been a very busy year from a human resource management perspective at Minnipa!

Roy Latta completed his contract with SARDI in April 2014, after leading the team at the Minnipa Agricultural Centre for 5 years. Roy tirelessly applied for project funds throughout his time at MAC, with successes including the Eyre Peninsula Grain Grower Rail Fund for annual grass weed management, DAFF funds for reducing methane and nitrous oxide emissions, Caring for our Country introducing new perennials on semi-arable land, GRDC crop sequencing, AWI sheep genetics program and many more. The livestock and pastures research component of the Minnipa Ag Centre certainly has been revived with Roy’s leadership. We will miss Roy for his many contributions to R&D and management within SARDI and more generally for his many outstanding contributions to agriculture throughout his career. Roy has worked in South Australia, Western Australia and Victoria and has a long list of achievements from each of the places that he has worked.

Upon Roy’s departure, Andrew Ware accepted the role of SARDI Senior Scientist Farming Systems, and the leadership role, across the Eyre Peninsula, to provide scientific leadership of SARDI’s R&D activities undertaken on the EP, providing a more efficient and collaborative approach across the New Varieties and Farming Systems Science Programs, while maintaining his project leadership role in canola research and development. Ultimately, the demands on Andrew in terms of time and travel to Minnipa from Port Lincoln each week, in conjunction with fulfilling his existing responsibilities, have been too great, so we will be seeking a Senior Scientist to be based at MAC in the near future. We’d like to take this opportunity to thank Andrew for his support and dedication, and we will be maintaining strong links with Andrew and the Port Lincoln team which have been strengthened over the past 6 months.

Linden Masters accepted a voluntary separation package in May 2014, he will continue working within EP agriculture in a private consultant/ extension role, in particular with EPARF to deliver the Landcare Regional Facilitator role and the Young Leaders projects.

We also welcomed Brian Dzoma to our staff. Brian has taken on a research role with DAFF funding for reducing methane and nitrous oxide emissions in low rainfall farming systems (cropping and livestock). Brian has moved from Orange, NSW with his wife and two young boys.

We farewelled Suzie Holbery in October, who gained a role as a Biosecurity Officer based in Hay. Suzie has been a valuable member of the MAC team, always willing to contribute and help out others and doing a great job of managing the crop sequencing and alkaline soils trials, and helping Jess and Mark with the lamb survival work. We will certainly miss having Suzie around and we wish her all the best in her role.

Amanda Cook was appointed as the Research Officer on two major projects for the Eyre Peninsula Agricultural Research Foundation (EPARF). Mandy’s focus will shift from Rhizoctonia (soil disease) to managing annual grasses (barley and rye grass) in our farming systems, and dealing with a range of other issues associated with retained stubble farming systems, such as snails, crop diseases, weeds and crop establishment.

Past staff

Bob Holloway was recently awarded a Soil Science Society LJH Teakle Award, for outstanding effort in promoting and raising the awareness of soil science in Australia. Congratulations Bob!

Projects

Projects completed in 2014:

- **Profit & Risk Project,** funded by GRDC and Low Rainfall Collaboration, coordinator: Naomi Scholz
- **Demonstrating best management for Rhizoctonia on upper EP,** funded by SAGIT, researcher: Amanda Cook
- **Increased rate of adoption of Sheep Genetics/MERINOSELECT Breeding Values on Eyre Peninsula,** funded by Australian Wool Innovations, researchers: Jessica Crettenden/Roy Latta
- **Lamb survival in low rainfall areas,** funded by the SA Sheep Advisory Group, researcher: Jessica Crettenden/Suzie Holbery

New projects commenced in 2014:

- **Improving fertiliser efficiency and reducing disease impacts using fluid delivery systems,** funded by SAGIT, researcher: Amanda Cook
- **Developing sustainable weed management strategies for the long term viability of farming systems on the Eyre Peninsula,** EP Grain Growers Rail Fund, partnership with EPARF, researcher: Amanda Cook

Ongoing projects include:

- **Eyre Peninsula Farming Systems 4 – Maintaining profitable farming systems with retained stubble on upper Eyre,** GRDC funded, partnership with EPARF, researchers: Roy Latta/Nigel Wilhelm, Amanda Cook
- **Reducing methane emissions from improved forage quality on mixed farms,** funded by the Australian Government's Action on the Ground program, partnership with EPARF and WA CSIRO, researcher: Roy Latta
- **Improving management practices of Rhizoctonia 'bare-patch' on upper EP soils,** funded by the Australian Government's Community Landcare Grants, partnership with EPARF, researcher: Amanda Cook
- **Eyre Peninsula Grain & Graze 3,** GRDC funded, partnership with Southern Farming Systems, researchers: Jessica Crettenden/Roy Latta
- **Crop Sequencing** funded by GRDC and Low Rainfall Collaboration, researchers: Roy Latta/Suzie Holbery, Nigel Wilhelm
- **Variety trials (wheat, barley, canola, peas etc.) and commercial contract research, coordinator:** Leigh Davis
- **Farmers leading and learning about the soil carbon frontier,** funded by the Australian Government's Action on the Ground program and GRDC, in partnership with Ag Excellence Alliance, researcher: Amanda Cook
- **Increasing carbon storage in alkaline sodic soils through improved productivity and greater organic carbon retention,** funded by the Australian Government's Filling the Research Gap program in partnership with the University of Adelaide, researcher: Roy Latta/Suzie Holbery
- **Efficient grain production compared with N_2O emissions,** funded by the Australian Government's Action on the Ground Program, in partnership with BCG and EPARF, researcher: Brian Dzoma
- **Improved nitrogen efficiency across biophysical regions of the Eyre Peninsula,** funded by the Australian Government's Action on the Ground program, in partnership with EPNRM, researcher: Brian Dzoma

2015 events

Major field day events at Minnipa Agricultural Centre in 2015:

- EPARF Day – Technology and Innovation (22 July)
- MAC Field Day – Celebrating 100 years (2 September)

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.

We look forward to seeing you all at farming system events throughout 2015, and all the best for a productive season!

Naomi Scholz

MAC Staff and Roles 2014

Nigel Wilhelm	Science Program Leader (visiting)
Roy Latta	Senior Research Scientist (to April 2014)
Andrew Ware	EP Science Leader
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) (to May 2014)
Amanda Cook	Senior Research Officer (Rhizoctonia, Stubble and Weed Management, Fluid systems)
Jessica Crettenden	Research Officer (EP Grain & Graze, Sheep Genetics)
Brian Dzoma	Research Officer (Greenhouse gases) (commenced April 2014)
Suzie Holbery	Research Officer (Alkaline Soils, Crop Sequencing) (to October 2014)
Leigh Davis	Agricultural Officer (NVT, Contract Research)
Wade Shepperd	Agricultural Officer (EP Farming Systems, Weed management, Rhizoctonia)
Brenton Spriggs	Agricultural Officer (NVT, Contract research)
Ian Richter	Agricultural Officer (Alkaline Soils, Crop Sequencing, Rhizoctonia, Fluid systems)
Brett McEvoy	Agricultural Officer (MAC Farm)
John Kelsh	Agricultural Officer (MAC Farm)
Sue Budarick	Casual Field Assistant
Roanne King	Casual Field Assistant

DATES TO REMEMBER

EPARF Member's Day: Wednesday 22 July 2015

MAC Annual Field day: Wednesday 2 September 2015 – Celebrating 100 years

To contact us at the Minnipa Agricultural Centre, please call 8680 6200.
Please note the main phone number has changed.

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Eyre Peninsula Agricultural Research Foundation Report 2014

Simon Guerin
Chairperson, EPARF

Board of Management

Simon Guerin, Bryan Smith, Craig James, Shannon Mayfield, Greg Scholz, Dion Trezona, Andy Bates, Mark Stanley, Prof Alan Tilbrook (SARDI), Dr Glenn McDonald (University of Adelaide), Jordan Wilksch (LEADA), Neil Ackland (EPNRM), Andrew Ware (Leader MAC), Dot Brace (Executive Officer).

Vision

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

Mission

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

Role of EPARF

The Eyre Peninsula Agricultural Research Foundation (EPARF) was incorporated in 2004 and has a Board comprising representatives of farmers, University of Adelaide, SARDI, local consultants and the EPNRM Board. Its purpose is to represent the interests of research, development and extension on Eyre Peninsula. We have been very effective over the past ten years in driving program direction and strategy and in attracting external funds to support those programs, many of which we contract in partnership with SARDI.

EPARF is a foundation drawing its income from membership, industry funding and sponsorship.

The EPARF Board is committed to ensuring the ongoing development of agricultural systems in low rainfall zones of Australia and recognises its obligations to Eyre Peninsula. This is the expectation of our significant number of farmer financial members, but also our large non farmer membership, substantial sponsorship and stakeholder base which includes major wheat breeding companies, multi-national chemical companies, universities, CSIRO, GRDC, SAGIT, livestock industries, banks, grain handling and grain marketing companies, machinery manufacturers, and accounting firms. This strength and diversity of our stakeholder base reflects the positive contribution EPARF and its research partners have made to advancing agriculture.

Membership

Membership support is a critical factor when seeking external funding to address local research needs. Membership funds are used to support a range of agricultural research and extension activities on the Eyre Peninsula.

Membership is an annual subscription of $132 and $66 for additional members involved in the farm business or entity. There were 285 financial members in 2014.

An annual field day is held for members, focusing on a specific topic. The aim is to inform farmers and industry of the latest research to assist in improving and sustaining farm practices with economic benefits in the region. In 2014, ‘Putting the lid on herbicide resistance’ was a great day and well attended. Topics covered included the current state of weed resistance on EP, potential problems, practical solutions and managing grass weeds under non chemical weed control. Many stayed for the BBQ tea and a chat with fellow members.

In 2015 the EPARF Member Day is looking at ‘Innovation and Technology’. The aim of the event is to demonstrate management changes and tools that provide practical outcomes and bring profit to our farming systems. EPARF are keen to also showcase farmer innovations at the event, so if you have a great innovation that makes farming easier and more efficient we would love to hear from you! Put the date in your diary now – Wednesday 22 July – and become a member today!

Sponsors

GOLD	Agrifood Skills Viterra/Glencore Nufarm Ltd Curtis's
SILVER	AGT Rabobank Intergrain Free Eyre grain
BRONZE	BankSA CBH Grain Agfarm EP Grain Letcher & Moroney - Chartered Accountants EPIC

Thank you to all sponsors for their generous support. Last year Rabobank and BankSA were recognised for ten years of support and this year Nufarm has joined them in ten years of ongoing support of EPARF. Sponsorship is a vital link in EPARF being able to provide the services to our members and we hope to be able to continue this relationship.

Appreciation and thanks

A special thank you to Roy Latta for all the effort he has put in on behalf of EPARF and MAC, the five years of his contract seemed to go very quickly. We welcomed Andrew Ware as the new leader in 2014 and thank him for his fantastic efforts in the role this year.

We also wish to thank Matthew Dunn who has served 9.5 years on the Board, 2 years as chairperson, and Mark Fitzgerald for contributing 3 years. Both have retired and we thank them for their efforts and support. We welcomed new board members, Greg Scholz and Dion Trezona onto EPARF, allowing others to be involved and keep ideas moving forward.

EPARF Board farmer members 2014

Eyre Peninsula Agricultural Research Foundation Members 2014

Michael	Agars	PORT LINCOLN SA
Brian	Ashton	PORT LINCOLN SA
Terry	Baillie	TUMBY BAY SA
Michael	Baines	LOCK SA
Graeme	Baldock	KIMBA SA
Heather	Baldock	KIMBA SA
Tristan	Baldock	KIMBA SA
Andrew	Baldock	KIMBA SA
Michael	Baldock	STREAKY BAY SA
Geoff	Bammann	CLEVE SA
Paul	Bammann	CLEVE SA
Ashley	Barns	WUDINNA SA
Andy	Bates	STREAKY BAY SA
Lance	Beinke	KIMBA SA
Joshua	Beinke	KYANCUTTA SA
Peter	Beinke	KIMBA SA
Brenton	Bergmann	CEDUNA SA
Bill	Blumson	SMOKY BAY SA
Daniel	Bowey	LOCK SA
Dion	Brace	POOCHERA SA
Jason	Brace	POOCHERA SA
Reg	Brace	POOCHERA SA
Bill	Brands	MINNIPA SA
Sharon	Brands	MINNIPA SA
Paul	Brown	CEDUNA SA
Daryl	Bubner	CEDUNA SA
Jason	Burton	RUDALL SA
Brian	Cant	CLEVE SA
Alexander	Cant	CLEVE SA
Shaun	Carey	CHANDADA SA
Peter	Carey	MINNIPA SA
Paul	Carey	CUNGENA SA
Matthew	Carey	CHANDADA SA
Damien	Carey	CHANDADA SA
Milton	Chandler	CEDUNA SA
Symon	Chase	COWELL SA
Trevor	Cliff	KIMBA SA
Randall	Cliff	KIMBA SA
Trevor	Clifford	KIMBA SA
Matt	Cook	MINNIPA SA
Brent	Crettenden	LOCK SA
Brent	Cronin	STREAKY BAY SA
Pat	Cronin	STREAKY BAY SA
Richard	Cummins	LOCK SA
Lyn	Cummins	LOCK SA
Wes	Daniell	MINNIPA SA
Robert	Dart	KIMBA SA
Terry	Dodgson	MINNIPA SA
Paul	Dolling	CLEVE SA
Ryan	DuBois	WUDINNA SA
Matthew	Dunn	RUDALL SA
Barry J	Durdin	PORT LINCOLN SA
David	Elleway	KIELPA SA
Ray	Elleway	KIELPA SA
Jim	Endean	MINNIPA SA
Michael	Evans	CLEVE SA
Andre	Eylward	STREAKY BAY SA
Leigh	Fitzgerald	KIMBA SA
Clem	Fitzgerald	KIMBA SA
Mark	Fitzgerald	TUMBY BAY SA
Scott	Forrest	MINNIPA SA
Ben	Forrest	MINNIPA SA
Daniel	Foster	WUDINNA SA
David	Foxwell	CLEVE SA
Tony	Foxwell	CLEVE SA
Brett	Francis	KIMBA SA
Shaun	Freeman	CEDUNA SA
John	Freeth	KIMBA SA
Thomas	Freeth	KIMBA SA
Jon	Fromm	MINNIPA SA
Jerel	Fromm	MINNIPA SA

Isacc	Gill	MANGALO SA	Saxon	Kay	TOOLIGIE SA
Trevor	Gilmore	STREAKY BAY SA	Ian	Kelly	LOCK SA
Trevor	Gosling	POOCHERA SA	Damian	Kelly	LOCK SA
Simon	Guerin	PORT KENNY SA	Craig	Kelsh	TYRINGA SA
Terry	Guest	SALMON GUMS WA	Cassy	Kenchington	KIMBA SA
Angus	Gunn	PORT KENNY SA	Trevor	Kennett	ADELAIDE SA
Ian	Gunn	PORT KENNY SA	Troy	Klante	WUDINNA SA
Les	Hamence	WIRRULLA SA	Rex	Kobelt	CLEVE SA
Andrew	Heath	PORT LINCOLN SA	Myra	Kobelt	CLEVE SA
Basil	Heath	PORT LINCOLN SA	Daryl	Koch	KIMBA SA
Bruce	Heddle	MINNIPA SA	Peter	Kuhlmann	GLENELG SOUTH SA
Kieran	Hegarty	WARRAMBOO SA	Robert	Kwaterski	MINNIPA SA
Clint	Hein	STREAKY BAY SA	Andrew	Lawrie	TUMBY BAY SA
Tom	Henderson	ELLISTON SA	Dion	LeBrun	TUMBY BAY SA
Andrew	Hentschke	LOCK SA	Maria	LeBrun	TUMBY BAY SA
Stuart	Hentschke	LOCK SA	Howard	Lee	CUNGENA SA
Bill	Herde	RUDALL SA	Matthew	Lewis	ELLISTON SA
Mike	Hind	TUMBY BAY SA	Roger	Lienert	ARNO BAY SA
Max	Hitch	PORT LINCOLN SA	Bill	Lienert	KIMBA SA
Peter	Hitchcock	LOCK SA	Nathan	Little	PORT KENNY SA
Nathan	Hitchcock	LOCK SA	Ken	Little	PORT KENNY SA
Joshua	Hollitt	PORT LINCOLN SA	Andrew	Longmire	SALMON GUMS WA
Ian	Hood	PORT KENNY SA	Jeffrey	Longmire	LOCK SA
Mark	Hood	PORT KENNY SA	Chris	Lymn	WUDINNA SA
Jennifer	Horne	WHARMINDA SA	Allen	Lymn	WUDINNA SA
Sarah	Horne	CLEVE SA	Christopher	Lynch	STREAKY BAY SA
Tim	Howard	CEDUNA SA	Bradley	Lynch	STREAKY BAY SA
Geoff	Hull	STREAKY BAY SA	Joel	Lynch	POOCHERA SA
Leroy	Hull	STREAKY BAY SA	Craig	Lynch	POOCHERA SA
Rohan	Hull	STREAKY BAY SA	Andrew	Mahar	CEDUNA SA
Jesse	Hull	PORT KENNY SA	Stephen	Maitland	KIMBA SA
Ed	Hunt	PORT NEILL SA	Shane	Malcolm	ARNO BAY SA
Evan	Hunt	PORT NEILL SA	Beth	Malcolm	ARNO BAY SA
Leon	Hurrell	LOCK SA	Cindy	Martin	CLEVE SA
Warwick	Hutchings	MINNIPA SA	John	Masters	ARNO BAY SA
Craig	James	CLEVE SA	Linden	Masters	ARNO BAY SA
Nik	Jensen	CLEVE SA	Todd	Matthews	KYANCUTTA SA
Janeen	Jericho	POOCHERA SA	Wes	Matthews	KYANCUTTA SA
Neville	Jericho	MINNIPA SA	Lindsay	Matthews	KYANCUTTA SA
Marcia	Jericho	MINNIPA SA	Nigel	May	ELLISTON SA
San	Jolly	CLARE SA	Debbie	May	ELLISTON SA
Jodie	Jones	WHARMINDA SA	Paul	May	KYANCUTTA SA
Jeff	Jones	WHARMINDA SA	Ashley	May	KYANCUTTA SA
Paul	Kaden	COWELL SA	Shannon	Mayfield	KIMBA SA
Tony	Kaden	COWELL SA	John	Michael	WUDINNA SA
Mark	Kammermann	WUDINNA SA	Ashley	Michael	WUDINNA SA
Dylon	Kay	TOOLIGIE SA	Darren	Millard	VERRAN SA

Leone	Mills	COWELL SA
Jon	Mills	COWELL SA
John	Montgomerie	STREAKY BAY SA
Ian	Montgomerie	STREAKY BAY SA
Carolyn	Mudge	STREAKY BAY SA
Darren	Mudge	STREAKY BAY SA
Damien	Mullan	WUDINNA SA
Lynton	Murray	PENONG SA
Blake	Murray	PENONG SA
Len	Newton	ELLISTON SA
Anthony	Nicholls	CEDUNA SA
Ian	Noble	WHARMINDA SA
Daryl	Norris	RUDALL SA
Darren	O'Brien	KYANCUTTA SA
Brett	O'Brien	KYANCUTTA SA
Craig	O'Brien	KYANCUTTA SA
Clinton	Olsen	WIRRULLA SA
John	Oswald	YANINEE SA
Clint	Oswald	YANINEE SA
Tim	Ottens	WHARMINDA SA
Joe	Pedler	WINGFIELD SA
Glen	Phillips	MINNIPA SA
Darcy	Phillips	MINNIPA SA
Jamie	Phillis	UNGARRA SA
Andrew	Polkinghorne	LOCK SA
Tim	Polkinghorne	LOCK SA
James	Pollock	MINNIPA SA
Lindsay	Pope	WARRAMBOO SA
Ben	Pope	WARRAMBOO SA
John	Post	MINNIPA SA
Clint	Powell	KIMBA SA
Kevin	Preiss	ARNO BAY SA
Joel	Prime	PORT NEILL SA
Peter	Prime	WHARMINDA SA
Chris	Prime	WHARMINDA SA
Andrew	Prime	WHARMINDA SA
Caleb	Prime	WHARMINDA SA
Jarrod	Prime	WHARMINDA SA
Rowan	Ramsey	KIMBA SA
Ben	Ranford	CLEVE SA
Peter	Rayson	KIMBA SA
Gavin	Rehn	ARNO BAY SA
Martin	Ryan	KIMBA SA
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Allen	Sampson	KAPUNDA SA
Terry	Schmucker	KYANCUTTA SA
Thomas	Schmucker	KYANCUTTA SA
Greg	Scholz	WUDINNA SA
Nigel	Scholz	WUDINNA SA

Neville	Scholz	WUDINNA SA
Lyle	Scholz	YANINEE SA
Michael	Scholz	YANINEE SA
Gareth	Scholz	MINNIPA SA
Leigh	Scholz	MINNIPA SA
Stuart	Scholz	WUDINNA SA
Yvonne	Scholz	WUDINNA SA
Kevin	Schopp	LOCK SA
Chris	Schumann	COWELL SA
Brook	Seal	KIMBA SA
Bill	Shipard	PENONG SA
John	Simpson	WUDINNA SA
Bryan	Smith	COORABIE SA
Reid	Smith	MAITLAND SA
Dustin	Sparrow	WUDINNA SA
Mark	Stanley	PORT LINCOLN SA
John	Stillwell	CEDUNA SA
Rodger	Story	COWELL SA
Suzanne	Story	COWELL SA
Anton	Taylor	CUMMINS SA
Geoff	Thomas	BLACKWOOD SA
Jarad	Tomney	CHANDADA SA
Clint	Tomney	STREAKY BAY SA
Rhys	Tomney	CHANDADA SA
Sarah	Traeger	CLEVE SA
Neville	Trezona	PETINA SA
Shane	Trowbridge	CEDUNA SA
Craig	Trowbridge	CEDUNA SA
Mark	Turnbull	CLEVE SA
John	Turnbull	CLEVE SA
Quentin	Turner	ARNO BAY SA
Tim	van Loon	WARRAMBOO SA
Daniel	Vater	GLEN OSMOND SA
Simon	Veitch	WUDINNA SA
Sally	Veitch	WUDINNA SA
Leon	Veitch	WARRAMBOO SA
Daniel	Vorstenbosch	WARRAMBOO SA
Michael	Walsh	COWELL SA
Graham	Waters	WUDINNA SA
Dallas	Waters	WUDINNA SA
Tristan	Waters	WUDINNA SA
Peter	Watson	WIRRULLA SA
Paul	Webb	COWELL SA
Craig	Wheare	LOCK SA
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Josie	Williams	WUDINNA SA
Scott	Williams	WUDINNA SA
David	Williams	PORT NEILL SA
Jack	Williams	PORT NEILL SA
Lewis	Williams	PORT NEILL SA
Dean	Willmott	KIMBA SA
Lyall	Wiseman	LOCK SA
Graham	Woolford	KIMBA SA
Dion	Woolford	KIMBA SA
Peter	Woolford	KIMBA SA
James	Woolford	KIMBA SA
Nathan	Woolford	KIMBA SA
David	Woolford	KIMBA SA
Simon	Woolford	KIMBA SA
Michael	Zacher	LOCK SA
Michael	Zerk	LOCK SA
Allan	Zerna	COWELL SA
Lisa	Zibell	KIMBA SA

EPARF Board and MAC staff at the launch of the EP Farming Systems projects in 2014

MAC Events 2014

Naomi Scholz
SARDI, Minnipa Agricultural Centre

EP Grain & Graze/SheepConnect SA Sheep Group meetings were held in February at Kimba, Lock, Poochera, Ceduna and Tumby Bay. Guest speakers included, Elise Matthews, PIRSA Biosecurity, speaking on abattoir surveillance and Dr Patrick Kluver, Livestock Biosecurity Network Pty Ltd, on "Practical on-Farm Biosecurity for Sheep Producers." This was followed by a water security discussion.

228 farmers and local agricultural re-sellers attended 13 upper EP Harvest Report/Farmer Meetings in March. Linden Masters, SARDI, facilitated the meetings with local Agricultural Bureaus to discuss results of research and current future issues affecting agriculture locally. Information presented included crop sequencing and sulla trial results, national variety trial results and implications for upper EP growers, fungicides for rhizoctonia trial results and best bets for managing rhizoctonia, increasing carbon storage in alkaline sodic soils trial results, greenhouse gas project results (nitrous oxide and methane emissions), Grain & Graze 2 outcomes and aims for Grain & Graze 3, improving lamb survival and breeding values in sheep, potential issues for the coming season and a discussion session on issues that are affecting farming systems now, emerging issues and farm business management.

Two snail management meetings were hosted by Linden Masters, SARDI, at Kimba and Elliston in late March/early April. Michael Richards, YP NRM Board, presented the latest information about snail management and experiences from managing snails on Yorke Peninsula. 24 growers attended the sessions.

Water storage and technology workshops were held at Warramboo and Port Kenny in April. Funded by EPNRM, the workshops covered a range of water harvesting and storage options, water monitoring technology and development of individual farm water plans. 80 people attended the workshops, which were facilitated by Mary Crawford, Rural Solutions SA, and Linden Masters, SARDI.

EP Grain & Graze/SheepConnect SA Sheep Group benchmarking sessions were held at Buckleboo, Kimba, Lock and Poochera in April, and Tumby Bay in June. 22 farm businesses participated in the benchmarking. Mary Crawford, Rural Solutions SA facilitated the sessions and Daniel Schuppan, Landmark presented the benchmark information of each business and opportunities for potential improvement.

The 2014 EPARF Member Day 'Putting the lid on herbicide resistance' was held at MAC on 16 July, with 153 farmers, consultants, sponsors and organisers attending. Guest speakers addressed current weed issues and potential problems with the development of resistance to many of the key herbicides and presented ideas on diverse weed control tools, stressing that herbicides are not the answer to herbicide resistance. The majority of growers (64%) that attended the Member Day were not actively trying to prevent weed seed set at harvest (eg. windrow burning, chaff cart, Harrington Seed Destructor), but following the presentations, 85% thought they would be actively managing weed seeds at harvest within the next 5 years, with windrow burning the most likely practice to be adopted (56%), followed by the use of a chaff cart (15%).

The Annual MAC Field Day was held on 3 September. 150 people attended. Alan Tilbrook, SARDI Director Livestock & Farming Systems, opened the event, and presentations were made by Brian Dzoma (nitrous oxide, methane), Mark Klante (farm overview), Nigel Wilhelm (national GRDC crop sequencing results), Katherine Linsell (pratylenchus, predicta B), Gupta Vadakattu (rhizoctonia), Helen de Graaf (insects on EP) and Amanda Cook (fluid delivery systems and rhizoctonia). In field presentations were made by Andy Bates (barley grass and GRDC Stubble Initiative project), James Edwards (SAGIT variety agronomy trial), Harm van Rees (DAFF soil carbon trial), Mick Lines (pulse type trials), Leigh Davis (canola), Andrew Ware (seed source trial, NVT wheat and barley, wheat phenology trial), Josh Hollitt (using Clearfield technology), Suzie Holbery (crop sequencing EP trial, sulla), Jake Howie (medics), and Stuart Nagel (vetch).

The Young Leaders program was successfully completed for the first two groups in 2014. Thirty young leaders from across upper Eyre Peninsula participated in a personal and business development program as part of a Community Landcare Grant project funded via EPARF, facilitated by Linden Masters.

Sticky beak days were held across upper Eyre Peninsula in September by 15 groups; 357 growers and 130 agribusiness representatives attended the events. Minnipa Ag Centre staff presented local trial sites to growers across the region.

For event programs, evaluations and photos visit the EPARF website: www.eparf.com.au

Andrew Toovey, Brian Dzoma and Nathan Phillips with methane testing equipment

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

EPARF Eyre Peninsula Agricultural Research Foundation Inc.

Eyre Peninsula seasonal summary 2014

Linden Masters[1] and Brett Masters[2]

[1]Linden Masters Consulting, Wharminda, [2]Rural Solutions SA, Pt Lincoln

OVERVIEW

Heavy rainfall events in February started 2014 with good subsoil moisture allowing many farmers to begin sowing early in April. Combined with mild conditions during May and June and generally low levels of root disease, as well as good nutrition from mineralised nitrogen, this ideal start to the season enabled crops to develop two to three weeks ahead of a normal season. High monthly rainfall totals in most districts to the end of July (decile 8 and above) resulted in record levels of in-crop nitrogen being applied. Good early crop vigour and a mild finish were vital factors in the final grain yields as very little rain fell from the end of July to harvest, with many districts receiving decile 1 rainfall for this period.

A succession of frosty nights were reported in July and August and despite significant damage to crops in isolated areas, the overall impact on yield was low. Despite the exceptionally dry spring, growers in western and eastern Eyre and the northern part of lower Eyre were surprised by above average grain yields and quality that resulted from good stored subsoil moisture and mild conditions during grain fill. Rust and insect pests were reported in crops during spring, however did not have a significant impact on yields. This is likely attributed to landholders managing pests and disease early and the dry conditions at the end of the season.

DISRTICT REPORTS

Western Eyre

High levels of stored soil moisture early in the season allowed sowing to begin early. This early sowing and mild conditions resulted in good early crop vigour.

Little rain fell from the end of July (Decile 3) with parts of the district receiving their lowest August rainfall on record, but temperatures were mild during the majority of the grain filling period allowing above average yield. A number of hot windy days in late September brought crops to rapid maturity. Light frosts were reported during late winter, with reports of widespread severe frosts causing significant damage to earlier sown crops at Penong, Wirrulla, Wudinna and even some coastal crops near Haslam.

The presence of leaf and stripe rust in wheat and net blotch in barley resulted in many growers applying preventive fungicides. Growers also sprayed medic pastures, pulse and canola crops to reduce aphid damage. Isolated mouse damage was reported, particularly in canola crops around Streaky Bay and Wudinna, which prompted some farmers to bait. Wheat Streak Mosaic virus and Wheat Curl mite were also reported on some crops from Streaky Bay through to Warramboo.

Harvest commenced in late September and the early crop vigour meant that, even with a dry spring, crop yields were exceptional. This is the second year in which well above average crops yields have been harvested, with some reports of yields 50% above the long term average. Barley yields were good with 2.5 to 3 t/ha common and reports of the best paddocks yielding up to 4 t/ha. Wheat yields averaged between 2.2 t/ha in the Far West, 2.5 t/ha near Wirrulla and 3 t/ha on the loamy soils in Central Eyre and around Mt Cooper. Low protein was an issue with little wheat receiving AH classification and most being delivered as ASW or APW. Screening levels were much lower than expected given the low rainfall at the end of the season.

Pasture paddocks contained high amounts of quality feed throughout the season. However medic pastures required some control of fungal disease and aphids early in the season, and those affected had below average production levels.

Eastern Eyre

Heavy rains in excess of 75 mm were received in the Cleve Hills in February which stored some soil moisture and allowed growers to begin sowing with confidence in mid-April. Rainfall from April to May was reported to be average in the east of the district and well above average in the western portion of the district. Mild to warm conditions in April and May encouraged early crop growth with most crops up to three weeks ahead of normal season development.

Rainfall continued to be above average until the end of June with most growers applying additional nitrogen fertiliser to cereals after sowing. However only 12 mm of rainfall was received in the district between the end of July and harvest.

Cool damp conditions favoured an increased number of aphids and mites in crops, with reports of Wheat Streak Mosaic virus and Beet Western Yellow virus common in crops from Warramboo to Cleve. Crops also suffered damage from cut worm and Diamond Back Moth larvae. Leaf and stripe rust were reported in wheat crops that were not treated with a preventative fungicide. However these had little impact on crop yield as most growers applied preventative fungicide applications and, combined with dry spring conditions, controlled these low level infections. Lodging of net blotch affected barley crops did not occur to the same extent as in 2013.

Successive frosts were reported throughout August with significant damage to early sown crops, particularly lupins and wheat, in isolated pockets around Kyancutta, Buckleboo, Darke Peak, Heggaton and Mangalo. Growers baited for mice near Warramboo and Kimba to lessen the damage to crops prior to grain fill.

Cereal crops yielded 10 to 30% above the long term average with canola yields generally above average with exceptional oil content. Wheat quality was variable with some reports of early sown crops achieving AH classification, however many growers were disappointed with low protein in wheat paddocks. Barley yields were better than expected with early sown crops yielding 3.0 to 4.0 t/ha on better soils and 1.2 to 1.5 t/ha on poorer soils. A large proportion of malting varieties achieved malt grade at delivery and much of the feed barley was delivered as FI with good grain weight and low screenings. However, dry conditions resulted in pinched grain on the heavier soils around Kimba and the Eastern Cleve Hills/Franklin Harbour which resulted in some barley being delivered as F3.

There were many excellent medic pasture paddocks across the district and livestock remained in good health during the season with many producers reporting over 100% lambing.

Lower Eyre

Good opening rains in April allowed growers to begin seeding before the end of April. Follow up rains in May and June enabled sowing to progress quickly and mild conditions ensured rapid crop establishment and good early vigour. Crop development was slowed by cold wet conditions in late June. Very heavy rainfall and strong to gale force winds on 13 June resulted in flash flooding of low lying areas near rivers and creeks. Rainfall from May to the end of July was well above average (Decile 9) with waterlogging a major issue causing irreversible crop damage on many paddocks south and west of Ungarra. Lighter textured soils around Kapinnie and Brooker and ironstone soils south of Cummins were particularly affected.

Nitrogen deficiency symptoms were observed on most paddocks during June and July with most growers applying in crop nitrogen.

Fungicide applications were used to slow the progression of leaf and stripe rust, eyespot, net blotch and powdery mildew and growers also sprayed to control Diamond Back Moth larvae and Green Peach Aphid (a vector of Beet Western Yellow virus in canola this season). Spraying was hampered by cold, wet and windy weather and trafficability of paddocks was a large issue with many reports of bogged tractors, spreaders and sprayers. Much of the in-crop management applications needed to be applied by air.

Little rainfall was received from the end of July to harvest (Decile 1 rainfall for the period). The dry finish saw crops mature rapidly with canola windrowed earlier than usual and harvesting of early sown cereals begin in October.

Canola yields were generally less than expected, with crops affected by Beet Western Yellow virus suffering some yield penalty, but the biggest impact on yield was waterlogging on poorer soil types. Canola yields on the lighter textured soils near Mt Hill and Karkoo canola yielded 1.3 to 1.5 t/ha with 1.7 to 2.0 t/ha reported on the better drained loamy soils around Butler/Ungarra and Mt Hope. On the highly leaching sand over clay soils and ironstone soils around Kapinnie and south of Edillilie yields of less than 0.8 t/ha were common. The high input costs combined with poor yields and lower price considerably reduced gross margins on canola this year and may reduce the area sown next year. Higher barley prices, particularly with many crops achieving malting grade at delivery may result in an increase in the area sown to barley in 2015.

Although cereals were generally less affected by the waterlogging than canola, yields still varied on different soil types. The better soil types around Butler, Ungarra, Yeelanna and Cummins yielded 3.0 to 4.0 t/ha of wheat, depending on the degree of waterlogging affected areas within the paddock. There were some exceptional yields in excess of 5.0 t/ha reported from the better soils around Yeelanna and Ungarra. Yields on lighter textured highly leaching soils were below average (1.5 to 2.0 t/ha), however growers commented that they were surprised by the yields that they did achieve.

Some producers hand fed livestock during winter as cold and wet conditions slowed pasture growth. Dry conditions during spring also saw a rapid senesence of annual pasture paddocks. There is however a high amount of quality feed in stubble residues which growers will be able to utilise and livestock are in excellent condition.

John Kelsh, Brian Dzoma, Suzie Holbery, Jessica Crettenden and shearer James Pollock

MAC Farm Report 2014

INFORMATION

Mark Klante
SARDI, Minnipa Agricultural Centre

Try this yourself now

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm

Key outcomes

- **On average MAC wheat yielded 2.8 t/ha, barley yielded 2.9 t/ha, canola 1.3 t/ha and peas 1.4 t/ha.**
- **80% of the total farm area was cropped.**
- **350 breeding ewes produced 110% lambs at marking.**
- **120 tonnes of certified seed was made available for sale to growers.**

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 Eyre Peninsula. The effective use of research information and improved technology is an integral part of the role of the MAC farm.

2014 season

Sowing commenced with vetch on 16 April 2014, followed by canola on 1 May. We sowed barley starting on 4 May and wheat on 6 May and we finished sowing with sulla on 20 May. Including vetch and medic we sowed 11 varieties in 2014.

MAC had white peg trials in 7 paddocks and whole paddock demonstrations in N1 (focus paddock), S7 (soil health), S4 and N7/8 (barley grass control options), N12 and Competition paddocks (methane testing) and Barn paddock (sulla, vetch and medic).

MAC farm was sown to wheat 640 ha (58%), barley 120 ha (11%), canola 40 ha (4%), medic 265 ha (24%) and peas 35 ha (3%).

What happened?

Wow, what a start to the year with 32 mm falling in January, 62 mm in February and 24 mm falling from 8-10 April - we were off to a great start. With good moisture we started sowing and had no further rain until 29 mm on 29 April. This was followed by 77 mm in May, 62 mm in June and 66 mm in July. Unfortunately the last fall over 10 mm was on 12 July.

We received 290 mm of growing season rainfall (GSR), falling on 62 days, compared to 236 mm of GSR in 2013. The crops benefited from the good early rain but suffered from only receiving 27 mm over 17 days from August to October. While no frosts were recorded at MAC we did record 0.8°C on 13 August and 0.5°C on 15 August. Plant development and grain fill were assisted by mild weather; August max 24°C, mean 18°C, September max 27°C, mean 22.8°C and October max 37°C, on 20 and 21, mean 29°C.

Harvest commenced on 20 October (Compass barley) and finished on 17 November. The average farm wheat yield of 2.8 t/ha was limited in some paddocks by annual grass competition. Barley yielded an average 2.9 t/ha, canola yielded 1.3 t/ha and peas 1.4 t/ha. According to the modified French and Schultz yield calculator, we could potentially have achieved yields of wheat 4.0 t/ha, barley 4.4 t/ha, peas 2.7 t/ha and canola 3.0 t/ha. We achieved considerably less, with wheat 70%, barley 66%, peas 52% and canola 43% of the calculated potential yield.

Livestock

350 ewes were joined on 5 February 2014. 259 ewes were scanned in lamb. The number of ewes in lamb was lower than would normally be expected due to very hot weather in January and joining, and because we single sire mated due to participating in the AWI genetics project (no backup rams were able to be used).

Scanning percentage 442 lambs = 127%

Lambing percentage 443 lambs = 127%

Marking percentage 386 lambs = 111%

Weaning percentage 366 lambs = 105%

The ewes averaged 6.4 kg of wool at 11 months, fibre diameter 21.1 microns and hoggets averaged 3.3 kg at 8 months, fibre diameter 17.8 microns.

The sheep were utilised in the Sheep Genetics, Lamb Survival and Methane Emissions research projects.

Acknowledgements

MAC farm staff, Brett McEvoy and John Kelsh.

Table 1 Harvest results, 2014 grain yields and protein aligned with paddock rotational histories

Paddock	Paddock History 09-13	Crop 2014	Sowing Date 2014	Yield (t/ha)	Protein (%)
North 1	W W W P W	Mace (W)	8 May	2.71	9.6
North 2	B P W W B	Medic (P)			
North 3	W Pe P W W	Vetch	17 April		
North 4	P W W B P	RAC1843	19 May	2.7	12.1
North 5 N	W B P P W	Wyalkatchem (W)	16 May	2.4	9.6
North 5 S	P P W W W	Scope (B)	5 May	2.4	12.6
North 6 E	P W W W B	Gunyah (Pe)	14 May	1.4	
North 6 W	W B Pe W W	Sturt (C)	1 May	1.3	
North 7/8	W W W B P	Wyalkatchem (W)	16 May	2.4	9.6
North 9	O P W W B	Cummins (V)	16 April		
North 10	B Pe W P W	Mace (W)	8 May	3.8	9.3
North 11	W W W P W	Medic (P)			
North 12	W W C W W	Wilpena (S)	20 May		
South 1	W W W B C	Mace (W)	6 April	2.7	9.1
South 1 Scrub	W B B B C	Mace (W)	6 April	2.7	9.1
South 2/8	W P W W Pe	Grenade (W)	10 May	3.5	11.2
South 2/8	P P W W Pe	Kord (W)	11 May	3.3	13.1
South 3 S	P W W W P	Medic (P)			
South 3 N	W W C W B	Medic (P)			
South 4	W W B P W	Medic (P)			
South 5	Pe W W C B	Kord (W)	11 May	2.9	9.7
South 6 E	W B P M W	Kord/Wyal (W)	13 May	2.8	11.1
South 6 W	W B Pe W Pe	Compass (B)	15 April	3.3	13.2
South 7	W P W P W	Mace (W)	10 May	3.2	9.1
South 9	W W P W W	Scope (B)	5 May	3.2	11.5
South 10	W W P W V	Compass (B)	15 May	3.3	14.0

P = pasture, Pe = field pea, W = wheat, B = barley, O = oats, C = canola, V = vetch, S= sulla

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

"A grower group that specifically addresses issues and finds solutions to improve farming systems in your area"

LEADA's 2014 achievements and 2015 focus

LEADA had an extremely productive 2014 with a wide range of activities related to specific projects as well as responses to local farmer concerns. The year began with the annual Expo in March drawing a great crowd to hear from local and interstate expertise. In conjunction with EPARF, a workshop was organised to provide technical information on herbicide resistance. In response to growing concerns locally, a workshop was organised to discuss the impacts and management of Beet Western Yellows virus, with over 100 farmers attending from all parts of the EP. The annual Spring Field Walk finished a busy year.

LEADA was approached by the Port Lincoln High School to support a class of year 9 students studying food production and food security. With support from the committee and local businesses, the students were able to undertake two separate tours to the local area learning about soils, food production, silos and grain management, flour milling and finally baking and food production. It was a pilot program and hopefully another group of students can be offered a similar opportunity in 2015.

The LEADA committee, with funding support from the EPNRM Board sustainable agriculture program, undertook a day trip across the region to visit and discuss farming topics at the properties of the 10 famer members. It was an extremely valuable day to learn more about the diversity of farming systems across the region.

LEADA has two significant projects running in the region - the GRDC stubble management project and PIRSA's New Horizons sub soil constraints project. The stubble project will continue for several years. The New Horizons project was funded with support from the EP Rail Levy funds and LEADA will now be seeking longer term support from PIRSA and other potential investors to ensure the continuation of the valuable work being done.

The LEADA committee has been committed to improving the governance of its organisation through 2014 and now has policies and procedures in place. Although some of the work in developing these is not seen as exciting, it is seen as core to the future success of the organisation. In conjunction with these and the security of funds within the organisation, LEADA has been able to offer small grants to members to allow a focus on local issues to be addressed.

The EP Rail Levy Fund is supporting two leadership development programs for farmers and businesses across lower EP. An Emerging Leaders program began late 2014 and will continue in 2015 to develop young farmers. A program "Making a Difference" will start in 2015, to assist those who want to develop their leadership and governance skills further. These programs are key for LEADA in developing the future success of farming locally and more broadly through contributions participants make back to their industries and communities.
Our links with GRDC, the Australian Government, Rural Solutions SA, SARDI, EPARF and the Eyre Peninsula NRM Board continue to be critical to the ongoing success of LEADA. LEADA has been and will continue developing its relationship with others, including local media and government.

Contact:
John Richardson, Chair **0429 407 073**
Helen Lamont, EO **0409 885 606**

Committee members:
Daniel Adams, David Giddings, Mark Modra, George Pedler, Bruce Morgan, Dustin Parker, John Richardson, Pat Head, Jamie Phillis, Tim Richardson, Kieran Wauchope, Michael Treloar, Jordan Wilksch, Neil Ackland (EPNRMB), Andrew Ware (SARDI), David Davenport (RSSA) and Mark Stanley (Ag Ex Alliance)

An initiative of the Australian Government Department of Agriculture.

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 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	$P \leq 0.05$
LSD (P=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.
Thanks to Jim Egan for the original article.

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 3	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

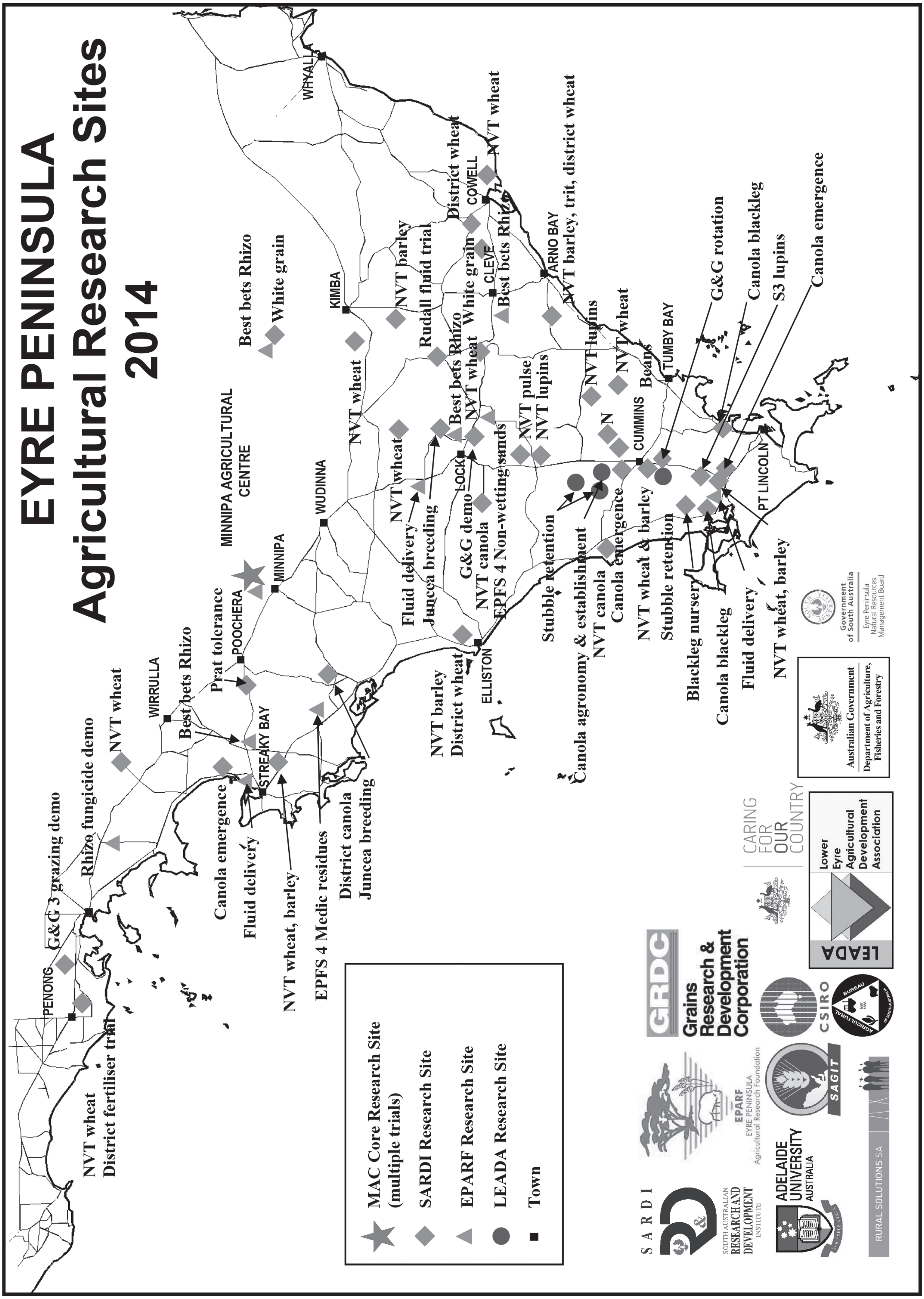
Pressure
10 psi(pounds per sq inch) = 0.69 bar = 69 kPa (kiloPascals)

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
2014
MAC Core Research Site (multiple trials)
SARDI Research Site
EPARF Research Site
LEADA Research Site
Town
WHYALLA
COWELL
ARNO BAY
CLEVE
KIMBA
TUMBY BAY
CUMMINS
PT LINCOLN
LOCK
ELLISTON
WUDINNA
MINNIPA
MINNIPA AGRICULTURAL CENTRE
POOCHERA
WIRRULLA
STREAKY BAY
PENONG
NVT wheat
District wheat
NVT barley, trit, district wheat
Best bets Rhizo
White grain
NVT barley
Rudall fluid trial
NVT lupins
NVT wheat
Beans
NVT pulse
NVT lupins
G&G rotation
Canola blackleg
S3 lupins
Canola emergence
Fluid delivery
Juncea breeding
G&G demo
NVT canola
EPFS 4 Non-wetting sands
Stubble retention
Canola agronomy & establishment
NVT wheat & barley
Blackleg nursery
NVT wheat, barley
District canola
EPFS 4 Medic residues
Prat tolerance
G&G 3 grazing demo
Rhizo fungicide demo
District fertiliser trial
SARDI
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EPARF EYRE PENINSULA Agricultural Research Foundation
GRDC Grains Research & Development Corporation
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Eyre Peninsula Natural Resources Management Board
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Section Editor:
Jessica Crettenden
SARDI
Minnipa Agricultural Centre

Cereals

Crop estimates by district (tonnes produced) in 2014

	Wheat	Barley	Oats	Triticale
Western EP	930,000	135,000	16,000	2,400
Eastern EP	712,000	144,000	7,000	6,000
Lower EP	370,000	195,000	7,000	1,250

Source: PIRSA, January 2015, Crop and Pasture Report, South Australia.

Port Kenny, Elliston, Wharminda and Franklin Harbour wheat and barley variety trials

EXTENSION

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

Try this yourself now

Location: Port Kenny - Geoff Hull
Mt Cooper Ag Bureau
Rainfall
Av. Annual: 400 mm
Av. GSR: 300 mm
2014 Total: 384 mm
2014 GSR: 239 mm
Yield
Potential: 3.1 t/ha (W), 3.5 t/ha (B)
Actual: 3.3 t/ha (W), 4.2 t/ha (B)
Paddock History
2013: Canola
2012: Wheat
2011: Canola
Soil Type
Grey sandy loam
Plot Size
1.5 m x 10 m x 3 reps
Yield Limiting Factors
Some leaf rust, sharp finish

Key messages

- **Trojan wheat shows its class, outperforming all other varieties apart from Phantom and Wyalkatchem at Port Kenny.**
- **Fathom, LaTrobe and Compass barley pushed towards the 5 t/ha at Port Kenny in 2014.**
- **Mace, Phantom and Wyalkatchem out-yielded all other varieties at Elliston.**
- **Corack was the top performing wheat variety at Wharminda.**
- **Corack, Mace, Emu Rock and Scout were the top four yielding varieties at Franklin Harbour.**

Why do these trials?

These variety trials were identified as priorities by local agricultural bureau groups to evaluate commonly grown varieties, compare them to newly released varieties and provide further information on varietal performance in soil types and rainfall regions where wheat and barley National Variety Trials (NVT) are not conducted.

Port Kenny district wheat and barley trials

How was it done?

Fifteen wheat varieties and twelve barley varieties, replicated three times, were sown on 8 May with both trials receiving 71 kg/ha of 19:13:0:9.4S and 63 kg/ha of 46:0:0:0 (urea) fertiliser at sowing. On 24 June a further 73 kg/ha of urea was applied. 1 L/ha glyphosate and 300 ml/ha Ester680 were applied to both trials pre-sowing, and 650 ml/ha LVE Agritone was applied for broad-leaved weed control on 1 July. No fungicides were applied to either trial.

What happened?

As in previous years, trials were sown into canola stubble, ensuring a paddock free of disease. Early rain provided substantial sub-soil moisture, setting up the season for high yield potential. Screenings and protein levels were low in the trial, but test weights were unusually low (Table 1). Observations throughout the year comparing barley to the wheat indicated that there was some factor impeding the wheat's growth. This may not have been evident in the yields and screenings, but it definitely affected the test weights where Phantom, Yitpi and Axe failed to meet the minimum 76 kg/hL standard test weight.

Location: Elliston
Nigel and Debbie May
Elliston Ag Bureau

Rainfall
Av. Annual: 427 mm
Av. GSR: 353 mm
2014 Total: 355 mm
2014 GSR: 296 mm

Yield
Potential: 3.74 t/ha (W)
Actual: 3.06 t/ha

Paddock History
2013: Grassy pasture
2012: Barley
2011: Wheat

Soil Type
Grey light sandy clay loam

Plot Size
1.5 m x 10 m x 3 reps

Yield Limiting Factors
Sharp finish

Location: Wharminda
Tim Ottens
Wharminda Ag Bureau

Rainfall
Av. Annual: 338 mm
Av. GSR: 253 mm
2014 Total: 338 mm
2014 GSR: 252 mm

Yield
Potential: 2.98 t/ha (W)
Actual: 3.36 t/ha

Paddock History
2013: Grass free pasture
2012: Barley

Soil Type
Sand

Plot Size
1.5 m x 10 m x 3 reps

Yield Limiting Factors
Sharp finish

Location: Franklin Harbour
Bevan & Cindy Siviour
Franklin Harbour Ag Bureau

Rainfall
Av. Annual: 350 mm
Av. GSR: 256 mm
2014 Total: 404 mm
2014 GSR: 216 mm

Yield
Potential: 2.91 t/ha (W)
Actual: 1,98 t/ha

Paddock History
2013: Grass free pasture
2012: Wheat

Soil Type
Red clay loam

Plot Size
1.5 m x 20 m x 3 reps

Yield Limiting Factors
Sharp finish

Table 1 Grain yield and quality of wheat varieties sown at Port Kenny in 2014

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Trojan	3.74	9.6	0.7	77.4
Phantom	3.52	9.1	1.1	75.0
Wyalkatchem	3.48	9.5	1.1	78.7
Corack	3.40	9.3	0.8	79.5
Cobra	3.36	9.6	1.3	78.6
Justica CL Plus	3.36	10.1	0.9	76.0
Scout	3.35	9.7	1.4	79.0
Mace	3.34	9.7	1.1	77.0
Kord CL Plus	3.32	10.4	1.1	76.6
Grenade CL Plus	3.16	10.2	1.1	76.2
Shield	3.14	9.7	1.6	76.8
Emu Rock	3.03	10.0	2.0	78.6
Yitpi	3.00	10.3	1.0	75.6
Axe	2.95	10.6	0.9	73.7
Mean	**3.25**	**9.9**	**1.1**	**77.1**
CV	*5.29%*			
LSD (P=0.05)	*0.29*			

Table 2 Grain yield and quality of barley varieties sown at Port Kenny in 2014

Variety	Yield (t/ha)	Protein (t/ha)	Screenings (%)	Test weight (kg/hL)	Retention (% by weight)
Fathom	4.73	9.5	3.4	66.3	82.0
LaTrobe	4.73	9.0	3.5	69.3	82.7
Compass	4.69	9.0	2.9	66.3	86.3
Hindmarsh	4.48	9.5	4.1	69.3	78.3
Skipper	4.37	9.5	3.4	69.0	84.1
Commander	4.32	9.9	4.6	66.4	83.1
Fleet	4.30	9.6	3.7	64.3	77.2
Oxford	4.27	9.9	9.0	66.6	59.7
Buloke	4.16	10.1	5.7	67.3	62.9
Scope	4.08	9.9	6.2	67.0	65.7
Flagship	3.69	10.6	10.6	68.1	57.7
Schooner	3.05	10.4	6.8	67.5	64.8
Mean	**4.24**	**9.7**	**5.3**	**67.3**	**73.7**
CV	*3.5%*				
LSD (P=0.05)	*0.12*				

Longreach Trojan showed that it was well adapted to conditions in 2014 and with the aid of an early break to the season proved itself to be the number-one performing variety at Port Kenny. Trojan significantly out yielded all other varieties apart from Phantom and Wyalkatchem, which made up the top three performing varieties.

Later in the season there was an insignificant amount of leaf rust present in the wheat. However a medium amount of leaf rust was present in the barley, which may have affected certain varieties.

Table 2 compares the current barley varieties to the older variety Schooner, which shows the benefits of growing the newer high yielding varieties.

LaTrobe and Compass out-yielded all other barley lines at Port Kenny, pushing towards the 5 t/ha mark and yielding more than 1.6 t/ha better than Schooner. The malting varieties performed as well, if not better, than the feed lines.

Elliston district wheat trials

How was it done?

Fifteen wheat varieties, replicated three times, were sown on 13 May with 100 kg/ha of 18:20:0:0 fertiliser and 400 ml/ha of flutriafol @ 250 g/ha. The site received 1 L/ha glyphosate @ 540 g/L, 0.8 L/ha of trifluralin @ 480 g/L, 1.5 L/ha prosulfocarb @ 800 g/L and s-metolachlor @ 120 g/L prior to sowing. 1.4 L/ha MCPA @ 200 g/L and bromoxynil @ 200 g/L were applied 30 June to control post emergent weeds. 3 L/ha of Zn, Mn and Cu foliar mix was applied twice on 30 June and 28 July. 300 ml/ha prothioconazole @ 210 g/L and tebuconazole @ 210 g/L was applied on 28 July with 500 ml/ha propiconazole @ 250 g/L and 500 ml/ha dimethoate @ 400 g/L was applied on 26 August to control any leaf disease and insects.

Grain from this trial was pinched, which may have been caused by the tough finish due to low rainfall in spring. Most other areas on upper EP had a substantial rainfall event in February of 40-100 mm, whereas Elliston only received 22 mm on average.

Table 3 Grain yield and quality of wheat varieties sown at Elliston, 2014

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Mace	3.36	9.8	4.9	80.3
Phantom	3.34	10.5	4.4	79.3
Wyalkatchem	3.20	10.0	3.5	80.4
Cobra	3.13	10.6	7.9	75.8
Justica CL Plus	3.11	10.7	3.3	78.7
Corack	3.10	10.1	5.4	79.1
Trojan	3.09	10.6	3.0	81.4
Shield	3.07	10.2	10.8	78.2
Grenade CL Plus	3.05	10.0	3.3	77.9
Scout	2.79	10.1	5.4	79.6
Kord CL Plus	2.92	10.8	8.0	78.6
Yitpi	2.87	11.3	2.9	79.8
Emu Rock	2.82	10.9	6.9	79.4
Axe	2.74	11.0	5.6	78.5
Mean	**3.06**	**10.5**	**5.4**	**79.1**
CV	*4.0%*			
LSD (P=0.05)	*0.20*			

Table 4 Grain yield and quality of wheat varieties sown at Wharminda, 2014

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Corack	3.90	11.1	2.5	79.8
Mace	3.69	11.0	2.2	79.1
Shield	3.53	11.3	4.8	78.4
Wyalkatchem	3.49	11.6	1.6	79.8
Cobra	3.43	11.6	2.7	79.6
Trojan	3.39	11.3	2.4	80.7
Justica CL Plus	3.29	11.6	2.6	76.8
Scout	3.29	11.4	4.4	80.1
Axe	3.28	12.0	2.6	78.9
Emu Rock	3.28	11.3	4.4	79.0
Grenade CL Plus	3.24	11.2	2.8	78.7
Phantom	3.24	11.5	3.6	77.8
Kord CL Plus	3.12	11.6	4.3	78.0
Yitpi	2.87	12.0	4.4	79.5
Mean	**3.36**	**11.5**	**3.2**	**79.0**
CV	*4.1%*			
LSD (P=0.05)	*0.24*			

Table 5 Grain yield and quality of wheat varieties sown at Franklin Harbour, 2014

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Corack	2.20	10.4	2.0	82.9
Mace	2.15	10.8	2.2	83.4
Emu Rock	2.14	11.1	2.7	83.4
Scout	2.14	11.1	3.5	82.8
Espada	2.06	11.4	3.5	81.8
Gladius	2.04	11.5	2.8	82.3
Cobra	2.01	10.8	1.9	82.5
Wyalkatchem	2.00	10.5	1.7	82.7
Axe	1.99	11.1	1.5	83.8
Kord CL Plus	1.93	11.8	3.8	82.4
Justica CL Plus	1.91	11.4	2.4	81.8
Shield	1.87	11.1	2.5	84.3
Grenade CL Plus	1.84	11.3	2.2	82.7
Yitpi	1.75	11.5	2.9	83.8
Phantom	1.74	11.7	3.3	81.8
Mean	**1.98**	**11.2**	**2.6**	**82.8**
CV	*7.3%*			
LSD (P=0.05)	*0.24*			

Wharminda District Wheat Trials

What happened?

The average yield from the trial was 3.06 t/ha with Mace, Phantom and Wyalkatchem producing the highest yields (Table 3). The screenings levels in this trial were high; this would have led to down-grading at the silos.

How was it done?

Fifteen wheat varieties, replicated three times, were sown on 14 May with 100 kg/ha of DAP fertiliser and 400 ml/ha of flutriafol @ 250 g/ha. On 1 July 3 L/ha of Zn, Mn and Cu foliar mix was applied and urea @ 50 kg/ha was applied in July. The trial chemical regime consisted of 1 L/ha glyphosate @ 450 g/L, 200 ml/ha 2,4-D ester @ 680 g/L and 40 ml/ha clopyralid @ 300 g/L at seeding. Broad-leaved weed control was applied on 1 July using 1.4 L/ha MCPA @ 200 g/L and bromoxynil @ 200 g/L. 300 ml/ha prothioconazole @ 210 g/L and 300 ml/ha tebuconazole @ 210 g/L was applied on 4 August to control any leaf diseases.

What happened?

Corack recorded the highest yields in the district trial at Wharminda yielding 3.90 t/ha and out-performed all other varieties apart from Mace at 3.69 t/ha (Table 4). Protein percentage was exceptional considering the high yields in the Wharminda trial in 2014.

Franklin Harbour District Wheat Trials

How was it done?

Fifteen wheat varieties, replicated three times, were sown on 25 May with 60 kg/ha of DAP fertiliser. 1 L/ha glyphosate, 118 g/ha Sakura, 100 ml/ha oxyflouren, 175 ml/ha ester 680, 0.1% wetter and 100 ml/ha alpha-cypermethrin were applied pre sowing. 500 ml/ha LVE MCPA was used to control broad-leaved weeds on 17 July.

What happened?

Corack, Mace, Emu Rock and Scout recorded the highest yields at Franklin Harbour in 2014 (Table 5). There were little differences between the top yielding varieties. There were no problems with screenings and test weights however there were some differences in protein levels.

What does this mean?

Variety selection should be made by evaluating yield performance over more than one year. The disease resistance package (either root or leaf), sprouting tolerance, maturity, height, herbicide tolerance (Clearfield) and grain quality are all important characteristics that should be considered when choosing a variety to fit your farming system.

For more extensive options and details on any variety visit the National Variety Trials (NVT) website at www.nvtonline.com.au, or refer to the articles in the EPFS Summary 2014 NVT Cereal Yield Performance Tables and the Cereal Variety Disease Guide.

Acknowledgements

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SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Wheat seed source and seed size effects on grain yield

RESEARCH

Cereals

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Searching for answers

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 3.95 t/ha (W)
Actual: 3.47 t/ha (average)
Paddock History
2013: Pasture
2012: Oats
2011: Wheat
Soil Type
Brown loam
Yield Limiting Factors
Early finish

Key messages

- **Seed size was the dominant factor influencing biomass and grain yield in 2014.**
- **The effects of seed size were site dependent: the greatest benefit was achieved at sites with yields >3 t/ha and there was no benefit at sites <2 t/ha.**
- **The beneficial effects of large seed were greatest in seed from sites with low nutrient concentrations. Using larger seed improved yield by 5-14% depending on the seed nutrient concentration.**
- **Variation in yield due to seed source was most closely associated with seed P, K and Zn concentrations.**

Why do the trial?

Seed quality refers to the size and nutrient concentration of the grain and these characteristics can potentially affect the vigour and yield of crops. Larger seed provides more nutrients for early growth, leading to good establishment and vigorous growth. The source of seed can be important since location can affect seed nutrient content due to the influences of soil type, fertilizer applications and seasonal conditions. Over the past few years, trials in South Australia (SA) have shown a small but significant benefit from using large seed, although the value of seed size tended to be greater in higher yielding environments. There were also effects of seed source that were associated with the seed nutrient concentrations. Of the seed nutrients, phosphorus (P) has been found to be the nutrient that has been most influential in describing differences in yield due to seed source although potassium (K) was found to be important in 2013 (EPFS Summary 2013, p 39).

This trial was conducted to determine the influence of seed size and seed source on plant vigour and grain yield and quality in a low rainfall environment. The experiment was conducted at three sites in SA (Minnipa Agricultural Centre, Karoonda and Turretfield) and this report will focus on the data from Minnipa with comparisons with other sites to examine the broader responses.

How was it done?

Three wheat varieties (Emu Rock, Mace and Corack) were selected from five National Variety Trial (NVT) locations across SA (Keith, Nangari, Nunjikompita, Turretfield and Wanbi). The sites were selected based on the nutrient concentrations of a sample of Mace seed from each trial in 2013 to provide seed sources with a range in grain protein concentrations and mineral nutrients.
Seed to be sown was graded into three grain size fractions, which measured greater than 2.8 mm (large), 2.5-2.8 mm (medium) and 2.2-2.5 mm (small) diameters. The trial was conducted as a split plot design with the wheat variety by seed source combination as main plots and seed size as sub plots. The trial was replicated at the three sites

The trial at Minnipa was sown on 13 May 2014 at a rate of 150 plants/m^2 in 5 m plots by 6 rows with 9.5 inch row spacing. Fertiliser (18:20:0:0) was applied @ 80 kg/ha at sowing. On 19 May 2014 the trial received Roundup @ 2 L/ha, TriflurX @ 1 L/ha, Hammer @ 60 ml/ha, Ester 680LVE @ 300 ml/ha and LI700 @ 500 ml/100L. Post emergent weed control involved applications of Astound Duo @ 300 ml/ha (17 June) and Ester 680LVE @ 800 ml/ha (30 July). On 15 August 2013 tebuconazole @ 290 ml/ha was applied followed by an application of LeMat @ 150 ml/ha on 29 August. The experiment was harvested on 11 November.

The trial was assessed for plant establishment, early vigour (Greenseeker hand held sensor used for normalized difference vegetation index - NDVI) and grain yield.

What happened?

The grain from the 2013 NVT trials had nutrient concentrations similar to or greater than those from the previous season. (Table 1) Grain from Nangari had the lowest concentrations of nutrients and low protein concentration in both years while grain from Turretfield generally had the highest nutrient concentrations. Using a grain P concentration of 2500 mg/kg as an indicator of adequate levels of P, grain from Nangari, Nunjikompita and Penong were low to marginally low while grain P from the other sites was adequate.

Table 1 Seed nutrient concentration for Mace from National Variety Trials at six sites in SA in 2012 and 2013

Seed source	Year	1000 Grain wt (g)	GPC (12% mc) (%)	P (mg/kg)	K (mg/kg)	S (mg/kg)	N:S ratio	Zn (mg/kg)	Mn (mg/kg)
Keith	2012	-	-	-	-	-	-	-	-
	2013	46	8.8	3100	4000	1160	14.9	19	29
Nangari	2012	39.1	9.7	1600	3300	1389	13.7	9	31
	2013	36.3	10.4	1990	3300	1380	14.8	11	38
Nunjikompita	2012	32.1	12.6	1780	3500	1570	15.8	20	38
	2013	32.6	11.5	2200	3600	1420	15.9	20	46
Penong	2012	36.5	15.0	2300	3800	1630	18.1	17	60
	2013	32.0	10.9	2500	3800	1380	15.5	17	43
Turretfield	2012	35.4	10.1	3200	4600	1477	13.4	20	46
	2013	27.9	13.4	4000	4900	1620	16.3	21	43
Wanbi	2012	38.9	11.7	2700	3800	1612	14.3	20	31
	2013	-	-	-	-	-	-	-	-

Note: N:S ratio can be used to indicate sulphur (S) deficiency; if ratio >16 it suggests S is low (but not deficient)
**GPC = Grain P concentration*

Table 2 Summary of the Analyses of Variance for NDVI measurements during the growing season at Minnipa. Only the treatment main effects are shown as there were no significant interactions among the treatments

Sample Date	Seed source	Variety	Seed size
19 June	P=0.055	ns	P<0.001
26 June	P=0.052	ns	P<0.001
2 July	P=0.073	P=0.009	P<0.001
7 July	P=0.023	P=0.026	P<0.001
18 July	ns	P=0.040	P<0.001
22 July	ns	P=0.0007	P<0.001
28 July	ns	P<0.001	P<0.001

Plant establishment was poor (average of 95 plants/m^2; establishment = 63%) but it was improved slightly by using larger seed. Plant establishment was not affected by seed source or variety. The early growth of the crops was affected by seed source, variety and seed size but the relative importance changed over time (Table 2). Initially seed source was important, probably through its effect on seedling vigour, but differences diminished over time. Crops using seed from Penong and Turretfield had greater vigour than seed from the remaining sites. Initially there was no difference among varieties but differences developed more strongly during July. Firstly Emu Rock showed greater vigour than Corack and Mace and then after 22 July Corack started to grow more vigorously than Mace. However seed size had a consistent effect at all times, with the crops grown from larger seed having greater vigour (Table 2; Figure 1). The greater difference was between the small and the medium sized seed.

Seed source did not affect yields at any site and the main factor influencing yield was seed size. Larger seed increased grain yields at Minnipa and Turretfield but not at Karoonda. This is a similar result to the previous year's experiment. Using large seed gave a yield advantage of 9% (Minnipa) and 6% (Turretfield) over the smallest sized seed and 3-4% over the medium sized seed at both sites.

While there was no overall effect of seed source on yield at Minnipa, there was a high seed source by size interaction, meaning that the effect of seed size on yield differed with the source of the seed. Compared to using small seed, the yield advantage of large seed was greatest with seed from Nangari (14% yield improvement) and Keith (12%), followed by Nunjikompita (9%) and was least with seed from Penong and Turretfield (5-6%). Using the medium sized seed as the basis of comparison, the advantages of large seed are less but the pattern is the same: 4-5% yield improvement with seed from Nangari, Keith and Nunjikompita and no yield improvement with seed from Penong and Turretfield. It would appear that seed with the lowest nutrient concentrations are more responsive to seed size differences than seed with high nutrient concentrations. The nutrients most strongly associated with the effects of seed source on yields at Minnipa were P, K and Zn.

When the effects of seed size in yield from 2012 and 2013 are combined it is apparent that the advantage of using larger seed was most consistently expressed when yields are high, although there is a strong seasonal effect (Figure 2). In 2014 the yield advantage of large seed was apparent at lower yields than in 2013.

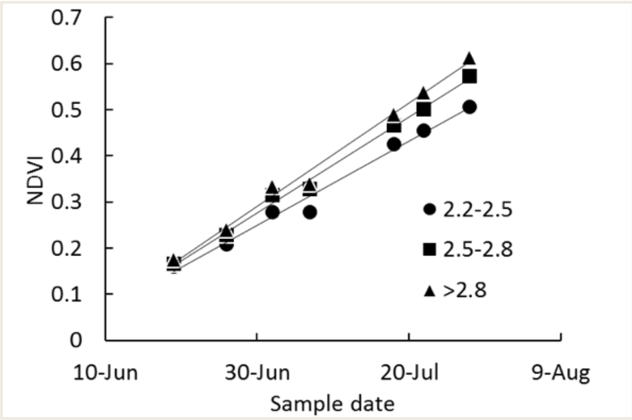

Figure 1 Changes in NDVI in crops grown from seed graded into three size categories. The effect of seed size was significant at each sample time

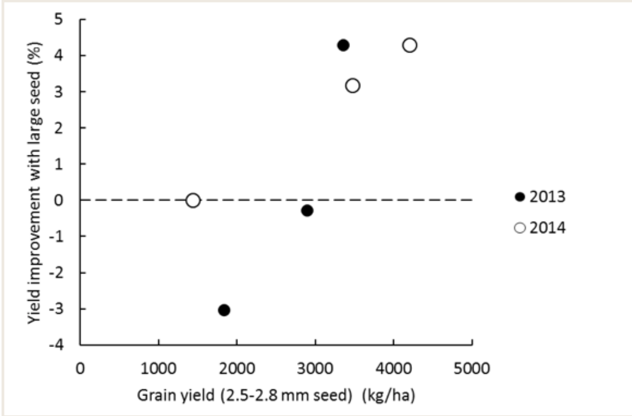

Figure 2 The relationship between the yield improvement from using large seed compared to medium sized seed and the mean yield of medium sized seed at the three sites

Table 2 Mean yields (kg/ha) of wheat graded into three size classes and grown at three sites in 2014

Seed size (mm)	Site		
	Karoonda	Minnipa	Turretfield
Small (2.2-2.5)	1401	3280	4130
Medium (2.5-2.8)	1440	3480	4210
Large (>2.8)	1440	3590	4390
	ns	P<0.001	P=0.01
LSD *(P=0.05)*	-	*44*	*169*
CV (%)	14.0	3.0	7.6

Table 3 Mean yields (kg/ha) of varieties grown at three sites in 2013

Variety	Site		
	Karoonda	Minnipa	Turretfield
Corack	1401	3232	4476
Emu Rock	1482	3463	4095
Mace	1399	3646	4160
	ns	P<0.001	P=0.07
LSD *(P=0.05)*	-	*132*	*344*
CV (%)	14.0	3.0	7.6

However the results show that over the two years at Karoonda there was no benefit from using larger seed (0% and 3% yield loss), while at Turretfield there was a consistent advantage in both years of about 4.5%. At Minnipa the value of large seed was more variable: there was no yield advantage from larger seed in 2013 and about a 3% advantage in 2014.

There was no significant difference in yield among the varieties at Karoonda, Mace yielded highest at Minnipa and Corack was the best variety at Turretfield (Table 3).

What does this mean?

The results have highlighted the benefits of well-filled seed with a high nutrient content to crop vigour and yield.

Seed size was the most consistent factor influencing yield in 2014 and in previous years. Given the yield advantages of large seed the results suggest that seed grading may be warranted, especially with seed with low nutrient concentrations.

The benefits of large seed are greatest and most consistent in higher yielding environments. There may be no benefit when yields are less than 2 t/ha.

Seed P is an important influence in crop vigour and yield and growers need to ensure that seed has high P concentrations. Given the site-to-site variation in seed P concentration, regular seed testing can be useful.

To some degree using larger seed may help overcome limitations of low seed nutrient concentrations by increasing the total amount of the nutrient available for seedling growth.

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Weed tolerance and suppression in wheat

RESEARCH

Andrew Egarr, James Edwards, Dan Vater and Haydn Kuchel
Australian Grain Technologies (AGT), Roseworthy Campus

Try this now

Key messages

- **Wheat variety selection can be used as a tool within an integrated weed management (IWM) strategy**
- **Axe provided the best suppression of weed seed set.**
- **Gladius demonstrated the best yield tolerance of weeds.**
- **Mace yielded well due to high yield potential.**
- **Grenade CL Plus had good weed suppression and Intervix tolerance, providing a two pronged approach to weed management.**
- **Although other varieties (e.g. Yitpi and Estoc) maintained yield in response to weed competition, when quality grade and yield potential are considered, Axe, Mace and Gladius are likely to produce the highest gross returns in areas of high weed competition.**

Why do the trial?

It is well documented that herbicide resistance in weeds is an increasing problem for grain growers (GRDC Herbicide Resistance Fact Sheet, 2012). As a consequence, the adoption of integrated weed management (IWM) practices are also increasing. These methods include manipulating seeding rate and sowing date to maximise crop competitiveness, reducing weed growth through the use of cultivation, and herbicide application both pre-sowing and in-crop. Weed seed control at or post-harvest can also be achieved with the use of chaff carts, the 'Harrington Seed Destructor' and burning crop residues.

One area that warrants more investigation is the role of wheat variety selection in IWM. To investigate whether individual varieties differ in their yield response to the presence of weeds (weed tolerance) and whether they vary in their ability to reduce weed seed set (weed suppression), Australian Grain Technologies (AGT) (with support from SAGIT and previously GRDC) established a multi-site and multi-year weed competition trial comparing varieties that are widely grown in South Australia, along with promising advanced breeders lines.

How was it done?

The trial was conducted at five locations over four years: Angas Valley (2012), Winulta (2012), Pinnaroo (2013), Rudall (2013) and Roseworthy (2010-2013). Rufus triticale was used as a 'weed' as it is easily distinguished from wheat and seed set can be readily calculated. A set rate of 'weeds' were spread (using a plot seeder) on top of the soil immediately prior to sowing the wheat plots, thereby scattering the seeds to mimic grass weeds that are typically present. The 'weeds' were hand harvested prior to crop harvest, threshed, weighed and seed set per square metre was calculated.

What happened?

When varieties grown over the four years of this trial were ranked for response to weed competition, their relative performance for both tolerance and suppression showed a high level of consistency across environments and years (data not shown). It is interesting to note, varieties that performed well were not of any particular maturity type, but the varieties that performed poorly all have a vernalisation requirement which is associated with poor early vigour.

The differing responses to weed competition are displayed in Figure 1. Axe, Gladius, Estoc and Yitpi all had a relatively small reduction in yield under weed competition (weed tolerance), while Wyalkatchem, Shield and Corack were the poorest performing varieties. The ability to suppress weed growth (lower weed seed set) was high for Axe, followed by Grenade CL Plus, Scout and Mace; average for Gladius; and poor for Wyalkatchem and Shield. Although Yitpi's yield loss was low, similar to Axe and Gladius, its ability to suppress weed growth was below average for the trial.

Figure 2 shows the yield of each variety without weed competition, plotted against yield with weed competition. The suppression effect of each variety is indicated by the diameter of the circle; as the diameter increases the weed suppression effect decreases. Of these varieties, Axe and Grenade CL Plus had the best suppression effect with a weed seed set of 1380/m^2 and 1562/m^2 respectively. Estoc (1849/m^2) was near the average; Corack (2015/m^2) and Wyalkatchem (2190/m^2) were at the higher end, while Shield had the highest weed seed set at 2512/m^2.

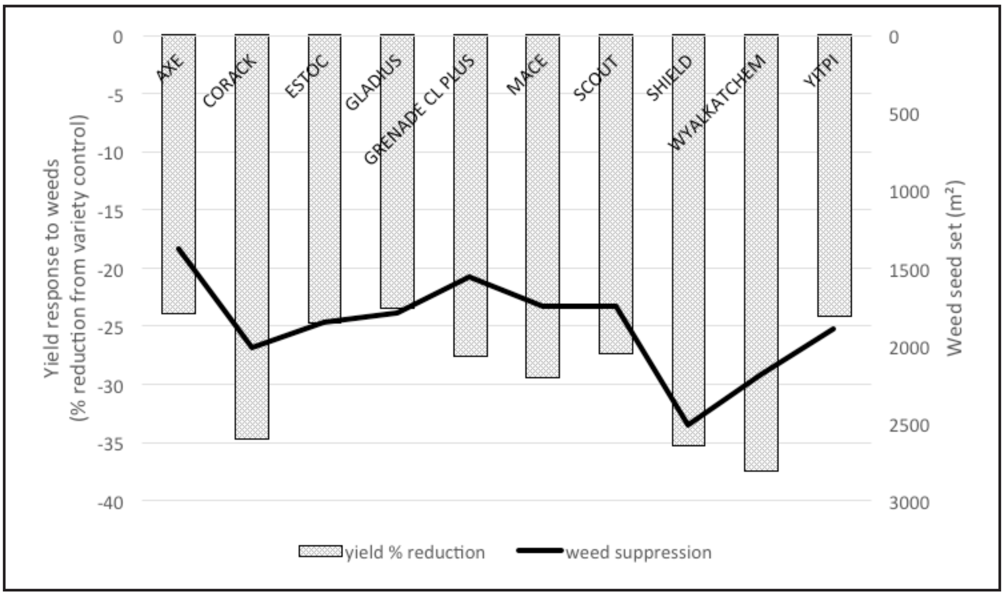

Figure 1 Yield response (tolerance) to weed competition, and weed suppression (weed seed set) of varieties. Response measured as the percentage yield loss of each variety compared to that variety with no weeds

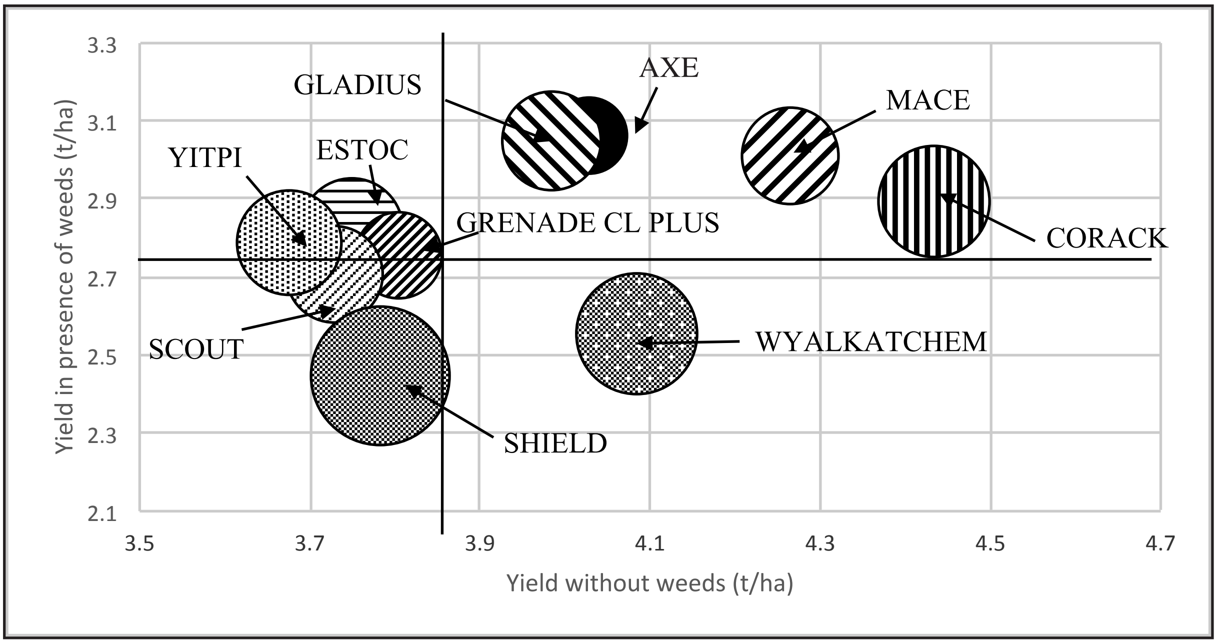

Figure 2 Yield without weeds vs yield with weeds. The diameter of the circle relates to the number of weed seeds set. The average yields are indicated by the horizontal (with weeds) and vertical (no weeds) lines

Although Axe only achieved average grain yield in the absence of weeds, it was the highest yielding variety when weeds were present. As expected, Mace and Corack performed similarly in this trial, although both were better than their major parent Wyalkatchem, for both weed tolerance and suppression, contributing to the agronomic advantage they offer growers.

The financial impact of weed competition is shown in Table 1. Although the percentage yield loss in response to weed competition for Mace was average for the trial (29%), it was still the third most profitable variety in the presence of weeds due to its high yield potential. However, this was not the case with Wyalkatchem which, despite its high yield (third ranking) without weeds, had the second lowest yield in the presence of weeds and as an APW variety, the gross margin was the lowest in the trial. Without weed competition the gross margin for Mace was $110/ha higher than Wyalkatchem but with weed competition it increased to $161/ha. Physical grain quality can also be affected by weed competition. On average, kg/hL (test weight) was lower in response to weed competition at all sites (Figure 3).

Table 1 Variety yield with and without weed competition, and financial impact

	No Weeds		Grazed		Yield reduction (%)	Weed seed set (seed/m^2)
	t/ha	$/ha	t/ha	$/ha		
Axe	4.0	1080	3.1	821	24	1380
Corack	4.4	1122	2.9	732	35	2015
Estoc	3.7	949	2.8	714	25	1849
Gladius	4.0	1068	3.0	817	23	1789
Grenade CL Plus	3.8	1020	2.8	739	28	1562
Mace	4.3	1143	3.0	807	29	1750
Scout	3.7	999	2.7	726	27	1749
Shield	3.8	1014	2.4	656	35	2512
Wyalkatchem	4.1	1033	2.6	646	37	2190
Yitpi	3.7	985	2.8	747	24	1893

$ values calculated as per quality classification, and assume that varieties have qualified for maximum eligible grades: AH – Axe, Gladius, Grenade CL Plus, Mace, Scout, Shield, Yitpi. APW – Corack, Estoc, Wyalkatchem. AH $268/tonne, APW $253/tonne based on 10 year average.

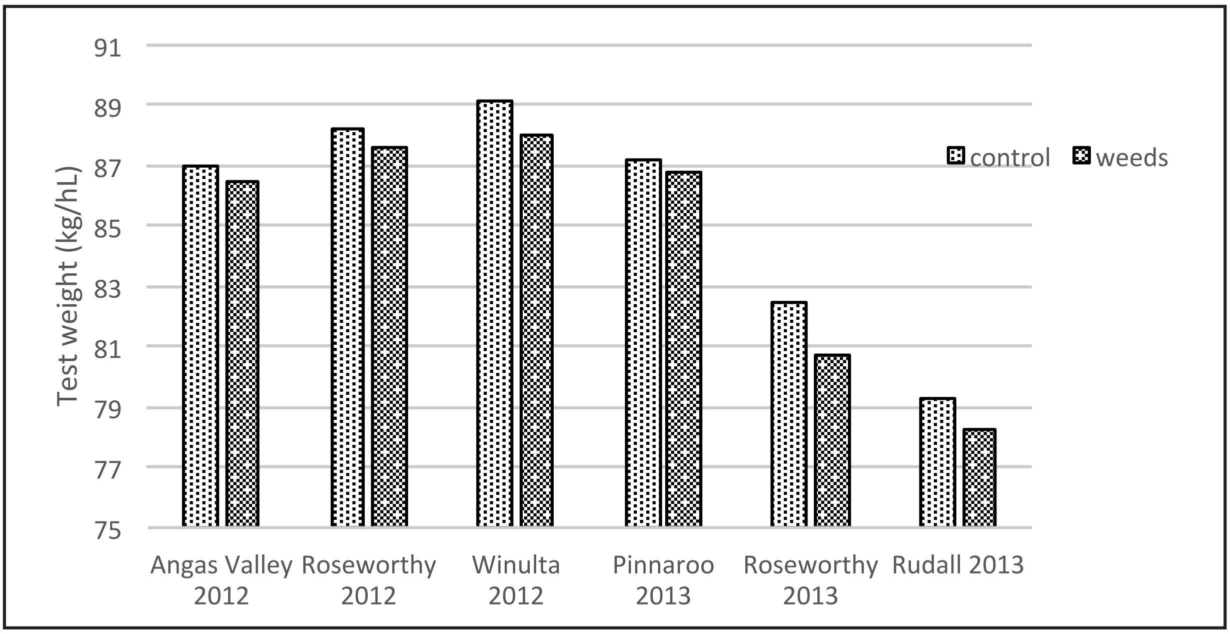

Figure 3 Average effect of weeds on test weight (kg/hL) in 2012 and 2013

Table 2 AGT ratings for variety tolerance and resistance to weeds

	Weed tolerance	Weed suppression (resistance)
Axe	MT-MI	MR
Corack	I	MS-S
Estoc	MT-MI	MS
Gladius	MT-MI	MS
Grenade CL Plus	MI	MR-MS
Mace	MI	MS
Scout	MI	MS
Shield	I	S
Wyalkatchem	I-VI	MS-S
Yitpi	MT-MI	MS

MR=moderately resistant, MS=moderately susceptible, S=susceptible, MT=moderately tolerant, MI=moderately intolerant, I=intolerant, VI=very intolerant

What does this mean?

Herbicide resistance in weeds is an ongoing problem for cereal growers that requires an integrated management approach. This study illustrates that variety selection can be an important aspect of an IWM strategy. Axe is the stand out variety for combined weed suppression (MR), tolerance (MT-MI) (Table 2) and gross return in the presence of weeds. Demonstrating good weed suppression (MR-MS) along with being tolerant to Intervix herbicide, Grenade CL Plus provides a two pronged approach to weed management. Gladius is the most tolerant to weed competition, followed closely by Axe, Yitpi and Estoc. However, while these varieties display the lowest percentage yield loss, when yield potential and the quality grade of the varieties are taken in to account Axe, Gladius and Mace are likely to produce the highest gross returns for growers when growing wheat in high weed competition paddocks. This demonstrates that existing perceptions of the value of a variety may need to be reconsidered depending on the expected weed load in a paddock.

Although the yield and weed suppression varied between varieties, the test weight effect of weeds is mostly variety independent. Therefore, the best strategy to manage test weight is to select varieties with higher inherent test weight when high weed competition is expected.

Interestingly, a breeders line (data not shown) that has now been discarded for other reasons, achieved a weed tolerance substantially better than Axe, providing confidence that breeding may offer even greater weed control benefits for farmers in the future.

Table 2 shows a summary of this experiment and provides a tool for growers to introduce wheat variety selection as part of their IWM program. When considered alongside the other agronomic, disease resistance and quality features of these varieties, this should enable growers to increase their returns when growing wheat in a high weed competition environment.

Acknowledgments

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Sowing early in 2014 – how did it work?

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RESEARCH

Key messages

- **Despite wide-spread stem frost, in the majority of 2014 time of sowing (TOS) trials in SA the highest yields came from mid-late April sowing.**
- **Based on one year of data, Trojan (mid maturing) complements Mace (fast maturing) in a cropping program and allows growers to sow earlier and achieve higher yields (16%) than with Mace alone sown in its optimal window.**
- **Existing slow maturing wheat cultivars from other states are poorly adapted to most regions in SA.**
- **For growers in frosty environments wishing to sow before 20 April, EGA Wedgetail is the safest option evaluated in these trials, but yields are likely to be less than Mace sown in its optimal window.**

Why do the trial?

In South Australia (SA) the time at which wheat flowers is very important in determining yield (Figure 1). With farm sizes increasing and sowing opportunities decreasing, getting wheat crops established so that they flower during the optimal period for yield is difficult. Whilst no-till and dry-sowing have been used successfully in SA to get more area of crop flowering on time, an opportunity exists to take advantage of rain in March and April to start sowing crops earlier than currently practiced. This is a tactic which complements dry sowing. Earlier sowing is now possible with modern no-till techniques, summer fallow management and cheaper insecticides and fungicides to protect against pests and diseases associated with early sowing.

However, in the last few decades wheat breeding has focused on mid-fast maturing varieties which are only suited to sowing in late April-May. Sowing earlier than is currently practiced requires cultivars which are not widely grown in SA, and which are much slower to mature, either through having a strong vernalisation/ cold requirement (winter wheat) or strong photoperiod/day length requirement (slow maturing spring wheat – Figure 2).

When sown at their optimal times, the wheat described in Figure 2 all flower during the optimal period in a given environment. Winter wheat also has a very flexible sowing window and if well adapted will flower during the optimum period in a given environment from a broad range of sowing dates.

GRDC funded research in NSW has demonstrated that slow maturing varieties sown early yield more than mid-fast varieties sown later when they flower at the same time. This is because early sowing increases rooting depth and water use, reduces evaporation and increases transpiration efficiency. Early sowing of slow maturing varieties is a way of increasing yield potential with very little initial investment.

APSIM modeling indicates that even with SA's Mediterranean climate, adoption of slow maturing varieties to allow early sowing has potential to increase whole-farm wheat yield, particularly in mid-high rainfall zones (Table 1). GRDC have funded a series of trials across rainfall zones to experimentally evaluate the suitability of early sowing in SA.

How was it done?

The early sowing trials in SA were undertaken at five locations (Cummins, Minnipa, Port Germein, Tarlee and Conmurra) and each had three times of sowing (aimed at mid-April, early-May, late-May) and ten wheat lines (6 commercial, 4 near-isogenic lines, or NILs, in a Sunstate background). The commercial lines are described in Table 2. Hart Field Site Group also planted a similar early sowing trial, and there are also trials funded by SAGIT evaluating different wheat lines for early sowing in the Mid North and upper Yorke Peninsula.

What happened?

Results from all experiments are presented in Table 3. At four out of five sites, Trojan sown in mid to late April was the highest or equal highest yielding treatment. Slow maturing cultivars bred in other states (e.g. EGA Wedgetail, EGA Eaglehawk and Rosella) showed poor adaptation to all sites.

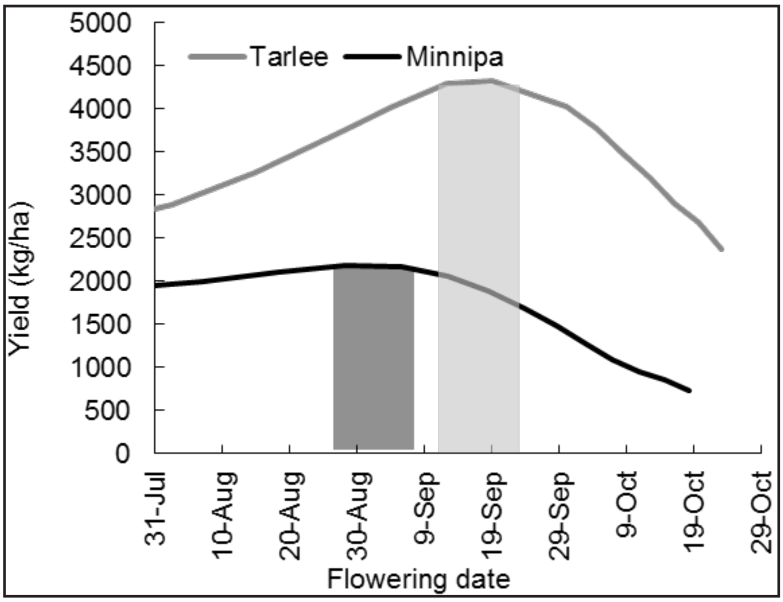

Figure 1 The relationship between flowering time and yield at Minnipa and Tarlee – optimal flowering periods are highlighted by light and dark grey boxes. Curves are derived from APSIM from 120 years of climate data and with a yield reduction for frost and extreme heat events. Optimal flowering periods are late August-early September at Minnipa, and mid-September at Tarlee

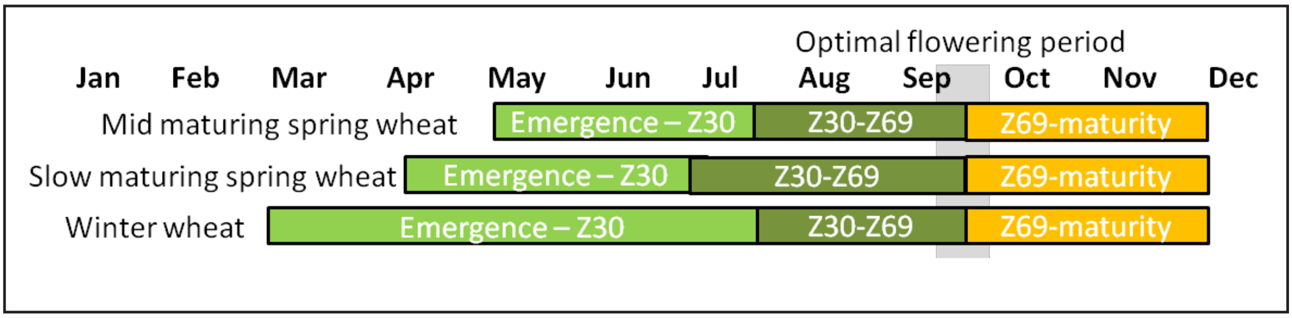

Figure 2 Diagram showing pattern of development in winter and slow maturing spring wheat relative to mid maturing spring wheat (most currently grown varieties in SA are mid to fast maturing)

Table 1 Average farm wheat yields from 50 years of simulation at different locations in SA, assuming either current practice (mid-fast varieties sown from mid-May including dry sowing) or the addition of a slow maturing variety to the cropping program which can be planted from 1 April, but is only sown when planting opportunities arise (occurs in about 60% of years)

Location	Average farm yield - current practice (t/ha)	Average farm yield - early sowing (t/ha)	Yield benefit from early sowing (t/ha)	Yield benefit from early sowing (%)
Conmurra	4.0	6.1	2.1	53
Cummins	3.3	4.0	0.8	24
Minnipa	2.1	2.2	0.1	5
Port Germein	1.9	2.1	0.2	11
Tarlee	3.5	4.0	0.5	14

Table 2 Commercial wheat varieties used in the SA trials at Cummins, Minnipa and Port Germein in 2014

Variety	Maturity	Comments
Manning (Conmurra only)	Very slow winter (very strong vernalisation, unknown photoperiod)	White feed – Resistant to BYDV but only adapted to environments with a very long, cool growing season.
SQP Revenue (Conmurra only) (NIL match: W46A)	Slow winter (strong vernalisation, unknown photoperiod)	Red feed – also adapted to long cool growing seasons, it is widely grown in SW Victoria and SE SA.
EGA Wedgetail (NIL match: W8A)	Mid maturing winter (strong vernalisation, moderate photoperiod)	APW (default in SA – APH in NSW) - The early sowing and dual purpose standard in SNSW and an excellent grain-only option. May be too slow in most of SA, only has APW quality and can be quite intolerant of problems associated with alkaline soils (CCN, boron, aluminium).
Rosella (NIL match: W7A)	Fast maturing winter (strong vernalisation, weak photoperiod)	ASW - Slightly faster than Wedgetail and trials in Victoria have shown better adaption to alkaline soils. However, being 29 years old it is at a distinct yield disadvantage to modern spring wheats.
EGA Eaglehawk (NIL match: W16A)	Very slow maturing spring (moderate vernalisation, very strong photoperiod)	APW (default in SA – APH in NSW) Very slow maturing photoperiod sensitive spring wheat that will flower at the same time as Wedgetail from a mid-April sowing but hit GS30 ~3 weeks earlier, therefore not as suited to grazing.
Forrest (NIL match: W16A)	Very slow maturing spring (weak vernalisation, very strong photoperiod)	APW - Very slow maturing photoperiod sensitive spring wheat which performs well in higher yielding environments.
Bolac (Tarlee and Conmurra only)	Slow maturing spring (moderate vernalisation, moderate photoperiod)	AH – Bred for the HRZ of SW Victoria but has performed well when sown early in the low rainfall regions of the western Riverina in NSW.
Estoc	Mid maturing spring (weak vernalisation, strong photoperiod)	APW - probably the slowest maturing recently released variety with good adaptation to SA. Not suited to sowing much before 20 April in most environments.
Trojan	Mid-fast maturing spring (moderate vernalisation, moderate photoperiod)	APW - Has demonstrated good adaption to SA and has an unusual photoperiod gene which may allow it to be sown in late April and flower at the optimal period.
Mace (NIL match: Sunstate)	Fast maturing spring (weak vernalisation, weak photoperiod)	AH - No introduction necessary! SA main-season benchmark and in the trial as a control from a mid-late May sowing.
Cobra (Conmurra only)	Fast maturing spring (weak vernalisation, weak photoperiod)	AH – very similar maturity to Mace but based on NVT results may out yield it in higher yielding environments.

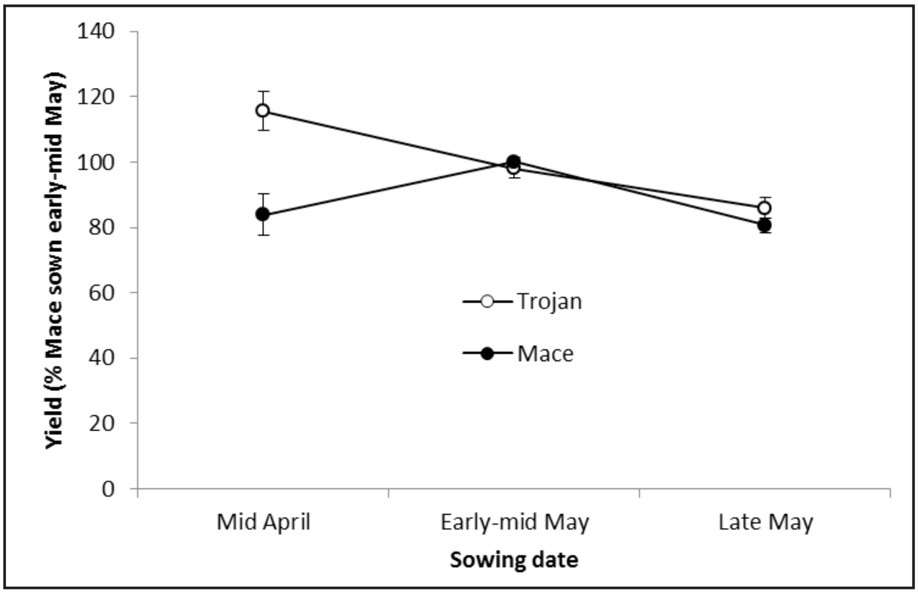

Figure 3 Mean yield performance (Minnipa, Cummins, Port Germein, Hart, Tarlee) of Trojan and Mace at different times of sowing relative to Mace sown in its optimal window of early-mid May. Error bars are standard error of means

Table 3 Grain yield for five out of six early sowing trial sites in SA in 2014 (results for Conmurra not available at time of preparation). Treatments known to have been affected by frost are marked with an asterisk

Location	Cultivar	Time of sowing			
		11 April	**13 May**	**28 May**	
Cummins	EGA Wedgetail	4.0	2.9	3.7	
	Rosella	4.0	4.1	2.5	
	EGA Eaglehawk	3.8	2.9	2.7	
	Estoc	4.3	4.7	3.8	
	Trojan	4.9	5.0	4.4	
	Mace	2.6*	5.1	4.1	
	P-value	<0.001			
	LSD (P=0.005)	*0.6*			
Minnipa		**11 Apr**	**13 May**	**28 May**	
	EGA Wedgetail	2.9	2.2	2.1	
	Rosella	2.7	2.4	2.1	
	EGA Eaglehawk	3.0	1.8	1.7	
	Estoc	4.0	2.7	2.6	
	Trojan	4.6	3.1	3.0	
	Mace	3.7	3.0	2.8	
	P-value	<0.001			
	LSD (P=0.005)	*0.2*			
Port Germein		**11 Apr**	**30 Apr**	**20 May**	
	EGA Wedgetail	2.5	1.9	1.7	
	Rosella	2.2	1.7	1.6	
	EGA Eaglehawk	3.0	2.1	1.9	
	Estoc	4.4	3.5	3.4	
	Trojan	5.2	4.2	3.9	
	Mace	4.3	4.3	3.7	
	P-value	<0.001			
	LSD (P=0.005)	*0.5*			
Hart		**14 Apr**	**8 May**	**2 Jun**	
	EGA Wedgetail	4.5	4.0	3.0	
	Rosella	4.3	3.7	2.8	
	Trojan	5.7	5.3	3.7	
	Mace	3.9*	4.7	3.3	
	RAC1843	0.8*	3.6	3.5	
	P-value	<0.001			
	LSD (P=0.005)	*0.3*			
Tarlee	Cultivar	**14 Apr**	**29 Apr**	**12 May**	**30 May**
	Rosella	5.5	5.4	4.6	3.5
	Bolac	6.1	6.1	4.6	3.7
	Trojan	6.6	7.4	6.1	4.6
	Mace	4.1*	7.4	6.4	5
	P-value	<0.001			
	LSD (P=0.005)	*0.6*			

Table 4 Flowering dates for Trojan and Mace from different times of sowing at Minnipa in 2014

Flowering date - Minnipa Cultivar	Time of sowing		
	11 April	13 May	28 May
Trojan	6 Aug	10 Sept	17 Sept
Mace	8 July	6 Sept	13 Sept

What does this mean?

Based on the 2014 trial data, growers in SA could improve whole-farm yields by including Trojan in their cropping program to complement Mace (Figure 3). Trojan has an unusual photoperiod sensitivity allele inherited from a European parent which is rare in Australian cultivars. This allele seems to delay flowering from an April sowing relative to Mace quite successfully (Table 4).

Despite performing strongly from a mid-April sowing in these trials, it is not recommended that Trojan be planted this early in the majority of SA locations as it incurs excessive frost risk. As a rough rule of thumb, it is best suited to being planted about 10 days earlier than Mace. As an example of how it may fit in a program, if 10 May is the optimal sowing time for Mace in a given environment, then the optimal sowing time for Trojan is 1 May. If a grower has a 20 day wheat sowing program and wants to grow half Trojan and half Mace, to maximize whole farm yield they should start with Trojan on 25 April, switch to Mace on 5 May and aim to finish on 15 May.

Sowing mid-April in low-frost environments such as Port Germein carries little risk, and as the results from this year show, yield gains (0.9 t/ha relative to Mace) can be achieved by sowing Trojan in mid-April purely because its longer growing season allows it to accumulate more dry matter.

For growers in frosty environments who wish to sow earlier than is safe with Trojan/Mace, EGA Wedgetail is probably the best option in most environments. However, because of its poor adaption to SA even if sown in early-mid April it is unlikely to yield as well as Mace sown in its optimal window. In this set of trials there was an average yield penalty of 0.5 t/ha between EGA Wedgetail sown mid-April and Mace sown in mid-May. Grazing early sown EGA Wedgetail would offset some of the reduction in income compared to mid-May sown Mace.

Remember that early sown crops require different management in order to get the most out of them;

- Don't dry-sow slow maturing varieties (EGA Wedgetail, EGA Eaglehawk), they will flower too late if not established early. There needs to be seed-bed moisture and ideally some stored soil water to get them through to winter.
- If growing winter wheat (EGA Wedgetail) and not grazing, sow at lower plant density and defer N inputs until after GS30.
- Pick clean paddocks – winter wheat at low plant densities is not competitive with ryegrass and common root diseases are exacerbated by early sowing.
- Protect against diseases associated with early sowing – barley yellow dwarf virus (imidicloprid on seed backed up with in-crop insecticides at the start of tillering if aphid pressure high), Septoria tritici in some areas (flutriafol on fertiliser and timely foliar epoxiconazole applications at GS30 and GS39). Many slow maturing varieties also have poor resistance to stripe rust (flutriafol on fertilizer and timely foliar fungicide application at GS39).

Despite a frosty July and August, highest yields in most trials came from mid-April sowing with Trojan being the stand-out performer. Trojan complements Mace in a cropping program and extends the sowing window about ten days earlier. EGA Wedgetail was the best performing variety suited to very early sowing, but even sown early it yields less than Mace planted in its optimal window.

GRDC project code: CSP00178, CSP00160

Managing sowing date and variety selection to minimise risk and maximise yield

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RESEARCH

Cereals

Key messages

- **Estoc yields best when sown early in trials at Roseworthy.**
- **Axe yields best when sown later.**
- **Mace yields best when sown mid-May but tends to out-yield most other varieties at all sowing times.**
- **In regions where frost risk is much lower than heat risk, Axe types may be the better option for all but the earliest sowing times. This strategy may also be an advantage in a terminal drought.**

Why do the trial?

The final yield of a wheat crop can be significantly compromised by either frost or heat stress regardless of the early season potential. Although there is some variety difference in grain yield response to these events, at extreme temperatures (e.g. <-2°C and >35°C) all varieties are very similarly affected. Damaging frost or heat events during flowering (growth stages (GS) 60 to 69) will result in a reduction in grain number whereas grain size will be reduced if they occur during grain fill (GS70 to 90). As there are currently no other forms of protection from these risks, altering sowing times to reduce exposure to frost and heat events during the sensitive growth stages (booting through to the end of flowering) is the best risk management option. However, as the scale of grain production systems continues to increase, completing sowing within the optimum sowing window becomes more difficult. This is where variation in the time to flowering for different varieties (maturity types) can be used as a risk management tool, allowing growers to adjust sowing date but still achieve an optimal flowering date.

The maturity types of wheat can be roughly allocated into one of three groups. The first group are photoperiod sensitive varieties (e.g. Yitpi) which require day length to be greater than 10 hours before flowering will occur. This photoperiod requirement can be satisfied by the longer days in autumn and therefore, sowing photoperiod sensitive varieties before April may result in early flowering (mid-winter). The second group are vernalisation responsive (e.g. Wyalkatchem). These varieties require minimum temperatures below 10°C (optimum 6°C) over periods ranging from 2-8 weeks for the plants to move from vegetative phase to reproductive phase, depending on variety. The final group display minimal or no sensitivity to both photoperiod and vernalisation (e.g. Axe). These varieties mature predominantly in response to temperature. Although each variety can be classified into these types, once the photoperiod and vernalisation requirements have been satisfied there is still variation in maturity rate between varieties. This is described as "earliness per se" and reflects multiple factors influencing maturity progression independent of vernalisation and photoperiod sensitivity.

Table 1 shows the vernalisation, photoperiod and "earliness per se" requirements of the well known varieties Axe, Wyalkatchem and Yitpi. Alternative varieties are shown in Table 2, grouped according to their photoperiod and vernalisation requirements. However, the requirements for vernalisation or photoperiod vary between each variety within each group. For example, Yitpi and Estoc are more sensitive to photoperiod than Gladius, and therefore flower later than Gladius, while Bolac combines vernalisation and photoperiod sensitivity and therefore flowers later than both Mace and Yitpi. Strategic use of these different maturity types can extend the sowing period while minimising the risk of grain yield loss due to frost and heat events. In this report we have featured Mace and Estoc as higher yielding replacements for Wyalkatchem and Yitpi, respectively.

How was it done?

AGT conducts 'time of sowing' trials to characterise new varieties with regard to maturity type, and to evaluate grain yield response of new and existing varieties to different sowing times. These trials provide information on how different varieties develop and progress through their life cycle, how this influences grain yield and ultimately allows us to characterise their frost and heat risk profiles.

Trials are sown at 2-3 week intervals, starting when the season permits. In 2014, sowing dates were 24 April, 8 May, 22 May and 12 June. All plots were regularly monitored and growth stages (GS31, GS55 and GS90) were recorded.

Table 1 Thermal time (cumulative daily temperature) required for vernalisation, photoperiod response and earliness per se in Axe, Wyalkatchem and Yitpi. Adapted from Brougham, 2006

Variety	Vernalisation (°C)	Photoperiod (°C)	Earliness *per se* (°C)
Axe	0	525	910
Wyalkatchem	221	840	924
Yitpi	0	1974	1176

Table 2 Common wheat varieties grouped by their maturity type

Minimal photoperiod and vernalisation sensitivity	Vernalisation sensitive		Photoperiod sensitive	
Axe	Bolac	Moderate	Correll	Moderate
Bonnie Rock	Cobra	Moderate	Estoc	Strong
Corack	Elmore CL Plus	Moderate	Frame	Strong
Emu Rock	Gregory	Moderate	Gladius	Moderate
Scout	Janz	Moderate	Grenade CL Plus	Moderate
Spitfire	Mace	Moderate	Justica CL Plus	Moderate
Wallup	Naparoo	Strong	Trojan	Moderate
Westonia	Shield	Moderate	Yitpi	Strong
	Wedgetail	Strong		
	Wyalkatchem	Moderate		

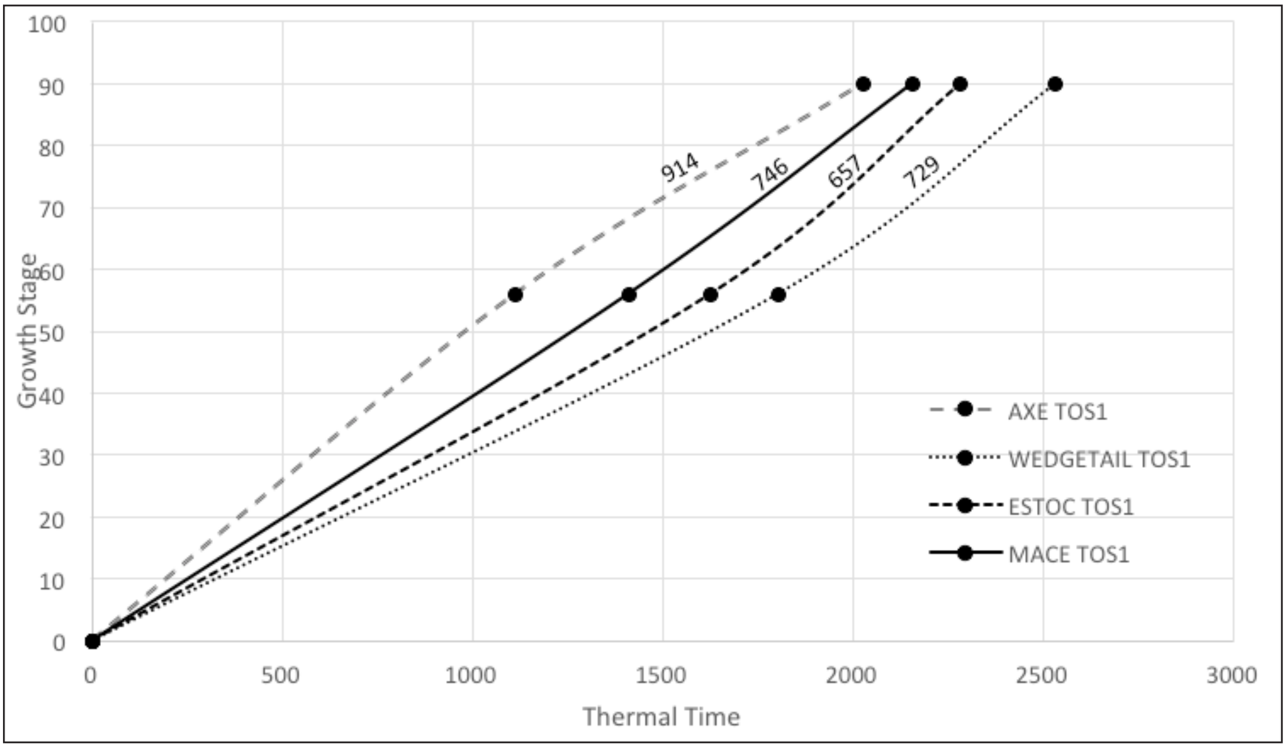

Figure 1 Thermal time (°C) required to reach head emergence (GS55) and physiological maturity (GS90); Axe, Mace, Estoc and Wedgetail, first time of sowing (24 April 2014) at Roseworthy. Thermal times (°C) required for each variety to complete the grain filling phase are marked

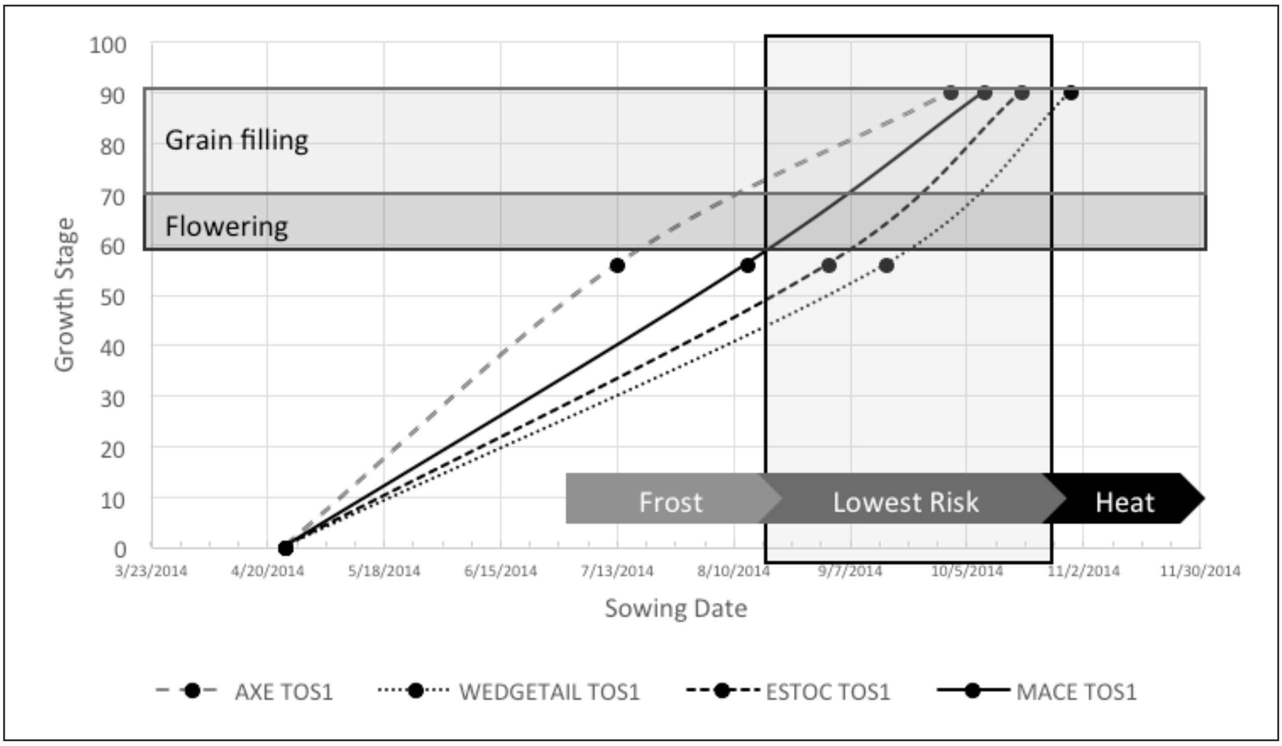

Figure 2 Differences in maturity times of Axe, Mace, Estoc and Wedgetail. Vertical rectangle represents the safe period with less than 20% chance of frost or heat stress occurring at Roseworthy (dates adapted from Zheng et al. using climatic data from 1960 - 2009). Horizontal rectangles represent flowering (GS60-69) and grain filling (GS70-90).

What happened?

Variety response to temperature and day length

The thermal time (cumulative daily temperature) from sowing to the end of grain fill is longest in Wedgetail and shortest in Axe with Estoc mid-way (Figure 1). This is principally because Estoc requires long days to initiate flowering and Wedgetail has a strong requirement for vernalisation whereas Axe matures independently of day length and vernalisation. Therefore, we observe that the development of Axe is closely linked to daily temperatures, and when sown early with warm autumn temperatures, Axe has rapid early growth, quickly reaching the reproductive growth stages, increasing likely exposure to the critical frost risk period (Figure 2). Another consequence of this rapid growth is less tillering and biomass development. In contrast, Mace, Estoc and Wedgetail spend a larger proportion of the total growth period in the vegetative growth stages. This means that they spend more time tillering and developing biomass, which increases the yield potential of the plant. In addition to this, Mace, Estoc and Wedgetail have a faster grain filling period, spending at least 20% less time than Axe in the grain filling growth stage (Figure 1). This allows them to ripen quicker, reducing the risk of heat stress during grain filling.

Impact of sowing date on yield

The data collected over multiple years demonstrated that the yield of each variety varied according to sowing time, with the previous four years shown in Figure 3a-3d. In general, over these trials the yield of Estoc was greatest with early sowing, reducing as sowing was delayed. The yield of Mace was relatively constant but peaked when sown in mid-May, while Axe's yield peaked at a similar point, but suffered less yield penalty when sown later. Frost in 2014 affected Mace and Axe when sown very early, exacerbating the yield penalty of sowing these varieties before their optimal sowing window (Figure 3d). A similar result was observed in 2013 when hot, strong north winds caused shattering in early sown Axe (Figure 3c).

What does this mean?

Selecting varieties to optimise flowering date

The length of the sowing window can be maximised by selecting a range of varieties with contrasting maturity, such as Axe, Mace and Estoc. As an example, Estoc could be used for early sowing in late April to early May, Mace for the majority of the sowing period (May) and finishing with Axe for those paddocks that might need to be sown in June. While Figure 2 shows the potential exposure to frost risk from sowing Axe or Mace in April, Figure 4 shows how a strategy of careful variety selection based on maturity type allows all paddocks sown within a 20 April to 10 June sowing window to flower and grain fill during the lowest risk period when there is a less than 20% chance of either a frost or heat stress event occurring.

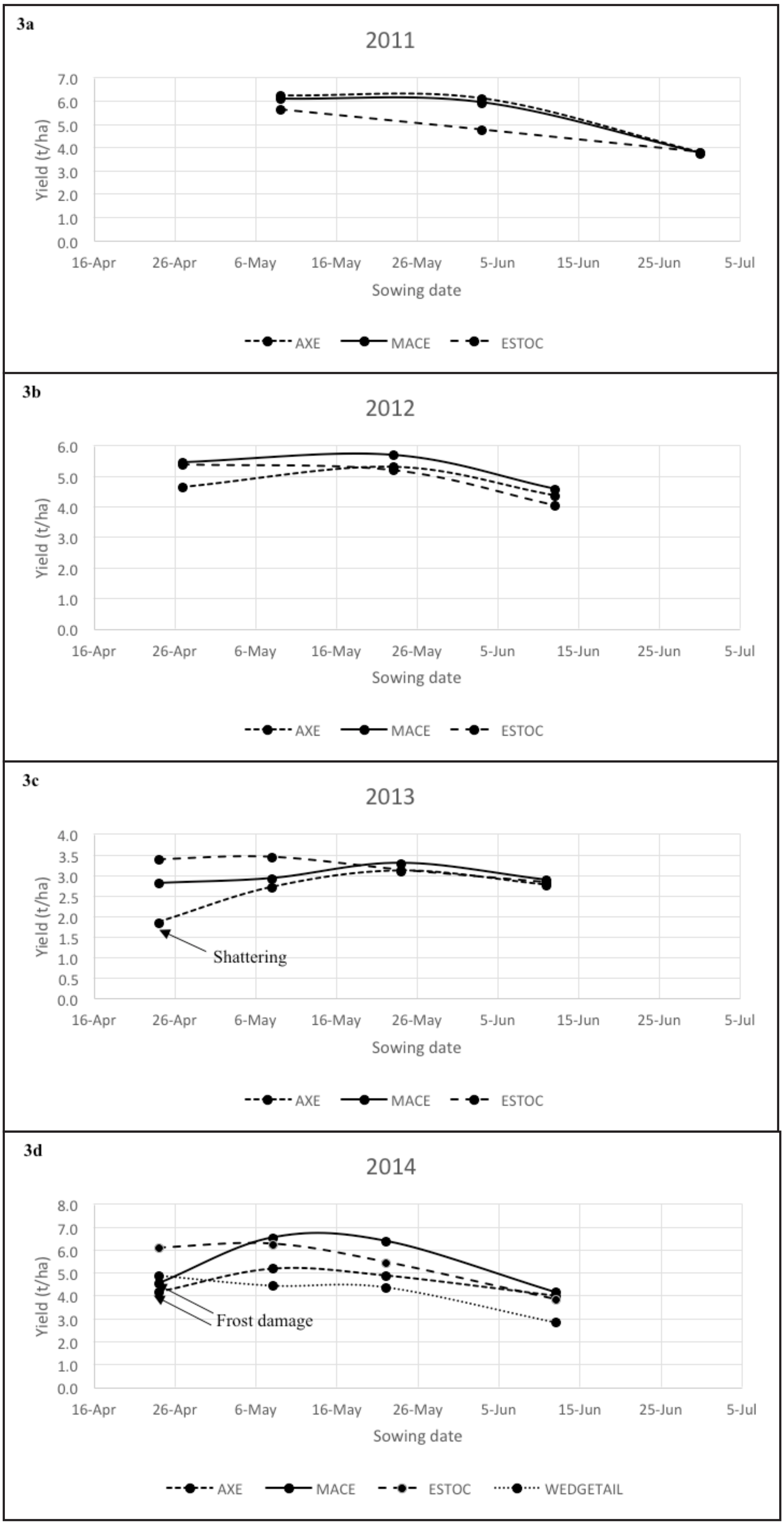

Figure 3 Grain yield results of the 2011 (3a), 2012 (3b), 2013 (3c) and 2014 (3d) Roseworthy time of sowing experiments

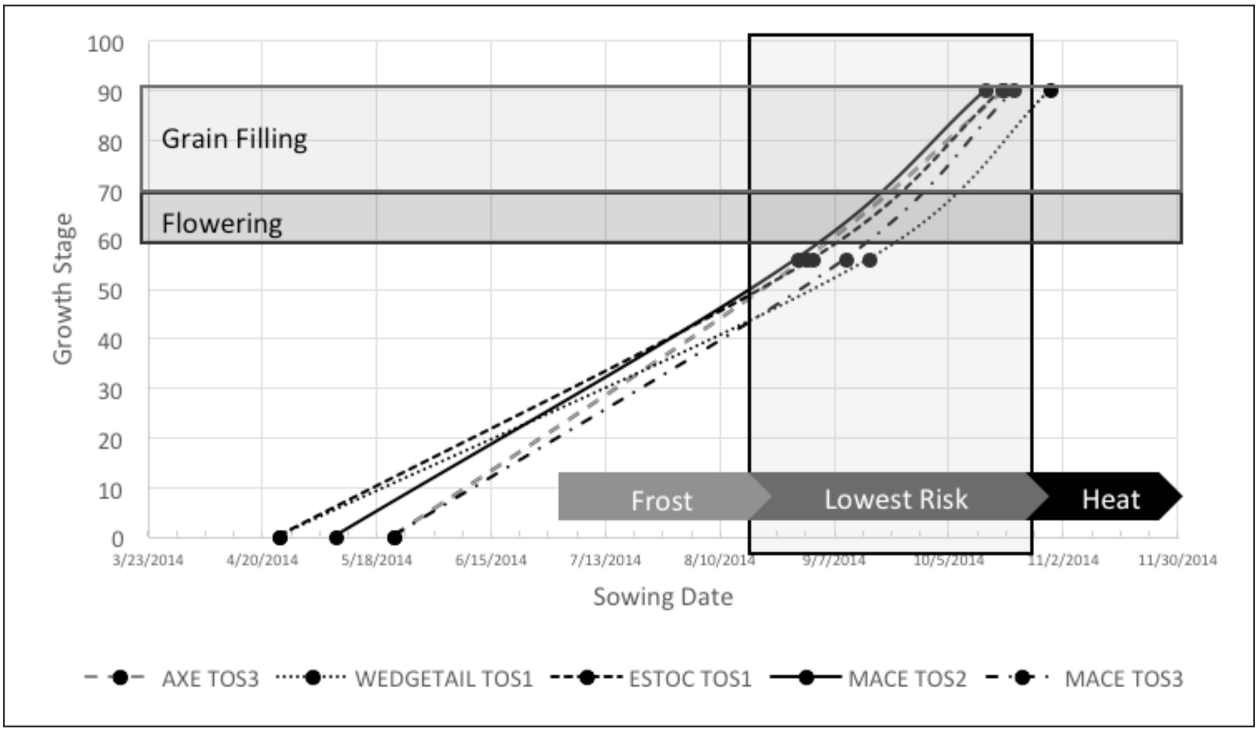

Figure 4 Managing the sowing dates of Axe, Mace, Estoc and Wedgetail to avoid major frost and heat events from 2014 time of sowing experiment at Roseworthy. GS55 and GS90 of each variety are marked. Rectangles as per Figure 2

Currently there are no adapted varieties that can be safely sown prior to 20 April in SA. For example, trials at Roseworthy suggest that although the highest yield for the winter wheat Wedgetail is when it is sown in April, it is still lower than that of Estoc (Figure 3d).

Selecting varieties to optimise grain yield

In order to maximise yield from whatever variety is grown, it is important to time sowing of each variety to match its yield potential. The best time to sow Estoc is late April to early May, Mace from early May to early June, and Axe from mid-May to mid-June. Although it is important to consider optimum sowing time to maximise the yield of an individual variety, the actual yield potential of each of these varieties at all sowing times should also be compared. Figures 3a-3d suggest that Mace and Estoc will yield higher than Axe at all but the latest sowing dates, in the majority of seasons. The experiments used to generate the data described in this article were grown at Roseworthy. Therefore, it is important to note that the results should be interpreted and adapted to the local environmental conditions with reference to local climatic data and grower experience.

Selecting varieties to reduce the frost and heat risks is currently the best available management practice to reduce the potentially substantial losses caused by extreme temperature events. This is achievable with the range of maturity types available in varieties that are commonly grown in southern Australia. Using Axe, Mace and Estoc as contrasting examples, this report illustrates how grain yield from each variety can be maximised while minimising the risks of yield loss due to frost and heat stress. However, using a variety with a higher inherent yield potential that may suffer some yield loss as a consequence of exposure to frost and heat events during the sensitive reproductive and grain filling growth stages may achieve higher returns than a lower yielding variety grown for its specific maturity type. For example, Mace will have a higher yield than most varieties in most environments, even when sown outside of its optimum sowing window. In this case variety selection would reflect the grower's attitude to risk and return.

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Brougham, M 2006, 'The relationship between vernalisation sensitivity, photoperiod sensitivity, basic vegatative period and grain yield in Australian wheat germplasm' Honours Thesis, University of Adelaide.

Zheng, B, Chen, K, Dreccar, MF and Chapman, SC 2012, 'Breeding for the future: what are the potential impacts of future frost and heat events on sowing and flowering time requirements for Australian bread wheat (Triticum aestivium) varieties?' Global Change Biology, vol. 18, 2899–2914.

Acknowledgments

This project was funded jointly by AGT and the SA Grain Industry Trust Fund (SAGIT).

SAGIT

AGT
Australian Grain Technologies
SEEDS FOR SUCCESS

Early sowing of wheat – do winter wheats have a fit?

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[1]Birchip Cropping Group, [2]CSIRO, [3]FAR Australia

RESEARCH

Almost ready

Location:
Quambatook, VIC
Rainfall
Av. Annual: 239 mm
Av. GSR: 168 mm
Soil Type
Clay loam without sub-soil constraints

Key messages

- **Winter wheat cultivars Wedgetail and Rosella sown on 1 April were higher yielding than Scout sown on 6 May.**
- **Reducing plant density to 50 plants/m^2 did not reduce the ability of winter wheats to compete with a simulated weed population (tame oats) when sown on 1 April.**
- **Winter wheat sown early produced more dry matter for grazing than spring wheat sown in May.**

Why do the trial?

Due to the ongoing decline in autumn rainfall and increase in farm sizes, the widening of crop sowing windows through adoption of early sowing has the potential to significantly increase average farm wheat yield and profitability. There are two mechanisms behind the yield increase:

1. Slow maturing wheat varieties (winter wheat and longer season spring wheat varieties) sown early and managed correctly have a yield advantage over mid-fast maturing varieties sown later, as they capture more resources (water, nutrients, radiation), particularly during growth stages vital for yield formulation.
2. Including a slow maturing variety which allows early sowing in conjunction with currently-grown mid-fast varieties in a farm program results in more area of crop flowering on time, increasing average farm yield.

Slow maturing varieties sown early can produce excessive amounts of biomass and 'hay off' in dry springs. This can be avoided by planting at low densities (~50 plants/m^2) and deferring N inputs until after GS30, though this may compromise competition with weeds. Excessive dry matter production can also be managed by grazing slow maturing wheats in the vegetative phase, which has additional benefits for farms with a livestock enterprise. This trial aimed to answer three questions:

1. Do slow maturing wheats sown early (early April) yield as well as mid-fast maturing spring wheats sown in their optimal window in the Mallee?
2. Does planting slow maturing wheats at low plant densities compromise their ability to compete with weeds?
3. How much dry matter can slow maturing wheats produce for grazing and does defoliation affect yield?

For previous results please refer to the 2013 BCG Season Research Results, p 39.

This trial was carried out at Quambatook in Victoria, to assess the impact of time of sowing (TOS) on a range of wheat variety maturity classes (Table 1) and to measure the impact of plant density and the presence of weeds (simulated with tame oats) on these varieties.

How was it done?

One replicated trial was sown using a split plot trial design with knife points, press wheels and 30 cm row spacing. Granulock supreme Z fertilizer was applied @ 50 kg/ha at sowing plus 180 kg/ha of urea (83 kg N/ha) top-dressed in two separate applications. Herbicide Sakura® @ 118 g/ha was applied prior to sowing, Velocity® @ 670 ml/ha + Hasten® @ 1% v/v was applied in crop. The trial was managed to be disease free so received adequate fungicide applications.

Treatments included two times of sowing (TOS1 on 1 April and TOS2 on 6 May), sown at low (50 plants/m^2) and standard plant densities (150 plants/m^2). Targeted plant densities were not quite attained and actual plant densities were 38 and 88 plants/m^2 in the low and standard treatments respectively.

Oat seeds were spread over the plots at a density of 25 seeds/m^2 prior to sowing to simulate the presence of weeds. Grazing occurred on plots specific to variety growth stage (Table 2). Grazing was mechanically simulated using a line trimmer.

The trial was harvested on 13 November (TOS1) and 1 December (TOS2).

Table 1 Details and disease rating of wheat varieties used

Variety	Maturity	Year of release	Quality	CCN	Stem rust	Stripe rust	YLS
Scout	Mid-spring	2010	AH	R	MR	MS	S-VS
Lancer	Long-spring	2011	APW (APH in NSW)	S	R	MR	MS
Rosella	Fast-winter	1985	ANW/GP	S	MR-MS	MS	S
Wedgetail	Mid-winter	2002	APW (APH in NSW)	S	MR-MS	MS	MS-S

**Resistance rating: VS=very susceptible, S=susceptible, MS=moderately susceptible, MR=moderately resistant, R=resistant*

Cereals

Table 2 Grazing dates on varieties in 2014

Date	Treatment	TOS	Variety*
6 June	Grazing	1	Scout
10 June	Grazing	1	Lancer
19 June	Grazing	1	Wedgetail, Rosella
18 July	Grazing	2	Scout
18 July	Grazing	2	Lancer
25 July	Grazing	2	Wedgetail, Rosella

**All varieties were grazed pre GS30 being reached, targeted late tillering for all varieties*

What happened?

Plants emerged very evenly following 83 mm of rain in March. The 2014 season saw a number of frosts (defined as air temperatures below 2°C) across the region, with severe stem frost damage occurring in July and early August. At the Quambatook site, 85 days were recorded as having a minimum temperature below 2°C. This severely damaged the spring wheats (Lancer, Scout) sown on 1 April.

Slow maturing cultivars sown early vs. fast maturing cultivars sown late

In the TOS1 plots, Wedgetail at both plant densities and Rosella at 50 plants/m², were the highest yielding treatments (Table 3). The spring wheat cultivars Lancer and Scout suffered severe stem-frost damage when sown at this time. Lancer at 150 plants/m² suffered 68% mortality on main stems while Scout at the same plant density suffered 94%.

Wedgetail in TOS1 outyielded the 'local best practice' control (TOS2 Scout) by 0.3 t/ha (Table 4), and also achieved a higher protein content (13.9% vs 12.1%). Although Wedgetail's screenings and test weight were marginal (Table 5 and 6), when sown at 50 plants/m² it would have achieved a binned grade of APW in Victoria and APH2 in NSW (or if directly marketed in Melbourne etc.). This season APH2 was trading at around a $40/t premium over APW and delivery into NSW, or direct marketing, would have been worthwhile.

Somewhat surprisingly, the slow maturing spring cultivar Lancer was the highest yielding treatment in the trial in TOS2. This was probably because its slower maturity helped it escape a series of frosts in mid-September, which would have damaged Scout. The slow maturing winter wheats in TOS2 were lower yielding than those in TOS1.

Table 3 Influence of sowing date, variety and plant density on grain yield

	Yield (t/ha)		
TOS	**1 April**		**6 May**
Seeding rate	**50 plants/m²**	**150 plants/m²**	**150 plants/m²**
Wedgetail	2.0	2.0	1.1
Rosella	1.9	1.7	0.6
Lancer	1.4	1.7	2.3
Scout	1.2	1.1	1.7
Sig. diff.	P<0.001		
LSD (P<0.05)	*0.2*		
CV%	10.7		

Table 4 Influence of sowing date, variety and plant density on grain protein

	Protein (%)		
TOS	**1 April**		**6 May**
Seeding rate	**50 plants/m²**	**150 plants/m²**	**150 plants/m²**
Wedgetail	13.9	13.5	14.0
Rosella	13.2	14.3	16.3
Lancer	14.6	13.0	12.3
Scout	14.2	14.1	12.1
Sig. diff.	P<0.001		
LSD (P<0.05)	*1.4*		
CV%	6.9		

Table 5 Influence of sowing date, variety and plant density on screenings

	Screenings (%)		
TOS	**1 April**		**6 May**
Seeding rate	**50 plants/m²**	**150 plants/m²**	**150 plants/m²**
Wedgetail	4.5	6.0	3.2
Rosella	6.4	8.2	2.3
Lancer	5.9	5.3	2.6
Scout	11.7	13.5	3.1
Sig. diff.	P<0.001		
LSD (P<0.05)	*2.3*		
CV%	25		

Table 6 Influence of sowing date, variety and plant density on test weight

	Test weight (kg/hL)		
TOS	**1 April**		**6 May**
Seeding rate	**50 plants/m²**	**150 plants/m²**	**150 plants/m²**
Wedgetail	78	77	75
Rosella	82	81	78
Lancer	77	81	80
Scout	74	77	78
Sig. diff.	P<0.001		
LSD (P<0.05)	*3.1*		
CV%	3.0		

Table 7 Influence of simulated weed population (tame oats) on grain yield of wheat sown 1 April at different plant densities

	50 plants/m²			150 plants/m²		
Cultivar	**No weeds**	**Weeds**	**% yield loss**	**No weeds**	**Weeds**	**% yield loss**
Wedgetail	2.0	1.8	10	1.9	1.6	16
Rosella	1.9	1.5	21	1.8	1.5	17
Lancer	1.3	1.1	15	1.6	0.8	50
Scout	1.3	0.7	46	1.1	0.7	36
Sig. diff. (yield)	P<0.034					
LSD (P<0.05)	*0.3*					
CV%	15.4					

Competitiveness of slow maturing cultivars sown early at low densities

Sowing slow maturing cultivars such as Wedgetail at low plant density (50 plants/m^2) did not decrease their competitive capacity. Winter wheats (Wedgetail and Rosella) were much more competitive than Scout, but some of this effect was probably due to the stem frost damage sustained by Scout at the early time of sowing (Table 7).

Grazing early and late sown wheat

Slow maturing varieties sown early provided more dry matter for grazing than faster varieties sown later. Defoliation of TOS1 did not affect yield in Wedgetail but increased yield in Rosella and Scout. This was probably due to reduced stem frost damage. There was no effect (main or interaction) of grazing on protein, screenings or test weight (Table 8).

What does this mean?

The results emphasise two important aspects of early sowing (pre 20 April) in the Mallee. One, that early sowing of a proportion of the acreage allows higher yield potential to be achieved across the whole wheat acreage, and two, that the yield potential for early sown wheat can be realised only if the variety is adapted to the earlier sowing and emergence date, which in this trial involved sowing winter wheat cultivars, not spring wheats.

The results demonstrate the risk of sowing early with faster maturing spring wheats not adapted for sowing windows earlier than the traditional ANZAC day start date. The effect of frost on these spring wheats in TOS1 was first evident early in the spring as stem frost, and then again at flowering.

The dual purpose aspect of sowing a winter wheat variety early can be very appealing to mixed farmers who are looking to fill the early winter feed gap. If grazing these varieties, growers should ensure that stock are removed prior to GS30 to minimise the chances of a yield penalty.

Sowing a proportion of wheat area early with slow maturing cultivars when the opportunity arises can increase whole farm wheat yield and profitability. At present, the most reliable options for sowing before ANZAC day are winter wheats, particularly Wedgetail. Grazing winter wheats provides excellent feed during the winter feed gap and eases pressure on pastures for greater production in spring. This in-turn increases potential stocking rates and hence the profitability of livestock enterprises.

Acknowledgements

This trial was funded by GRDC and conducted in collaboration with CSIRO and FAR. This trial work was also partially funded through GRDC's Grain and Graze 3 project (SFS00028).

Table 8 Grain yield for different cultivars at different times of sowing

		Grain yield (t/ha)		Dry matter at grazing (t/ha)
Time of sowing	**Cultivar**	**Ungrazed**	**Grazed**	
1 April	Wedgetail	2.0	1.8	1.6
	Rosella	1.7	1.9	1.8
	Lancer	1.7	1.7	1.1
	Scout	1.1	1.5	1.1
6 May	Wedgetail	1.1	1.2	1.2
	Rosella	0.6	0.9	1.1
	Lancer	2.3	1.9	1.1
	Scout	1.6	1.6	1.3
Sig. diff.		P<0.001		P<0.001
LSD (P<0.05)		*0.2*		*0.2*
CV%		8.3		13.1

Managing Yellow Leaf Spot in wheat with fungicide and genetic resistance

Andrew Egarr, James Edwards, Dan Vater and Haydn Kuchel
Australian Grain Technologies (AGT), Roseworthy Campus

RESEARCH

Searching for answers

Location:
Rudall
Matthew and Mignon Dunn

Rainfall (Cleve)
Av. Annual: 355 mm
Av. GSR: 282 mm
2014 Total: 421 mm
2014 GSR: 294 mm

Yield
Potential: 4.1 t/ha (W)
Actual: 3.9 t/ha (Mace control)

Paddock History
2013: Wheat
2012: Pasture (medic)
2011: Wheat
2010: Pasture (medic)

Soil Type
Grey calcareous sand

Plot Size
1.25m x 3.2m x 3 reps

Yield Limiting Factors
Dry finish

Key messages

- **Propiconizole application is effective at reducing the incidence of Yellow Leaf Spot (YLS) infection in wheat.**
- **In this study, the most cost effective treatment was spraying foliar fungicide at both GS31 and GS39.**
- **Protecting susceptible varieties such as Scout and Shield with fungicide can lead to large financial benefits.**
- **Fungicide application is not able to eliminate YLS infection, so choosing resistant varieties may be a more effective solution when high YLS infection is expected.**
- **Under high YLS infection, resistant varieties may benefit marginally from fungicide application, but this needs to be confirmed with further study.**

Why do the trial?

The cost to growers due to fungal diseases can be considerable and the benefit of using fungicide has previously been reported by Australian Grain Technologies (AGT) and many others. Yellow Leaf Spot (YLS) is a rain dispersed, stubble borne fungal disease that occurs predominantly when wheat is grown in short rotation, particularly in a wheat on wheat situation. Yield losses are generally less than 15% but can be much higher in favourable conditions (GRDC fact sheet, September 2011 and GRDC Media release 20 April 2011: Growers need strategy to manage Yellow Leaf Spot). As there are fungicides registered for YLS control, this trial was conducted to determine if using these would produce a measurable yield improvement and if any yield increase would be economic or just a 'feel good exercise'. Also, the trial was designed to assess the effect of the resistance or susceptibility of a variety on the response to the fungicide.

How was it done?

As part of the South Australian Grain Industry Trust Fund (SAGIT) and AGT ongoing investigation into the effect fungicides have on the productivity and profitability of individual wheat varieties, a trial was conducted in 2013 near Rudall. YLS infection was high and no rust was present, therefore the specific roles of fungicide application and genetic resistance in YLS control were able to be effectively investigated.

Sixteen fungicide treatments were applied to five wheat varieties, chosen to include a range in resistance to YLS (Table 1). The fungicide treatments combined seed coating and spray applications at three growth stages: GS31 (first node detectable), GS39 (flag leaf fully emerged) and GS69 (completion of anthesis), and an untreated control. Although fungicide treated fertiliser was the preferred option, seed treatment was used due to logistical limitations associated with trial management. Seed treatment was fluquinconazole 167 g/L applied at 4.5 L/t, and spray treatments were propiconazole 250 g/L applied at 500 ml/ha. All plots were monitored for disease and scored for YLS at two growth stages, GS39 and GS69.

What happened?

The first visual scores for YLS damage were taken four weeks after the GS31 foliar application (when plants were at approximately GS39). Those plots sprayed at GS31 had less YLS damage than the seed treated and untreated plots. When flag leaf damage was scored four weeks after the GS39 spray (at GS69), the advantage of the GS31 spray had been reduced, while those sprayed at GS39 had less flag leaf damage than all other plots (Figure 1).

Table 1 YLS resistance ratings of the varieties used in the trial (SARDI Cereal Variety Disease Guide 2014)

Variety	Corack	Mace	Shield	Grenade CL Plus	Scout
YLS resistance rating	MR	MR – MS	MS – S	S	S – VS

Most of the fungicide treatments resulted in a positive effect on yield, test weight or screenings; and in general, the inclusion of a seed treatment improved the effect of subsequent foliar treatments. However, using a treatment on seed with no follow up foliar application, using a single foliar treatment at GS69, and combining these two treatments all showed a negligible positive effect (data not shown).

Figure 2 displays treatments that produced a yield advantage over the control. Yield improvement was seen after applying a single foliar application at either GS31 or GS39. However, the best yield response was from plots that received all four treatments, yielding on average 377 kg/ha higher than the un-treated control.

Figure 3 shows that many of the fungicide treatments increased test weight and decreased screenings compared to the untreated control. The greatest positive response to both test weight and screenings was observed in the treatments that included two foliar applications (at GS31 and GS39).

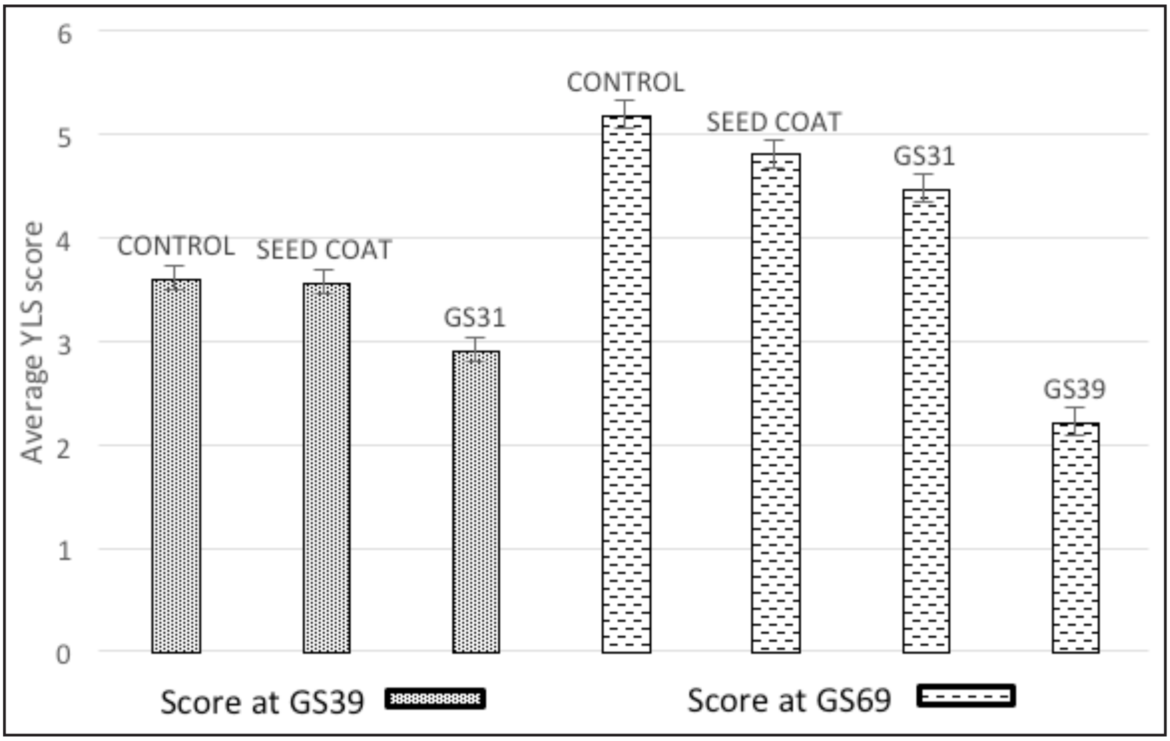

Figure 1 Average YLS score for all varieties scored at GS39 and GS69 (1 = lowest level of infection, 9 = highest level of infection)

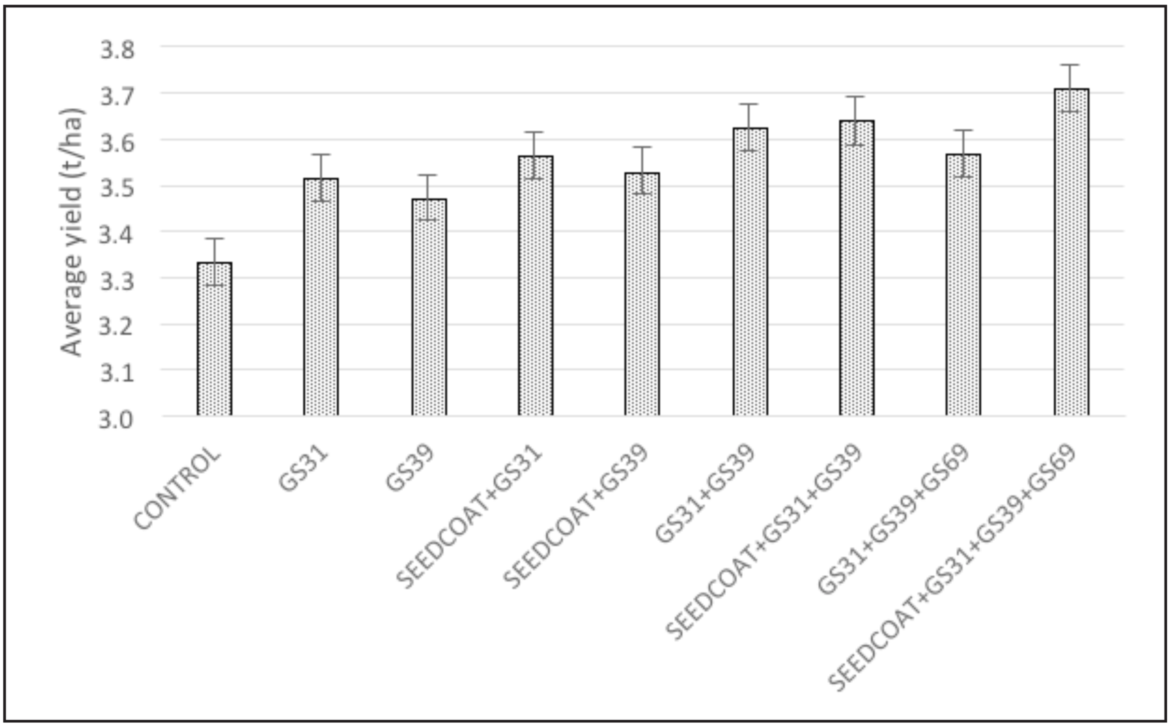

Figure 2 Average effect of fungicide application on grain yield

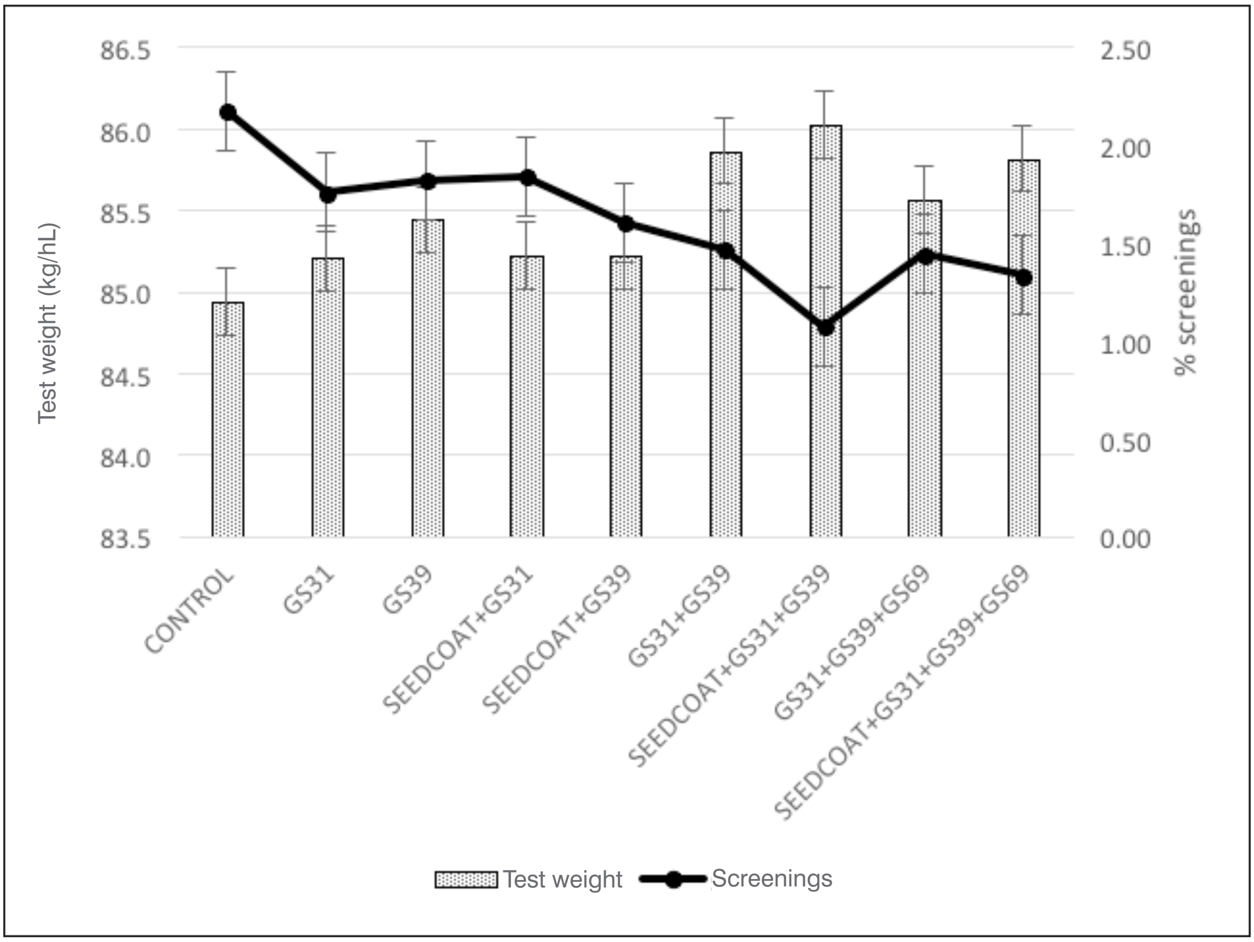

Figure 3 Average effect of fungicide application on test weight and screenings

Table 2 Cost of fungicide treatments

	Cost ($/ha)	Cost of application ($/ha)	Total cost per application ($/ha)
Seed treatment	24.8[1]*	at sowing	24.8
Fungicide spray	5.8	10	15.8

*[1]Seed treatment $550/10L, 4.5 L/tonne seed = $24.75/ha allowing 100 kg/ha seed rate, * no allowance for seed application.*

Table 3 Cost of application, yield response and economic gain for fungicide treatment combinations (return based on $253/tonne APW 10 year average)

Treatment	Cost ($/ha)	Yield response (kg/ha)	Return ($/ha)	Return after treatment ($/ha)
GS31	15.8	180	45	30
GS39	15.8	135	34	19
Seedcoat+GS31	40.5	230	58	18
Seedcoat+GS39	40.5	195	49	9
GS31+GS39	31.5	288	73	41
Seedcoat+GS31+GS39	56.3	306	77	21
GS31+GS39+GS69	47.3	235	59	12
Seedcoat+GS31+GS39+GS69	72.0	377	95	23

Table 4 Fungicide treatment effect on yield and net return* of five varieties with differing levels of resistance to YLS (values displayed for fungicide treatments are relative to the untreated control value)

Treatment	Corack (MR)		Mace ^ (MRMS)		Shield ^ (MSS)		Grenade CL PLUS ^ (S)		Scout ^ (SVS)	
	Yield (kg/ha)	Net return ($/ha)	Yield (kg/ha)	Net return ($/ha)	Yield (kg/ha)	Net return ($/ha)	Yield (kg/ha)	Net return ($/ha)	Yield (kg/ha)	Net return ($/ha)
Control	3649	923	3874	980	3124	790	3110	787	2911	737
GS31	-29	-23	156	24	217	39	206	36	348	72
GS39	113	13	133	18	129	17	92	8	211	38
Seedcoat+GS31	110	-13	203	11	208	12	136	-6	495	85
Seedcoat+GS39	251	23	61	-25	352	49	76	-21	234	19
GS31+GS39	-24	-38	3	-31	661	136	118	-2	684	142
Seedcoat+GS31+GS39	120	-26	115	-27	340	30	360	35	597	95
GS31+GS39+GS69	102	-21	126	-15	623	110	-19	-52	340	39
Seedcoat+GS31+GS39+GS69	303	5	325	10	635	89	256	-7	364	20

**Net return based on 10 year average APW price of $253/tonne, minus cost and application of fungicide*
^ Denotes varieties that have an AH quality classification and therefore may be eligible for higher returns

Table 2 outlines the costs of each fungicide treatment, while Table 3 shows the net returns of each treatment. When averaged across all varieties, applying foliar fungicide at both GS31 and GS39 gave the best result, increasing yield returns by $41/ha on average.

When the varieties were viewed individually, the most pronounced effects were observed in Scout and Shield. Although all varieties showed some degree of response to fungicide application, yield benefits for the other varieties were less consistent across treatments. With the exception of Corack (rated MR), the yield of all varieties was increased through the application of foliar fungicide at GS31. The financial impact of these treatments on each variety is shown in Table 4.

Spraying foliar fungicide at both GS31 and GS39 increased returns (after spraying costs) by approximately $140/ha in Scout and Shield. Conversely, this two-spray treatment had no financial benefit in the other varieties.

Many of the treatments showed economic losses for varieties Corack, Mace and Grenade CL Plus; and the economic gains that these varieties did produce were only minor in comparison to that of Scout and Shield. It is unclear why Grenade CL Plus, which is rated as susceptible to YLS, did not have a positive response to fungicide treatment similar to the other susceptible varieties Scout and Shield.

The effect on test weight was similar to yield: Scout and Shield were the only varieties to have a change in test weight associated with fungicide treatment. The test weight of both Scout and Shield increased by approximately 2.8 units using the seed+GS31+GS39 treatment, and by more than 2 units using the GS31+GS39 treatment (data not shown).

There was no significant treatment by variety effect on screenings. In all varieties there were fewer screenings in response to fungicide treatment, with the lowest screenings being observed for the seed+GS31+GS39 treatment.

What does this mean?

Application of fungicide reduced visible effects of YLS for all varieties, and treatments that included a foliar application at GS31 were particularly effective. Visual scoring of YLS damage showed that protection achieved by the foliar application at GS31 was reduced by GS69 (approximately 8 weeks). This suggests that propiconazole fungicide may only be active up to approximately four weeks after application, which is consistent with label recommendations and GRDC information. Therefore, a second foliar treatment may be required to ensure effective control of YLS, particularly in extended damp conditions.

Although the cosmetic improvement was observed regardless of the resistance level of the variety, large (and therefore likely repeatable) economic improvements from fungicide application were only observed in the more susceptible varieties Shield and Scout. Even under the maximum fungicide treatment, these susceptible varieties still had higher levels of YLS infection than the more resistant variety Mace and failed to reach its profitability under their best treatment (Table 4, Figure 4). Interestingly, even for the more resistant varieties Mace and Corack, targeted fungicide application was able to slightly improve profitability in the presence of high YLS infection. However, the financial benefits of these treatments were not consistent, and even the best treatment was just one sixth ($23-24/ha) of the return observed for the best fungicide treatment on Scout and Shield ($136-142/ha).

The greatest positive response to both test weight and screenings was observed in the treatments that included two foliar applications (at GS31 and GS39) and therefore these growth stages seem to be the most critical for fungicide application.

Given that this study has been carried out in just one location, where YLS infection was high, the risk of a negative return (loss) following fungicide application on Mace and Corack to control low-moderate YLS infection is likely. Additional environments and years are being investigated to confirm these effects under differing infection levels.

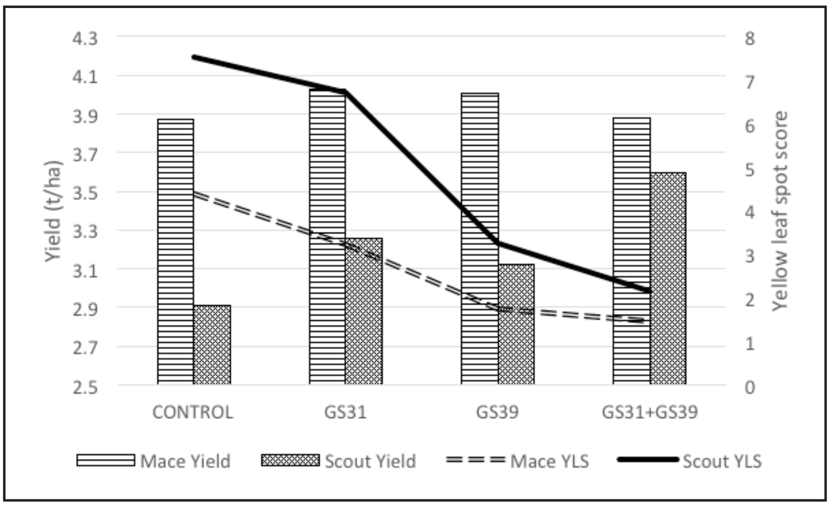

Figure 4 Effect of fungicide treatment on yield and YLS score taken at GS69 for Mace and Scout

Acknowledgments

This project was funded jointly by AGT and the SA Grain Industry Trust Fund (SAGIT).

Yellow Leaf Spot resistance scores sourced from the SARDI 2014 Sowing Guide.

SAGIT

AGT

Australian Grain Technologies

SEEDS FOR SUCCESS

SA Wheat variety yield performance *2014 and long term (2010-2014) expressed as t/ha and % of site average yield*

Variety	Upper Eyre Peninsula										Mid and Lower Eyre Peninsula						
	2014 (as % site average)							Long term av. across sites (10-14)			2014 (as % site average)				Long term av across sites (10-14)		
	Kimba	Minnipa	Mitchelville	Nunjikompita	Penong	Piednippie	Warramboo	t/ha	as % site av.	# Trials	Cummins	Rudall	Ungarra	Wanilla	t/ha	% site av.	# Trials
AGT Katana	FROSTED	102	147	99	95	93	FROSTED	2.36	102	28	98	FROSTED	97	114	4.38	102	15
Axe		97	142	94	96	97		2.27	98	28	97		99	88	4.20	98	15
Cobra		101	45	107	103	105		2.37	103	21	100		98	98	4.57	106	12
Corack		97	72	105	94	92		2.50	108	28	104		109	117	4.68	109	15
Correll		94	118	97	93	97		2.31	100	28	106		96	88	4.21	98	15
Cosmick		100	114	109	107	109		2.48	107	9	111		108	114	4.74	110	6
Emu Rock		98	172	93	97	99		2.40	104	28	94		105	105	4.43	103	15
Espada		98	123	96	95	92		2.40	104	28	108		99	90	4.35	101	15
Estoc		96	68	89	96	92		2.36	102	28	97		98	98	4.33	101	15
Gladius		101	100	95	93	91		2.32	101	28	101		92	91	4.24	98	15
Grenade CL Plus		99	91	93	99	96		2.30	99	21	101		95	86	4.14	96	12
Harper		-	-	-	-	-		2.36	102	7	95		94	101	4.28	99	8
Justica CL Plus		91	101	90	90	90		2.29	99	28	89		96	95	4.20	97	15
Kord CL Plus		98	106	91	95	86		2.34	101	21	96		92	96	4.20	97	12
Mace		106	65	94	104	94		2.51	109	28	93		109	113	4.62	107	15
Phantom		92	92	92	93	98		2.28	99	28	102		99	94	4.32	100	15
Scout		98	91	93	93	91		2.36	102	28	103		102	97	4.53	105	15
Shield		93	111	95	96	94		2.36	102	21	91		99	100	4.33	100	12
Trojan		115	62	114	115	122		2.49	108	21	112		107	89	4.73	110	12
Wyalkatchem		96	62	99	87	85		2.39	104	28	99		101	109	4.50	104	15
Yitpi		95	72	90	94	92		2.28	99	21	95		92	89	4.16	97	11
Supreme		-	-	-	-	-					93		102	108	4.45	103	5
Viking		-	-	-	-	-					106		92	92	-	-	-
Zen		-	-	-	-	-					104		105	117	4.62	107	5
Site av. yield (t/ha)		**3.44**	**0.57**	**2.83**	**1.82**	**2.24**		**2.36**		**28**	**4.01**		**4.07**	**2.32**	**4.37**		**15**
LSD % (P=0.05)		*7*	*16*	*8*	*6*	*8*					*11*		*8*	*11*			
Date sown	6 May	3 May	7 May	4 May	4 May	5 May	6 May				16 May	08 May	12 May	15 May			
Soil type	LS	L	LS	SL	SL	SL	SL				LC	LS	LSCL	SG			
J-M/A-O rain (mm)	88/224	102/290	72/126	122/218	86/198	124/258	116/231				78/325	123/260	121/315	83/399			
pH (water)	8	8.6	8.8	8.0	8.9	9.0	8.6				7.6	8.5	6.2	6.2			
Previous crop	peas	pasture	pasture	pasture	pasture	pasture	pasture				canola	pasture	beans	canola			
Site stresses	dl,fr	dl	dl,cr	dl,rh	dl	dl,rh	dl,fr				fr	fr,dl	dl	dl			

Soil type: S=sand, L=loam, C=clay, G=gravel
Site stress factors: cr=crown rot, dl=dry post anthesis, fr=frost, rh=rhizoctonia
Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2010-2014)
Data analysis by GRDC funded National Statistics Group

SA Barley variety yield performance *2014 and long term (2010-2014) expressed as t/ha and % of site average yield*

Variety	LOWER EYRE PENINSULA					UPPER EYRE PENINSULA							
	2014 (% site average)		Long term average across sites (2010-14)			2014 (as % site average)					Long term average across sites (2010-2014)		
	Cummins	Wanilla	t/ha	as % site av.	# Trials	Darke Peak	Elliston	Minnipa	Piednippie	Wharminda	t/ha	as % site av.	# Trials
Alestar	107	95	3.73	103	6	88	94	103	99	89	2.41	99	12
Barque	-	-	3.58	99	22	94	90	93	92	-	2.57	106	33
Bass	101	102	3.79	104	21	101	84	94	89	95	2.54	105	24
Buloke	98	107	3.68	101	28	90	101	88	94	100	2.53	104	37
Commander	103	101	3.82	105	28	104	94	100	95	100	2.62	108	37
Compass	99	119	4.12	114	8	106	111	119	114	119	2.95	121	12
Fathom	104	101	3.98	110	14	114	98	111	108	103	2.86	118	20
Flagship	88	97	3.54	97	28	92	93	89	87	96	2.48	102	37
Fleet	97	109	3.87	107	28	100	91	105	107	97	2.80	115	37
Flinders	91	87	3.69	102	14	80	92	87	87	92	2.42	100	20
Gairdner	108	78	3.50	96	26	-	-	-	-	84	2.39	98	9
Granger	104	92	3.84	106	14	94	87	101	80	90	2.53	104	20
Hindmarsh	100	117	3.99	110	26	110	116	99	109	116	2.76	113	33
Keel	98	102	3.70	102	28	106	102	119	99	112	2.63	108	35
La Trobe	106	110	4.04	111	11	113	109	110	110	112	2.77	114	16
Macquarie	95	77	3.51	97	10	-	-	-	-	84	-	-	-
Maltstar	98	97	3.75	103	8	103	93	102	102	96	2.41	99	8
Maritime	102	96	3.55	98	28	84	98	84	107	94	2.46	101	37
Oxford	97	91	3.82	105	19	89	81	88	82	93	2.41	99	24
Schooner	89	91	3.32	91	28	78	85	84	82	87	2.29	94	37
Scope	96	104	3.66	101	17	87	94	88	90	98	2.52	104	24
Skipper	98	106	3.87	107	14	109	102	106	103	111	2.72	112	20
Westminster	93	76	3.56	98	12	-	-	-	-	78	-	-	-
Site av. yield (t/ha)	**4.62**	**3.07**	**3.57**		**28**	**2.94**	**3.07**	**3.76**	**2.93**	**3.51**	**2.57**		**37**
LSD % (P=0.05)	*15*	*9*				*8*	*7*	*6*	*9*	*6*			
Date sown	16 May	15 May				8 May	13 May	13 May	15 May	14 May			
Soil type	LC	S				SL	S	L	SL	NWS			
J-M/A-O rain (mm)	78/325	83/399				123/260	47/296	102/290	124/258	70/252			
pH(water)	7.6	6.2				8.4	8.4	8.4	9.0	6.8			
Previous crop	canola	canola				canola	pasture	pasture	pasture	pasture			
Site stress factors	fr					dl	dl	dl	dl,rh	dl			

Soil type: S = sand, L = loam, C = clay, NW = non wetting. Site stress factors: dl=dry post anthesis, fr=frost, rh=rhizoctonia

Data source: SARDI/GRDC & NVT (long term data based on weighted analysis of sites, 2010-2014).

Data analysis by GRDC funded National Statistics Group

Section 2

Section Editor:
Amanda Cook
SARDI, Minnipa Agricultural Centre

Break Crops

Crop estimates by district (tonnes produced) in 2014

	Peas	Canola	Lupins	Vetch	Beans	Chickpeas
Western EP	4,500	6,000	1,000	400	0	0
Eastern EP	3,300	9,000	5,000	500	200	100
Lower EP	6,500	63,000	32,000	1,500	7,000	250

Source: PIRSA, January 2015, Crop and Pasture Report, South Australia

SA field pea variety trial yield performance 2014

(as a % of site mean) and long term (2010-2014) average across sites (as % of site mean)

	Lower Eyre Peninsula				Upper Eyre Peninsula		
Variety	**2014**		**2010-2014**		**2014**	**2010-2014**	
	Lock	**Yeelanna**	**% Site mean**	**Trial #**	**Minnipa**	**% Site Mean**	**Trial #**
Kaspa	86	86	92	10	98	105	4
Parafield			85	8		87	4
PBA Coogee**	73	73	91	6		84	2
PBA Gunyah	96	96	93	10	108	105	4
PBA Oura	110	100	106	10	101	99	4
PBA Pearl	115	111	123	10	70	102	4
PBA Percy	89	89	104	10	93	101	4
PBA Twilight	104	91	87	10	113	103	4
PBA Wharton	98	102	94	10	139	98	4
Sturt						93	4
Yarrum			105	4			
Site mean yield (t/ha)	**1.96**	**2.12**	**1.90**		**1.89**	**1.82**	
LSD (P=0.05)	*11*	*15*			*18*		
Date sown	12/05	20/05			5/5		
Soil type	S/SL	S/SL			L		
Previous crop	Wheat	Wheat			Barley		
Rainfall (mm) J-M/A-O	63/210	80/318			102/290		
pH (water)	8	8.4			8.6		
Site stress factors		wl,we			bs		

** = Dual purpose type (hay production, or green/brown manuring)
Soil Types: S=sand, L=loam, / = over
Site stress factors: wl=waterlogging, bs=black spot, we=weed competition high
Data source: *SARDI/GRDC, PBA & NVT (long term data based on weighted analysis of sites and courtesy National Statistics Program).*

EP faba bean variety trial yield performance 2014

2014 and predicted regional performance, expressed as % of site average yield

Variety	Lower Eyre Peninsula				Upper Eyre Peninsula			
	2014	Long term average across sites			2014	Long term average across sites		
	Cockaleechie	t/ha	% Site Mean	# Trials	Lock	t/ha	% Site Mean	# Trials
Farah	No valid result	2.13	100	11	97	1.55	101	4
Fiesta		2.13	100	11	98	1.56	101	4
Fiord		2.09	98	9	-	-	-	-
Nura		2.09	98	11	110	1.45	94	4
PBA Rana		1.99	94	9	89	1.37	89	3
PBA Samira					107			
Site av. yield (t/ha)		**2.13**			**1.17**	**1.54**		
LSD (P=0.05) as %					*0.13*			
Date sown					12 May			
pH (water)					8.0			
Apr - Oct rain (mm)					264			

Data source: SARDI/GRDC, NVT and PBA - Australian Faba Bean Breeding Program.
2007-2013 MET data analysis by National Statistics Program

EP lupin variety trial yield performance 2014

2014 and predicted regional performance, expressed as % of site average yield

Variety	Lower Eyre Peninsula					Upper Eyre Peninsula			
	2014		Long term average across sites			2014	Long term average across sites		
	Wanilla	Ungarra	t/ha	% of Site Mean	# Trials	Tooligie	t/ha	% of Site Mean	# Trials
Jenabillup	101	95	2.53	102	20	96	2.02	100	14
Jindalee	92	80	2.02	82	20	62	1.64	81	14
Mandelup	104	105	2.40	97	20	87	2.00	99	14
PBA Gunyidi	100	107	2.63	106	14	86	2.14	106	10
PBA Barlock	102	108	2.62	106	16	106	2.11	105	12
Wonga	99	92	2.24	90	16	104	1.85	92	12
Site av. yield (t/ha)	**1.84**	**1.76**	**2.48**			**1.16**	**2.01**		
LSD (P=0.05) as %	*0.23*	*9*				*0.19*			
Date sown	15 May	8 May				5 May			
Soil type									
pH (water)		5.9				6.7			
Apr - Oct rain (mm)	399	315				264			
Site stress factors		wl							

Site stress factors: wl=waterlogging
Data source: SARDI/GRDC & NVT
2007 - 2013 MET data analysis by National Statistics Program

SA chickpea variety trial yield performance 2014

(as a % of site mean) and long term (2010-2014) average across sites (as a % of site mean)

Variety	LOWER EYRE PENINSULA			UPPER EYRE PENINSULA		
	2014	2010-2014		2014	2010-2014	
	Yeelanna	% Site mean	Trial #	Rudall	% Site mean	Trial #
Desi trials						
Ambar	110	115	5	97		
Genesis 079	97	99	3	101		
Genesis 090	93			86		
Neelam	95	115	6	101	117	3
PBA Maiden	88	106	6	98	99	3
PBA Slasher	105	112	6	104	111	3
PBA Striker	99	111	6	99	112	3
Site mean yield (t/ha)	**1.52**	**1.69**		**1.69**	**1.08**	
LSD (P=0.05) as %	*13*			*11*		
Kabuli trials						
Almaz	101	100	3			
Genesis 079	99	105	3			
Genesis 090	100	108	3			
Genesis Kalkee	92	91	3			
PBA Monarch	84	92	3			
Site mean yield (t/ha)	**1.04**	**1.22**				
LSD (P=0.05) as %	*18*					
Date sown	20/5			12/5		
Soil type	S/SL			S/SL		
Rainfall (mm) J-M/A-O	80/318			63/210		
pH (water)	8			8		
Previous crop	Wheat			Wheat		
Site stress factors	we,dl					

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

Site stress factors: dl=post flowering moisture stress, we=weed competition high

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

SA lentil variety trial yield performance 2014

(as % of site mean yield) and long term (2010-2014) average across sites (as a % of site mean)

Variety	LOWER EYRE PENINSULA		
	2014	2010 - 2014	
	Yeelanna	% site mean	Trial #
Nipper	84	94	3
Nugget	101	98	3
PBA Ace	99	99	3
PBA Blitz	77	96	3
PBA Bolt	93	96	3
PBA Flash	95	106	3
PBA Herald XT	83	83	3
PBA Hurricane XT	126	100	3
PBA Jumbo	99	101	3
PBA Jumbo 2	122	108	3
Site mean yield (t/ha)	**1.22**	**1.80**	
LSD % (P=0.05)	*20*		
Date sown	20 May		
Soil type	S/SL		
Rainfall (mm) J-M/A-O	80/318		
pH (water)	8.4		
Previous crop	Wheat		
Site stress factors	wl, dl		
CV %	12.5		

Soil type: C=clay, L=loam, /=over

Site stress factors: dl=post flowering moisture stress, wl=waterlogging

CV=This trial has a high CV of 12.54% indicating high variability across the trial. Make variety selection decisions using information from multiple trials.

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

Eyre Peninsula canola variety trial yield performance

(2014 performance expressed as % of site average yield)

Variety	Lower Eyre Peninsula					Upper Eyre Peninsula						
	2014		Long term average across sites			2014			Long term average across sites			
	Mt Hope	Yeelanna	t/ha	% of site mean	No. Trials	Lock	Minnipa	Mt Cooper	t/ha	% of site mean	No. trials	
AV Garnet	99	88	2.35	106	10	96	NO TRIAL	NO TRIAL	1.25	108	5	Conventional
AV Zircon	91	94	2.28	103	8	75			1.09	95	4	
Hyola 50	106	113	2.45	111	10	106			1.34	117	5	
Hyola 635CC	94	104	2.41	109	3	77			-	-	-	
Nuseed Diamond	100	102	2.50	113	5	146			-	-	-	
Victory V3002	94	97	2.38	108	4	-			-	-	-	
Site av yield (t/ha)	**2.32**	**1.60**	**2.21**			**0.96**			**1.15**			
LSD (%)	*6*	*15*				*6*						
Archer	99	91	2.30	106	4	-	-	-	1.21	103	4	Clearfield
Carbine	-	-	2.17	99	4	-	-	-	1.24	105	2	
Hyola 474CL	99	107	2.16	99	6	106	110	113	1.36	115	2	
Hyola 575CL	98	111	2.21	102	8	107	110	113	1.36	115	5	
Hyola 577CL	95	96	2.24	103	2	-	-	-	1.25	106	3	
Pioneer 43Y85 (CL)	-	-	2.01	92	2	88	-	93	1.18	100	4	
Pioneer 44Y84 (CL)	-	-	2.18	100	8	-	-	-	-	-	-	
Pioneer 44Y87 (CL)	99	103	2.27	104	2	101	96	87	1.30	110	3	
Pioneer 44Y89 (CL)	102	102	-	-	-	116	109	111	1.42	120	4	
Pioneer 45Y86 (CL)	101	97	2.28	105	8	-	-	-	-	-	-	
Pioneer 45Y88 (CL)	98	93	2.33	107	4	-	-	-	1.17	99	5	
Site av yield (t/ha)	**2.23**	**2.20**	**2.18**			**0.95**	**1.84**	**1.43**	**1.18**			
LSD (%)	*6*	*11*				*7*	*5*	*6*				
ATR Bonito	-	-	2.04	103	4	91	95	113	1.24	101	3	Triazine Tolerant
ATR Gem	96	96	1.96	100	8	-	-		-	-	-	
ATR Stingray	93	85	1.86	94	10	120	105	118	1.31	107	5	
ATR Wahoo	93	81	2.01	102	6	-	-	-	-	-	-	
Crusher TT	-	-	2.05	104	8			-	-	-	-	
Hyola 450TT	103	114	1.96	99	4	114	101	116	1.34	109	2	
Hyola 559TT	-	-	2.07	105	5	111	104	121	1.41	114	3	
Hyola 650TT	108	103	2.09	106	3	-	-	-	-	-	-	
Hyola 750TT	103	89	-	-	-	-	-	-	-	-	-	
Monola 314TT	-	-	1.75	89	2	-	-	-	-	-	-	
Pioneer Atomic TT	-	-	-	-	-	104	93	73	1.36	111	2	
Pioneer Sturt TT	95	95	1.81	92	2	84	91	59	1.22	99	4	
Telfer	-	-	1.58	80	2	-	-	-	0.98	80	3	
Thumper TT	-	-	1.83	93	8	-	-	-	-	-	-	
Site av yield (t/ha)	**2.06**	**1.62**	**1.97**			**0.76**	**1.61**	**1.28**	**1.23**			
LSD (%)	*7*	*15*				*9*	*6*	*12*				
Date sown	30 Apr	30 Apr				1 May	30 May	8 May				
Soil type	LS	CL				SL	L	SCL				
Rainfall (mm) J-M/A-O	82/ 359	80/ 318				32/ 229	96/ 275	138/ 242				
Site stress factors		H										

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

Site stress factors: H=damage on TT and Conv

Data source: SARDI/GRDC, NVT and District Canola Trials. 2010-2014 MET data analysis by National Statistics Program.

Maximising canola yield by getting establishment right – upper EP experience in 2014

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

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Almost ready

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 2.26 t/ha (C)
Actual: 2.32 t/ha
Paddock History
2014: Canola and Field peas trials
2013: Spray topped pasture
2012: Oaten hay
2011: Wyalkatchem wheat
Plot Size
Replicated 1.5m x 10m
Yield Limiting Factors
Aphids, Diamond back moth

Key messages

- **Early sowing (15 April) had the largest positive impact on canola yield when comparing a range of treatments trialled in 2014, similar to results observed in 2013. Sowing on 15 April improved yields up to 45%, depending on variety, compared to 13 May sowing date.**
- **Good seeding depth and the correct seed rate proved important in maximising canola yield at the sites trialled in 2014, but not to the same extent as time of sowing. Sowing at 4.5 kg/ha at a 2 cm depth gave a 13% yield improvement over sowing at 1.5 kg/ha at 1 cm depth.**
- **Achieving approximately 50 plants/m^2 of triazine tolerant varieties and 40 plants/m^2 of Clearfield tolerant varieties was needed to maximise canola yields in trials conducted at Minnipa Agricultural Centre in 2014.**
- **Using farmer retained open pollinated seed did not cause a yield penalty when compared to commercially purchased seed in trials conducted at Minnipa in 2014.**

Why do the trial?

This is a South Australian Grains Industry Trust (SAGIT) funded project. It aims to maximise canola productivity through creating soil specific management strategies that improve canola yields, profitability and establishment in field trials on lower and upper Eyre Peninsula (EP).

In 2014, ten separate trials were conducted as part of this project at Minnipa Agricultural Centre, and Piednippie on upper EP. Four trials will be reported in this article but only from Minnipa Ag Centre trials, as the Piednippie trial site was too variable. Further trials were conducted on lower EP and will be reported in the LEADA results booklet.

How was it done?

Trial 1 – Time of Sowing (Minnipa Agricultural Centre)

Aim: To evaluate the effect of four different sowing times, in combination with two different seeding depths and two different seeding rates has on canola emergence and yield of two triazine tolerant varieties on Minnipa Agricultural Centre.

Treatments: Sowing dates: Time of Sowing (TOS) 1: 15 April 2014, TOS2: 30 April 2014, TOS3: 13 May 2014, TOS4: 29 May 2014. Two varieties were sown each time: ATR Stingray (open pollinated) and Hyola 559TT (hybrid). Sowing depths of, Normal (2 cm) and Deep (4 cm). Sowing rates: 40 plants/m^2 (equivalent to 1.8 kg/ha Stingray and 1.7 kg/ha Hyola 559TT) and 60 plants/m^2 (equivalent to 2.7 kg/ha Stingray and 2.6 kg/ha Hyola 559TT). Seed size: Stingray = 0.32 g/100 seeds and Hyola559TT = 0.37 g/100 seeds.

Management: The trial received a total of 71 kg/ha 19:13:0 S9% + 63 kg/ha Urea fertiliser, applied at seeding and a further 81 kg/ha of Urea and 168 kg/ha Sulphate of Ammonia (SOA) broadcast during the season (total of 113 kg/ha of nitrogen). 1 L/ha Atrazine (500g/L a.i), 250 ml/ha Select, 250 ml/ha Targa and 1% Kwicken was applied to control weeds. Multiple products were used during the season to control insects, which included aphids and diamond back moth.

Table 1 Grain yield (t/ha) for ATR Stingray and Hyola 559TT with four sowing times at Minnipa in 2014

Variety	TOS1	TOS2	TOS3	TOS4
ATR Stingray	2.25	1.59	1.22	0.34
Hyola 559	1.69	1.50	1.11	0.44
LSD (P=0.05)	*0.09*			
CV (%)	10			

Table 2 50% flowering date (start of flowering) for ATR Stingray and Hyola 559TT sown at two seeding rates (40 and 60 plants/m²); at 2 cm deep, over four sowing times at Minnipa in 2014

		50% Start of flowering dates	
Variety	**Rate TOS**	**40**	**60**
ATR Stingray	TOS1	9 Jul	8 Jul
	TOS2	30 Jul	30 Jul
	TOS3	19 Aug	19 Aug
	TOS4	6 Sep	6 Sep
Hyola 559TT	TOS1	31 Jul	29 Jul
	TOS2	10 Aug	10 Aug
	TOS3	28 Aug	27 Aug
	TOS4	06 Sep	06 Sep

Table 3 Grain yield and establishment rates for ATR Stingray and Hyola 559TT sown over four sowing times at Minnipa in 2014 at 2 and 4 cm sowing depths

		Grain yield (t/ha)				Emergence (plants/m²)			
Variety	Rate TOS/ Depth	40		60		40		60	
		4 cm	2 cm	4 cm	2 cm	4 cm	2 cm	4 cm	2 cm
ATR Stingray	TOS1	2.32	2.12	2.20	2.34	27	39	36	43
	TOS2	1.54	1.62	1.52	1.69	16	38	35	43
	TOS3	1.09	1.26	1.18	1.35	14	40	26	49
	TOS4	0.30	0.34	0.35	0.36	6	13	9	24
Hyola 559TT	TOS1	1.73	1.63	1.69	1.71	23	30	45	45
	TOS2	1.44	1.51	1.53	1.51	22	36	35	47
	TOS3	1.03	1.12	1.14	1.14	23	32	26	45
	TOS4	0.41	0.43	0.42	0.52	7	26	15	29
LSD (P=0.05%)	*TOS x rate x depth*	*0.18*				*10*			
CV (%)		10							

Break Crops

What does this mean?

- Time of sowing had a large impact on yield, where the earliest sowing time produced the highest yield and each subsequent time of sowing producing significantly lower yields.
- There was no penalty from seeding an early maturing variety such as ATR-Stingray in mid-April in 2014 i.e. it managed to utilise the soil moisture available very effectively, and didn't appear to be affected too greatly by early season frosts.
- The first three times of sowing had similar establishment rates (TOS1: 36, TOS2: 34, and TOS3: 32 plants/m^2, irrespective of variety, sowing depth and seeding rate), but establishment was almost reduced by half (TOS4: 16 plants/ m^2) for the final time of sowing.
- From this it can be deduced that while establishment can be significantly affected by time of sowing (TOS4 and data collected from a similar trial in 2013) for the majority of the 2014 seeding window (mid-April – mid-May) conditions were suitable to achieve good establishment rates and that the differences observed in yields from different seeding dates were more due to factors other than establishment, such as physiological development.
- Other treatments such as sowing depth and seeding rate while significantly affecting establishment, did not in general terms significantly affect grain yield within the same time of sowing (i.e. all treatments sown on the same day, regardless of sowing rate and sowing depth didn't yield significantly different to each other.)
- A similar trial was established in the high rainfall zone of lower EP, near Wanilla, and similar results were achieved.

Trial 2 – Triazine Tolerant Canola Emergence Trial

Aim: To evaluate the effect of two triazine tolerant varieties, sown at three different seeding rates and three different depths has on emergence and yield at Minnipa Agricultural Centre.

Treatments: The trial was sown on the 6 May 2014. The varieties ATR Stingray, a small seeded open pollinated variety, (seed size 0.32 g/100 seeds) and Hyola 450TT, a large seeded hybrid variety, (seed size 0.52 g/100 seeds) were used in all treatments. The trial was planted at three depths (1 cm, 2 cm, and 4 cm) and at three rates (1.5 kg/ha, 3 kg/ha and 4.5 kg/ha).

Management: This trial received a total of 71 kg/ha 19:13:0 S9% and 39 kg/ha Urea fertiliser, applied at seeding and 73kg/ha of Urea and 168 kg/ha SOA broadcast during the season (total of 110 kg/ha nitrogen). The trial received knockdown of Roundup, plus 60 ml/ha Hammer and a bare earth insecticide of 1L/ha Chlorpyrifos. 650 ml/ha Terbyne Extreme, 400 ml/ha Targa was applied to control weeds. Multiple products were used during the season to control insects, which included aphids and diamond back moth.

Table 4 Grain yield and establishment rates for ATR Stingray, and Hyola 450TT sown at Minnipa in 2014 at 2 and 4 cm sowing depths

Variety	Rate (kg/ha)	Grain yield (t/ha)			Emergence (plants/m^2)		
		1 cm	2 cm	4 cm	1 cm	2 cm	4 cm
Hyola 450TT	1.5	1.34	1.31	1.40	17	19	23
	3	1.39	1.36	1.48	32	47	40
	4.5	1.38	1.56	1.50	63	58	50
ATR Stingray	1.5	1.53	1.49	1.44	38	32	34
	3	1.70	1.72	1.66	58	65	52
	4.5	1.62	1.76	1.75	71	70	76
LSD (P=0.05%)	*depth x rate*	*0.14*			*7*		
CV (%)		8.1					

What does this mean?

- The highest yielding treatments were sown at 3 and 4.5 kg/ha, this gave significantly higher yields than treatments sown at 1.5 kg/ha.
- Sowing depth (seed sown at 1 cm, 2 cm or 4 cm) did not have a significant effect on yield Minnipa in 2014.
- Results from both of these trials indicate that low plant numbers can have a significant detrimental effect on yield and also suggests that growers should target an establishment rate of at least 50 plants/m^2 to maximise yield.
- Results from similar trials sown on sandier soils (Piednippie and Wanilla) conducted in 2014, but not reported here, show that seed placement is more important on sandier soils. Sowing at 4 cm deep significantly reduced yields compared to 2 cm.

Trial 3 – Clearfield Tolerant Canola Emergence Trial

Aim: To evaluate the effects of seed source, sowing depth and seeding rate on Clearfield canola emergence and yield at Minnipa Agricultural Centre.

Treatments: This trial was sown on the 6 May 2014. The varieties used in this trial consisted of open pollinated Pioneer 43C80 (seed size 0.43 g/100 seeds) and hybrid Pioneer 43Y85 (0.62 g/100 seeds). The trial was planted at three depths (1 cm, 2 cm, and 4 cm) and at three rates (1.5 kg/ha, 3 kg/ha and 4.5 kg/ha).

Management: This trial received a total of 71 kg/ha 19:13:0 S9% and 39 kg/ha Urea fertiliser, applied at seeding and 73 kg/ha of Urea and 168 kg/ha SOA broadcast during the season (total of 110 kg/ha nitrogen). The trial received knockdown of Roundup, plus 60 ml/ha Hammer and a bare earth insecticide of 1 L/ha Chlorpyrifos. 650ml/ha Intervix, 400 ml/ha Targa was applied to control weeds. Multiple products were used during the season to control insects, which included aphids and diamond back moth.

Break Crops

Table 5 Grain yield and establishment rates for Pioneer 43C80 and Pioneer 43Y85 sown at Minnipa in 2014 at 2 and 4 cm sowing depths

Variety	Rate (kg/ha)	Grain yield (t/ha)			Emergence (plants/m^2)		
		1 cm	2 cm	4 cm	1 cm	2 cm	4 cm
43C80	1.5	1.32	1.27	1.36	31	36	28
	3	1.48	1.38	1.40	47	46	48
	4.5	1.45	1.45	1.46	62	69	49
43Y85	1.5	1.32	1.18	1.24	27	20	22
	3	1.49	1.44	1.42	41	32	29
	4.5	1.43	1.51	1.40	47	58	42
LSD (P=0.05%)	*depth x rate*	*0.07*			*6*		
CV (%)		4.7					

Table 6 Grain yield and establishment rates for farmer retained Pioneer 43C80CL (graded large and small) and store purchased 43C80 sown at Minnipa in 2014

	Grain yield (t/ha)				Emergence (plants/m²)			
Rate (kg/ha)	1.5		4.5		1.5		4.5	
Size/depth	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
Large	1.23	1.26	1.49	1.44	35	20	41	59
Small	1.27	1.37	1.44	1.49	17	47	39	66
Store	1.28	1.40	1.51	1.48	24	30	57	72
LSD (P=0.05%)	*0.12*				*11*			
CV (%)	5.1							

What does this mean?

- The lightest seeding rate (1.5 kg/ha) yielded lower than the heavier rates (3 and 4.5 k/ha) for both varieties. Establishment rates were significantly lower in these treatments.
- Sowing depth (seed sown at 1, 2 or 4 cm) did not have a significant effect on yield Minnipa in 2014.
- Results from this trial indicates that sowing canola too thin can have a significant detrimental effect on yield and also suggests that growers should target an establishment rate of at least 40 plants/m² to maximise yield.

Trial 4 – Retained Clearfield Tolerant Seed Trial

Aim: To evaluate the effect of retaining seed on yield and establishment of Clearfield canola at Minnipa Agricultural Centre when sown at two different rates and two different depths.

Treatments: This trial was sown on the 6 May 2014. The variety used in this trial was open pollinated, Pioneer 43C80. The seed came from commercially purchased seed (store) (seed size 0.43 g/100 seeds), retained seed graded smaller than 2 mm (small) (seed size 0.33 g/100 seeds) and retained seed graded larger than 2 mm (large) (seed size 0.44 g/100 seeds). The trial was planted at two depths (2 cm and 4 cm) and at two rates (1.5 kg/ha and 4.5 kg/ha).

Management: This trial received a total of 71 kg/ha 19:13:0 S9% and 39 kg/ha Urea fertiliser, applied at seeding and 73 kg/ha of urea and 168 kg/ha SOA broadcast during the season (total of 110 kg/ha nitrogen). The trial received knockdown of Roundup, plus 60 ml/ha Hammer and a bare earth insecticide of 1 L/ha Chlorpyrifos. 650 ml/ha Intervix, 400 ml/ha Targa was applied to control weeds. Multiple products were used during the season to control insects, which included aphids and diamond back moth.

What does this mean?

- Retaining seed and the size of the seed did not significantly affect yield in this trial. The highest seeding rate produced the highest yields regardless of seeding depth or seed source.
- This trial again showed that seeding rates need to be sufficient to achieve 40 plants/m² in order to maximise yield.
- Similar results were achieved from a trial using retained seed of triazine tolerant variety Pioneer Sturt TT at Minnipa in 2014, but as no commercial seed was available for comparison, full results are not reported here.

Acknowledgements

Thank you to the South Australian Grains Industry Trust (SAGIT) for providing the funding. Thank you to Minnipa Agricultural Centre for providing the land to the trials. ATR Stingray is a registered variety of Nuseed Pty Ltd. Hyola 559TT and Hyola 450TT are registered varieties of Pacific Seeds. Pioneer 43C80 and Pioneer 43Y85 are registered varieties of DuPont Pioneer.

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Nitrous oxide emission levels in response to alternative crop rotations

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RESEARCH

Searching for answers

Location:
Minnipa Ag Centre,
Airport paddock
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Paddock History
2013: Wheat (Mace)
2012: Wheat (Kord)
Soil Type
Calcareous red sandy loam
Plot Size
10m x 3m x 3 reps

Location:
Wanilla: David Giddings
Rainfall
Av. Annual: 550 mm
Av. GSR: 400 mm
2014 Total: 437 mm
2014 GSR: 368 mm
Paddock History
2013: Canola
2012: Wheat
Soil Type
Duplex sand over loam
Plot Size
10m x 3m x 3 reps

Key messages

- **Work conducted in low and medium rainfall environments indicate that N_2O emissions are low from an overall national perspective.**
- **Results showed that there was no clear response of N_2O emissions to nitrogen applied at sowing and post sowing.**
- **High pre-sowing soil mineral nitrogen raises the possibility of higher N_2O losses over the fallow period following significant rainfall.**

Why do the trial?

Agricultural soils are the main source of emission of the greenhouse gas (GHG) nitrous oxide (N_2O) to the atmosphere. N_2O is a potent GHG which lasts in the atmosphere for 114 years and has a global warming potential of approximately 300 times greater than that of carbon dioxide over a 100 year timescale. Agriculture accounts for 16% of Australia's greenhouse gas emissions but produces 80% of Australia's N_2O emissions.

This project seeks to measure and quantify N_2O emissions from wheat grown in rotation with canola, pulses and legume pastures at two sites in low and medium/high rainfall farming systems of the Eyre Peninsula, while assessing best management practices that local farmers can adopt to reduce the risk of N_2O losses and ultimately improve the paddock's crop productivity and gross margin.

How was it done?

During the first year of the trial, the plots were sown to canola, legume pasture (annual medic/ sub clover) and pulses (lupins/peas) and the data was presented in the Eyre Peninsula Farming Systems (EPFS) Summary 2013, p75. In 2014 (Table 1), both trial sites were sown to Mace wheat; [1]Minnipa Agricultural Centre (MAC) on 12 May 2014 and [2]Beaumont (near Wanilla) on 11 May 2014.

All treatments were replicated 3 times. Diammonium phosphate fertilizer (DAP) was applied at sowing; 50 kg/ha at MAC and 80 kg/ha at Beaumont. 21 units of nitrogen (N) were applied on the canola-wheat high input plots at MAC at growth stage 31 (15 July) and 56 units of N were applied at Beaumont on the canola-wheat high input treatment (28 units at sowing and 28 units at growth stage 31on 18 July).

N_2O gas sampling was done 5 times at MAC (11 and 14 April; 14 May; 14 and 18 July). At Beaumont sampling was done 5 times; on 30 April, 2 and 13 May, 10 and 21 July). Associated measurements collected at the time of gas sampling included:

- 0-10 cm and 10–30 cm soil water content (mm)
- Live crop biomass and stubble biomass (t/ha)
- Soil temperature (5 cm)
- 0–10 cm and 10–30 cm soil samples for mineral nitrogen (NH_4 and NO_3) analysis.

MAC trial was harvested on 5 November 2014 and Beaumont, on 25 November 2014.

Table 1 Trial treatments and rotation crops

	Year 1 crop	Year 2 crop	Treatment
1	canola-high input	wheat	Recommended yield potential rate of N
2	canola-low input	wheat	Recommended rate of N, nothing post seeding
3	[1]annual medic, [2]sub clover	wheat	Recommended rate of N, nothing post seeding
4	[1]field peas, [2]lupins	wheat	Recommended rate of N, nothing post seeding

What happened?

2013 N_2O fluxes ranged from 0–38.9g N_2O-N/ha/day (MAC) and 1.1–129.9 g N_2O-N/ha/day (Beaumont). However the N_2O fluxes for 2014 at both sites were much lower, ranging from 0.3–11.1 g N_2O-N/ha/day at Beaumont and 0–4.7 g N_2O-N/ha/day at MAC. The highest N_2O fluxes occurred on the canola-wheat high input treatments. Mean N_2O emissions were significantly higher on the canola-wheat high input treatment at Beaumont, but no significant differences in mean emissions were observed at MAC on all treatments (Table 2).

N_2O emissions at MAC peaked on a sampling done on 11 April, at 4.7 g N_2O-N/ha/day (Figure 1) and dropped to levels below 1.5 g N_2O-N/ha/day 3 days later. N_2O fluxes were relatively low after sowing (0–1.1 g N_2O-N/ha/day, and there was no indication of an increase in emission as a result of in crop N applied at GS31 (15 July 2014). The drop in soil temperature (23.4°C – 10.3°C) may have been part of the lower N_2O fluxes post sowing, coupled with low mineral nitrogen (8–12 mg/kg (NO_3 + NH_4) compared to 26–41 mg/kg on 14 April 2014.

Emission levels at Beaumont peaked at 11.1 g N_2O-N/ha/day pre-sowing following a rainfall event (30 mm on 29 April) and were higher post sowing (0.3 – 7.3 g N_2O-N/ha/day) as compared to MAC. There was an indication of an emission response (Figure 2) from the canola-wheat high input treatment, to the in-crop N applied at sowing (11 May) and GS31 (15 July).

In 2014, the wheat following lupins grain yield (2.93 t/ha) at Beaumont was significantly higher than the other treatment yields, and at MAC annual medic had the highest grain yield (2.91 t/ha), however it was not significantly higher than the other treatment yields (Table 2). The canola-wheat treatment had the highest grain protein (%) at both sites. There were no significant differences in grain protein and screenings at MAC.

A gross margin analysis for the 2014 wheat crop (not including 2013 rotation) was carried out using guidelines from the Farm Gross Margin and Enterprise Planning Guide, Rural Solutions, SA (2014). Wheat following annual medic had the highest gross margin ($477/ha) at MAC, while wheat following sub-clover had the lowest gross margin at Beaumont (Table 3).

The total variable costs were highest in the canola-wheat high input treatment at both sites due to urea inputs and freight costs, and this reduced the gross margin by 47% for the canola-wheat high input crop at Beaumont.

What does this mean?

The National Nitrous Oxide Research Program has found that N_2O emissions can range from 0.03 to 1 kg N_2O-N/ha/day depending on environment and soil type, and work conducted in low and medium rainfall environments indicate that N_2O emissions are low from an overall national perspective.

Table 2 Average N_2O emissions from 5 samplings at MAC and Beaumont in 2014

MAC		Beaumont	
Treatment	**Mean N_2O fluxes (gN_2O-N/ha/day)**	**Treatment**	**Mean N_2O fluxes (gN_2O-N/ha/day)**
ex canola H	1.34 a	ex canola H	5.71 a
ex canola L	0.71 a	ex canola L	2.97 b
ex medic	0.78 a	ex sub clover	2.14 b
ex peas	0.50 a	ex lupins	2.52 b
LSD (P=0.05)	*0.85*		*1.62*

Means followed by the same letter are not significantly different

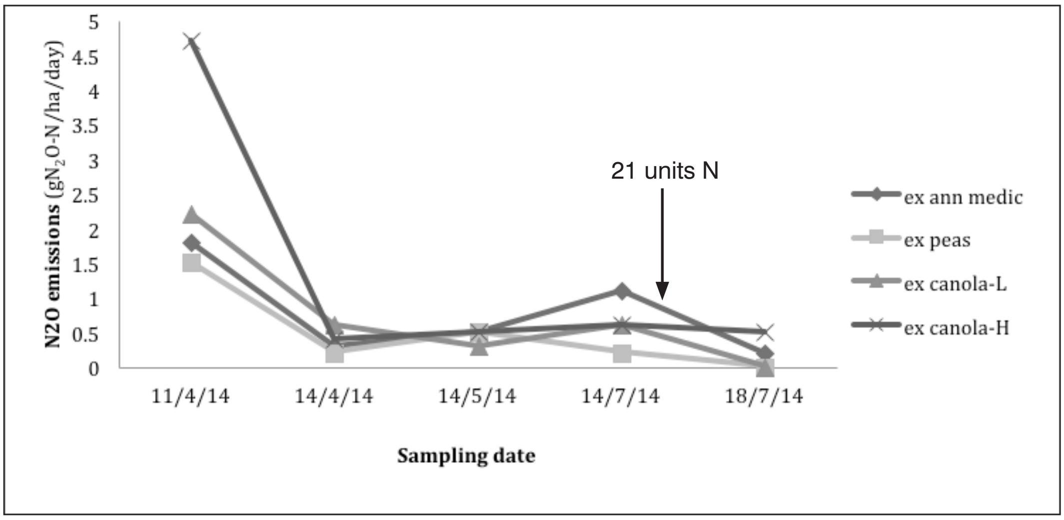

Figure 1 MAC N_2O fluxes in 2014

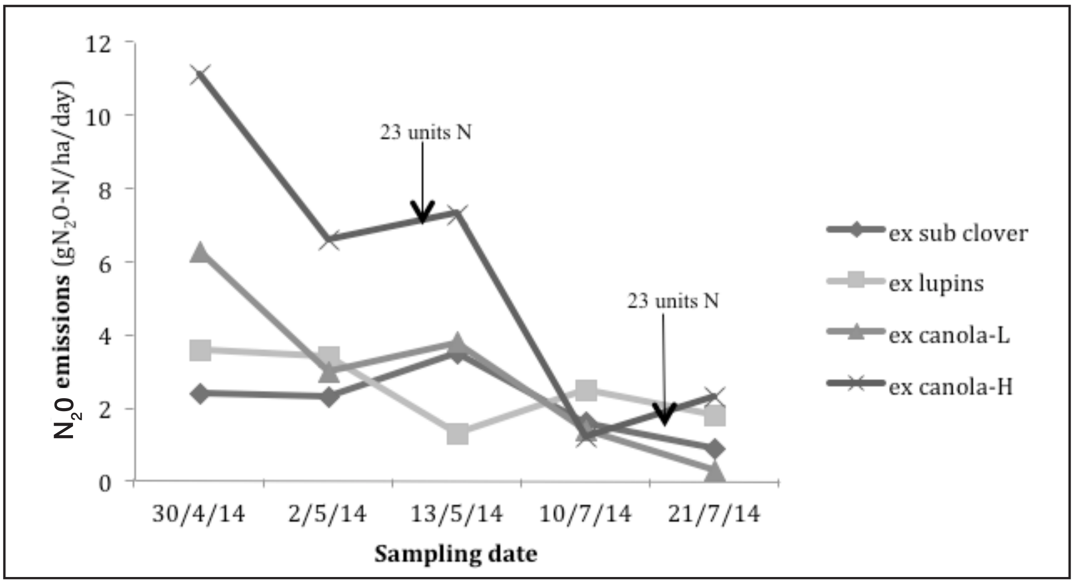

Figure 2 Beaumont N_2O fluxes in 2014

Table 3 Crop productivity and gross margins for Mace wheat at MAC and Beaumont in 2014

Location	2013 crop	2014 Crop productivity				Gross margin analysis		
		Yield (t/ha)	Protein (%)	Screenings (%)	Grain N uptake (kg/ha)	Gross income ($/ha)	Total variable costs ($/ha)	Gross margin ($/ha)
MAC	medic	2.9	9.7	1.6	49.4	717	239	477
	canola L	2.6	9.6	0.7	44.5	648	234	414
	field peas	2.7	9.7	0.9	44.9	655	234	421
	canola H	2.8	10.3	1.1	50.3	682	266	416
LSD (P=0.05)		*0.34*	*0.68*	*0.79*	*8.08*			
CV		6.1	3.5	37.3	8.6			
Beaumont	sub clover	2.3	9.3	6.2	37.8	564	233	331
	canola L	2.4	9.3	6.2	38.4	576	234	342
	lupins	2.9	9.7	4.4	49.6	721	245	476
	canola H	2.7	10.3	5.6	48.6	657	310	346
LSD (P=0.05)		*0.42*	*0.35*	*2.01*	*8.08*			
CV		8.2	1.8	17.9	9.30			

2014 All treatments sown to wheat (Mace)

Results presented so far indicate that N_2O emissions were low at both sites on the Eyre Peninsula as compared to high rainfall (>650 mm) farming systems of South West Victoria with emissions up to 588 g N_2O-N/ha/day (Harris et al., 2014).

Results also showed that there was no clear response of N_2O emissions to higher soil mineral N and moisture. The water-filled pore space (WFPS) percentage ranged from 33–42% for MAC and 20–75% for Beaumont, indicating that most of the N_2O losses occurred through nitrification and not denitrification which is driven by oxygen limiting waterlogged conditions. 2013 peak N_2O fluxes of 129 and 39 g N_2O-N/ha/day for Beaumont and MAC respectively suggest that high pre-seeding soil N (levels > 75 mg/kg NH_4 + NO_3) can have a great influence on N_2O losses over the fallow period following a significant rainfall event.

There was a weak correlation between N_2O emission and the key factors that drive emissions i.e. WFPS, mineral N, and soil temperature (low r^2 values for both sites ranging from 0.01–0.48 after a linear regression analysis), hence more work needs to be done to better understand the key drivers of N_2O emissions on the Eyre Peninsula.

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Forage peas – a potential new break crop option for SA?

RESEARCH

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Searching for answers

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: Pulses 2.7 t/ha
Actual: Peas 1.5 - 2.1 t/ha
Paddock History
2013: Spray topped cereal
2012: Barley
2011: Wheat
Soil Type
Red loam
Plot Size
1.5m x 10m x 3 reps
Yield Limiting Factors
High black spot infection, late season moisture stress

Key messages

- **The new forage field pea, PBA Hayman performed poorly under high blackspot disease pressure in 2014. It appears to be less suited to conditions at Minnipa than it is to other parts of SA such as the Mid North, where it has shown higher biomass production potential than alternative field pea varieties (up to 70%), however it is more susceptible to black spot and has lower grain yields.**
- **Vetch varieties produced greater biomass than field peas at Minnipa over two years of evaluation, but field peas had equal or higher grain yields.**
- **Dual purpose field pea varieties offer the flexibility of a "forage" option if grain yield is affected by seasonal stresses such as frost, and more established grain markets than vetch if taken through to harvest.**
- **Blackspot significantly reduced biomass production and most likely grain yield of field peas in 2014, particularly in PBA Hayman. Sowing dates of field peas in these environments need to be as early as possible around safe "black spot manager" predictions to avoid heavy disease infections in wet years.**
- **Kaspa and Morgan had similar biomass production levels to PBA Coogee but equal or higher grain yields, however PBA Coogee remains a dual purpose field pea option in disease prone areas due to improved resistance to bacterial blight and resistance to powdery mildew.**
- **Where sowing of field peas was delayed, biomass was maximised by increasing sowing densities above 50 plants/m^2 with little negative effect on grain yield.**

Why do the trial?

These trials form part of a SAGIT funded project which aims to assess the potential of the newly released forage (PBA Hayman) and dual purpose (PBA Coogee) field pea varieties as alternatives to vetch and grain field peas. Outcomes from these trials and similar trials at Lameroo, Hart and Tarlee will be used to develop agronomic management guidelines to allow the successful production of these varieties in SA.

How was it done?

Two forage experiments were undertaken at Minnipa in 2014 following on from similar trials held in 2013. The first experiment aimed to compare field pea and vetch varieties for biomass and grain yield potential, and the second to determine optimum sowing dates and sowing densities for maximising biomass production of field pea varieties. In the first trial, four field pea varieties (Kaspa, Morgan, PBA Coogee and PBA Hayman) and four vetch varieties (Morava, Rasina, Capello and Volga) were sown at two sowing dates (5 May and 3 June). The second trial included the four field pea varieties sown at four plant densities (25, 50, 75 and 100 plants/m^2) sown on the same dates. In both trials biomass measurements were taken during flowering and at maturity. Cuts during flowering were timed to correlate with early pod development (1-2 flat pods per plant, approximately 10-14 days after commencement of flowering). Final grain yield was also recorded.

All trials were sown with 59 kg/ha of DAP (18:20:0:0) and weeds and pests were controlled as required in line with standard field pea management.

What happened?

Early growing season conditions at Minnipa were similar to those in 2013. Above average rainfall and warm temperatures favoured rapid early plant growth but also high levels of disease pressure. The 'Blackspot Manager' disease prediction for Minnipa at the early sowing date was for a medium risk level indicating that a yield loss in field peas of 20-35% could occur. Growing season rainfall (290 mm) and annual rainfall (407 mm) were both around 50 mm above average with almost all of this falling by the end of July. Moderate to high levels of early season black spot disease infection did occur and restricted early vegetative growth.

Higher levels of disease infection were observed in PBA Hayman compared with all other varieties. Like the rest of South Australia rainfall ceased in spring and the finish to the season was characterised by a dry but relatively cool finish to the season. Grain yields of Kaspa field peas averaged 1.3 t/ha sown 5 May and 1.0 t/ha sown 3 June and were below potential yields due to the combination of high disease loading and late season moisture stress.

Trial 1 Comparison of field pea and vetch cultivar performance

PBA Coogee commenced flowering around a week before Kaspa and Morgan at both sowing dates in 2014. PBA Hayman was 18 days later than Kaspa at the early sowing date and a week later when sown in June. Similar to the 2013 results all field pea varieties except PBA Hayman flowered earlier than vetch varieties when sown in early May. At the later sowing time flowering commencement dates were more condensed than at the earlier timing but a similar ordering of varieties was observed (Table 1).

An interaction between sowing date and variety for both Early Pod Development Stage (EPDS) biomass production and grain yield occurred in 2014. Delaying sowing by 5 weeks from early May to early June resulted in a two to three fold reduction in biomass yields in all varieties except for the very low yielding forage pea variety PBA Hayman, where no response occurred (Figure 1). In contrast a three week delay in sowing in 2013 resulted in a more moderate biomass reduction of 30% across all varieties. Apart from Morava which had a similar biomass yield to Kaspa, all vetch varieties produced higher biomass yields than the field peas at the early sowing date. It is likely that biomass production of the field peas was restricted by high black spot disease infection, particularly in PBA Hayman which has been found to be more susceptible than the other varieties. Morava vetch had lower biomass yields than the other vetch varieties when sown early, different to the 2013 result where it was found to produce higher yields than the early flowering variety Rasina. At the late sowing date all field pea and vetch varieties had similar biomass yields except for PBA Hayman which while similar to the other field peas was lower yielding than all vetch varieties.

Biomass yields at maturity showed a similar trend to EPDS biomass yields with vetch still having higher yields than field peas, although this time Volga was lower yielding than Rasina and Morava which performed similarly (data not shown). Final biomass yields were lower in some varieties than those recorded at the EPDS. This is likely to be due to significant leaf drop occurring at maturity from blackspot infections in field peas and the rapid dry down conditions during spring in the later maturing vetch types.

Grain yields (Figure 2) were reduced by a delay in sowing time in the grain field pea variety Kaspa and the common vetch varieties Morava, Rasina and Volga.

Table 1 Flowering dates of field pea and vetch varieties, Minnipa 2014

Field Pea	**Variety**	**Kaspa**	**Morgan**	**PBA Coogee**	**PBA Hayman**
	5 May	17 Aug	18 Aug	11 Aug	5 Sep
	3 June	15 Sep	10 Sep	6 Sep	22 Sep
Vetch	**Variety**	**Morava**	**Rasina**	**Volga**	**Capello**
	5 May	11 Sep	4 Sep	4 Sep	13 Sep
	3 June	18 Sep	11 Sep	15 Sep	16 Sep

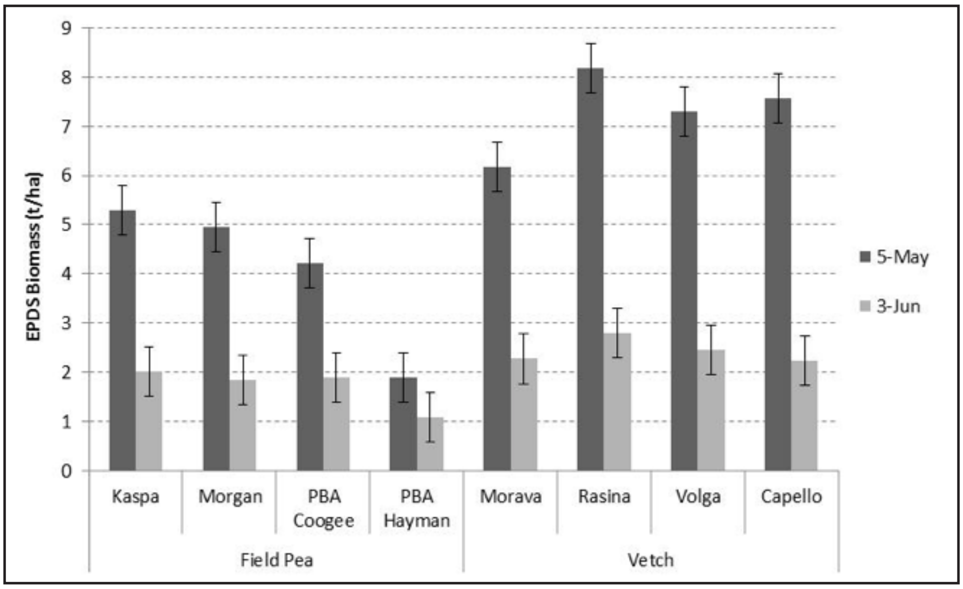

Figure 1 Effect of sowing date on early pod development stage (EPDS) biomass yield (t/ha) of field pea and vetch varieties, Minnipa 2014

There was no response in grain yield to a delay in sowing time in the dual purpose and forage pea and the woolly pod vetch, Capello. Kaspa had higher grain yields than all varieties except Rasina when sown early and all varieties when sown late. The "dual purpose" field pea varieties Morgan and PBA Coogee showed similar grain yields as found in 2013 and as expected, the forage field pea PBA Hayman produced the lowest grain yield of all field pea varieties, and also showed lower grain yield than all vetch varieties, again as found in 2013.

Trial 2 Maximising biomass potential of forage and dual purpose field pea varieties through sowing date and plant density

A variety by seeding density interaction occurred for both EPDS biomass production and grain yield in this experiment. As found in Experiment 1, PBA Hayman had very low biomass yields and exhibited little response to changes in seeding density. All other varieties had very low yields with 25 plants/m² and maximum yields with 75 to 100 plants/m² (Figure 3). This finding was different to that in 2013 where maximum biomass production occurred with 50 plants/m² and again is likely to be a reflection of the increased disease levels and dry season finish last year. Grain yield trends reflected a similar pattern to biomass production and there was no yield penalty associated with the higher seeding densities in 2014 (Figure 4).

What does this mean?

Dual purpose and/or forage field pea varieties were developed with the aim of providing growers with a competitive alternative to vetch and other current break crop options. Dual purpose field pea varieties may also provide growers with the flexibility to react to seasonal conditions eg. frost, drought, or high grain/hay prices.

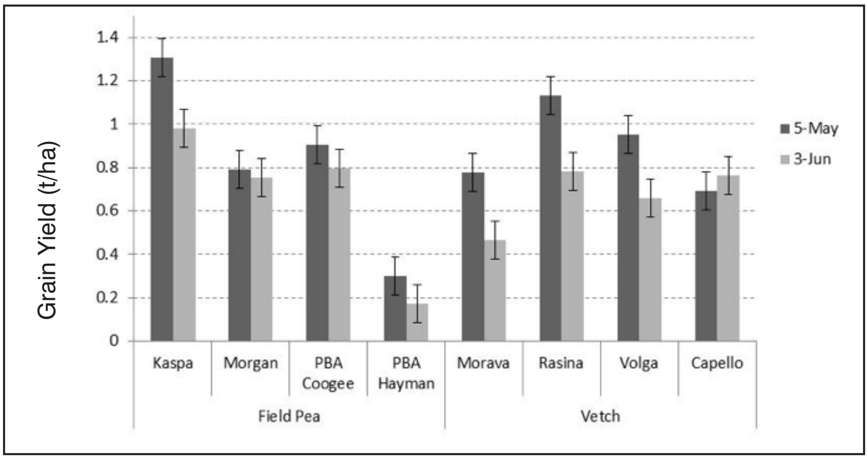

Figure 2 Effect of sowing date on grain yield (t/ha) of field pea and vetch varieties, Minnipa 2014

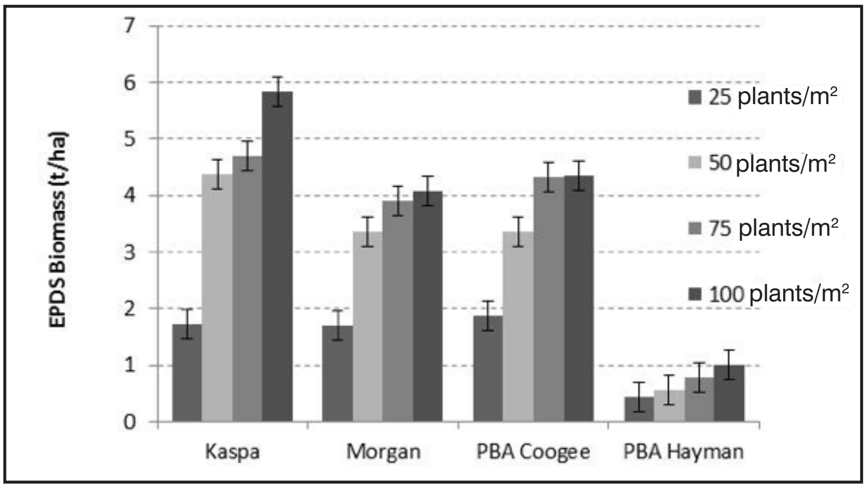

Figure 3 Effect of sowing density on early pod development stage (EPDS) biomass yield (t/ha) of field pea varieties, Minnipa 2014

Forage and dual purpose field peas were compared with grain field peas and vetch at Minnipa and three other sites in 2013 and 2014 providing an understanding of their performance and potential as a break crop option in SA farming systems. The forage field pea variety PBA Hayman agronomically performed very differently to the grain variety Kaspa and dual purpose varieties Morgan and PBA Coogee and will require a different management strategy to optimize its production.

PBA Hayman was found to have a higher biomass production potential than all other field pea varieties evaluated producing yields 50-70% greater than Kaspa and Morgan at Hart and Tarlee in 2013. This high production potential was particularly evident when sown early or grown in more favourable environments. In some situations it produced greater biomass levels than both the common and woolly pod vetch varieties evaluated. However its performance at Minnipa was below that found at other locations in SA, particularly in 2014.

PBA Hayman was more sensitive to the pea disease 'blackspot' than the other varieties and under high disease pressure biomass production was dramatically reduced, as seen at Minnipa in 2014. Blackspot disease severity was assessed at Hart in 2014 and PBA Hayman had twice the amount of disease infection compared with Kaspa and Morgan at both an early May and late May sowing date. Relative biomass production of PBA Hayman was lower in this experiment compared with at other sites in SA where blackspot disease pressure was minimal and a biomass increase of up to 70% was measured over other varieties. Its increased susceptibility to this disease is of significant concern and likely to be a major reason for the relatively poor performance of PBA Hayman at Minnipa in both 2013 and 2014 as black spot infections were assessed as being moderate and high respectively, in these years.

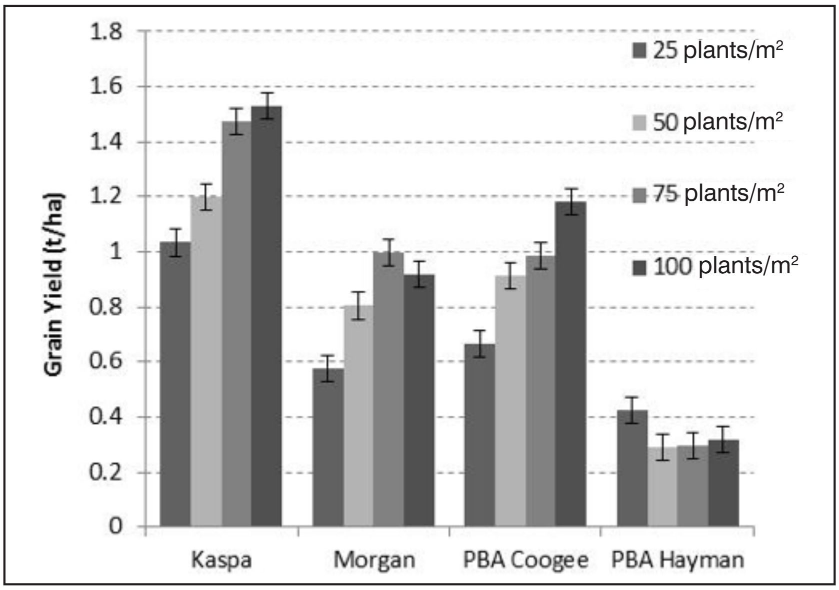

Figure 4 Effect of sowing density on grain yield (t/ha) of field pea varieties, Minnipa 2014

Delayed sowing also reduced the biomass production advantage of PBA Hayman over other field peas in some situations most likely due to its later maturity and relatively slower early growth rate. While these characteristics are likely to reduce the potential biomass yield of PBA Hayman in low rainfall environments, they do tend to suit varieties sown for hay as they promote good hay quality by extending the timing of cutting into more favourable (warmer and quicker) curing conditions compared to earlier flowering varieties. This is a significant benefit of PBA Hayman, which often flowers two or more weeks later than other field pea varieties, and at a similar time to vetch but it does reduce its potential in dry environments and seasons.

PBA Hayman has significantly lower grain yield potential than other field pea varieties (20-80% lower) and grain retrieval may be difficult in some seasons or environments, however due to its small seed size (14 g/100 seeds) a lower seeding rate can be used. The value of PBA Hayman as an alternative to vetch in SA will depend largely on being able to sow it early and control blackspot disease infection. This will often be difficult to achieve in field pea producing areas of this state and sowing dates will need to be as early as possible around safe 'Blackspot Manager' predictions.

Across all forage experiments in SA, biomass production of the dual forage/grain field pea variety PBA Coogee was generally only similar to Kaspa and Morgan. Its grain yield was always lower than Kaspa (14-54%) and equal or lower than Morgan. This suggests Kaspa or Morgan remain the variety of choice for grain yield or "dual purpose" situations apart from in disease prone areas, as PBA Coogee has improved resistance to bacterial blight over Kaspa and is the only option with resistance to powdery mildew. Biomass comparisons between field peas (Kaspa, Morgan and PBA Coogee) and vetch were complex, varying with site, year, variety and sowing date. Generally vetch varieties produced equal or greater biomass levels when blackspot was present or in favourable growing environments.

The best relative performances by the field pea varieties were at later sowing dates in lower rainfall environments. Conversely field peas varieties generally showed similar or greater grain yields than the vetch varieties and have larger established markets available. Current recommendations for maximizing grain yield in field pea will also maximize biomass production, i.e. earliest sowing around 'Blackspot Manager' recommendations and sowing densities of 50 plants/m^2. Where the sowing date is delayed past optimum to manage blackspot or due to late season breaks, biomass yield can be maximized by increasing sowing density of all varieties to 75 plants/m^2 with little negative effect on grain yield.

These SAGIT funded trials are also comparing the varieties for nitrogen fixation and hay quality at specific sites, data is currently being collated and analysed. This information when available will provide additional information to the grain yield and biomass data and provide a more complete comparison of the forage types with grain field pea and vetch varieties under SA conditions.

Pulse options for low rainfall areas – have we made progress?

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Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: Pulses 2.7 t/ha
Actual: Peas 1.5 - 2.1 t/ha
Paddock History
2013: Spray topped cereal
2012: Barley
2011: Wheat
Soil Type
Red loam
Plot Size
1.5 m x 10 m x 4 reps
Yield Limiting Factors
High black spot infection, late season moisture stress

Key messages

- **All pulse crops produced higher yields than their long term averages under favourable production conditions at Minnipa in 2014.**
- **Careful soil type and paddock selection combined with early sowing, correct varietal choice, good pulse crop agronomy and sound market awareness is essential to maximise the chance of successful pulse production in low rainfall environments.**
- **New variety options in chickpeas, lentils and field peas with earlier maturity and improvements in agronomic characteristics such as harvestability, disease, boron and herbicide tolerance over older standards will help aid production in low rainfall areas.**
- **Blackspot disease in field peas and frost and high temperature events during flowering/pod fill in all pulse crops remain major limitations to production and their occurrence and impact must be considered.**

Why do the trial?

In recent seasons increasing interest in using an alternative pulse crop to field peas as a break crop option in low rainfall farming systems has occurred. This has largely been due to higher commodity prices, new variety releases, production successes elsewhere in the state and the ongoing need to find an alternative source to bagged nitrogen. In particular, the opportunity to find a higher priced grain alternative to field pea appeals to many growers. This was the first comparison of this type at Minnipa Agricultural Centre since similar trials were held in 1999 and a selection of those past results have been included for reference.

How was it done?

A trial was set up at Minnipa to compare newly released lentil, chickpea and faba bean varieties with field peas, focusing on types with earlier maturity, improvements in plant type (harvestability), disease resistance, tolerance to boron and herbicides. Five varieties of peas, lentils, faba beans and chickpeas were selected including a widely grown commercial standard (Kaspa field pea, Nugget lentil, Nura faba bean and Genesis 090 chickpea) (Table 1). Each crop was sown as a separate trial to aid in achieving optimum trial management and harvester setup. However all crops were sown on 5 May with 59 kg/ha of 18:20:0:0, P-Pickle-T seed treatment, weeds and pests were controlled as required in line with standard pulse crop management. Field peas were sown with Group E inoculum at plant densities of 55 plants/m^2, lentils with Group F at 120 plants/m^2 and faba beans with Group F at 24 plants/m^2. The kabuli chickpea varieties, Genesis 090, Genesis 079 and PBA Monarch, were sown at 35 plants/m^2 and the desi chickpea varieties, PBA Slasher and PBA Striker, at 50 plants/m^2. All chickpea varieties were sown with Group N inoculum. Flowering observations and final grain yield were recorded.

What happened?

Above average rainfall and warm temperatures during the early part of the season led to rapid early plant growth. A severe blackspot disease infection occurred in the field pea trial due to the wet conditions and the sowing date occurring before the majority of the blackspot spores had been released from the previous year's stubble, which was in the neighbouring paddock. The blackspot manager disease prediction system suggested a medium risk level for Minnipa up until 11 May and indicated that a yield loss in field peas of 20-35% could occur with sowing prior to this date. Growing season rainfall (290 mm) and annual rainfall (407 mm) were both around 50 mm above average with almost all of this falling by the end of July. Moderate to high levels of early season blackspot disease infection did occur and restricted early vegetative growth in field peas. No significant disease level was observed in the other crops. The rainfall events ceased in spring and the finish to the season was characterised by a dry but relatively cool finish.

Grain yields of all four pulse species were well above long term average yields at Minnipa although they were lower than potential yields given the seasonal conditions and well below cereal yields achieved on the agricultural centre. Faba beans with a site mean of 1.9 t/ha and field peas (1.8 t/ha) were the highest yielding pulse crops evaluated, followed by lentil (1.4 t/ha) and chickpeas (1.3 t/ha) (Table 1).

The recently released early maturing 'Kaspa' type field pea PBA Wharton was the highest yielding field pea. It was 39% higher yielding than the mid maturing variety Kaspa and 23% higher yielding than its fellow early maturing type, PBA Twilight. PBA Wharton also has improved boron and virus tolerance over these varieties.

Lentil yields were generally similar to field peas except for the two varieties PBA Flash and Nugget, which unexplainably had yields almost half that of the other three varieties. These two varieties are more susceptible to ascochyta blight than the other varieties evaluated however no significant level of this disease was observed in the lentil trial last year. The Group B tolerant lentil variety PBA Hurricane XT was the highest yielding variety at 1.8 t/ha slightly in front of the earlier maturing types of PBA Bolt and PBA Blitz. PBA Bolt has an erect and tall plant type and performs particularly well in mallee type environments where harvestability of lentils is often an issue. It also has improved tolerance to boron over all other varieties except for PBA Flash.

The old small seeded, early maturing and disease susceptible faba bean variety Fiord along with an early maturing PBA breeding line (AF09167) were the highest yielding faba beans. Fiord was 16% higher yielding than the newly released disease resistant variety PBA Samira, 18% higher than Nura and 19% higher than Farah, all of which are later in maturity timing. Interestingly Fiord had the same yield as the highest yielding field pea PBA Wharton in 2014.

Table 1 Field pea, lentil, faba bean and chickpea variety performance at Minnipa 2014 (listed in descending order of grain yield) compared with 1999 performance of pulses at Minnipa
In 1999 season MAC had 272 mm total rainfall and 177mm GSR.

Field pea variety	**Yield (t/ha)**	**Flower day (Julian)**	**Maturity rating**	**Lentil variety**	**Yield (t/ha)**	**Flower day (Julian)**	**Maturity rating**
PBA Wharton	2.12	221	Early	PBA Hurricane	1.80	235	Mid
PBA Oura	1.88	218	Early	PBA Bolt	1.76	238	Early-mid
PBA Aura	1.73	216	Early	PBA Blitz	1.70	236	Early
PBA Pearl	1.68	223	Early-mid	Nugget	1.01#	240	Mid-late
Kaspa	1.52	225	Mid	PBA Flash	0.93#	238	Early-mid
Crop mean (t/ha)	**1.79**				**1.43**		
LSD (0.05)	*0.31*				*0.04*		
1999 Yield Comparison							
Parafield	0.6		Mid	Cumra	0.1		Early
Faba bean variety	**Yield (t/ha)**	**Flower day (Julian)**	**Maturity rating**	**Chickpea variety**	**Yield (t/ha)**	**Flower day (Julian)**	**Maturity rating**
Fiord	2.13	208	Early	PBA Striker	1.52	233	Early
AF09167	1.92	210	Early	PBA Slasher	1.35	236	Mid
PBA Samira	1.84	223	Early-mid	Genesis079	1.34	235	Early
Nura	1.80	225	Early-mid	PBA Monarch	1.23	233	Early
Farah	1.79	210	Early-mid	Genesis090	1.09	237	Mid
Crop mean (t/ha)	**1.89**				**1.30**		
LSD (P=0.05)	*0.22*				*0.16*		
1999 Yield Comparison							
Fiesta VF	0.3		Early-mid	Heera	0.2		Early

 # Lower yields of these varieties are unexplaned, treat with caution

Chickpeas were the lowest yielding of the four crops evaluated and also have the latest maturity timing. The early maturing desi variety PBA Striker was the highest yielding variety some 13% higher yielding than the mid maturing desi type PBA Slasher. The small seeded early maturing kabuli Genesis 079 and the medium seeded early maturing kabuli type PBA Monarch yielded similarly and higher than the mid maturing small seeded ascochyta blight resistant type Genesis 090.

What does this mean?

Grain yields of all pulses evaluated in 2014 were very much higher than their long term averages and also than those achieved in 1999, the last time these four pulse types were compared at Minnipa. The higher yields achieved last year are largely a result of the more favourable season that occurred in 2014 compared with 1999. The growing season rainfall was 85 mm higher in 2014 and annual rainfall 144 mm higher than 1999. Another major factor was the earlier sowing date in 2014 (5 May) compared with 28 May in 1999. Previous studies on upper Eyre Peninsula have shown that field pea yield is reduced by between 0.1–0.2 t/ha for every week sowing is delayed. The other critical seasonal difference in 2014 was the absence of hot days during the flowering and grain fill period. In 1999 a severe hot day in early September (33^0C) drove crops rapidly towards premature maturity, the absence of these types of events in 2014 allowed crops to finish last year despite the lack of significant rainfall after July.

Under favourable conditions there was little separation in grain yield between the pulse types in 2014. Field pea yields are likely to have been reduced by the high disease infection that occurred last year while the later maturing chickpeas were lower yielding than all other crops. Generally earlier maturing varieties yielded higher than those maturing later across all crops and this reflected the dry finish to the season. Apart from in faba beans recent early maturing variety releases (PBA Wharton & PBA Oura field peas, PBA Blitz, PBA Bolt & PBA Hurricane lentils and PBA Striker and PBA Monarch chickpea) were all higher yielding than the older standard later maturing varieties (Kaspa field peas, Nugget lentils and Genesis 090 chickpeas). This reflects recent good progress being made by the relevant PBA breeding programs particularly when considering that a number of these varieties also contain agronomic improvements such as boron tolerance, disease resistance, harvestability and in the case of PBA Hurricane XT, herbicide tolerance. The PBA faba bean program is targeting medium to higher rainfall production areas with a large emphasis on improving disease resistance and seed quality and recent releases have not been aimed at low rainfall environments.

In previous years PBA Wharton has generally performed similar to PBA Twilight and Kaspa at Minnipa, however it was the highest yielding variety last year. It also was high yielding at many other sites in SA in 2014 most likely due to it being well suited to 'favourable' short season environments due to its early maturity and slightly lower biomass production than Kaspa. Its suitability to years with lower winter rainfall levels is still questionable and requires further evaluation on the upper Eyre Peninsula. Its combination of early maturity, boron tolerance and virus resistance makes it well suited to the lower rainfall regions and it has performed well in the Victorian mallee over a number of years.

Clearly the results in Table 1 show that successful and potentially profitable pulse crops can be grown in some regions of the low rainfall zone given favourable season conditions. Despite only similar yields to other crops in 2014, field pea remains the best adapted pulse to these regions, particularly in lower rainfall seasons due to their higher levels of winter biomass production and broader soil type adaptation. Pulses are not suited to all soil types in the low rainfall regions and should be targeted at the better loamy soil types free of herbicide residues, sticks and stones. Early sowing dates are also critical to maximise success but as seen in 2014 consideration of black spot risk is required with field peas particularly in the more reliable production areas and where sown in close proximity to the previous year's pea stubble. Frost risk also needs careful consideration. Faba beans are the least susceptible to frost but still incur yield loss and the other three pulse options are all susceptible. Delayed sowing does not guarantee frost avoidance and areas prone to regular frost events should be avoided. Dual purpose field peas, forage peas or vetch all provide alternative options to the straight grain crops for these areas. Lentil, faba bean and chickpea despite varietal improvements and a similar performance to field pea at Minnipa in 2014 remain suited to the better soil types and more reliable production areas of Eyre Peninsula. Outside of this they are at best opportunistic options in years with early season breaks and favourable seasonal outlooks. Where they are grown, correct varietal choice will be critical to success. Earlier maturing varieties with improvements in disease, boron and in particular improved height and lodging resistance to aid harvestability will all help to increase the chances of success and should be used where available. Timely insect control and harvest is critical to maximise yield and reduce seed quality down grading. Growers also need to be aware of the specific market requirements for pulses including limitations with market access, often on farm storage will be required until the appropriate market is secured.

Vetch trials and results on EP

Stuart Nagel[1], Gregg Kirby[1], Leigh Davis[2] and Rade Matic[1]

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

RESEARCH

Searching for answers

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: Vetch hay 7.0 t/ha
Actual: Vetch hay trials 3.0 - 4.9 t/ha
Paddock History
2013: Spray topped cereal
2012: Barley
2011: Wheat
Soil Type
Red loam
Plot Size
1.5 m x 10 m x 3 reps
Yield Limiting Factors
Late season moisture stress

Location:
Piednippie
Rainfall
Av. Annual: 290 mm
Av. GSR: 230 mm
2014 Total: 365 mm
2014 GSR: 263 mm
Yield
Potential: Vetch hay
Actual: Vetch hay trials 1.2-2.0 t/ha
Paddock History
2013: Oats
2012: Oats
2011: Barley
Soil Type
Grey calcareous loam
Plot Size
1.5 m x 10 m x 3 reps
Yield Limiting Factors
Spray damage, late season moisture stress

Key messages

- **Vetch dry matter yields at Minnipa were excellent in 2014 with a mean yield of 3.7 t/ha across two trials and the top lines producing 4.9 t/ha of hay.**
- **The SAGIT funded trial at Piednippie showed good early vigour, before suffering spray damage. It produced a mean dry matter yield of 1.6 t/ha, but showed the potential of vetch on the grey calcareous sands given the right treatments.**
- **Herbicide choices for vetch are very dependent on local conditions so talk to your local agronomist about the best options for your conditions.**

Why do the trial?

The trials in 2014 were designed to investigate advanced common vetch lines with specific traits best suited to these regions. SAGIT have funded this research to provide a genuine legume break crop option for cereal and mixed farmers in the marginal cropping areas of South Australia, focusing on Western Eyre Peninsula, the Upper North and the Murray lands/ Mallee in South Australia.

How was it done?

The objective of this research is to investigate material bred in GRDC funded projects, which may not have been suitable for broad scale release, but may be locally adapted to these areas with the potential to be used as new varieties specifically for the local area.

Advanced lines and existing varieties were also tested in the S4 trial at Minnipa as part of the GRDC funded National Vetch Breeding Program.

The trial at Piednippie received damage from a malfunctioning boom spray sometime in July, it is unclear what chemical damaged the trial but it appears that the boom failed to shut off after spraying adjacent Canola plots and the trial was heavily supressed. It was not as a result of any of the chemicals directly applied to the vetch plots.

What happened?

On upper Eyre Peninsula, Minnipa received above average rainfall until the middle of August and the results (Table 3 and 5) reflect this with the top performing lines producing 4.9 t/ha of hay.

One of the aims of this project was to demonstrate the potential of vetch on the grey calcareous sands of Eyre Peninsula (particularly west of Minnipa). The trial at Piednippie (west of Streaky bay) showed good early establishment and vigour, demonstrating vetch's potential in this area. The trial then suffered spray damage from a malfunction with the spray rig, sometime in July. Yields were still achieved, although not to full potential with a mean yield less than half of the mean yield at Minnipa (Table 4), but the initial demonstration of the potential of vetch was positive.

Of the existing and new varieties trialled in the S4 trial in 2014, Timok and Volga again performed well, with the above average rainfall for the first part of the growing season enabling Timok to be the best of current varieties (Table 5). Both these varieties proved higher yielding than the older varieties Morava and Rasina. However they were nowhere near the best in trial, this was in part due to the exceptional early season rainfall which favoured certain lines over the varieties that are suited to lower rainfall years.

Definitive conclusions cannot be drawn from these initial results of the SAGIT trials. Further replicated trials at each site will be conducted in 2015 to add further data. Selections will be made from the 2014 trials to target the lines which performed best in this area.

Table 1 Trial details for Minnipa 2014

Minnipa		Date
Sowing		6, 7 May
Fertiliser	59 kg/ha MAP	
Pre sowing chemicals	1.2 L/ha Roundup+1.2 L/ha Treflan+60 ml/ha Hammer+ 1 L/ha Lorsban+500 ml/100L LI700	1May
Post sowing pre emerg	150 g/ha Lexone + 680 g/ha Simazine + 1 L/ha Lorsban	7 May
Insecticides	500 g/ha Aphidex	26 Aug
	500 ml/ha Astound Duo	5 Sep
Grass herbicides	400 ml/ha Targa+200 ml/ha LeMat+40 ml/ha Karate+ 1 L/100L Kwicken	16 Jun
Harvest/cut for hay		16 Sep

Table 2 Trial details for Piednippie 2014

Piednippie		Date
Sowing		8 May
Fertiliser	No fertiliser	
Pre sowing chemicals	2 L/ha Sprayseed+1.5 L/ha TriflurX+1 L/ha Lorsban+500 ml/100L LI700	7 May
Post sowing pre emerg	100 g/ha Lexone + 450 g/ha Simazine PSPE	8 May
Insecticides	300 ml/ha Dimethoate + 300 ml/ha Astound Duo	23 May
	150 ml/ha Success Neo + 100 ml/ha Transform	18 Aug
Grass herbicides	400 ml/ha Targa + 500 ml/100L Kwicken	3 Jul
Harvest/cut for hay		15 Sep

Table 3 SAGIT vetch trial Minnipa 2014, mean dry matter yields (t/ha)

Site	Line	Rank	Dry matter (t/ha)
Minnipa	37107	1	4.97
	34748	2	4.95
	34823-2	3	4.61
	35019	4	4.57
	34831	5	4.47
	35122	6	4.20
	34876	7	4.11
	35036	8	4.06
	37058	9	3.98
	Volga	10	3.95
	34742	11	3.92
	Timok	12	3.90
	34883	13	3.66
	34822	14	3.65
	33258	15	3.64
	34842	16	3.61
	35061	17	3.41
	35054	18	3.31
	34885	19	3.31
	35004	20	3.30
	34895	21	3.19
	37248	22	3.05
	37003	23	3.03
	34559	24	2.97

Table 4 SAGIT vetch trial Piednippie 2014, mean dry matter yields (t/ha)

Site	Line	Rank	Dry matter (t/ha)
Piednippie	34748	1	1.99
	Volga	2	1.91
	35122	3	1.88
	37107	4	1.84
	37058	5	1.79
	34876	6	1.74
	34823-2	7	1.74
	34883	8	1.71
	34842	9	1.70
	35019	10	1.69
	Timok	11	1.68
	33258	12	1.68
	34822	13	1.66
	34831	14	1.63
	34742	15	1.61
	35036	16	1.60
	37248	17	1.55
	35004	18	1.53
	35061	19	1.48
	34895	20	1.47
	34885	21	1.44
	35054	22	1.31
	37003	23	1.28
	34559	24	1.22

Table 5 Minnipa S4 trial vetch mean dry matter yields (t/ha)

Site	Line	Rank	Dry matter (t/ha)
S4 Minnipa	34462-1	1	4.79
	37107	2	4.18
	34883	3	4.14
	37457	4	4.10
	37102	5	3.92
	37661	6	3.74
	Timok	7	3.73
	Volga	8	3.69
	34822	9	3.59
	Rasina	10	3.43
	35054	11	3.42
	Morava	12	3.05

What does this mean?

These results, while not as high as dry matter yields produced in recent years, show the adaptability of vetch in years with little spring rain.

Several new lines showed excellent yields at Minnipa in both the S4 and SAGIT trials, in particular SA-37107 yielded well in both trials. 2014 was not a typical year for the region with an early start and little spring rainfall so caution with the results is required.

The Piednippie trial showed potential, but further research is required in these areas to validate results before any solid recommendations can be made.

For more information on the value of vetch in crop rotations see an article by Dr. Chris McDonough http://msfp.org.au/vetch-maximises-n-advantage/

The new varieties Volga (Heritage Seeds) and Timok (Seed Distributors) are expected to be available to purchase for seeding in 2016. These new varieties have consistently out-yielded current varieties in both grain and hay production at Minnipa.

Acknowledgements

The National Vetch Breeding Program would like to thank SAGIT, GRDC, RIRDC and SARDI for funding this program and acknowledge the ongoing support and interest provided by Australian farmers. Farmers and not for profit farmer groups and organisations provide trial sites ,feedback, advice, recommendations and their wish lists for future varieties to the program all of which are gratefully received and appreciated.

Preliminary assessment of grain legume nodulation on upper Eyre Peninsula

Maarten Ryder[1], Matt Denton[1] and Ross Ballard[2]
[1]University of Adelaide, [2]SARDI, Waite

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Try this yourself now

Location:
Verran
Rainfall
Av. Annual: 340 mm
Av. GSR: 254 mm
2014 Total: 347 mm
2014 GSR: 252 mm

Key messages

- **Grain legume growers are urged to take plant samples in late winter/early springtime to assess root nodulation by nitrogen-fixing bacteria.**
- **Guidelines, including photos, are available online as a resource at http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/.**

Why do this work?

- To get some preliminary information on grain legume nodulation in the area.
- Poor nodulation is often not obvious above ground, and if no or few nodules are present then little nitrogen will be fixed.
- Assessment of nodulation success is a useful exercise to guide future decision making about inoculation.
- For inoculated legumes, it is worth checking to see if the inoculation has worked well or not.
- For uninoculated crops, it is worth checking to see whether or not they should be inoculated in the future.
- While checking the root systems, you can also see if they are generally healthy. Has there been disease damage? For example, you may see a lot of Rhizoctonia "spear tips", depending on crop, season and paddock history.

How was it done?

Nodulation of grain legumes was assessed on three properties near Verran in September 2014. Two chickpea crops and one lentil crop were sampled. All had been inoculated with root nodule bacteria at sowing. At each paddock, three sets of 10 plants were carefully dug up at approximately 50 metre intervals, starting 20 m from the edge of the paddock to avoid the headlands.

After sampling, root systems were washed carefully and individual plants were scored as having "adequate" or "inadequate" nodulation compared to a set of photos (nodulation assessment guide, found at http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/). The % of plants with adequate nodulation was calculated for each sample location and the numbers were averaged across the three sample locations. Overall nodulation was considered good if the average nodulation scores were at least 70% "adequate".

What happened?

Property 1

Crop details: Chickpea after oats (2013), medic pasture (2012) and wheat (2011); soil alkaline. Chickpea 'Genesis 090' (kabuli type), inoculated with group N rhizobia as a peat slurry. Fertilizer (DAP) @ 80kg/ha. Herbicides: knockdown glyphosate; pre-emergence Treflan; post-emergence Balance at sowing. Insecticide: Dimethoate.

Nodulation assessment: 43% of plants rated as good. This is below expectation for an inoculated crop (Figure 1). Note that many plants had Rhizoctonia damage (roots with spear tips, blackened collar) which may have contributed to the low nodulation result.

Yield: not satisfactory at 0.6 t/ha.

Troubleshooting: grower suspects herbicide (there was obvious chemical damage on sandier soils). Note also that high nitrogen fertiliser at sowing needs to be used cautiously. When combined with soil nitrate levels, this may reduce nodulation.

Property 2

Crop details: Lentil after 3 years wheat, soil pH 8.5. Lentil 'Blitz' inoculated with TagTeam (N fixing and P solubilizing).

Fertilizer single super applied @ 75 kg/ha, placed alongside seed. Herbicides: knockdown glyphosate; pre-emergence Diuron, Simazine, Treflan; post-emergence Select, Targa.

Nodulation assessment: 42% of plants rated as good. This is below expectation for an inoculated crop (Figure 2A, compared to Figure 2B). Note that some root systems had apparent Rhizoctonia damage, but many plants had healthy roots (i.e. variable root health, mostly good, healthy).

Result: the crop yielded 1 t/ha on only 250 mm growing season rainfall.

The grower plans to sow lentils again in future and to sow early.

The nodulation result may have been improved by using a double rate of inoculant as it was the first time lentils had been grown in that paddock.

Figure 1 Chickpea nodulation, (less than desirable), *Rhizoctonia* damage common. Expect to see considerable nodulation at the crown of the plant, near the seed; refer Figure 3

Property 3

Crop details: Chickpea after barley (2013), wheat (2012) and canola (2011); soil pH 8.5. Chickpea 'Genesis 090' (kabuli type), inoculated with group N rhizobia as a peat slurry.

Fertilizer UAN @ 30 L/ha, DAP @ 40 kg/ha. Herbicides: knockdown glyphosate, Treflan; post-emergence Balance. Insecticide: Alpha Scud (September).

Nodulation assessment: 90% of plants rated as good, with many very large nodules around the crown of the plant. An excellent nodulation result (Figure 3). Growers might expect more nodules on lateral roots on second and later crops in the same paddock, when the rhizobia have become widely dispersed through the soil. Note that some plants had Rhizoctonia damage (roots with spear tips) but most appeared good, healthy.

Result: the grower was pleased with crop yield and quality (average 0.8 t/ha across all chickpea paddocks) and will grow chickpeas again.

Figure 2a Lentil nodulation (less than desirable)

Figure 2b Example of adequate lentil nodulation

Figure 3 Excellent nodulation of a first time chickpea crop

What does this mean?

There appears some opportunity to improve the nodulation of first time sown grain legume crops. One of the chickpea crops had excellent nodulation and, given suitable conditions especially regarding soil moisture, would have been expected to fix a considerable amount of nitrogen.

Nodulation of the other chickpea crop and the lentil crop could have been better. Root disease (Rhizoctonia) and herbicides may have impacted root health and contributed to this result, but even so nodulation was still well below par.

Other suggested measures to improve nodulation include doubling the rate of inoculant for a first time sowing, avoiding close contact between the inoculated seed, fertilisers and pesticides, and sowing into a moist seed bed as soon as possible after inoculation. Root disease (particularly Rhizoctonia root rot) was noted on a proportion of plants in all samples taken. Agronomic practices which optimise legume growth, including those that reduce the impacts of soil borne disease will benefit nodulation and nitrogen fixation.

Acknowledgements

The assistance of Linden Masters is gratefully acknowledged. We thank the three growers for allowing access to their crops. Thank you to GRDC for funding this research through GRDC National Nitrogen Fixation Program project number UA000138.

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SARDI, Minnipa Agricultural Centre

RESEARCH

Disease

Results from the 6 year Streaky Bay experiment - Management of soilborne Rhizoctonia disease risk in cereal crops

Vadakattu Gupta[1], Amanda Cook[2], Alan McKay[3], Kathy Ophel-Keller[3], Paul Bogacki[3], Nigel Wilhelm[3], Jack Desbiolles[4] and David Roget[5]
[1]CSIRO, Waite, [2]SARDI, Minnipa Agricultural Centre, [3]SARDI, Waite, [4]University of SA, [5]Private Consultant, deceased Dec 2013.

Searching for answers

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

Key messages

- **Effective control of rhizoctonia disease in cereal crops requires both the reduction of the pathogen inoculum and control of the infection process; this has to be achieved through management practices spread over more than one cropping season.**
- **Canola or mustard in rotation reduce rhizoctonia pathogen inoculum consistently and can be considered as an effective control option for the next cereal crop. It should be noted that the rotation benefits last for only one crop season.**
- **Experiments across the lower rainfall cropping region in southern Australia indicated that grass free canola, mustard, chickpeas, field peas, vetch, medic pasture and fallow can result in significant reductions in Rhizoctonia inoculum in a cropping sequence.**
- **Management practices which preserve soil moisture over the summer period and remove plant host, such as summer weed control, will reduce Rhizoctonia inoculum and yield losses in the following cereal crop.**
- **Ideally the time of sampling for DNA assessment of inoculum is closer to sowing, however, sampling during late March to early April may be a more practical option.**
- **Higher microbial activity at the start of the season results in lower disease incidence even in the presence of higher pathogen inoculum.**
- **Rhizoctonia inoculum levels at sowing were significantly lower in cultivated treatments compared to no-till however, in the trials to date, the decline in inoculum with cultivation has not always been sufficient to provide a yield benefit. Disturbance below seeding depth facilitating root growth down profile reduces risk of Rhizoctonia.**
- **SARDI and DAFWA field trial results showed that that liquid banding treatments of fungicides produced greater and more consistent yield responses than seed treatment alone. For example, dual banding of Uniform® in-furrow 3-4 cm below the seed and on the surface behind the press wheel gave the most consistent yield and root health responses across seasons. However, fungicide treatments need to be used as part of an integrated management strategy/ package to effectively reduce Rhizoctonia impacts.**

Rationale for the experiment

Rhizoctonia continues to be an important (average annual cost $59 million with potential costs $165 million, Brennan and Murray, 2009) but complex disease in the southern agricultural region, especially on upper Eyre Peninsula.

A six year cropping crop rotation and tillage experiment was conducted on an alkaline Calcarosol near Streaky Bay.

The aim of this research is to improve long term control of Rhizoctonia by increasing our understanding of the interactions between disease inoculum and natural soil biological activity and to improve the prediction and management of the disease. The Streaky Bay experiment was part of multi-year field trials conducted at different sites in SA and NSW and these trials were complemented with annual field experiments to investigate the effect of specific management practices including fungicide evaluation.

How was it done?

A replicated experiment was established on an alkaline Calcarosol at Streaky Bay in 2008 (Table 1). The multi-year experiment was generally sown during the second fortnight of May every year. Surface 0-10 cm soil samples collected during off-season and within the crop were used for microbial and pathogen properties such as Rhizoctonia pathogen DNA levels, root disease incidence, dry matter production, microbial activity, grain yield and quality. Disease incidence was monitored at 7 weeks and after anthesis.

Key findings

The fungus *Rhizoctonia solani* AG8 is present in Australian soils as part of the microbial community. This pathogenic fungus is a good saprophyte, adapted to dry conditions and lower fertility soils with most of the inoculum occurring in the top 5 cm of soil. Management practices and environmental changes, that either alter the physico-chemical environment or affect plant-pathogen interactions, are likely to influence the Rhizoctonia disease occurrence in various ways. Therefore, effective management of Rhizoctonia disease in rainfed cropping systems requires both the management of inoculum and the infection process. The success of available disease control strategies, e.g. soil disturbance, fertiliser addition or fungicides is greatest at low to medium inoculum levels, however, their effectiveness declines as inoculum levels increase or where disease suppressive activity is low.

A. Management of inoculum: Rhizoctonia inoculum build-up in one year's crop is the major determinant of disease risk in the following year.

1. Wheat crop increases Rhizoctonia inoculum from seedling stage to maturity in all seasons. This was also observed with barley and cereal rye at all sites in Eyre Peninsula and other regions in Southern and Western Australia and in NSW.
2. Non-cereal crops can be infected by Rhizoctonia however most do not allow the build-up of inoculum. Grass free canola and medic pastures reduce Rhizoctonia inoculum level resulting in significant increases in subsequent cereal yield. Other legumes such as field peas, chickpeas and vetch also showed limited or no inoculum build-up (based on field experiments in the Mallee). Importantly, the effect of rotations generally lasts for one crop season only.
3. Crown root infection late into the crop season results in the build-up of *Rhizoctonia solani* AG8 inoculum in cereal crops. Therefore, observation of infected crown roots late in the season could provide a visual indication of inoculum build-up that will impact the following crop.

Table 1 Details of treatments during the six years of the experiment

Treat No.	Treatment		2008	2009	2010	2011	2012	2013	
1	Continuous cereal	No Till	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat NT	W-W-W NT
2	Continuous cereal	Conv cult	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat Conv cult	W-W-W cult
3	Continuous cereal	Strategic cult	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat-Multiple culti-vations	W-W-W Multiple
4	Fallow-wheat	No-Till	Fallow	Wheat	Fallow	Wheat	Wheat	Wheat-No weed control	F-W-W-W No weed
5	Wheat - Fallow	No-Till	Wheat	Fallow	Wheat	Fallow	Wheat	Wheat NT	W-F-W-W
6	Canola - wheat	No-Till	Canola	Wheat	Canola	Wheat	Wheat	Wheat NT	C-W-W-W
7	Wheat - canola	No-Till	Wheat	Canola	Wheat	Canola	Wheat	Wheat NT	W-C-W-W
8	Pasture - wheat	No-Till	Pasture	Wheat	Pasture	Wheat	Wheat	Wheat-No weed control	P-W-W-W NT No weed
9	Pasture - wheat	Conv cult	Pasture	Wheat	Pasture	Wheat	Wheat	Wheat conv cult	P-W-W-W Cult
10	Wheat - pasture	No-Till	Wheat	Pasture	Wheat	Pasture	Wheat	Wheat NT	W-P-W-W NT

Note: Details of field operations are given in EPFS Summaries from 2009-13. Plot size - 40m x 1.48 m x 4 reps

4. In cereals, Rhizoctonia inoculum builds-up from sowing to crop maturity (in all environments) and inoculum levels generally peak at crop maturity while rain post maturity of a crop and over the summer fallow causes a decline in inoculum.
5. Levels of *Rhizoctonia solani* AG8 DNA in soil during summer are a key factor in understanding the changes in Rhizoctonia inoculum – in the absence of host plants, summer rainfall events of >20 mm in a week substantially reduce the level of inoculum whereas inoculum levels can recover during prolonged dry periods. Multiple rainfall events can reduce inoculum levels from high to low disease risk. This has important implications to the timing of soil sampling and interpretation of DNA measurements.
6. Reduction in inoculum DNA was lower in colder soils compared to that in warm (>15°C) and moist soils.
7. Weed control during summer significantly reduced Rhizoctonia pathogen inoculum levels. This complements benefits through moisture conservation and increased mineral N levels in the overall management of Rhizoctonia disease impacts.
8. Summer cultivation, as applied in this experiment, caused some reduction in the inoculum levels however the disease risk remained high.
9. *R. solani* AG8 DNA levels are generally highest in the surface 5 cm of soil and declined with depth. Disturbance at sowing caused redistribution of inoculum through soil movement; however concentrations remained higher in the surface soils. Differences in particulate soil organic matter, microbial activity, CO_2:O_2 ratio and moisture are some of the factors influencing the depth based distribution. Inoculum levels were generally higher in the crop row compared to inter-row space.
10. Ideal time of sampling for DNA assessment of inoculum is closer to sowing. However, as samples need to be taken earlier to allow both for processing and planning a cropping program, sampling during late March to early April may be a preferred option as substantial inoculum changes are less likely due to the declining soil temperatures. Multiple summer rainfall events reduce the Rhizoctonia pathogen inoculum levels from high to lower disease risk whereas prolonged dry periods can even cause an increase in inoculum levels.

B. Infection and disease impacts: Plant-soil-microbe interactions can influence the severity of disease incidence and the effect of rhizoctonia disease on crop yield.

11. Soils and cropping systems that maintain higher microbial activity at the start of the season had lower disease incidence even with higher inoculum. A strong relationship between the amount of Rhizoctonia DNA at sowing and Rhizoctonia disease score on 6 week old wheat plants was observed.
12. The level of disease incidence is due to a combination of inoculum level, level of soil microbial activity, the amount of soil disturbance below seeding depth, N levels at seeding, soil temperature and moisture during the seedling growth stage.
13. Damage from the disease is greatest when root growth is restricted and/or soil temperatures drop to around 10°C. When crops are sown early into warm soils, seminal roots can escape severe Rhizoctonia damage but as the temperature drops below 10°C slowing the root growth, the crown roots and seminal roots can still be infected causing uneven crop growth. Uneven crop growth, instead of distinct bare patches is now the most common symptom in the majority of crop paddocks affected by Rhizoctonia.
14. Crop rotation and tillage treatment had a significant effect on the microbial activity, microbial biomass and catabolic diversity in soils which contributed to lower disease impacts following non-cereal crop rotations.
15. Disease suppression potential in Streaky Bay soil was very low compared to soils from Avon, Waikerie and Galong. Streaky Bay soil showed lower overall catabolic diversity and the diversity of Pseudomonas bacteria compared to soils from Waikerie and Avon (highly suppressive soil). The influence of specific microbial communities on disease incidence in EP soils requires further investigation.
16. The effect of rotations and cultivation on Rhizoctonia inoculum, disease severity and patch score was generally reflected in anthesis dry matter and grain yield.
17. A strong relationship between patch area and yield loss in wheat occurred at Streaky Bay. Grain yield declined by 0.27 t/ha (average) for every 10% increase in patch area. However, assessment of yield loss from Rhizoctonia based on the area of distinct patches underestimates the true costs. Rhizoctonia damage to crown roots can result in significant loss (>10%) in wheat grain yield.
18. During 2013, a lack of summer weed control ('no weed control' treatment (F-W-W-W no weed) caused a 21% yield reduction compared to chemical summer weed control (W-F-W-W).

19. SARDI and DAFWA field trial results showed that liquid banding of fungicides produced greater and more consistent yield responses than seed treatments alone. Dual banding of Uniform® in-furrow 3-4 cm below the seed and on the surface behind the press wheel gave the most consistent yield and root health responses across seasons. Responses in barley were greater than wheat; responses also appear to be greater in better spring rainfall seasons. Banding BYF14182 in-furrow combined with EverGol® Prime seed treatment significantly improved root health. However, fungicide treatments need to be used as part of an integrated management strategy/ package to effectively reduce Rhizoctonia impacts (also refer to EPARF Rhizoctonia fungicide trial article by Amanda Cook et al. 2013). Uniform® applied either by liquid banding or coated fertiliser has been registered to control Rhizoctonia root rot.

Overall, the Streaky Bay multi-year field experiment not only helped to identify shorter-term solutions to reduce disease incidence and its impact on plant growth and yield but combined with other field experiments it also delivered new knowledge that will assist in the longer-term control of rhizoctonia through improved prediction of disease occurrence and severity. In addition, the identification of the need for alternate methods of fungicide application provided a new avenue for the development of a management tool (banding fungicides) for farmers to reduce rhizoctonia disease impacts and provide yield and economic benefits.

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GRDC project codes: CSP00150, DAS00122, DAS00123

Targeted liquid delivery of fungicides: a new tool for Rhizoctonia root rot control

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Years:
2011-2013
Location:
SA (mainly Murray Mallee) and WA
Uniform evaluated in 21 trials
BYF14182 evaluated in 9 trials
Paddock History
Cereal in year previous to trial
High Rhizoctonia risk
Soil Type
Varied from sand to loam/sand
Soil Test
PreDicta B
Diseases
Rhizoctonia was the predominant soil-borne pathogen
Plot Size
20 m x 1.5-1.8 m x 6 reps
Yield Limiting Factors
Rhitoctonia/dry finish in 2012
Environmental Impacts
Soil Health
Tillage type: Narrow point soil openers used

Key messages

- **This three year trial program contributed to Uniform being registered in late 2014 for liquid application in-furrow and on the soil surface to control Rhizoctonia root rot.**
- **Uniform banding treatments had better efficacy than Vibrance seed treatment. Banding treatments were associated with more significant and bigger yield responses, with dual banding of Uniform in-furrow 3-4 cm below the seed and on the surface behind the press wheel giving the most consistent yield and root health responses across seasons.**
- **Efficacy data was also generated to support registration for the liquid application of coded fungicide BYF14182 in-furrow to control Rhizoctonia. Registration is pending and expected in early April.**
- **Yield responses achieved by banding BYF14182 in-furrow were not significantly different from EverGol Prime seed treatments. However, banding in-furrow combined with seed treatment significantly improved root health compared to banding in-furrow or seed treatment alone.**
- **Fungicide responses did vary from season to season suggesting there is an environmental component affecting efficacy. Yield responses were generally bigger in the better seasons.**
- **Growers now have greater flexibility in choosing a method of fungicide application for Rhizoctonia control, which can also offer improved efficacy. Importantly, fungicides still need to be used as part of an integrated management package. Banding will reduce patch incidence and severity but not eliminate patching altogether.**

Why do the trial?

Rhizoctonia root rot caused by the fungus *Rhizoctonia solani* AG8 continues to be the most yield depleting fungal root disease in the southern and western agricultural regions. The aim of this trial program was to evaluate the efficacy of banding fungicides as an alternative to seed treatments

RESEARCH

for Rhizoctonia control, which in our trials have increased wheat and barley yields by around 0.07 t/ha or 5% on average. With more growers adopting liquid delivery systems for combined nutrition and disease management, or considering the switch, it was important that fungicides with good efficacy against Rhizoctonia be registered for furrow banding to offer greater flexibility in application.

How was it done?

We evaluated the efficacy of banding the fungicides Uniform (Syngenta, previously coded as SYNSIF1) and BYF14182 (Bayer CropScience) in field trials conducted in SA and WA from 2011-2013. Uniform was evaluated in 21 trials (11 wheat/10 barley) and BYF14182 in 9 trials (1 wheat/8 barley). Trial sites were selected based on paddocks with a Rhizoctonia history in which a cereal crop had been grown in the previous year. Results from PreDicta B soil DNA tests were then used to identify medium to high risk paddocks and to ensure Rhizoctonia was the predominant soil-borne pathogen.

The main treatments included banding different rates of fungicide in-furrow 3-4 cm below the seed as a stand alone application or in combination with a surface band or seed treatment. The in-furrow and surface bands were aimed to protect the seminal and crown roots, respectively. The efficacy of Uniform and BYF14182 banding treatments was compared to that of seed treatments with Vibrance and EverGol Prime, respectively.

Trials had a randomised block design with six replicate plots per treatment. In SA, individual 6 row plots were split into treated and untreated halves whereas in WA each 8 row treated plot was adjacent to an untreated plot. All treatments were compared to untreated control plots and yield responses generally had to be in excess of 10% for them to be significant using this trial design.

All trials were sown using narrow points cultivating to a depth of 10 cm, with seed placement at 3 cm depth under press wheel furrows. In SA, plots received either liquid NP fertiliser or a mix of granular DAP + liquid UAN in different years (all deep banded at full tillage depth) and fungicide was co-located separately in water at 75-80 L/ha. In WA, Flexi-N +/- fungicide was injected to the bottom of the furrow below the seed in 2012 and 2013, while a granular fertiliser was applied below the seed in 2011 and fungicides were injected with water at 100 L/ha. The dual application scenario (in-furrow + surface banding) maintained the same chemical rate per hectare but doubled the application volume per hectare.

The surface application treatment with Uniform was applied during sowing as a continuous 2 cm wide band behind the press wheel in SA using a low volume narrow angle nozzle. In WA, the surface band treatment was applied as a liquid stream in a separate pass following the first pass application of fungicide as a liquid stream below the seed.

Table 1 Summary of wheat and barley yield responses for treatments with Vibrance (Vib; ml/100 kg seed) and Uniform (Uni) liquid banded in-furrow (IF) and on the surface (Sur) at the specified rates (ml/ha)

Crop	Treatment	Years	No. trials where yield response significant P > 0.05 §	No. trials with +ve yield responses	Yield		
					Untreated (t/ha)	Treated (t/ha)	Net (t/ha)
Barley	Vib seed 360	3	1 of 10	6 of 10	2.34	2.37	0.02
	Vib seed 360 + Uni IF 200	3	5 of 10	9 of 10	2.34	2.53	0.18*
	Uni IF 300	3	5 of 10	8 of 10	2.34	2.55	0.21*
	Uni IF 400	2	5 of 6	5 of 6	2.65	2.95	0.30*
	Uni IF 150 + Uni Sur 150	2	3 of 6	5 of 6	2.65	2.93	0.28*
	Uni IF 200 + Uni Sur 200	1	2 of 3	3 of 3	3.03	3.48	0.46*
Wheat	Vib seed 360	3	3 of 11	10 of 11	2.18	2.25	0.07
	Vib seed 360 + Uni IF 200	3	6 of 11	9 of 11	2.18	2.31	0.13*
	Uni IF 300	3	8 of 11	9 of 11	2.18	2.33	0.15*
	Uni IF 400	2	4 of 6	6 of 6	2.22	2.39	0.17*
	Uni IF 150 + Uni Sur 150	3	5 of 6	6 of 6	2.07	2.30	0.22*
	Uni IF 200 + Uni Sur 200	1	3 of 3	3 of 3	2.79	3.11	0.32*

*§ Yield increase significantly greater than untreated based on individual site analyses, * Net yield increases significant at P < 0.05 based on META analysis of combined data from all sites.*

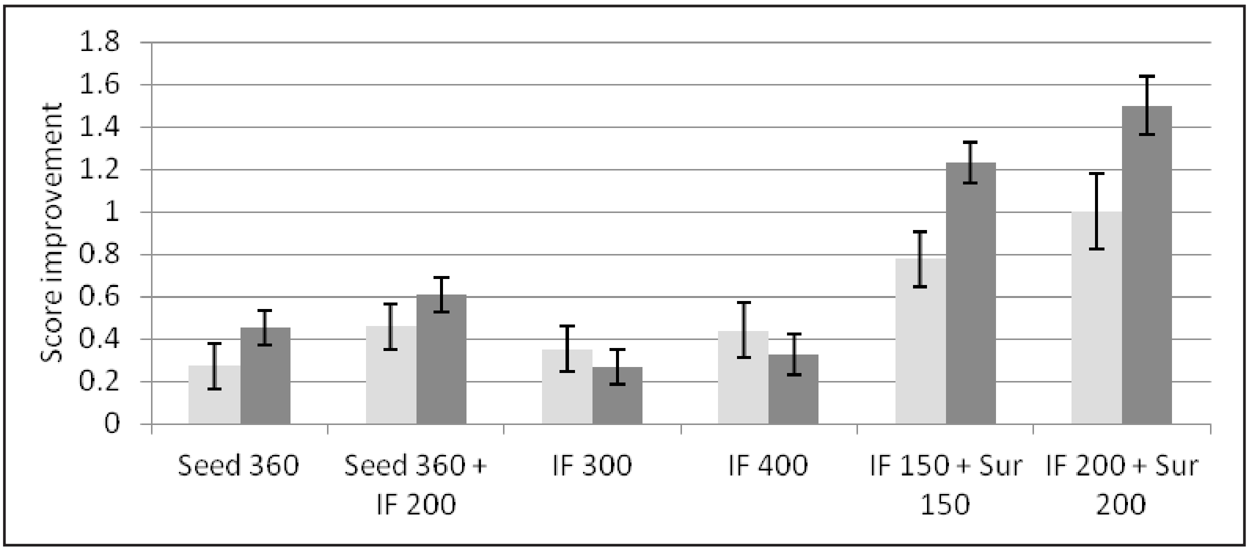

Figure 1 META analysis of seminal (light shade) and crown (dark shade) root health responses relative to untreated associated with Uniform banding and Vibrance seed treatments. IF = Uniform in-furrow band, Sur = Uniform surface band. *Numbers indicate rate of application, ml/100 kg for seed and ml/ha for IF and Sur liquid banding. Error bars represent standard error of the mean. All treatments were significant (P < 0.05) relative to the untreated.*

Table 2 Summary of barley yield responses for EverGol Prime (EP) seed treatment (ml/100 kg seed) and BYF14182 banded in-furrow (IF). IF rates are not specified as product is not currently registered for banding

Treatment	Years	No. trials where yield response significant P > 0.05 §	No. trials with +ve yield responses	Yield		
				Untreated (t/ha)	Treated (t/ha)	Net (t/ha)
EP seed 40	1	0 of 3	2 of 3	2.12	2.17	0.04
EP seed 80	3	2 of 6	6 of 6	2.37	2.51	0.14*
BYF14182 IF rate 1	2	0 of 4	4 of 4	2.25	2.32	0.07
BYF14182 IF rate 2	3	1 of 6	3 of 6	2.37	2.46	0.09
BYF14182 IF rate 3	1	1 of 2	1 of 2	2.62	2.81	0.20
BYF14182 IF rate 4	2	1 of 4	3 of 4	2.25	2.34	0.08
EP seed 40 + BYF14182 IF rate 1	1	1 of 2	1 of 2	2.62	2.74	0.13

*§ Yield increase significantly greater than untreated based on individual site analyses, * Net yield increases significant at P < 0.05 based on META analysis of combined data from all sites.*

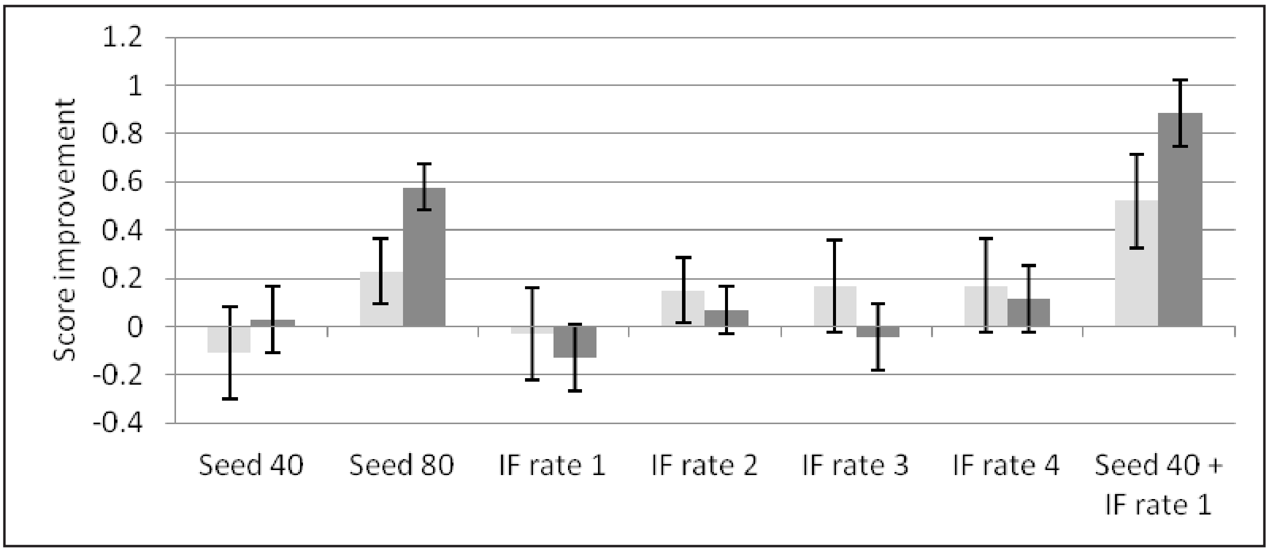

Figure 2 META analysis summarising seminal (light shade) and crown (dark shade) root health responses relative to untreated associated with BYF14182 banding and EverGol Prime seed treatments. IF = BYF14182 in-furrow band. *Numbers for seed treatment indicate rate of application (mL/100 kg seed). Rates of application for the BYF14182 in-furrow treatments have been withheld as this product is currently not registered for furrow banding. Error bars represent standard error of the mean.*

What happened?

A summary encompassing yield data across all trials is presented. Uniform trials showed that all banding treatments yielded significantly better than the control (Table 1). Responses in wheat and barley were highly correlated (r = 0.95) and banding treatments resulted in more significant yield responses than Vibrance seed treatment. Significant responses were seen 4/21 times in wheat and barley trials for the Vibrance seed treatment, 11/21 times for banding Uniform in-furrow combined with Vibrance seed treatment, 22/33 times for banding Uniform in-furrow only, and 13/18 times for the dual application of Uniform in-furrow and on the soil surface using equivalent total rates of product as banding in-furrow alone. Banding treatments were also associated with bigger yield responses, with the dual application treatments consistently producing the biggest net yield gains across seasons – up to 0.32 and 0.46 t/ha on average in wheat and barley, respectively, depending on rate used. The cost of Uniform has not been released at time of printing to enable net profit calculation.

Analysis of wheat and barley root health responses across all sites showed that all Uniform banding treatments and Vibrance seed treatment resulted in seminal and crown roots that were significantly healthier than the control (Figure 1). Furthermore, the dual application treatments also had significantly healthier seminal and crown roots than the other treatments, which is reflected in the yield data.

The trial program with BYF14182 was not as extensive which impacted on the statistical power of the corresponding META analysis (Table 2). Responses across treatments averaged 0.11 t/ha or 6% and there was no yield advantage associated with BYF14182 in-furrow banding treatments over the EverGol Prime seed treatment.

Only the seed treatment at 80 ml/100 kg seed produced a net yield gain (0.14 t/ha) that was significantly better than the control. The best response (0.20 t/ha) was obtained from one of the higher rate in-furrow treatments with BYF14182, however, this was not statistically significant in the META analysis as the corresponding treatment was only evaluated across two trials in one year. At time of printing BYF14182 had not yet been registered for banding.

In terms of root health, banding BYF14182 in-furrow combined with EverGol Prime seed treatment was the only treatment which resulted in both crown and seminal roots being significantly healthier than the control (Figure 2). However, this did not translate into significantly better yield responses in our trials.

What does this mean?

With Uniform now registered for banding (in-furrow + soil surface) and BYF14182 registration imminent (in-furrow only), growers have better flexibility - and improved efficacy - to use fungicides to control Rhizoctonia root rot. In the case of Uniform, banding treatments resulted in more consistent and generally bigger yield responses than Vibrance seed treatment, whereas with BYF14182, yield responses between banding BYF14182 and EverGol Prime seed treatments were similar. Based on results to date, dual banding of fungicide 3-4 cm below the seed and on the furrow soil surface is likely to increase chances of seeing a significant yield response. However, this requires additional hardware and doubles the application volume per hectare.

The impact of season on the different fungicide application methods warrants further investigation, as we did see variation in efficacy between seasons. Dual banding, for example, produced bigger yield responses in the better seasons (e.g. 2013) whereas responses were not as pronounced in seasons with a dry finish (e.g. 2012 and related trial work in 2014). Nutrition and pre-emergence herbicide interactions and their impact on Rhizoctonia have also been raised as potential areas of future research.

Importantly, fungicides still need to be used as part of an integrated disease management package to control Rhizoctonia root rot. Recommended management practices include:

- Incorporating a break with grass free canola, pulses or pastures to reduce inoculum levels (effect will only last one season)
- Controlling summer weeds and the autumn "green bridge"
- Sowing early and incorporating furrow tillage below the seed to facilitate rapid root growth down the soil profile
- Banding N below the seed and avoid incorporating stubble to minimise N deficiency during crop establishment
- Addressing in-crop nutrient/ trace element deficiencies with foliar application
- Using narrow point soil openers instead of low disturbance discs
- Considering increasing seeding rate to reduce impact of lost tillers from Rhizoctonia damage to crown roots
- Significant summer rainfall events will reduce inoculum levels.

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Vibrance and Uniform are registered trademarks of Syngenta; EverGol Prime is a registered trademark of Bayer CropScience.

GRDC project codes: DAS00122 and DAS00123

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Department of Agriculture and Food

Economic evaluation of 'best bets' for Rhizoctonia management on upper EP and the Mallee

RESEARCH

Amanda Cook[1], Ian Richter[1], Wade Shepperd[1] and Mike Krause[2]

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Best practice

Location:
Warramboo
Rainfall
Av. Annual: 300 mm
Av. GSR: 204 mm
Soil Types
Calcareous loamy sand over limestone
Calcareous loamy sand

Location:
Wynarka
Rainfall
Av. Annual: 335 mm
Av. GSR: 243 mm
Soil Type
Brown sandy loam over limestone

Location:
Piednippie
Rainfall
Av. Annual: 298 mm
Av. GSR: 243 mm
Soil Type
Highly calcareous grey loamy sand

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
Soil Type
Red loam

Key messages

- **Canola, Juncea canola, medic and vetch break crops lowered Rhizoctonia inoculum levels, allowing other weed control options, earlier sowing opportunities and higher yield for the following cereal.**
- **Vetch/wheat rotation (compared to medic pasture/wheat) gave the best financial result.**
- **Low input vetch lowered Rhizoctonia inoculum levels similar to medic, and provided a gross margin improvement of $100/ha.**
- **Oilseeds proved to be a financial risk compared to medic, with economic modelling indicating canola needs to yield at least 0.36 t/ha to provide an equivalent gross margin with higher risk compared to a 'medic pasture (sheep)/wheat' rotation in this environment.**
- **Fungicide products for Rhizoctonia suppression varied in performance in 2013 paddock demonstrations depending on products and application.**
- **In farm demonstrations the lower cost products provided a better economic benefit. Economically the yield responses were positive on wheat but not on barley and the lower cost options performed well economically despite not achieving the highest yields.**

Why do the trial?

The aim of this SAGIT funded project was to use the latest Rhizoctonia research to demonstrate 'best bet' strategies in broad acre environments of the upper EP and Mallee. In the last 10 years Rhizoctonia research has increased and contributed to understanding how to manage this disease. Reducing initial Rhizoctonia inoculum levels is an important tool in minimising disease impact in cereal crops. Looking at various 'best bets' to reduce inoculum levels and their economics will help farmers decide on where to concentrate efforts to get the most likely chance of reward, where 'short-cuts' might be appropriate and how to treat paddocks with different risks with different management strategies. A report on the economics of the break crops and fungicides using gross margins was prepared by Mike Krause, Applied Economic Solutions.

For further details on the research and information collected, the related articles from previous seasons can be found in the Eyre Peninsula Farming Systems (EPFS) Summary 2012, p 66; and EPFS Summary 2013, p 88, p 84, p 93.

How was it done?

Three farmer co-operators, two on Eyre Peninsula (Piednippie and Warramboo) and one in the SA Mallee (Wynarka) undertook broad acre demonstrations to reduce the impact of Rhizoctonia within their farming system. Management strategies to reduce the impact of Rhizoctonia were implemented in one year and then followed by a cereal to determine the level of impact.

The 'best bets' used in the farmer demonstrations for minimising Rhizoctonia inoculum levels included canola, fallow, vetch and medic as break crops within the rotation with adequate grass and summer weed control and controlling the green bridge before sowing.

The 'best bets' used to reduce the impact of Rhizoctonia infection in the crop included adequate nutrition, particularly zinc and other trace elements, fluid phosphorus fertiliser delivery in calcareous grey soils, sowing depth, timeliness of sowing (earlier into warmer soil temperatures) and use and placement of fungicides.

Piednippie
In 2011 a paddock with a high grass history was sown to CB Telfer (TT) canola. The paddock had a seeder strip which was a fallow with some medic and a few weeds (melon and milk thistle). In 2012 the paddock was sown with Mace wheat @ 60 kg/ha on 12 June with 50 kg/ha of DAP (18:20:0:0) and the fallow/medic and canola areas were monitored for any differences in Rhizoctonia disease incidence and grain yield.

In 2012 CL Oasis mustard was the break crop option used in a paddock with a medic/fallow strip (one seeder run). The previous paddock history was; 2011 barley (with high Rhizoctonia damage); 2010: wheat (mouse plague resulted in large bare patch causing the pimpernel weed problem and grass issues in this paddock). The PreDicta B *Rhizoctonia solani* AG8 risk was medium with 62 pg DNA/g soil after canola and low (22) after the medic/fallow. The paddock was sown with CL Kord wheat on 27 April 2013 with 55 kg/ha of DAP with a post sowing application of 2 L/ha Zn.

Warramboo
The break crop options evaluated at Warramboo in 2012 included Blanchefleur vetch (no fertiliser) and self-regenerating medic (mixture of Harbinger and Parabinger). The paddock was grass free sprayed twice, and spray topped ensuring adequate grass control and no seed set was achieved during the break phase. The PreDicta B disease *Rhizoctonia solani* AG8 risk was low for both vetch and medic. The paddock was sown early on 12 May 2013 with Mace wheat using a fluid fertiliser delivery system.

In 2012 and 2013 +/- fungicide strips were monitored for Rhizoctonia disease incidence using a fluid fertiliser system with 6 units P, 9 units N (dissolved urea) and trace elements (TE) of 1.5 kg/ha each of elemental Mn and Zn. Urea @ 35 kg/ha was applied in-crop. The fungicide treatment and control was sown with two seeder widths and were approximately a kilometre in length.

Wynarka (Mallee)
In 2012 and 2013 Rhizoctonia fungicide EverGol Prime was used in broad acre Scope barley strips @ 55 kg/ha on 25 May with a Morris Concept seeder. Fertiliser was 28:13 banded below the seed at 75 kg/ha. Five L/ha of a fluid trace element mix was also banded under the seed with 80 g/L of Zn sulphate, 60 g/L of Mn sulphate and flutriafol in the liquid cart. The fungicide treatment strip, one seeder width wide, and a control treatment located parallel were monitored during the season.

What happened?

Piednippie: Canola and Juncea canola (mustard) as break crops compared to medic
The cereal crops following the canola and medic break crops at Piednippie in 2012 and 2013 performed well and had a lower Rhizoctonia inoculum level following both the canola and medic/fallow rotations, validating previous trial research.

2011 was a poor year and the medic being in the same paddock as the canola was not grazed, so no income was generated from the medic in the medic/wheat rotation. While the wheat yields were the same following both rotation options in 2011, the rotation gross margin results were very different. The rotation gross margin was significantly in favour of the medic/wheat rotation ($104/ha) as the variable costs were greater in the canola ($22/ha gross margin (GM)) in the poor year of 2011. This highlights the risk associated with canola compared to a volunteer medic pasture in this environment.

In 2012 the rotational choices of Juncea canola (mustard) and medic/fallow in the demonstration resulted in different wheat yields in the second year of 2 t/ha and 1.7 t/ha respectively. However, the rotation gross margins of the break crops showed little difference in financial performance with only $4/ha difference in gross margin.

The wheat/wheat rotation provided the lowest rotation gross margin ($228/ha) when compared to the rotations with a break year ($284 and $288/ha) indicating the overall production and financial benefits of a rotation with a break when compared to a wheat/wheat rotation.

Rotation selection can make an economic difference, however this season again showed how risky oil seed is to grow profitably in this area. Modelling was undertaken to determine the break-even yield for canola in this environment, and it would need to yield 0.36 t/ha for it to be financially equivalent with a medic/wheat rotation, given average seasonal conditions. However canola is a riskier crop to grow. A long term yield of 0.45 t/ha is needed to provide a profitable risk reward and should be considered as the necessary canola break-even yield in this environment (M Krause).

Warramboo: vetch and medic as break crops
The wheat gross margin after low input vetch was $100/ha higher than after a medic pasture due to a 0.4 t/ha increase in yield. As the medic pasture was not grazed in this trial, there was no allowance for sheep gross margin. However, sheep would have had to achieve a gross margin of $100/ha for both treatments to have the same economic outcome.

Fungicides: Warramboo, Wynarka and Minnipa

The new fungicide products available for Rhizoctonia suppression varied in performance in 2013 in paddock demonstrations with some products only performing marginally better than the controls in grain yield. There were differences detected in the demonstrations in the level of Rhizoctonia infection of seminal (seedling) roots but these were not significant in 2013.

At Warramboo average yield obtained from two areas within the demonstration were used for the economic analysis. Both fungicides had lower Rhizoctonia patch score but not lower Rhizoctonia root infection. The economic evaluation in this demonstration showed the selection of fungicide was important as the EverGol Prime gave an improved gross margin ($251/ha) due to an increase in yield and lower input costs. The use of Uniform ($183/ha) gave minimal improvement in gross margin over the control treatment ($180/ha) despite an increase in yield, due to the higher input cost ($17/ha).

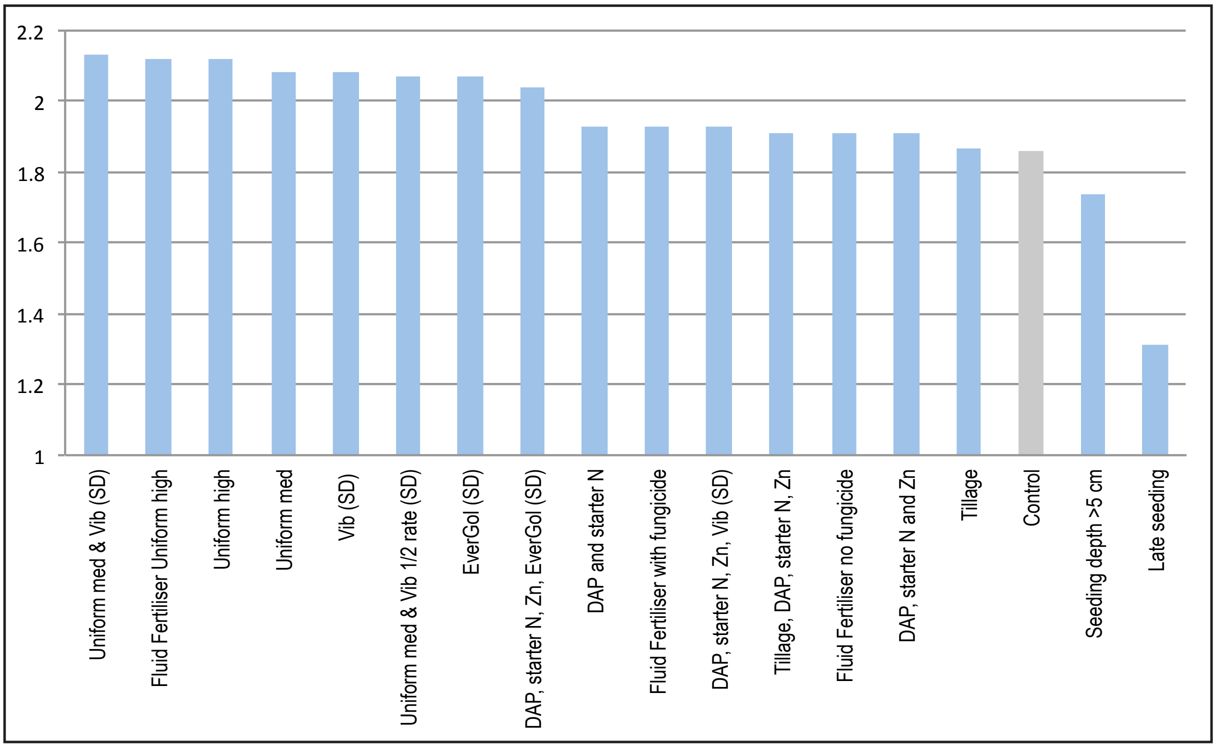

Figure 1 Yield (t/ha) of CL Kord wheat in EPARF fungicide trial in MAC S3N, 2013

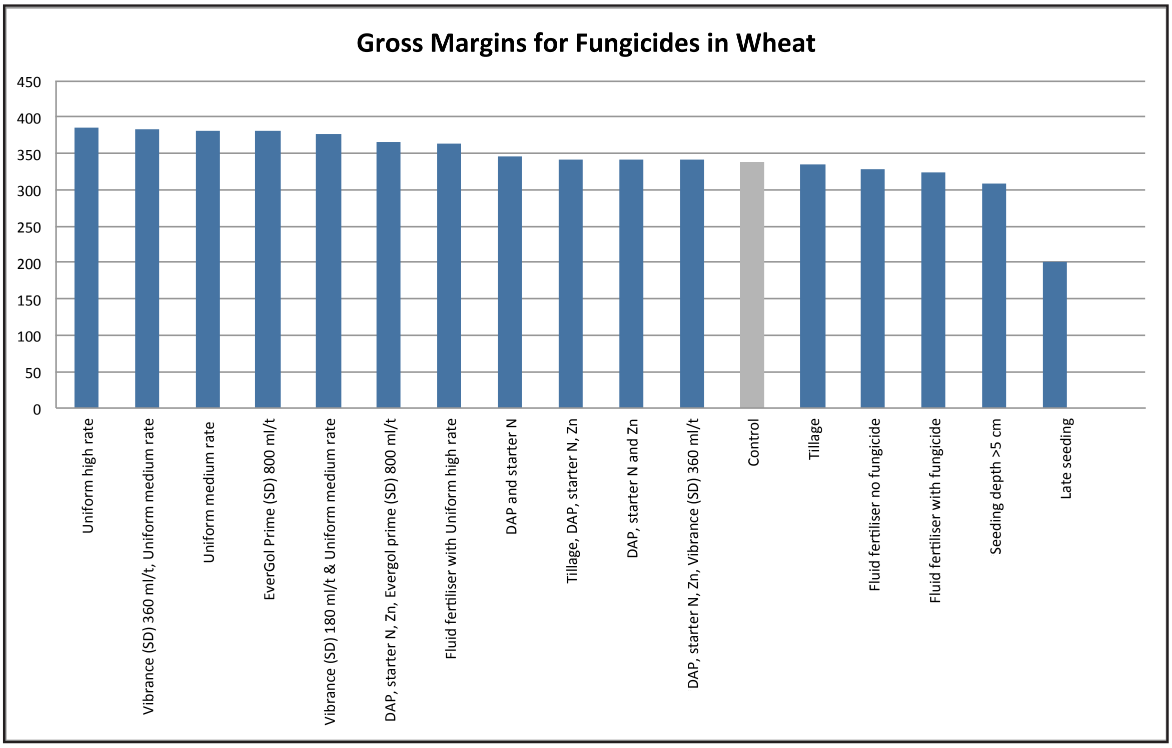

Figure 2 Yield (t/ha) of CL Scope barley in EPARF fungicide trial in MAC S3N, 2013

Disease

At Wynarka there were no differences in plant growth, Rhizoctonia seminal or crown root scores, grain yield or grain quality between the control and the fungicide treatment at this site in 2013. While there was some gross margin improvement when using fungicides (EverGol Prime and flutriafol), this financial improvement was minimal when comparing the three year rotational gross margin.

Results from the Best Bets for Rhizoctonia trial at Minnipa showed banded in-furrow fungicides were more effective than seed treatments, and new products at higher rates were also effective. There were yield responses to fungicide treatments in both wheat and barley, however there were still visual Rhizoctonia patches present in the treatments. Treatments and yields (t/ha) for wheat and barley are shown in Figures 1 and 2. Tillage, starter nitrogen and zinc produced similar yields to many of the fungicide treatments. A three week delay in seeding reduced yield of all treatments by nearly one third. The fungicide treatments did not prevent an increase in Rhizoctonia inoculum levels during the cereal phase.

Gross margins ($/ha) for fungicides in wheat are shown in Figure 3. Sowing 3 weeks later than the control produced the poorest gross margin of $200/ha. Eight treatments provided noticeably improved gross margins (over $350/ha) when compared to the 'control treatment' ($338). The use of fungicides Uniform (SYN SIF1), EverGol Prime and Vibrance seed dressing provided improvements in gross margins when compared to the control. The use of fluid fertiliser did not improve gross margin over the control in this soil type.

Gross margins ($/ha) for fungicides in barley are shown in Figure 4. Sowing 3 weeks later than the control produced the poorest gross margin ($217/ha). Most treatments in the barley trial gave no significant gross margin improvement when compared to the control. Only one fungicide treatment, Vibrance seed dressing 360 ml/t & Uniform (SYN SIF1) in-furrow medium rate ($372/ha), produced an improved gross margin above the control treatment ($345/ha).

What does this mean?

Grass free break crops are currently the best recommended option to lower the Rhizoctonia inoculum level, allowing the following cereal crop to have lower initial disease pressure. The break crop options included in the farmer demonstrations of canola, Juncea canola, vetch and medic lowered Rhizoctonia inoculum levels, allowed other grass weed control options and earlier sowing for the cereal crop in the following season. Growers are currently using rotation as a Rhizoctonia management option with higher levels of canola being used in the Mallee, and medic pasture on EP.

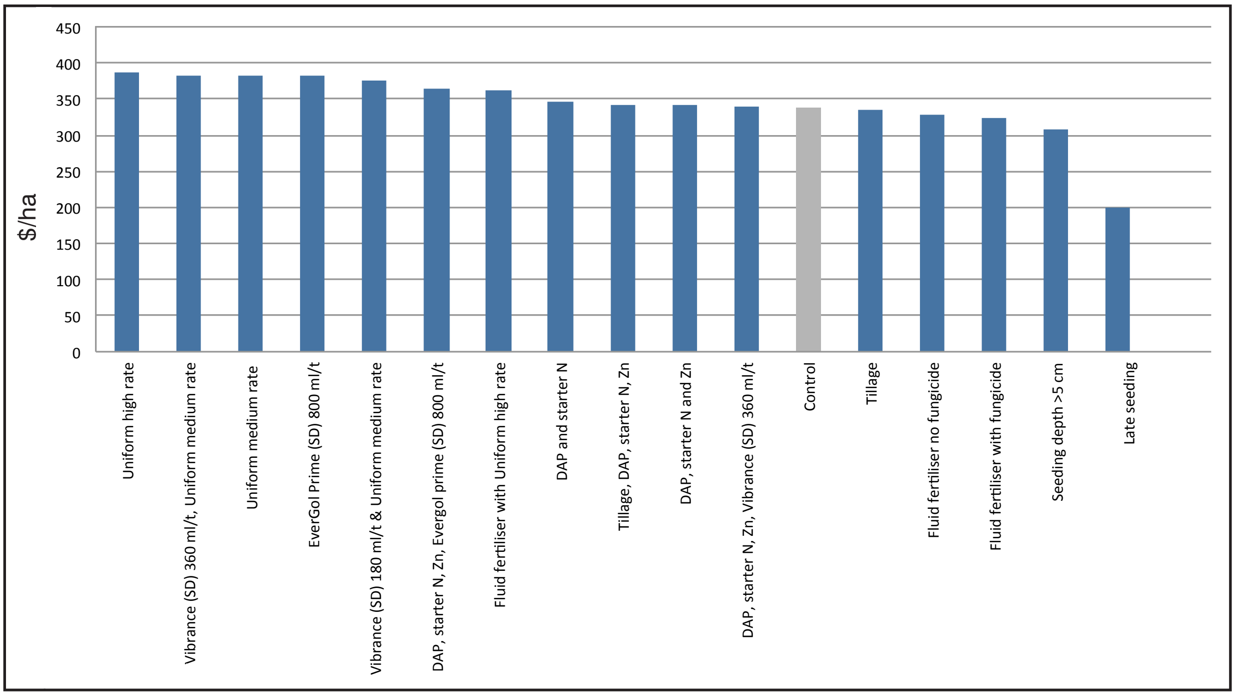

Figure 3 Gross margin ($/ha) of CL Kord wheat treatments in EPARF fungicide trial in MAC S3N, 2013

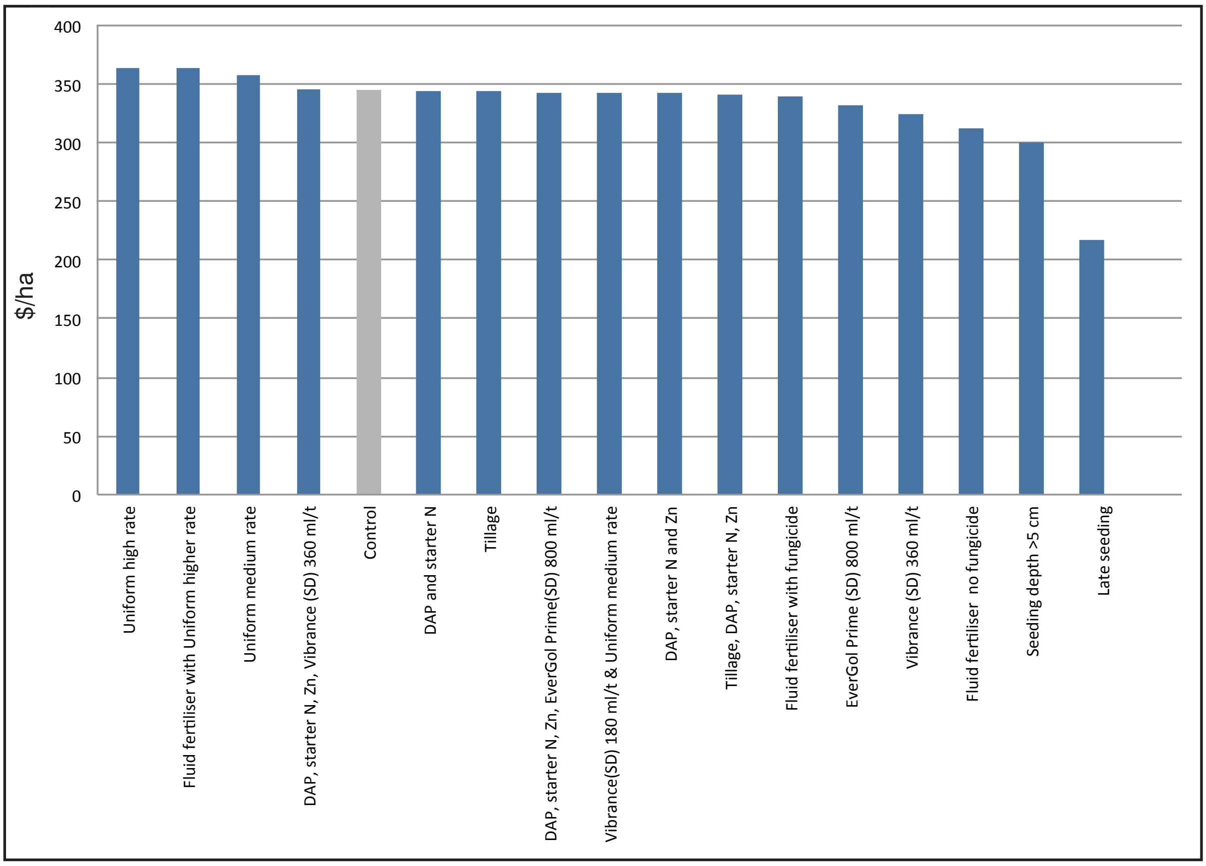

Figure 4 Gross margin ($/ha) of CL Scope barley treatments in EPARF fungicide trial in MAC S3N, 2013

However on upper EP in the seasons tested, canola and Juncea canola proved to be a significant financial risk compared to medic. Economic modelling for average seasons indicated that canola needed to yield at least 0.36 t/ha to provide an equivalent gross margin with 'medic pasture (sheep)/wheat' rotation in this environment. When allowing for the risk of growing canola, a yield of 0.45 t/ha in an average season should be the break-even yield.

The low input vetch break crop performed well as a break crop compared to medic. The rotation of vetch/wheat compared to medic pasture/wheat gave the best financial result with a higher yield being achieved and an increase of $100/ha with the vetch rotation.

New fungicide products for Rhizoctonia suppression have varied in performance in paddock demonstrations with some products only performing marginally better than the controls in grain yield. The lower cost products provided better economic benefits in these demonstrations in 2013.

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Fluid delivery systems and fungicides in wheat at Warramboo and Streaky Bay

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RESEARCH

Searching for answers

Location: Warramboo
Darren Sampson and family
Rainfall
Av. Annual: 313 mm
Av. GSR: 227 mm
2014 Total: 302 mm
2014 GSR: 190 mm
Yield
Potential yield: 2.1 t/ha (W)
Actual: 2.0 t/ha
Paddock History
2014: Wheat
2013: Wheat
Soil Type
Red sandy loam
Plot Size
20m x 2m 3 reps

Location: Streaky Bay
Luke Kelsh and family
Rainfall
Av. Annual: 379 mm
Av. GSR: 304 mm
2014 Total: 441 mm
2014 GSR: 227 mm
Yield
Potential yield: 3.8 t/ha (W)
Actual: 1.0 t/ha
Paddock History
2014: Wheat
2013: Medic pasture
Soil Type
Grey calcareous sandy loam
Plot Size
20m x 2m x 3 reps

Key messages

- **2014 trial results showed using phosphoric acid as the phosphorus source compared to granular fertiliser produced a significant response in early dry matter and a 0.13 t/ha yield increase on highly calcareous soil at Streaky Bay.**
- **Zinc deficiency was present at mid tillering at Streaky Bay but it was corrected with the trace element treatment.**
- **There were no differences to grain yield as a result of fungicide applications or rates at Streaky Bay which had a high Rhizoctonia inoculum level.**
- **There were no differences in yield given differing nutrition applications at Warramboo, with DAP and trace elements or phosphoric acid and manganese performing similar.**
- **The Warramboo site had medium Rhizoctonia inoculum levels and low disease expression, however there were differences in late dry matter and yield with trace element plus fungicide applications, but there were no differences between fungicide placement or rates.**
- **Research into fluid delivery for nutrition and fungicides will continue for another two seasons.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrients and disease control strategies in current farming systems. The fluid systems (fertilisers or nutrients) have the potential to increase production through delivery of micro and macro nutrients, reduce cost of trace element delivery, and increase control of cereal root and leaf disease, resulting in possible increases in dry matter production and grain yield.

Historically, fungicidal control of Rhizoctonia which infects the major crops grown in southern Australia has generally been poor, but fluid delivery systems with fungicides are a new option of delivery which may increase production and improve disease control. With the relatively recent development of processes to evenly coat fertiliser granules with fungicides and to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products. This trial was undertaken to assess the benefits of these products, and various application strategies, on wheat in two upper Eyre Peninsula environments.

How was it done?

Two identical replicated trials were established at Warramboo on a red sandy soil and Streaky Bay on a grey calcareous soil in 2014. Both trials were divided into nutrition delivery treatments and fungicide application strategies. The fluid fertiliser delivery system placed fluid fertiliser approximately 3 cm below the seed at an output rate of 100 L/ha. The fungicide fluid system could also be split to delivery fluids both below the seed at approximately 3 cm, and above in the seeder furrow behind the press wheel in a 1 cm band.

The control treatment was 60 kg/ha of Mace wheat with 50 kg/ha of 18:20:0:0 (DAP). Manganese (Mn) was selected as the main focus trace element, with zinc (Zn) and copper (Cu) also included in the trace element mix. A DAP fertiliser blend with Mn @ 1.5 kg/ha was sourced. Phosphoric acid and granular urea, and ammonium poly phosphate (APP) and urea ammonium nitrate (UAN) were used as fluid fertiliser products to compare with granular fertilisers. Manganese sulphate was dissolved with standard rate being 1.5 kg/ha, with 0.8 kg/ha as the low rate and 3 kg/ha as a high rate. 1 kg/ha Zn, as zinc sulphate and 0.2 Cu of copper sulphate were dissolved in the standard rates of trace elements and half these products as the low rate.

Trace elements were also delivered as foliar applications at 4-5 leaf stage, and also a half foliar rate.

The fungicides Uniform (SYNSIF1 in furrow), EverGol Prime and Vibrance (seed dressings) were assessed for Rhizoctonia disease suppression with trace elements, at different rates and in split applications.

The Warramboo trial was sown on 16 May with pre-sowing weed control of 1.5 L/ha Roundup Power max Extra, 1.5 L trifluralin, 80 ml/ha Hammer and a wetter. In crop weed control was on 31 July with 700 ml/ha Amicide 700.

The Streaky Bay trial was sown in slightly drier conditions on 20 May with pre-sowing weed control using 1 L/ha Roundup Power max Extra, 1 L/ha trifluralin and 80 ml/ha Hammer, before a 20 mm rainfall event. It was sprayed on June 16 with 25 ml/ha of Karate for slight insect damage. In crop weed control for ryegrass and small medic was applied on 28 July with 430 g/ha Achieve, 60 ml/ha Lontrel Advance and wetter.

PreDictaB disease inoculum levels (RDTS), plant establishment, Rhizoctonia seminal root score, Rhizoctonia crown root score, green leaf area index, grain yield and quality were measured during the season.

Rhizoctonia infection on seminal roots and crown roots was assessed using the root scoring method described by McDonald and Rovira (1983) eight weeks from seeding, on 18 July at Warramboo and 21 July at Streaky Bay. Crown roots per plant were also counted on these samples with the number of roots infected with Rhizoctonia used to calculate % crown root infection.

Trials were harvested on 12 November at Warramboo, and harvest started on 17 November at Streaky Bay, but finished on the 21 November due to a header breakdown. Selected reps were sampled for harvest soil moistures.

Data were analysed using Analysis of Variance in GENSTAT version 16.

What happened?

At Warramboo the initial Predicta B inoculum level predicted a medium risk of Rhizoctonia disease (51 pgDNA/g soil). The Take-all level was high but there were low levels of inoculum for other soil borne diseases. Plant establishment at Warramboo was the same for all treatments, with an average of 124 plants/m^2 in the fluid nutrition trial and 100 plants/m^2 in the fungicide trial.

The initial Predicta B inoculum level at Streaky Bay predicted a high risk of Rhizoctonia disease (745 pgDNA/g soil) and there were low levels of inoculum for all other soil borne diseases. There were no differences in plant establishment with an average of 125 plants/m^2 in wheat in the fluid nutrition trial and 118 plants/m^2 in the fungicide trial.

The 2014 season had late summer and good autumn rains with adequate soil moisture and early sowing in most areas compared to the average sowing date. These conditions provided lush early crop growth as plants were not as limited as by moisture and the increased availability of nutrition, especially nitrogen and phosphorus, enabling greater root growth. This allowed the plants to grow through the impact of Rhizoctonia root infection, especially at the Warramboo site.

Drier conditions at seeding and only spraying the green bridge out just before sowing as well as a high inoculum level resulted in Rhizoctonia patches being present in the Streaky Bay trial. The trial at Warramboo had less Rhizoctonia disease pressure and was generally even all season except the urea only treatment, which had less growth.

At the Warramboo site there was a low level of Rhizoctonia inoculum present and generally the trial was even with little disease expression. There were no 'stand out' treatments during the season, however the urea only treatment looked poor all season. There were no differences at Warramboo in the nutrition trial in early dry matter or yield measurements recorded this season, however the DAP and liquid trace element mix was the highest yielding (Table 1). Grain quality showed no differences with the trial averages being test weight of 81.4 (kg/hL), protein 9.9%, screenings 2.2% and 1000 grain weight of 37.8 g (data not presented).

The fungicide trial at Warramboo had no differences in early dry matter or Rhizoctonia root assessment taken at eight weeks (Table 2). There were differences in late dry matter and grain yield with some fungicide treatments plus trace elements mix having higher dry matter and yield (Table 2). The split application of fungicides in furrow did not perform better than fungicide in furrow below the seed, seed dressing or fertiliser application at this site in the 2014 season. Grain quality showed no differences with the trial averages being test weight of 79.8 (kg/hL), protein 10.0%, screenings 2.9% and 1000 grain weight of 36.6 g (data not presented).

Table 1 Fluid delivery of nutrition trial growth measurements (dry matter), yield and grain quality for Mace wheat at Warramboo, 2014

Treatment	Early DM (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late DM (kg/m^2)	Yield (t/ha)
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	17.8	3.0	47.3	1.6	2.13
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	19.2	2.9	42.4	1.3	2.11
Phosphoric acid and 3kg/ha MnSO4 liquid and Gran Urea	19.3	3.0	39.4	1.5	2.07
Phosphoric acid and urea (equivalent 50 kg/ha DAP)	16.0	2.9	36.8	1.3	2.05
Phosphoric acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	17.1	2.9	39.1	1.4	2.03
DAP and Foliar Mn @ 1.5 kg/ha	18.9	3.0	45	1.3	1.98
Half rate Phosphoric acid (equivalent 25 kg/ha DAP) and urea	16.2	2.9	45.6	1.3	1.97
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	15.5	2.9	42.0	1.2	1.96
Control	17.7	2.9	38.7	1.4	1.95
Control	16.6	2.9	33.9	1.2	1.95
APP and UAN (equivalent 50 kg/ha DAP)	18.3	2.8	40.3	1.3	1.94
DAP with Mn coated fertiliser 1.5 kg/ha	19.5	2.9	40.5	1.3	1.90
Phos acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	15.9	2.8	40.8	1.3	1.90
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	15.5	2.8	33.9	1.3	1.89
Urea only	12.9	3.0	39.0	1.1	1.74
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*

The trial at Streaky Bay was very uneven and had patchy growth due to a high initial inoculum level and Rhizoctonia disease expression. The fungicide trial was visually more even in growth earlier in the season than the nutrition trial but Rhizoctonia patches were still present. There were no treatments which were visually better in the trial. There were differences in the early dry matter in the nutrition treatment on the grey calcareous soil with most phosphoric acid with granular urea treatments having better early growth at 8 weeks. The tissue test taken at mid tillering showed some zinc deficiency at this site, with the trace element treatments having adequate levels.

There were no differences at Streaky Bay in nutrition in yield measurements recorded this season in the trial, however the phosphoric acid treatments with manganese were highest yielding (Table 3). Grain quality showed no differences with the trial averages being test weight of 80.2 (kg/hL), protein 10.3%, screenings 1.6% and 1000 grain weight of 39.7 g (data not presented).

There were no differences at Streaky Bay in fungicide in dry matter, Rhizoctonia root scores, yield or quality measurements recorded this season in the trial (Table 4). Grain quality averages of the trial were, test weight of 80.7 (kg/hL), protein 10.0 %, screenings 1.7 % and 1000 grain weight of 40.4 g (data not presented).

Table 2 Disease scores, growth measurements and yield for fungicides in Mace wheat at Warramboo trial, 2014

Treatment	Fertiliser	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
Uniform @ 300 ml/ha – split application	DAP and Liquid Trace elements (Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha)	17.8	2.6	42.3	1.45	2.24[a]
Fungicide in furrow low	DAP and TE	15.4	2.8	48.1	1.58	2.24[a]
Uniform @ 150 ml/ha – split application	DAP and TE	22.8	2.6	49.6	1.48	2.21[a]
Uniform @ 300 ml/ha on fertiliser	DAP and TE	19.5	2.6	43.8	1.42	2.19[ab]
Uniform @ 300 ml/ha and Vibrance seed dressing @ 300 ml/100 kg seed	DAP and TE	20.0	2.6	38.0	1.44	2.18[abc]
Uniform @ 300 ml/ha	DAP	19.9	2.7	45.8	1.46	2.15[abcd]
Uniform @ 150 ml/ha	DAP and TE	16.9	2.6	49.1	1.59	2.12[abcd]
Fungicide in furrow low	DAP	16.8	2.6	48.9	1.46	2.12[abcd]
EverGol Prime seed dressing @ 80ml/100 kg seed	DAP and TE	16.9	2.6	49.9	1.26	2.12[abcd]
Uniform @ 300 ml/ha – split application	Mn only @ 1.5 kg/ha	17.5	2.4	44.4	1.17	2.12[abcd]
Control	DAP	18.1	2.8	57.9	1.17	2.10[abcd]
Fungicide in furrow high	DAP and TE	14.3	2.7	43.6	1.47	2.05[bcd]
Control	DAP	17.1	2.6	54.9	1.22	2.00[bcd]
Uniform @ 300 ml/ha	DAP and TE	17.5	2.5	53.0	1.36	2.04[cd]
Uniform @ 300 ml/ha – split application	DAP	15.6	2.8	45.0	1.26	2.03[cd]
Uniform @ 150 ml/ha and Vibrance seed dressing @ 150 ml/100 kg seed	DAP and TE	15.2	2.4	40.1	1.43	2.02[d]
LSD (P=0.05)		*ns*	*ns*	*ns*	*0.075*	*0.15*

The analysis of the main effects of the trials at Warramboo and Streaky Bay showed no differences in the treatments except the use of phosphoric fertiliser at Streaky Bay which resulted in a 0.13 t/ha increase in yield over the standard practice of using granular DAP fertiliser.

What does this mean?

In the 2014 season all nutrition treatments at Warramboo performed similarly, except the urea only treatment which was poor all season, but the DAP or phosphoric acid and trace element mixes performed best in both the nutrition and fungicide trial at this site. There were no nutritional differences detected in mid-tillering tissue tests.

The Warramboo site had medium Rhizoctonia inoculum levels and low disease expression and there were no differences in root disease assessment of seminal or crown roots at 8 weeks. There were differences in late dry matter and yield due to fungicide treatments plus trace elements mixes having higher dry matter and yield. The application method of the fungicides; split in furrow, in furrow below the seed, seed dressing or fertiliser application, were not different at this site in this season and higher rates did not perform better than lower rates.

Table 3 Fluid delivery of nutrition trial growth measurements, yield and grain quality for Mace wheat at Streaky Bay, 2014

Treatment	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
Phosphoric acid and 3 kg/ha $MnSO_4$ liquid and Gran Urea	0.20 a	3.4	82.6	0.61	1.15
Phosphoric acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	0.17 ab	3.3	73.7	0.59	1.15
Control	0.13 bc	3.5	80.2	0.38	0.98
Half rate Phosphoric acid (equivalent 25 kg/ha DAP) and urea	0.16 abc	3.3	87.1	0.3	0.98
DAP and Foliar Mn @ 1.5 kg/ha	0.13 bc	3.5	86.1	0.53	0.97
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.11 c	3.3	85.2	0.37	0.95
Phosphoric acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	0.16 abc	3.2	84.3	0.50	0.94
Urea only	0.14 bc	3.4	79.6	0.43	0.91
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.12 c	3.5	83.5	0.48	0.91
DAP with Mn coated fertiliser 1.5 kg/ha	0.13 bc	3.3	93.0	0.41	0.90
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	0.13 bc	3.5	86.1	0.66	0.90
Control	0.11 c	3.3	82.2	0.48	0.88
Phosphoric acid and urea (equivalent 50 kg/ha DAP)	0.13 bc	3.4	81.9	0.40	0.88
APP and UAN (equivalent 50 kg/ha DAP)	0.14 bc	3.3	85.4	0.70	0.88
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.12 c	3.5	85.4	0.62	0.79
LSD (P=0.05)	*0.05*	*ns*	*ns*	*ns*	*ns*

Table 5 Analysis of main treatments in unbalanced design at Warramboo and Streaky Bay, 2014

Fluid delivery - Fertiliser	Warramboo yield (t/ha)	Streaky Bay yield (t/ha)
DAP	2.00	0.90 b
Phosphoric acid	2.01	1.03 a
APP	1.92	0.91 ab
LSD (P=0.05)	*ns*	*0.13*
Fluid delivery - Fungicide	**Warramboo yield (t/ha)**	**Streaky Bay yield (t/ha)**
Control	2.15	0.94
Uniform	2.12	0.89
EverGol Prime	2.11	0.93
LSD (P=0.05)	*ns*	*ns*

Table 4 Disease scores, growth measurements and yield for fungicides in Mace wheat at Streaky Bay trial, 2014

Treatment	Fertiliser	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
EverGol Prime seed dressing @ 80 ml/100 kg seed	DAP and Liquid Trace elements (Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha)	0.17	3.1	76.6	0.58	1.00
Uniform @ 150 ml/ha	DAP and TE	0.19	3.2	78.4	0.49	0.98
Uniform @ 300 ml/ha – split application	DAP and TE	0.17	2.9	74.3	0.49	0.98
Uniform @ 150 ml/ha and Vibrance seed dressing @ 150 ml/100 kg seed	DAP and TE	0.19	2.9	78.7	0.54	0.97
Fungicide in furrow low	DAP and TE	0.18	3.1	75.7	0.66	0.97
Fungicide in furrow high	DAP and TE	0.18	3.0	80.1	0.52	0.94
Uniform @ 150 ml/ha – split application	DAP and TE	0.18	3.1	78.4	0.49	0.92
Control	DAP	0.19	3.3	85.3	0.5	0.91
Uniform @ 300 ml/ha – split application	Mn only @ 1.5 kg/ha	0.15	3.0	82.5	0.53	0.91
Uniform @ 300 ml/ha and Vibrance seed dressing @ 300 ml/100 kg seed	DAP and TE	0.18	2.9	67.8	0.64	0.90
Uniform @ 300 ml/ha	DAP and TE	0.18	3.1	75.5	0.53	0.88
Uniform @ 300 ml/ha – split application	DAP	0.16	3.0	75.1	0.56	0.88
Uniform @ 300 ml/ha	DAP	0.16	3.0	76.6	0.47	0.86
Fungicide in furrow high	DAP	0.16	3.2	81.9	0.39	0.80
Control	DAP	0.14	3.2	88.6	0.45	0.77
Uniform @ 300 ml/ha on fertiliser	DAP and TE	0.12	3.2	85.8	0.38	0.75
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*

The Streaky Bay trial showed a 0.13 t/ha yield increase over 18:20:0:0 using phosphoric acid as the phosphorus source. There were also differences in the early dry matter with phosphoric acid with manganese with granular urea treatments having greater early growth. The tissue tests taken at mid tillering indicated zinc deficiency in some treatments at Streaky Bay, but it was corrected with the trace element treatment. Manganese deficiency was not detected at this site in tissue tests, despite the treatments with added manganese having better early growth. There were no significant differences in fungicide treatments, application method or rates at this site, but treatments will be included next season with phosphoric acid, trace elements and fungicide mixes.

These trials will continue for another two seasons to have a better understanding of the best fertiliser mixes and fungicide applications and to increase confidence in fluid delivery systems.

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Fluid delivery systems in canola

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RESEARCH

Searching for answers

Location:
Coulta, Morgan family
Rainfall
Av. Annual: 525 mm
Av. GSR: 465 mm
2014 Total: 499 mm
2014 GSR: 421 mm
Yield
Potential: 4.8 t/ha (C)
Actual: 1.2 t/ha
Paddock History
2014: CL canola
2013: Justica wheat
2012: Medic pasture
Soil Type
Grey loamy clay
Plot Size
20m x 2m x 3 reps

Key messages

- **This season showed no trace element differences given different delivery methods of granular, fluid or foliar application.**
- **The type of fertiliser used, fluid or granular, showed no differences in yield this season.**
- **There was no difference in yield, dry matter or disease with the addition of trace elements with fungicide treatments.**
- **The fungicide treatments combined did increase yield over the nil control treatment at this site, however the difference in blackleg disease levels scored was not significant.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. The fluid systems have the potential to increase production through delivery of micro and macro nutrients, reduce cost of trace element delivery, and increase control of cereal and canola root and leaf disease, resulting in possible increases in dry matter production and grain yield.

Blackleg continues to be a major issue facing canola growers especially on lower Eyre Peninsula and fluid delivery systems for product delivery may increase production and improve disease control. With the relatively recent development of processes to evenly coat fertiliser granules with fungicides and to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products.

How was it done?

A replicated canola fluid delivery trial was established at Coulta, sown with Clearfield 45Y86CL (CL canola) at 3 kg/ha. PreDictaB disease inoculum levels (RDTS), plant establishment, dry matter, blackleg infection, grain yield and quality were measured during the season.

The control fertiliser treatment was 100 kg/ha of 18:20:0:0. A fluid fertiliser delivery system placed fluid fertiliser approximately 3 cm below the seed at an output rate of 100 L/ha. The fluid fertiliser treatments were equivalent to 100 kg/ha of 18:20:0:0 as phosphoric acid and granular urea banded below the seed.

Manganese (Mn) was selected as the focus trace element in the nutrition trial, with zinc (Zn) and copper (Cu) also included in the trace element mix. The rate of Mn was 1.5 kg/ha as the standard rate as manganese sulphate, 1 kg/ha Zn as zinc sulphate and 0.2 kg/ha Cu as copper sulphate. Trace elements were also delivered as foliar applications at 4-5 leaf stage, and also at a half rate. Fungicides Jockey and Intake were included for blackleg disease control.

Weed control was applied broad acre on 20 June with Intervix @ 500 ml/ha and Select @ 500 ml with 5% uptake. On 3 July 120 kg/ha of sulphate of ammonia was applied broad acre and 100 kg/ha of urea on 25 July. The trial was harvested on 11 November 2014.

Data were analysed using Analysis of Variance in GENSTAT version 16, and also with an unbalanced design used for the main effects.

What happened?

The soil was shallow with limestone below and due to the direction of seeding and the knife points used on the plot seeder, some rocks were pulled up which resulted in uneven plots. However there were no significant differences in plant establishment counts within the trial (data not shown) with the average plant establishment being 41 plants/m^2. There were no differences in early dry matter, yield or grain quality measurements recorded this season in the trial (Table 1). The reduction in phosphorus fertiliser with the urea only and half rate of phosphoric acid reduced yield by 0.5 t/ha (Table 1).

Plants were tested for Beet Western Yellows virus but the test was negative at this site. Plant tissue tests (youngest leaf) were analysed at late cabbage stage which showed no trace element deficiencies at this site.

Table 1 Growth measurements (dry matter), yield and grain quality for CL canola in Coulta trial, 2014

Treatment	Early dry matter (g/plant)	Yield (t/ha)	Oil (%)	Protein (%)
Phos acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	0.12	1.49	42.5	21.0
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	0.10	1.33	42.8	20.9
APP and UAN	0.10	1.33	43	21.0
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.07	1.31	43.4	21.3
Control	0.07	1.27	43.1	20.6
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.10	1.25	43.3	20.7
Phos acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	0.10	1.24	42.8	21.2
Control	0.10	1.22	42.7	20.8
Phos acid and 3 kg/ha $MnSO_4$ liquid and Gran Urea	0.08	1.22	43	20.9
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.06	1.20	42.7	21.0
Phos acid and urea (equivalent 100 kg/ha DAP)	0.08	1.17	43	20.8
DAP and Foliar Mn @ 1.5 kg/ha	0.07	1.14	42.6	20.7
DAP with Mn coated fertiliser 1.5 kg/ha	0.08	1.09	42.1	21.3
Urea only	0.05	0.99	42.8	20.8
Half rate Phos acid (equivalent 50 kg/ha DAP) and urea	0.10	0.94	42.4	21.1
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*

Table 2 Yield of CL canola with different nutrition treatments at Coulta trial, 2014

Fertiliser source	Yield (t/ha)
APP and UAN	1.32
Control	1.24
Phosphoric acid	1.21
Granular fertiliser	1.20
Urea only	0.99
LSD (P=0.05)	*ns*

Table 3 Disease scores, growth measurements and yield for CL canola with fungicides and nutrition treatments at Coulta trial, 2014

Nutrition treatment	Late dry matter (kg/plant)	Blackleg score (% infection)	Yield (t/ha)
Zn, Cu, Mn with fungicide	0.68	25	1.22
Mn with fungicide	0.92	27	1.16
No TE with fungicide	0.79	34	1.14
Control	0.72	33	0.99
LSD (P=0.05)	*ns*	*ns*	*ns*

Table 4 Disease scores, growth measurements and yield for CL canola with fungicide treatments at Coulta trial, 2014

Fungicide treatment	Late dry matter (kg/plant)	Blackleg score (% infection)	Yield (t/ha)
Intake and Jockey	0.82	12	1.63 a
Intake	0.67	28	1.30 ab
Jockey	0.75	29	1.05 b
Control	0.72	33	0.99 b
LSD (P=0.05)	*ns*	*ns*	*0.35*

There were no significant differences at this site using different fertilisers types, granular or fluid; APP and UAN, phosphoric acid, granular DAP or urea only (Table 2). There were no differences recorded in early dry matter or grain quality given the different fertiliser treatments and applications.

In the trial this season there were no differences in plant growth, disease or yield given nil or different trace elements mixes applied this season (Table 3). The treatment with both fungicides applied did increase yield over the nil treatment at this site (Table 4), which is supported by previous research in this region but there were no significant differences in the blackleg disease scores in the trial. There were no differences in plant establishment or grain quality depending on the fungicide and nutrition treatment applied (data not shown; protein (average 20.9%), oil (average 42.8%)).

What does this mean?

The initial season at this site has showed no response to trace elements using different delivery methods, of granular, fluid or foliar application on canola. The type of fertiliser used, fluid or granular showed no differences in yield this season, however the lower phosphorus and urea only treatments had lower yields indicating a phosphorus response at the site. This is the first year of this research and it will be repeated over another two seasons.

There was no difference in dry matter or disease with the addition of trace elements or fungicide treatments. The fungicide treatments when combined did significantly increase yield over the nil fungicide control treatment at this site, however the difference in blackleg disease levels scored was not significant. The combined effect of fungicides giving additional protection has been reported in other research in this area, and the early protection of plants is important to reduce blackleg infection early due to rain splash.

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SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SAGIT

Farmer fungicide demonstration strips

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DEMO

Searching for answers

Location:
Buckleboo
Graeme and Heather Baldock
Rainfall
Av. Annual: 295 mm
Av. GSR: 210 mm
2014 Total: 298 mm
2014 GSR: 201 mm
Yield
Potential: 2.2 t/ha (W)
Actual: 1.4 t/ha
Paddock History
2014: Mace wheat
2013: Mace wheat
2012: Chemical fallow
Soil Type
Brown sandy loam

Location:
Lock - Andrew, Jenny and Tim Polkinghorne
Rainfall
Av. Annual: 333 mm
Av. GSR: 253 mm
2014 Total: 350 mm
2014 GSR: 254 mm
Yield
Potential: 3.5 t/ha (W)
Actual: 2.9 t/ha
Paddock History
2014: Mace wheat
2013: Medic pasture
2012: Hindmarsh barley
Soil Type
Grey calcareous sandy loam

Location:
Cleve
Matt and Amanda Price
Rainfall
Av. Annual: 402 mm
Av. GSR: 220 mm
2014 Total: 290 mm
2014 GSR: 209 mm
Yield
Potential: 2.7 t/ha (B)
Actual: 2.6 t/ha
Paddock History
2014: Scope barley
2013: Mace wheat
2012: Justica wheat
Soil Type
Red loam

Key messages

- **In the 2014 season there were no significant yield advantages recorded at five sites across upper Eyre Peninsula when using the fungicide products over the nil treatments. This was in a season with an early start and minimal stress during crop establishment, and at sites with high Rhizoctonia inoculum levels.**
- **The broad acre farmer demonstrations in the 2014 season showed no visual differences or early plant growth measured at the given sites during the cropping season.**
- **There were differences in the level of crown root infection at Cleve, where the nil treatment had a higher number of crown roots infected and a greater % of crown root infection than the fungicide treatments.**
- **There were differences between treatments recorded in the mid-May sown barley crop at Piednippie in Rhizoctonia patch score and the seminal root score.**
- **Differences in protein, screenings and test weights were recorded between treatments at several sites with a general trend of lower yields having higher protein, higher screenings and lower test weights.**
- **Further evaluation of research trials and farmer demonstrations using new fluid products and fungicide placement, will occur over two more seasons to evaluate the economics of using fungicides in low rainfall farming systems.**

Why do the demonstration?

Caring for Our Country funding was obtained to demonstrate the impact of new fungicides for Rhizoctonia suppression by monitoring farmer broad acre strips in their current farming systems in 2014.

How was it done?

Farmers applied fungicide products within broad acre paddocks using fluid systems and different nutrient mixes depending on their individual systems. None of these systems implemented split application of the fungicide products, all were applied with or below the seed.

Within each of the treated areas of the paddock, and an untreated control, four sampling lines were established to measure and collect data. Five paddock demonstrations were monitored; Graeme and Heather Baldock, Buckleboo, Andrew and Jenny Polkinghorne, Lock, Matt and Amanda Price, Cleve, Simon and Tanya Patterson, Piednippie and Peter Kuhlmann, Mudamuckla. Plant establishment, dry matter, Rhizoctonia seminal and crown root scores, grain yield and quality were measured in the treated and nil strips.

Plants were sampled 8-9 weeks after the sowing date to be assessed for root disease and early dry matter. Paddock patch score for Rhizoctonia is a visual score (0-5) of the number plants out of 5 plants affected by Rhizoctonia (400 plants scored per treatment) across 4 transects measured at the same time. Rhizoctonia seminal root scores were measured using 0-5 root scoring rating (McDonald and Rovira, 1983) of 80 plants per treatment across 4 transects and tops of plants were collected, dried and weighed for dry matter. Crown roots were also counted on the same plants with the number of roots infected with Rhizoctonia used to calculate % crown root infection.

Location:
Piednippie
Simon Patterson
Rainfall
Av. Annual: 366 mm
Av. GSR: 295 mm
2014 Total: 374 mm
2014 GSR: 284 mm
Yield
Potential: 4.4 t/ha (B)
Actual: 1.57 t/ha
Paddock History
2014: Fleet barley
2013: Scout wheat
2012: Medic pasture
Soil Type
Grey calcareous sandy loam

Location:
Mudamuckla
Peter Kuhlmann
Rainfall
Av. Annual: 291 mm
Av. GSR: 216 mm
2014 Total: 369 mm
2014 GSR: 293 mm
Yield
Potential: 3.8 t/ha (W)
Actual: 1.5 t/ha
Paddock History
2014: Mace wheat
2013: Mace wheat
2012: Axe wheat
Soil Type
Grey calcareous sandy loam

Buckleboo

The paddock was sown on 6 May with Mace wheat@ 60 kg/ha pre-treated with Rancona C as seed dressing with 18:20:0:0 @ 60kg/ha and $ZnSO_4$ @ 2 L/ha and UAN @ 20 L/ha. The paddock was top-dressed with 40 kg/ha of urea on 3 August. Uniform was added to the fluid at 200, 300 or 450 ml/ha rates. The initial Rhizoctonia inoculum level was high risk at 719 pg/DNA g soil, and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each seeder run and the yield data from broad acre header was also obtained.

Lock

The paddock was sown on 16 May with Mace wheat @ 55 kg/ha with the control being fluid fertiliser with 8 units P, 13.8 units N as urea and elemental rates of trace elements dissolved as 1 kg zinc monosulphate, 2 kg of manganese sulphate, 150 g of copper sulphate plus flutriafol @ 200 ml/ha. The Rhizoctonia fungicide treatment was applied with APP (ammonium polyphosphate) at 30 L/ha, UAS (urea ammonium sulphate (28% N)) at 25 L/ha and Uniform at 325 ml/ha. The initial Rhizoctonia inoculum level was medium risk at 60 pg/DNA g soil, Crown rot and Take-all were high risk, and low levels of *Pratylenchus neglectus*, with all other diseases below detection levels. Seven 20 m strips were harvested with the plot header in each seeder run and the yield data from the broad acre header was also obtained.

Cleve

Broad acre strips were sown on 11 May with Scope barley@ 45 kg/ha with control having 40 kg/ha 18:20:0:0, trace element mix 60:40:20 ZMC@10 L/ha and 20 L/ha UAN. Uniform was applied at 200, 300 or 400 ml/ha with all having 360 ml Vibrance seed dressing and Agriphar experimental product was applied at four rates of 160, 320, 480 or 640 ml/ha (Table 4). The initial Rhizoctonia inoculum level was high risk at 113 pg/DNA g soil, Crown rot and Take-all were medium level risk, with all other disease levels below detection levels. The plot header was used to harvest 20m strips within the treatments and grain quality was analysed.

Piednippie

Paddock 6 at Piednippie was sown on 20 May with Fleet barley at 60 kg/ha with a fluid fertiliser system using 4 units of phosphorus as phosphoric acid, 12 kg/ha of nitrogen as granular urea, 450 g/ha Zn and Intake Hiload Gold @150ml/ha. Uniform at 280 ml/ha and Agriphar Experimental product at @ 270 ml/ha was applied in strips with the fertiliser the same as the rest of the paddock. The initial Rhizoctonia inoculum level was in the high risk range at 314 pg/DNA g soil and all other diseases were below detection levels. Eight 20 m strips were harvested with the plot header in each seeder run and the yield data from the broad acre header was also obtained.

Mudamuckla

Paddock 25 at Mudabie was sown on 26 April with Mace wheat treated with Raxil seed dressing using variable rate technology (Rx) with three different rates of seed, phosphoric acid and urea depending on the paddock zone. The rates were 40, 50 or 55 kg/ha of seed, rates of 3.2, 5 or 6.3 kg P/ha as phosphoric acid and urea at rates of 0, 15, 22 kg/ha. Flutriafol was applied at 100 ml/ha and zinc monosulphate at 330 g/ha on the whole paddock.

A run with the standard rate of input, phosphoric acid at 5 kg P/ha, was included to compare with the normal practice variable rate runs. Uniform was applied at 300 ml/ha in a variable rate run and the standard rate (5 kg P/ha) run to compare to the nil treatments. The runs were approximately 1.5 km x 25.4 m wide. The initial Rhizoctonia inoculum level was high risk level at 105 pg/DNA g soil, Crown rot risk and *Pratylenchus thornei* risk were also high and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each treatment and the yield data from the broad acre header was also obtained on 21 November, and the paddock grain protein averaged 10.2%.

What happened?

The 2014 season with early summer and good autumn rains resulted in adequate soil moisture and early sowing, providing exceptional conditions for early crop growth. The plants were not limited by moisture and the increased availability of nutrition, especially nitrogen and phosphorus, enabled greater root growth. This allowed the plants to grow through the impact of Rhizoctonia root infection due to soil moisture and nutrition not being as limiting as in other seasons.

The farmers implemented the addition of the fungicides within their current farming practices, with different fluid fertiliser mixes which prevents a direct comparison of all the farmer demonstrations.

At Buckleboo the initial Rhizoctonia inoculum level was in the high risk category.

Table 1 Farmer fungicide demonstrations, Buckleboo 2014

Treatment	Early DM (g/plant)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infection (%)	Number crown roots	Late DM (g/m row)	Plot header yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)	Broad acre yield (t/ha)**
Nil Control	0.55	1.51	2.86	74.4	7.7	112	1.39	12.2	1.2	84.3	1.75
Uniform 200 ml/ha	0.6	1.68	2.86	78.5	8.8	122	1.36	13.6	1.0	83.7	1.75
Uniform 300 ml/ha	0.56	1.7	2.91	75.8	7.4	72	1.16	14.5	1.0	83.2	1.68
Uniform 450 ml/ha	0.55	1.69	2.93	69	8.4	82	1.25	14.1	1.2	83.3	1.81
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*0.09*	*0.7*	*ns*	*0.4*	*ns*

**(0=nil damage, 5=all seminal roots with spear tips) **Average of two separate runs*

Disease

This demonstration had different rates of Uniform applied, and the Uniform 300 ml/ha treatment coincided with high barley grass numbers. There were no differences in the plant growth parameters or disease infection levels at this site. The plot header yields were significantly different with the Uniform 300 ml/ha area being lower, possibly due to the higher grass competition. There were no significant differences in the broad acre paddock yields taken as an average of the two runs, although the Uniform 300 ml/ha area was lowest. There were differences in protein and test weight with the highest yielding Nil treatment having the lowest protein and highest test weight of grain, due to the dilution of protein in the grain (Table 1).

At Lock the initial Rhizoctonia inoculum level was medium risk but Crown rot and Take-all were high risk. In this demonstration the differences in fertiliser mixes of APP and phosphoric acid, do not allow a direct comparison of the effect of the fungicide treatment (Table 2). There were no differences detected in early growth or root disease levels. There were differences in late dry matter, yield and grain quality but we are unable to determine if this is a fertiliser or fungicide effect.

At Cleve the initial Rhizoctonia inoculum level was high risk with Crown rot and Take-all at a medium level risk. With a base granular fertiliser this extensive demonstration compared different nutrition and fungicides at different rates. The early dry matter, Rhizoctonia patch score and seminal root scores measured were not significant, but the % of crown root infection and the number of crown roots were significant (Table 3). The Nil treatment had a greater % crown root infection and a greater number of crown roots compared to the Uniform treatments.

There were no differences in plot header yields but protein, screenings and test weights differed with a general trend of lower yield having higher protein, higher screenings and lower test weight (Table 4).

Table 2 Farmer fungicide demonstrations, Lock 2014

Treatment	Run	Early dry matter (g/plant)	Rhizoctonia seminal root score (0-5)	Crown root infection (%)	Late dry matter (g/m row)	Plot header yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)	Broad acre yield (t/ha)**
APP, UAS, Uniform 325 ml/ha	23	1.15	2.4	65	153	3.16	11.7	7.0	82.5	2.82
Phos acid, UAS, Flutriafol, TE	24	1.25	2.8	65	193	2.91	12.5	7.5	81.4	3.01
Phos acid, 25 kg/ha Urea, Flutriafol	22	-	-	-	-	2.75	10.9	4.0	84.0	2.92
LSD (P=0.05)		*ns*	*ns*	*ns*	*17*	*0.13*	*0.3*	*1.3*	*0.8*	-

**(0=nil damage, 5=all seminal roots with spear tips) **Average of two separate runs*

Table 3 Plant growth and root disease levels of farmer fungicide demonstration at Cleve, 2014

Treatment	Early DM (g/plant)	Plants/m^2	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection	Number crown roots	Late DM (g/m row)
Nil –Run 19	0.8	82.5	1.02	2.8	68.8	6.2	170
Uniform 200 – Run 20	0.96	66	1.26	2.76	60.4	4.8	188
Uniform 300 – Run 21	0.87	77	1.45	2.81	58.4	4.0	200
Uniform 400 – Run 22	0.81	72	1.36	2.9	59.3	3.8	198
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*7.9*	*0.8*	*ns*

Table 4 Yield and grain quality of farmer fungicide demonstrations, Cleve 2014

Fluid mix	Seed treat-ment	Plot header yield (t/ha	Protein (%)	Screenings (%)	Test weight (kg/hL)
Normal – 300 ml/ha flutriafol, 10 L/ha trace element, 20 L/ha UAN	No	2.60	11.2	4.1	74.2
Nil Control - 10 L/ha trace element, 20 L/ ha UAN	No	2.69	11.1	3.5	74.9
200 ml/ha Uniform , 10 L/ha trace element, 20 L/ha UAN	360ml Vibrance	2.76	10.3	2.3	74.8
300 ml/ha Uniform, 10 L/ha trace element	360ml Vibrance	2.74	10.8	3.4	74.5
400 ml/ha Uniform, 10 L/ha trace element	360ml Vibrance	2.76	11.5	6.4	73.3
160 ml/ha Agriphar Experimental, UAN and Trace	No	2.72	10.8	2.7	73.4
320 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.72	9.8	2.0	74.1
480 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.41	10.0	2.2	74.4
640 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.72	9.7	2.5	73.8
10 L/ha trace element, 20 L/ha UAN	No	2.59	9.4	2.9	74.4
Normal – 300 ml/ha flutriafol, 10 L/ha trace element, 20 L/ha UAN	No	2.66	8.9	2.2	75.0
LSD (P=0.05)		*ns*	*0.73*	*1.6*	*1.0*

At Piednippie the initial Rhizoctonia inoculum level was a high risk level. This demonstration used a base fluid fertiliser of phosphoric acid and granular urea and compared different fungicides. The paddock had some grass weeds present and was the latest sown of all the demonstrations on the 20 May. There were differences in the Rhizoctonia patch score and the seminal root score with the Uniform treatment having the lowest (Table 5). There were also differences in the number of crown roots with Intake Hiload Gold having lower numbers. There were no differences in plot header yields at this site at the 5% significance level. There were differences in protein, screenings and test weights again with a general trend of lower yield having higher protein and higher screenings.

At Mudabie variable rate technology is used over different paddock zones using 3 different rates of phosphoric acid, urea and seeding rates. A standard run using 5 kg P/ha as phosphoric acid was also included to compare the use of the fungicide Uniform. The initial Rhizoctonia inoculum level was in the high risk range at 105 pg/DNA g soil, Crown rot risk and *Pratylenchus thornei* risk were also high. This was the earliest paddock sown in the demonstrations. There were no significant differences in early dry matter or root disease measurements.

There were differences in plot header yields with the phosphoric acid and Uniform treatment being lowest, but this may have also been a slight nitrogen response due to added urea.

Table 5 Plant growth and root disease levels of farmer fungicide demonstrations, Piednippie 2014

	Early DM (g/ plant)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infec-tion (%)	Num-ber crown roots	Plot yield (t/ha)	Pro-tein (%)	Screen-ings (%)	Test weight (kg/ hL)	Broad acre yield (t/ ha)**
Intake Hiload Gold 150 ml/ ha	0.34	2.1	3.2	70.2	2.9	1.79	9.0	0.37	66.5	1.60
Uniform @ 280 ml/ha	0.29	1.9	2.9	78.3	3.4	1.78	9.2	0.46	66.6	1.66
In furrow fungicide	0.37	2.1	3.1	76.2	4.2	1.76	9.5	0.50	67.6	1.42
Agriphar Experimental 270 ml/ha	0.27	2.5	3.0	77.4	3.9	1.46	9.6	0.64	68.1	1.63
LSD (P=0.05)	*ns*	*0.3*	*0.2*	*ns*	*0.6*	*ns*	*0.34*	*0.13*	*1.1*	-

*(0=nil damage, 5=all seminal roots with spear tips) ** (average of two strips)*

Table 6 Plant growth and root disease levels of farmer fungicide demonstrations, Mudamuckla 2014

Treatment	Run	Early DM (g/ plant)	Rh patch score (0-5)	Semi-nal root score (0-5)	Crown root infec-tion (%)	No. crown roots	Plot yield (t/ ha)	Pro-tein (%)	Screen-ings (%)	Test weight (kg/ hL)	Broad acre yield (t/ ha)**
Rx (VRT)	8	0.41	1.54	2.5	60	8.6	2.09	10.0	1.2	85.5	1.53*
Rx (VRT) +300 ml/ha Uniform	9	0.41	1.38	2.6	73	9.9	2.30	9.9	1.6	85.6	1.50
Phos Acid	10	0.56	1.51	2.4	66	9	2.10	10.0	1.6	85.4	1.57
Phos acid +300 ml/ha Uniform	11	0.48	1.50	2.7	65	8.8	1.88	9.7	1.3	85.4	1.57
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*	*0.17*	*ns*	*ns*	*ns*	-

*(0=nil damage, 5=all seminal roots with spear tips) ** (average of two strips)*

What does this mean?

In 2014 the exceptional start to the season resulted in early seeding, good crop establishment and early growth. The farmer demonstrations were all sown early, with the latest being the Piednippie barley on 20 May. The broad acre farmer demonstrations in the 2014 season showed no visual or differences in early plant growth measured at the given sites during the cropping season. There were differences in crown root numbers and % crown root infection at Cleve with the Nil treatment having higher numbers of both. There were differences at Piednippie in the barley crop sown mid-May, in Rhizoctonia patch score and the seminal root score which was later than the other crops included in the demonstrations.

In the 2014 season there were no significant yield advantages in the small plot header yields when using the fungicide products over the Nil treatments, but this was at sites with high Rhizoctonia inoculum levels, and in a season with an early start and minimal stress during crop establishment. There were differences in protein, screenings and test weights with a general trend of lower yields having higher protein, higher screenings and lower test weights. Further evaluation of research trials and farmer demonstrations using new fluid products and fungicide placement, will occur over two more seasons to evaluate the economics of using fungicides in low rainfall farming systems.

Acknowledgements

Thank you to the farmers involved in establishing the demonstration strips. Thank you to Syngenta for supplying products for the demonstrations.

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Rhizoctonia survey of Eyre Peninsula and Mallee farmers 2014

SURVEY

Naomi Scholz and Amanda Cook
SARDI, Minnipa Agricultural Centre

Key message

Research into Rhizoctonia on upper Eyre Peninsula and in the SA Mallee and extension of results has successfully led to increased farmer awareness and adoption of management practices that could be used to reduce the yield loss caused by the disease.

Background

The soil-borne fungus *Rhizoctonia solani AG8* causes crop damage by pruning newly emerged roots. This can occur from emergence right through to crop maturity. The infection results in water and nutrient stress in the plant. When severe, the infection is seen as patches of poor crop growth with very sharp edges. GRDC has a fact sheet on Rhizoctonia for more information.

Rhizoctonia solani AG8 is estimated to cost grain growers $59 million in cereal losses each year, mainly in the low to medium rainfall regions across southern Australia. The incidence of this disease has risen in recent years due to an increase in intensive cereals, continued reduction in tillage and a higher frequency of drought years (McKay, 2010). Even with several higher than average rainfall seasons recently on upper Eyre Peninsula, Rhizoctonia continues to be a dominant cereal disease.

There has been an increased effort in Rhizoctonia research, development and extension on Eyre Peninsula and in other areas of South Australia over the past decade. While there is still more to understand about Rhizoctonia, much has been learnt about reducing the level of Rhizoctonia inoculum in soil and also the impacts of disease through implementing a range of farm management practices.

The factors which can reduce the impact of Rhizoctonia in the crop include; adequate nutrition especially zinc and phosphorus (especially when delivered as fluid fertilisers in calcareous grey soils), 'directed or targeted' disturbance (tillage), reducing herbicide residues, sowing depth, timeliness of sowing (warmer soil temperatures) and the use and placement of fungicides (ongoing research). Other factors that reduce Rhizoctonia inoculum include weed control over summer and removal of weeds 6-8 weeks prior to sowing, wet summers, and non-cereal or grass free phases in the prior growing season, especially canola.

The level of adoption of these farm management practices was investigated as part of a SAGIT funded project 'Demonstrating best management for Rhizoctonia on upper EP and the Mallee'.

Why do the survey?

To determine the level of knowledge, skills, attitudes, awareness and levels of adoption by growers of practices to reduce the impact of the soil-borne disease *Rhizoctonia solani* in low rainfall farming systems of the upper Eyre Peninsula and Mallee regions. This will enable us to determine how effective we have been at influencing the adoption of best practice and to identify gaps to target in the future.

How was it done?

The survey was conducted online, using Survey Monkey® in August 2014. Emails with links to the survey were sent to EPARF and Mallee Sustainable Farming members, who could complete the survey voluntarily. Eight questions were asked in total.

What happened?

A total of 78 growers responded to the survey; 66% were Eyre Peninsula growers (50 growers), 29% Mallee growers (24) and 5% listed themselves as 'other' (4), all from WA. The majority of respondents (97%) factor Rhizoctonia into decisions about their farming program.

To help farmers manage Rhizoctonia, a Rhizoctonia risk tool has been developed to enable farmers to evaluate their Rhizoctonia disease risk level depending on previous crop rotation, management decisions, timing in the cropping season and the environmental conditions. A copy of the tool is located on the inside back cover of this book, or it can be downloaded from the EPARF website: www.eparf.com.au/research-type/publication.

When asked if they feel they have sufficient up to date information to deal with Rhizoctonia, 57% felt they had, 23% were unsure and 20% felt they did not.

Nineteen percent of EP and Mallee farmer respondents are using fluid delivery systems for fertilisers and trace elements.

Table 1 Growers were asked to evaluate the following statements as to whether they thought the statement was true, false or they did not know. *Responses are expressed as a percentage of total respondents.*

Statement	% of respondents that answered:			Comments from the authors
	True	False	I don't know	
Rhizoctonia root damage is only on seminal (seedling) roots	7	75	18	False. Root damage can also be found on the crown roots later in the season.
Canola and other grass free break crops will reduce the Rhizoctonia inoculum level	86	8	6	True. Canola and mustard can reduce inoculum levels for the following crop (one year effect only), whereas cereals (and grasses) provide the most rapid increase in inoculum. Recent research shows peas, medic and vetch can also lower inoculum levels for the following crop.
Cold, wet and late seeding conditions will increase Rhizoctonia disease risk	82	7	11	True. Warmer soil temperatures are less conducive to the disease, so early sown crops more likely to extend seminal roots into the subsoil before root damage occurs.
Wheat shows greater visual symptoms of Rhizoctonia than barley	8	76	16	False. Barley shows the greatest symptoms in cereals, followed by wheat, triticale and oats. Other broad acre crop types are also susceptible to damage by Rhizoctonia.
Summer rainfall events will reduce inoculum levels if no weeds are present	76	11	13	True. Multiple rainfall events during summer can reduce inoculum from a high to a lower disease risk due to increased microbial activity in competition with Rhizoctonia. However, where there are long periods between rainfall events (about 4 weeks) or if weeds are present, inoculum levels can recover.
Crown root damage can be an indicator of the level of Rhizoctonia inoculum for the next season	26	18	56	True. Crown root damage can be an indicator of the level of Rhizoctonia inoculum for the next season – dig up plants and examine crown roots towards harvest.

Table 2 Responses to the question; 'What do you do to manage Rhizoctonia?' Responses are expressed as a percentage of total respondents.

What do you do to manage Rhizoctonia?	Yes, I have been doing this for more than 2 years (%)	Yes, but I have only begun using this practice in the past 2 years (%)	No, I don't do this at all (%)	Comments from the authors
Dig up and examine plant roots during season for Rhizoctonia damage	71	6	23	Confirm cause of damage and address accordingly in the following season.
Use Predicta B test to determine diseases present	16	8	76	Identify potential issues, change management accordingly.
Examine cereal crown roots for Rhizoctonia damage near grain fill	19	11	70	Confirm cause of damage and address accordingly in the following season.
Grow break crops (canola, peas, vetch, beans)	66	9	25	To reduce Rhizoctonia inoculum for the following crop. Break crops need to be grass free.
Grass free pastures	79	7	14	To reduce Rhizoctonia inoculum for the following crop. Pastures must be free of grass or grass removed early in the season to ensure reduction in inoculum levels.
Sow as early as possible	87	2	11	Warmer soil temperatures are less conducive to the disease, so early sown crops are more likely to extend seminal roots into the subsoil before root damage occurs. Ensure good weed control 6-8 weeks prior to sowing or sow into paddock with low weed numbers.
Control summer weeds within 3 weeks of germination	79	10	11	A green bridge enables the build-up of Rhizoctonia inoculum over summer.
Control green bridge 6-8 weeks before seeding	80	10	10	A green bridge enables the build-up of inoculum prior to sowing.
Cultivate/work up paddocks for disease break	34	9	57	Soil disturbance 'breaks up' the network of fungal hyphae or filaments.
Use tynes/points which work below sowing depth	76	7	17	Disturbance below sowing depth promotes rapid early root growth.
Ensure adequate P fertilizer	90	3	7	Promotes crop and root vigour.
Ensure adequate N fertilizer	84	7	9	Promotes crop and root vigour.
Ensure adequate trace elements	83	8	9	Promotes crop and root vigour.
Use fungicides for Rhizoctonia	26	20	54	Can suppress Rhizoctonia. Further research and economic evaluation required, especially in high Rhizoctonia inoculum situations.
Avoid sulphonylurea (SU) chemical use	59	10	31	The use of SU chemicals can reduce crop and root vigour.
Deep rip/work compacted soils	20	6	74	Soil disturbance 'breaks up' the network of fungal hyphae or filaments and allows unrestricted root growth.

Table 3 Responses to the question, If you had no barriers such as cost, time, labour or machinery, what would you change in your system to manage Rhizoctonia? *These were written responses, with no options or limits provided, so the sum is greater than the number of growers responding. The answers have been grouped into similar responses and are shown as a percentage of responders from each area.*

Responses	EP Growers (%) (43 responders)	Mallee Growers (%) (22 responders)
Fluid delivery system for fungicide application	23 split application of fungicide – 16	41 split application of fungicide - 32
Fluid delivery system for TE application	21	18
Bigger machinery to implement tillage below seed, better seed placement or deep rip	21	23
Apply fungicides (not necessarily fluid system)	19	9
Increase break crop in rotation (legume), longer breaks, two year grass free	9	50
Summer weed control improved and green bridge control in autumn	14	5
Canola in rotation or increase amount canola	12	9
Increase urea at seeding/split application urea	9	0
Earlier seeding	9	5
Fluid delivery system for liquid P application	7	0
Increase P application	0	18
Increase Predicta B root disease testing	5	0
No change/Rhizoctonia not an issue	5	5
Increase applied TE (Zn, Cu, Mn)	2 Soil applied and foliar to crop at least twice	14
Develop resistant cereals	0	5
Remove medic from rotation	0	5
Increase organic matter by spading to improve microbial activity	0	5
Fumigate the soil	0	5
Infra-red spot spray in summer (Weedseeker)	2	0
No sheep in system (better grass control)	2	0
Remove barley from rotation	2	0
Two year chemical fallow in rotation	2	0
More holidays in July (so don't see Rhizoctonia)	2	0

Table 4 Responses to the question: 'Where do you access information on Rhizoctonia from?' *These were written responses, with no options or limits provided, so the sum is greater than the number of growers responding. The answers have been grouped into similar responses and are shown as a percentage of responders from each area.*

Information source	EP Growers (%) (43 responders)	Mallee Growers (%) (22 responders)
Minnipa Agricultural Centre, Amanda Cook, EPFS Summary, EP Farmer Ag Bureau meetings/sticky beak days and Minnipa field days	56	18
GRDC publications and GRDC updates/agronomy sessions	26	66
Consultants and agronomists	14	73
Internet	6	7
MFS, Alan McKay, Jack Desbiolles, SARDI, CSIRO, BCG, Farmer Ag Bureau meetings/groups/sticky beak days	14	45
Stock Journal/ Newspapers/Other	12	23
Other farmers/neighbours (pub/football)	12	9

Summary

- Growers in both regions have good knowledge of Rhizoctonia as a cereal root disease as well as disease management and environmental factors which impact on disease severity.
- Only 26% of growers knew crown root damage can be an indicator of the level of Rhizoctonia inoculum for the next season. This message could be extended more to the industry. Most dig up roots during the season to check for Rhizoctonia damage, but checking for crown root damage closer to harvest has only relatively recently been part of the extension message, and this is reflected with a growing number adopting the practice in the past 2 years.
- 71% of growers examine plant roots but there is a low use of Predicta B testing.
- Break crops are used widely as a Rhizoctonia management option, with canola being higher in the Mallee and medics higher on EP. 25% of respondents do not grow a break crop, but half of the Mallee growers surveyed said they would ideally like to be able to increase their break crop in rotation (legume), have longer breaks, or have two year grass free if there were no barriers such as time, cost etc.
- Other changes which growers would implement given no constraints to their systems would be the adoption of fluid delivery systems for fungicide application, apply fungicides, not necessarily as fluids, fluid delivery system for trace elements, bigger machinery to implement tillage below seed, better seed placement or deep rip.
- Fungicide application has been the highest practice change in the last 2 years and the most frequent change farmers would implement if possible. An economic analysis of the use of fungicides for Rhizoctonia has been conducted (see article Fluid Delivery Systems in Wheat). Initial results (based on one year of research) suggest that fungicides can reduce the impact of Rhizoctonia, but the economic benefits are limited on upper EP. Research is ongoing on placement of fungicides.
- Controlling summer weeds and the green bridge have increased in the last two years.
- There is a high level of adoption of sowing early and good nutrition – there have been strong extension messages delivered across a wide range of programs with regards to sowing time and nutrition.

What does this mean?

While gains have been made, there is room for improvement in adoption of ‘best practice’ for the management of Rhizoctonia. Further extension of the key messages and especially new findings will be important to improve grower understanding of the disease and options for management. The survey demonstrated that local research, grower groups, events, and publications provide an important source of information and extension, and also that information is acquired from a wide range of sources, so the messages need to be spread in as many ways as possible to capture the broader farming community.

Acknowledgements

Sincere thanks to the growers that participated in the survey – we know how much farmers get asked to complete surveys!! Thanks to Mallee Sustainable Farming for circulating the survey to the Mallee growers.

References

GRDC Rhizoctonia Fact Sheet, March 2012.

Improvements to the PreDicta B sampling strategy and development of new tests

RESEARCH

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Key messages

- **Crown rot, rhizoctonia root rot and take-all are likely to be the main soil/stubble borne disease risks in 2015.**
- **Crown rot risk assessment by PreDicta B is improved when the samples (made up from soil cores collected in 15 locations across the paddock) are supplemented with 1 (or 2) piece(s) of stubble (about 5 cm long from base of old cereal or grass weeds) from each of the 15 locations. Soil cores should be collected from along the rows of the previous cereal crop (when visible) and retain any plant debris. The weight of PreDicta B samples should be in range 400-500 g.**
- **The GRDC project DAS00137 has been established to improve the value of PreDicta B to grain producers. This includes improving the current tests, broadening the range of tests and fast tracking these onto PreDicta B reports.**
- **To fast track results for new tests e.g. Pythium and Bipolaris onto PreDicta B reports, a provisional risk category system based on population density, is expected to be implemented within the next 12 months. This system will be used pending development of regional yield loss risk categories.**
- **Tests for pathogens associated with yellow spot and eyespot are under evaluation.**
- **A new website for PreDicta B is expected to be operational by mid-March 2015 via the SARDI website. This will include latest information including emerging trends via current and previous maps of PreDicta B results.**

Why do the trial?

A focus paddock survey conducted in northern NSW from 2010 to 2012, found that 23% of the PreDicta B samples had underestimated the risk of crown rot by at least two risk categories compared to the incidence of infection in stubble based on pathogen isolation at harvest. This trial was conducted to assess whether the addition of stubble to PreDicta B soil samples would improve the detection of crown rot.

PreDicta B risk categories were developed based on pathogen detection in samples collected along the rows of the previous cereal with all plant debris retained in the sample. We suspected a number of soil samplers had defaulted to using the soil nutrition sampling strategy i.e. coring is targeted midway between the rows of the previous crop and plant debris is avoided/removed.

How was it done?

In autumn 2014, a national trial was set up to examine sampling position and stubble addition effect on crown rot detection. Four separate soil samples were collected from each of 129 NVT sites. At each site, two samples were collected on the row and two between the rows of the previous cereal crop. For each sampling position, one sample was supplemented with 15 pieces of cereal or grass weed stubble about 5 cm long (one piece by 15 locations) and the other was not. Samples were analysed using the PreDicta B DNA test.

What happened?

When stubble was added to PreDicta B samples, the assessment of crown rot risk increased by at least two risk categories in 27% of samples and 10 fold in the high risk category, compared to samples where stubble was avoided (Figure 1).

Stubble from the sites collected at harvest will be assessed over summer, to determine the incidence of crown rot that developed at each site. Preliminary results indicate the plus stubble PreDicta B samples give better prediction of crown rot levels when compared to the final infection level.

Disease

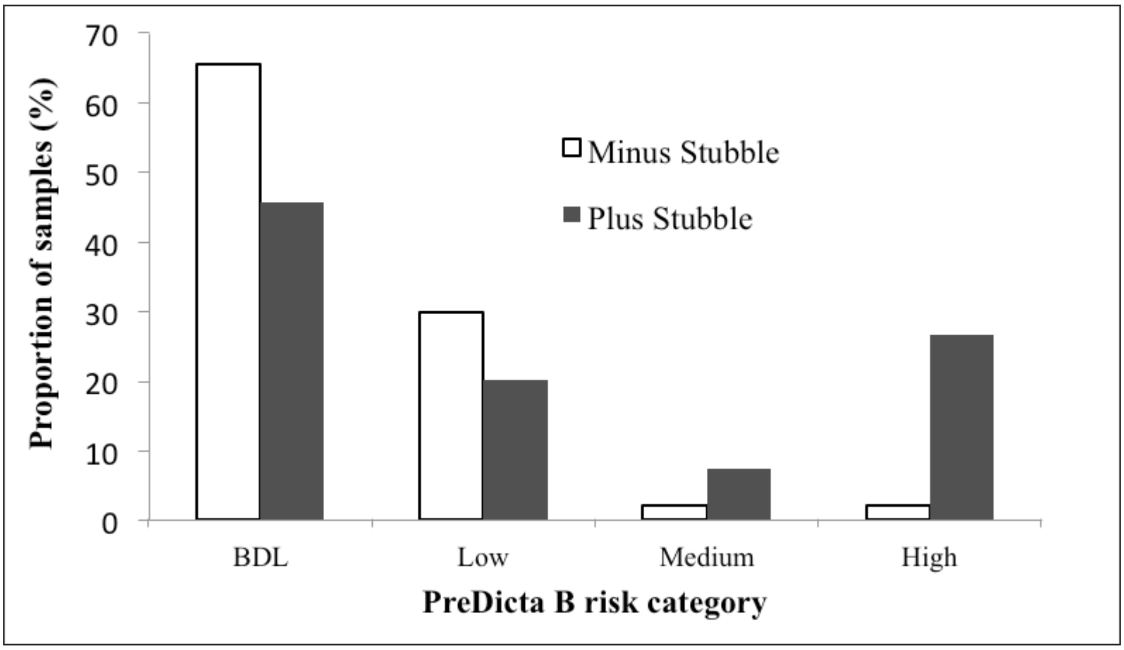

Figure 1 Impact of adding stubble to PreDicta B samples on risk assessment of Crown rot

What does it mean?

- Adding stubble to PreDicta B samples will improve risk assessment of crown rot. Growers who are considering growing very intolerant crops e.g. durum or are in high risk districts should consider adding 1-2 pieces of stubble per location.
- Adding stubble will also improve detection of other pathogens present in the crown of the plant including those associated with take-all and common root rot. It does not affect detection of nematodes, unless there is a significant amount of seminal roots attached to the stubble.
- Adding stubble will also enable PreDicta B to assess stubble borne pathogens such as those associated with yellow spot and eyespot; tests for both are under development.
- PreDicta B is a unique DNA based service developed to assist Australian grain producers identify which soil borne diseases posed a significant risk to the next crop. The service now includes tests for the organisms that cause most of the main soil borne diseases, including cereal cyst nematode, take-all, rhizoctonia root rot, root lesion nematodes and crown rot.
- PreDicta B soil samples should be collected from the row of the previous cereal crop and include at least 15 pieces of stubble in the soil sample if visible on the soil surface. Do not remove plant debris from the sample.

Acknowledgments

GRDC has funded a national project DAS00137 led by SARDI to increase the value of PreDicta B to growers. This includes expanding the range of tests for a broader range of organisms associated with soil borne diseases such as Pythium root rot and common root rot, broadening the range of stubble borne diseases including yellow spot and eyespot, and expanding the range of tests for soil borne diseases of pulses and canola, and developing tests for indicators of soil health. We also gratefully acknowledge the assistance of the National Variety Trial service providers for collecting the soil and stubble samples.

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Eyespot – variety tolerance and fungicide efficacy

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Searching for answers

Location:
Cummins
Jarrod and Jacqui Phillips
Rainfall
Av. Annual: 424 mm
2014 Total: 430 mm
2014 GSR: 325 mm
Paddock History
2013: Mace wheat
Soil Type
Loamy sand over clay

Key messages

- **Differences in resistance to eyespot were observed in bread wheat varieties in trials at Cummins, Templars and Tarlee and in barley varieties in trials at Templars and Tarlee.**
- **Fungicide treatments were demonstrated to have good efficacy against eyespot and it is expected this will lead to label extensions for control of eyespot in cereals in Australia in the near future.**
- **The wheat varieties Trojan and Emu Rock showed consistently useful levels of resistance to eyespot infection. Axe, Mace, Cobra, Scout and Shield were shown to be quite susceptible.**
- **At Cummins, barley was less affected by eyespot than was bread wheat. However, at trial sites at Tarlee and Templars the variety La Trobe and, to a lesser extent, Hindmarsh were badly affected by eyespot. Compass was less affected by eyespot at all sites.**

Why do the trials?

These variety and fungicide efficacy trials will assist in identifying resistance sources for eyespot and will provide data to support chemical companies acquiring label extensions to register fungicides for use against eyespot in cereals in Australia.

Eyespot is becoming an increasing problem in the medium to high rainfall grain growing areas of SA (including the area around Cummins) due to farming systems moving to stubble retention, direct drill and more cereals in rotations. Yield losses have not been quantified in Australia, but overseas experiences suggest an average of 5% yield loss from eyespot, with losses as high as 40% occurring in some circumstances. This fungal disease is stubble-borne and affects stem bases, causing eye-like lesions which can girdle the stem. Yield losses occur as a direct result of the stem lesions and also from plants lodging (due to weakened stem bases) which makes it difficult or impossible to harvest affected plants. Overseas, eyespot control is provided through varietal resistance and fungicide application. In Australia no fungicides are registered for control of eyespot, and until 2013 there has been no research conducted into the presence of resistance amongst commercial varieties. As far as we are aware none of the breeding companies in Australia have been breeding for this trait.

This work is GRDC-funded and follows on from a GRDC-funded fast-tracked trial (managed in collaboration with Agrilink Agricultural Consultants, the Mid North High Rainfall Zone farming systems group and Bayer CropScience). Independent trials were also run in 2013 by Landmark - Cummins Agricultural Services (Patrick Head).

How was it done?

The Cummins site was located in a paddock which had eyespot problems in the 2013 wheat crop and had a heavy stubble load carrying over from that crop. Two other sites, at Tarlee in the Mid North and at Templars on the Adelaide Plains, were managed in a similar manner and had similar treatments.

To encourage eyespot expression, the trial was sown early in the seeding window (19 May 2014) at a high plant density (250 plants/m^2) and with high nitrogen inputs (187 units of N). Trials were sown and managed by Cummins Agricultural Services. Plots were 5 rows (2 m) wide by 8 m long and each trial had three replicates.

Variety screening. Twenty one bread wheat and four barley varieties were screened for resistance to eyespot. Many of the varieties are in general commercial use and were chosen for screening as they represent a range of genetic backgrounds (including genes for resistance to crown rot) and maturities.

Fungicide efficacy. The variety Mace was used in the fungicide trial and products assessed were all registered for use in cereals in Australia, but not for eyespot control. Eleven products (including plant growth regulants) were represented in the fungicide trial, which was done in collaboration with Adama Agricultural Solutions Ltd, BASF Australia Ltd, Bayer CropScience Australia and Syngenta Australia Pty Ltd. Details of fungicides assessed cannot be presented here as they are not registered for control of eyespot in cereals in Australia.

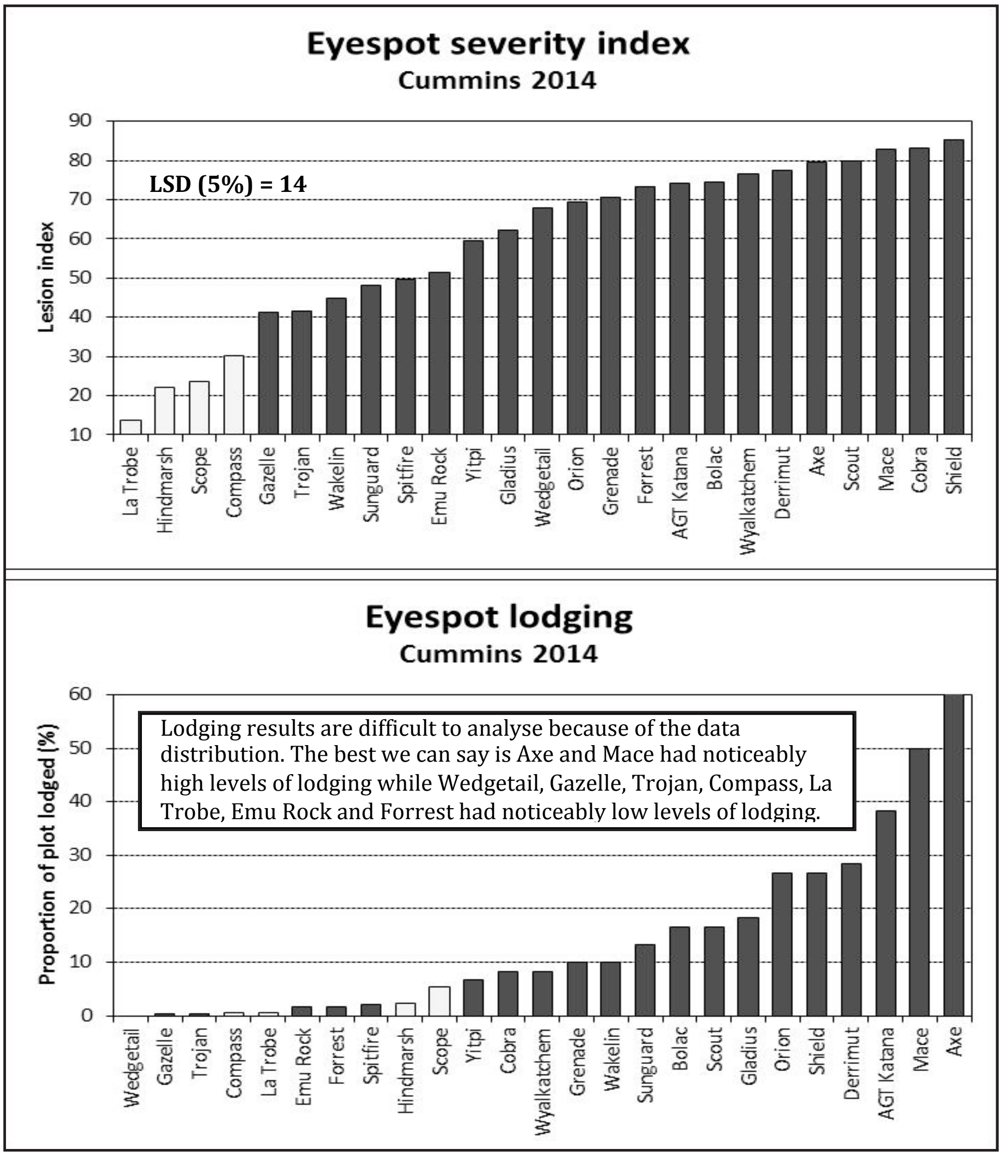

Figure 1 Screening for eyespot resistance in commercial barley varieties (white columns) and bread wheat varieties (black columns) at Cummins in 2014. *Raw data are presented here, but analyses were done on transformed data which were adjusted for spatial variability.*

Fungicide treatments were applied using a hand boom on 14 July at the start of stem elongation (GS30).

Stem samples were assessed for eyespot expression on 22 October 2014, when plants were at late grainfill. A total of 25 stems were assessed in each plot, with 8-9 stems taken from each of the 3 inner rows of the plot. A scoring scale of 0-3 was used, where:

- 0 = no lesions.
- 1 = slight eyespot – small lesion(s) on less than half the stem circumference.
- 2 = moderate eyespot - lesion(s) on at least half the stem circumference.
- 3 = severe eyespot – lesion(s) girdling the whole stem; tissue softened, lodging would occur readily.

This scale was taken from Scott and Hollins (1974) and their formula was used to calculate a disease index: (1*tillers in score 1 + 2*tillers in score 2 + 3*tillers in score 3 / total tillers scored) * (100 / 3).

Plots were scored for lodging on 9 October 2014, with the % of the plot showing lodging being recorded.

What happened?

The trials established well and high levels of eyespot (96% incidence on Mace stems) occurred due to the Decile 9 winter providing many rainy days during tillering and early stem extension. Weeds, other diseases and insect pests were adequately controlled. Low but significant numbers of volunteer Mace (very susceptible to eyespot) plants were present in both trials and this may have influenced results in the variety screening trial by masking entries with very low eyespot expression.

Variety screening. Barley varieties were mildly affected by eyespot when compared with wheat varieties and consequently also showed least lodging (Figure 1), with no differences in disease expression being found between the four varieties. At the other two sites in this research project the same barley varieties were screened and there were differences between the varieties - La Trobe was badly affected by eyespot and Hindmarsh was only slightly less affected both in disease expression and an associated increase in lodging.

Compass was not seriously affected by eyespot at any of the sites.

The worst affected wheat varieties included Shield, Cobra, Mace, Scout and Axe. The least affected wheat varieties included Trojan, Emu Rock, Spitfire and Sunguard as well as the long season wheat varieties Wakelin and Gazelle. Lodging problems were worst for Axe, Mace and AGT Katana.

Fungicide efficacy. All the products applied provided some protection against eyespot with the disease index ranging from 15 to 54, compared with a disease index of 74 for the untreated control. Yield improvements over the untreated control were also achieved, with yield increases ranging from 8% to 25% across the products applied. These results make it likely that data packages will be sent to the APVMA in the next few months requesting label extensions for eyespot control in cereals for at least some of the products assessed in this trial.

What does this mean?

There is variation amongst the current Australian bread wheat varieties in resistance to eyespot. This means that where eyespot is a problem, the best locally adapted varieties with some resistance to eyespot can be selected and varieties which are very susceptible to eyespot can be avoided. This variation in resistance will also provide a base for breeding commercial varieties with improved eyespot resistance. It is interesting to speculate whether the resistance genes for crown rot in Trojan, Emu Rock, Sunguard and Spitfire are conferring some resistance to eyespot as these varieties are amongst the most resistant to both diseases. Variety screening will continue at three sites in 2015. Entries will be guided by 2014 results and will include widely grown current/potential commercial varieties.

Although the four barley varieties screened at Cummins had similar and good levels of resistance to eyespot, this was not the finding from the Mid North and the Adelaide Plains screening trials. At these sites, La Trobe and, to a lesser extent, Hindmarsh had significant disease expression with associated increases in lodging. It is unclear why this inconsistency in results occurred between the sites. It is possible that it is a season/ site effect or due to chance alone. However, it is also possible that the eyespot isolate at Cummins differs from those in the Mid North and on the Adelaide Plains (supported by some anomalies in the PredictaB results for the sites) and this possibility will be explored in 2015.

Fungicide efficacy results from the Cummins trial are consistent with findings from trials undertaken at Cummins by Landmark – Cummins Agricultural Services in 2013 and it is anticipated that label extensions to include eyespot control in cereals for one or more products may become available this season. Fungicide efficacy trials will continue at three sites in 2015 to ensure that data packages for label extensions can be submitted prior to the 2016 season. Products registered for eyespot control in cereals should be available during the 2016 season. Once products are registered for use on eyespot, details of results from the fungicide efficacy trials will be made available in the EPFS Summary.

Acknowledgements

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Tolerance and resistance of cereals to Root Lesion Nematode *Pratylenchus thornei* on Eyre Peninsula

RESEARCH

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Searching for problems
Searching for answers

Location:
Minnipa Ag Centre, paddock S4
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 393 mm
2011 GSR: 256 mm
Paddock History
2009: Wheat
2010: Peas and beans
Soil Type
Red sandy loam
Diseases
Root Lesion Nematode *(Pratylenchus thornei)* and Rhizoctonia barepatch (AG8)
Plot Size
12m x 1.5m x 5 reps

Location:
Streaky Bay/Chandada
Rhys Tomney
Rainfall
Av. Annual: 326 mm
Av. GSR: 263 mm
2012 Total: 204 mm
2012 GSR: 179 mm
2014 Total: 340 mm
2014 GSR: 233 mm
Paddock History
2013: Peas
2014: Wheat and barley
Soil Type
Brown sandy loam
Diseases
Root Lesion Nematode *(Pratylenchus thornei)* and Rhizoctonia barepatch (AG8)
Plot Size
12m x 1.5m x 5 reps

Key messages

- **Yield losses caused by *Pratylenchus thornei* on upper EP in 2011, 2012 and 2014 were relatively small and varied between seasons.**
- **Choose the best adapted high yielding varieties, but try to minimize use of very susceptible/ susceptible varieties as these can support very high populations that may cause problems for subsequent crops in some seasons.**
- ***P thornei* appears to be spreading on EP, but is not yet common; it can cause large yield losses in the northern region of Australia (Queensland).**
- ***Pratylenchus neglectus* is the most common RLN on EP. Yield losses in trials conducted elsewhere in SA have also been relatively small and variable between sites and seasons.**
- **Some cereal wheat varieties have useful levels of resistance to *P. thornei*, including Axe, Catalina, Mace and Scout, while Estoc, Espada and Peake are susceptible. The effect on nematode numbers varies depending on the starting population and between seasons. At least 2 consecutive resistant cultivars/crops are needed to reduce high numbers.**
- **See the Cereal Variety Disease Guide for resistance ratings.**
- **NVT sites are now being assessed for soilborne pathogens including *P. thornei* at seeding.**

Why do the trial?

Pratylenchus thornei can cause large yield losses in Australian northern regions, where it occurs on the deep self mulching grey clay soils. It is slowly spreading across upper EP and is becoming established in calcareous sands.

The aim of these trials is to provide field data to assist growers select the best varieties to grow when *P. thornei* is present in their paddocks, and assist breeders to develop new *P. thornei* resistance and tolerant varieties for the EP.

Trials have been conducted on upper EP since 2011 (EPFS Summary 2011, p 83) to determine the magnitude of yield losses caused by *P. thornei* compared to those on self mulching clay soils in the northern region and Victorian Wimmera. The impact each variety had on nematode multiplication was also assessed in each trial.

How was it done?

Field sites at Minnipa Agricultural Centre (red sandy loam) in 2011 and at Streaky Bay (brown sandy loam) in 2012 and 2014, were selected with medium populations of *P. thornei* and low incidence of other pathogens. Avoiding Rhizoctonia proved difficult however. Duplicate trials were also conducted in the Victorian Wimmera in 2012 and 2013.

Narbon beans and field peas were grown in year 1 to create paired plots of high and low numbers of *P. thornei* respectively. In the following year, 33 cereal varieties including premium hard and wheat, durum wheat and barley; some varieties not normally grown on upper EP were included as checks. Trial design was a paired plot, randomized block design with 5 replicates.

Minnipa 2011				Streaky Bay 2012				Streaky Bay 2014			
Variety	Crop Type	Yield (t/ha) Low Pi (15)	Net Yield (t/ha) High Pi (120)	Variety	Crop Type	Yield (t/ha) Low Pi (7)	Net Yield (t/ha) High Pi (23)	Variety	Crop Type	Yield (t/ha) Low Pi (9)	Net Yield (t/ha) High Pi (19)
Flagship	Barley	3.00	-0.09	Tjilkuri	Durum	0.93	0.00	Tjilkuri	Durum	2.87	-0.01
Buloke	Barley	3.17	0.00	Catalina	Wheat	1.07	0.01	WID802	Durum	2.87	0.45*
Hindmarsh	Barley	3.23	-0.21*	Oxford	Barley	1.10	-0.06	Saintly	Durum	3.03	0.34*
Tamaroi	Durum	3.75	-0.04	Gladius	Wheat	1.11	-0.13*	Yawa	Durum	3.22	0.05
Fleet	Barley	3.81	0.22*	Hyperno	Durum	1.11	-0.07	KordCLPlus	Wheat	3.58	0.17*
Yitpi	Wheat	3.83	-0.01	Peake	Wheat	1.13	-0.03	Wyalkatchem	Wheat	3.73	0.08
Lincoln	Wheat	3.85	-0.07	Wallup	Wheat	1.14	-0.06	Gladius	Wheat	3.78	-0.03
Commander	Barley	3.87	0.06	Derrimut	Wheat	1.17	-0.05	Axe	Wheat	3.78	0.01
Catalina	Wheat	3.89	0.15	Espada	Wheat	1.17	0.10*	GrenadeCLPlus	Wheat	3.79	-0.05
Hyperno	Durum	3.95	-0.06	AGTKatana	Wheat	1.17	0.03	Phantom	Wheat	3.79	0.10
Correll	Wheat	3.97	-0.11	Grange	Barley	1.18	-0.02	Wallup	Wheat	3.81	0.01
Wyalkatchem	Wheat	4.06	-0.07	JusticaCLPlus	Wheat	1.19	-0.01	Estoc	Wheat	3.84	-0.01
KordCLPlus	Wheat	4.08	-0.25*	Estoc	Wheat	1.19	0.00	Bass	Barley	3.87	0.03
Peake	Wheat	4.09	-0.12	KordCLPlus	Wheat	1.22	0.01	AGTKatana	Wheat	3.87	0.08
Estoc	Wheat	4.15	-0.49*	Scout	Wheat	1.23	-0.01	Fleet	Barley	3.96	-0.18*
Axe	Wheat	4.19	0.11	Axe	Wheat	1.23	0.08*	Correll	Wheat	3.97	-0.06
Derrimut	Wheat	4.40	-0.20*	Corack	Wheat	1.27	-0.13*	Commander	Barley	3.97	0.01
Young	Wheat	4.57	0.02	Mace	Wheat	1.27	-0.06	Espada	Wheat	3.98	-0.09
Scout	Wheat	4.61	0.02	Commander	Barley	1.35	-0.04	Shield	Wheat	3.99	-0.23*
Espada	Wheat	4.62	-0.28*	EmuRock	Wheat	1.36	-0.07	Yitpi	Wheat	3.99	-0.14
Mace	Wheat	5.05	0.16	Gairdner	Barley	1.38	-0.07	Buloke	Barley	4.04	-0.11
				Henley	Barley	1.42	-0.11*	Scout	Wheat	4.04	-0.08
				Scope	Barley	1.43	-0.08*	Scope	Barley	4.05	-0.12
				Flinders	Barley	1.44	-0.06	Oxford	Barley	4.07	0.01
				Buloke	Barley	1.56	-0.12*	Navigator	Barley	4.11	-0.02
				Flagship	Barley	1.58	-0.18*	EmuRock	Wheat	4.12	-0.06
				Fathom	Barley	1.73	0.09*	Corack	Wheat	4.16	0.08
				Navigator	Barley	1.74	0.04	Flagship	Barley	4.17	-0.01
				Hindmarsh	Barley	1.76	0.01	Mace	Wheat	4.21	0.01
				Skipper	Barley	1.76	-0.06	Grange	Barley	4.25	0.13
								Skipper	Barley	4.31	-0.04
								Fathom	Barley	4.36	-0.04
								Trojan	Wheat	4.41	-0.00
								Compass	Barley	4.52	-0.06
								LaTrobe	Barley	4.68	-0.02
								Hindmarsh	Barley	4.70	-0.03

Table 1 Summary of predicted yields for cereal varieties grown in low levels of P. thornei (low Pi) and net yield response when grown in paired plots of high initial P. thornei (high Pi) at Minnipa 2011 and Streaky Bay 2012 and 2014. *Significant net yields (P<0.05) are indicated by an asterisk*.*

Table 2 Summary of P. thornei resistance of the cereal varieties based on their multiplication rates (P. thornei/g soil) in the high and low nematode plots which had initial levels of 120 and 15 per g soil at Minnipa 2011 and 23 and 7 at Streaky Bay 2012. The varieties are ranked in order based on their yields at the low nematode numbers

⇧ Increasing Yield ⇧

Minnipa 2011				Streaky Bay 2012			
Multiplication rate (Final/Initial)				Multiplication rate (Final/Initial)			
Variety	**Crop**	**High**	**Low**	**Variety**	**Crop**	**High**	**Low**
Flagship	Barley	0.33	0.47	Tjilkuri	Durum	0.42	0.96
Buloke	Barley	0.50	0.86	Catalina	Wheat	1.18	1.97
Hindmarsh	Barley	0.46	0.73	Oxford	Barley	0.43	0.87
Tamaroi	Durum	0.30	0.43	Gladius	Wheat	2.42	4.54
Fleet	Barley	0.46	0.74	Hyperno	Durum	0.20	0.41
Yitpi	Wheat	0.94	2.90	Peake	Wheat	1.44	3.88
Lincoln	Wheat	0.87	2.58	Wallup	Wheat	0.99	1.98
Commander	Barley	0.38	0.55	Derrimut	Wheat	1.39	3.52
Catalina	Wheat	0.34	0.70	Espada	Wheat	1.94	4.14
Hyperno	Durum	0.21	0.26	AGTKatana	Wheat	1.32	2.86
Correll	Wheat	0.98	3.11	Grange	Barley	0.44	0.91
Wyalkatchem	Wheat	0.92	2.97	JusticaCLPlus	Wheat	1.98	4.79
KordCLPlus	Wheat	0.87	2.64	Estoc	Wheat	2.78	5.36
Peake	Wheat	1.14	3.75	KordCLPlus	Wheat	1.49	3.44
Estoc	Wheat	1.11	4.10	Scout	Wheat	0.98	2.25
Axe	Wheat	0.53	1.22	Axe	Wheat	0.86	2.05
Derrimut	Wheat	0.97	2.99	Corack	Wheat	2.66	5.80
Young	Wheat	0.50	1.17	Mace	Wheat	1.10	2.63
Scout	Wheat	0.55	1.30	Commander	Barley	0.45	1.03
Espada	Wheat	0.98	3.24	EmuRock	Wheat	1.45	3.49
Mace	Wheat	0.68	1.79	Gairdner	Barley	0.95	2.09
				Henley	Barley	0.34	0.73
				Scope	Barley	0.66	1.25
				Flinders	Barley	0.45	0.91
				Buloke	Barley	0.71	1.50
				Flagship	Barley	0.50	1.03
				Fathom	Barley	0.52	1.25
				Navigator	Barley	0.46	0.91
				Hindmarsh	Barley	0.55	1.24
				Skipper	Barley	0.38	0.79

P. thornei numbers in each plot were measured before sowing and after harvest using SARDI's PreDicta B DNA based soil testing service. The impact of P. thornei on yield (tolerance) for each cultivar was determined by comparing yield in the low and high paired plots. The variety effect on *P. thornei* multiplication (resistance) was assessed by calculating the change in nematode numbers post harvest compared to those present pre-sowing.

The latest data analysis techniques were used to minimize the effect of spatial variability on results.

What happened?

The impacts of the nematode on crop yields were relatively small, 1-2% across many varieties but some varieties lost between 10 to 15%. Magnitude of losses varies between seasons (Table 1).

The trials produced good data on impact of each cultivar on nematode multiplication (Table 2).

The rankings were generally highly correlated with interstate trials.

What does this mean?

Sow the best adapted high yielding varieties, and where possible minimise use of those varieties that are rated S to VS as these may create problems for subsequent crops. If growing varieties rated S, try to choose MR-MS varieties for subsequent crops.

At Minnipa in 2011 the most tolerant high yielding wheat varieties were Mace, Scout, Young, and Axe with no significant yield losses. The most intolerant varieties were Estoc with 12% (0.5 t/ha), Kord and Espada with 6% (0.2 t/ha) yield losses. The most tolerant higher yielding barley varieties were Fleet and Commander with no significant yield losses while Hindmarsh was the most intolerant barley with a 6.5% (0.2 t/ha) loss.

At Streaky Bay in 2012 and 2014 the most tolerant higher yielding wheat varieties were Axe, Espada and AGT Katana with no significant yield losses while Mace and Corack were the most intolerant with yield losses (0.05–0.1 t/ha). In both 2012 and 2014 the highest yielding barley varieties were Fathom, Skipper and Hindmarsh which were all tolerant.

The resistance responses at Minnipa 2011 were highly correlated with those at Streaky Bay in 2012 (0.6), and the Victorian Wimmera in both 2012 and 2013 (0.7). The correlation between the Streaky Bay and Victorian resistance trials was low (0.1), this may be due to the high Rhizoctonia levels at Streaky Bay.

The most resistant varieties at all trials were durum wheat varieties, followed by the barley varieties. The most susceptible wheat varieties were Estoc, Peake and Espada, and these can increase low to moderate *P. thornei* numbers to high levels and will maintain high populations. Try to minimise use of these varieties where *P. thornei* is a problem.

A note of caution, the highest yielding tolerant wheat cultivars in the EP trials can all support relatively high *P. thornei* numbers that could affect subsequent crops. Barley cultivars are often more resistant that locally adapted wheat cultivars. However, some barley cultivars can still leave relatively high nematode populations so it may take several seasons to reduce populations to numbers lower than damage thresholds.

The crop and cultivar resistance responses at the Minnipa and Streaky Bay sites were highly correlated with similar trials conducted in Victoria. Therefore resistance classifications will be applicable across regions. A statistical analysis incorporating all the South Australian and Victorian trial data over 4 seasons will be undertaken in 2015 to better understand the effects of environmental factors (rainfall, temperature, soil type, Rhizoctonia) on tolerance.

Acknowledgements

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Cereal variety disease guide 2015

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Summary of 2014 season and implications for 2015

Some early sown crops and a wet winter encouraged the development of many diseases in cereal crops in SA in 2014. Damage to many crops was reduced by the effective use of fungicides and a dry spring that reduced later infection of foliar diseases. The same conditions will have favoured build-up of crown rot and take-all inoculum for 2015.

Leaf rust and stem rust in wheat are re-emerging as high risk diseases with a new virulent strain of leaf rust detected and an increasing list of long season varieties susceptible to stem rust being released.

Leaf rust in wheat

A new strain of wheat leaf rust was identified across South Australia and into Southern Victoria in 2014. It is most likely that the strain was present in the past couple of years but went undetected being at a very low level. The effective use of fungicides to control stripe rust in Mace would have helped to control the leaf rust. Several varieties have proven to be more susceptible to this new strain including Axe, Corack, Grenade CL Plus, Mace, Scout, Revenue, Wallup and Wyalkatchem which have all dropped by 2 or more rating levels. This leaves South Australian crops much more exposed to leaf rust damage whilst these varieties are widely grown. Growers are therefore urged to be even more vigilant than in the past in removing volunteer wheat, the "green bridge", over summer and in having an active plan for applying fungicides should the need arise.

Stem rust

At the end of 2014 stem rust was observed in variety trials on the Adelaide Plains and South-East. In January it was also observed on volunteer barley on the Bellarine Peninsula in Victoria. Whilst the levels were only low it highlights the ability of this rust to survive and cause a problem where susceptible varieties are grown. Of particular concern are the many new long season wheats that are susceptible to stem rust. Stem rust, once established, can be hard to control with fungicides and crops of these varieties helping form a green bridge for survival of rust through summer, especially in the long season areas. Varieties of particular concern are Adagio, Beaufort, Einstein, Frelon, Mansfield, Ovalo, Preston and Scenario. Some of these varieties are very new; others are used by only a few growers. Taken together they may come to cover an extensive area and present a serious risk to all growers.

Eyespot

Eyespot was observed more widely than previously with recordings from Balaklava and the Lower Yorke Peninsula as well the expected areas of the Lower Eyre Peninsula, Adelaide Plains, Mid-North high rainfall region and South–East.

GRDC funded research on eyespot in SARDI is providing some early indications of differences between varieties although it is premature to provide formal ratings at this stage. Early indications however suggest that Trojan and Emu Rock have some useful resistance whereas Axe, Cobra, Corack, Mace, Scout, Shield and Wyalkatchem are all quite susceptible.

Barley has been considered more resistant to eyespot than wheat and this appears to be the case in a variety trial at Cummins. At trials near Templars and Tarlee however the varieties La Trobe and Hindmarsh were quite susceptible to eyespot. Compass, and to a lesser extent Scope, appear to be more resistant compared to these varieties. Other DNA evidence also suggests the eyespot on the Eyre Peninsula may differ slightly from that in the Mid-North.

Shorter and/or stronger strawed varieties are likely to lodge less when infected by eyespot.

Septoria tritici blotch

This disease is becoming more severe in the South-East of SA as cropping with cereals intensifies and early sowing is practised. The septoria population in the South East and in Western Victoria appears to have different virulences to those previously observed in more mainstream areas of SA. The varieties Mace, Phantom and Wyalkatchem are rated SVS in the long season South East SA and Western Victoria regions.

Net form net blotch

Net form net blotch was largely controlled with early and well-timed applications of fungicides. Virulence on Fleet was widespread and no new virulences were detected in 2014 so varieties ratings for 2015 remain much the same as in 2014.

Spot form net blotch

The exceptional yield loss to SFNB observed in some crops in northern districts of SA in 2013 was not repeated in 2014. A GRDC funded yield loss trial at Wharminda where SFNB was severe indicated that Hindmarsh (S) suffered yield loss of around 13% whilst La Trobe (MSS) which is marginally less susceptible lost 10.4%. Sloop SA (SVS) lost around 21%.

Oats

It was a good year for oat production as there was little in the way of disease development. The wet winter caused some bacterial blight early in the growing season, but it did not develop. Leaf rust was observed on very susceptible varieties, but the warm, dry spring was not conducive for its development.

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 to other growers.

Where a '-' is used then the rating is given as a range of scores that may be observed depending on which strain of the pathogen is present.

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 yield losses are rarely severe.

Other information

This article supplements other information available including the SARDI Sowing Guide 2015 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, not just before a weekend, to the following address:

SARDI Diagnostics
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 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	Stripe	Leaf					*P. neglectus*	*P. thornei*					
Adagio	SVS	RMR	MS	S	MRMS	MR	MRMS	MS	MS	SVS	MS	MS	–	Red feed
Axe	MS	RMR	S	S	S	MS	SVS	MS	MS	S	MSS	S	S	AH
Bolac	MRMS	RMR	S	S	S	MRMS	MS	MSS	MRMS	S	MS	RMR	MSS	AH
Cobra	RMR	MSS	MR	MRMS	MRMS	MRMS	MSS	MS	MSS	S	MSS	S	MS	AH
Corack	MR	MS	SVS	RMR	MR	SVS	S	S	S	S	MS	S	S	APW
Correll	MRMS	MRMS	S	MR	SVS	MRMS	MSS	MSS	S	S	MS	R	MS	AH
Cosmick	MS	MS	S	MS	MRMS	MS	MSS	MS	MS	S	MSS	SVS	–	AH
Emu Rock	MRMS	MRMS	S	S	MRMS	S	SVS	MSS	S	MS	MSS	MS	MS	AH
Estoc	MR	MS	MRMS	MR	MSS	MSS	S	S	S	S	MRMS	MRMS	MS	APW
Forrest	RMR	RMR	MS	S	MRMS	MS	SVS	S	SVS	SVS	MS	MR	MR	APW
Gladius	MR ^	MRMS	MS	MS	MS	MSS	S	MS	S	S	MS	RMR	MS	AH
Grenade CL Plus	MR	MRMS	S	MR	S	MS	S	MSS	S	S	MRMS	RMR	MS	AH
Impala	MR	MR	SVS	S	MSS	RMR	SVS	S	S	S	MSS	SVS	MRMS	Soft
Kiora	MRMS	RMR	MR,MS	MS	MSS	MRMS	MS	MS	MRMS	S	MS	MRMS	MS	AH
Kord CL Plus	MR	MRMS	MS	MR	MSS	MSS	MSS	MSS	MS	S	MRMS	MR	MRMS	AH
Mace	MR	SVS	MSS	MRMS	MRMS	MSS	MRMS	MS	MS	S	MS	S	MRMS	AH
Manning	MR	RMR	RMR	MS	MRMS	MR	MR	MSS	S	VS	SVS	R	–	Feed
Orion	MR	MSS	R	S	MSS	MS	MS	MS	MSS	S	MSS	S	S	Soft / Hay
Phantom	MS	MR	MSS	MRMS	SVS	MRMS	MS	S	S	MSS	MSS	MRMS	MRMS	AH
Revenue	RMR	R	S	S	MS	MR	MS	MSS	MSS	S	SVS	S	MS	Feed
Scout	MR	MS	MS	R	SVS	MS	MSS	S	MS	MSS	S	MR	SVS	AH
Shield	RMR	MR	R	MRMS	MSS	MRMS	MSS	MS	MSS	S	MRMS	S	MS	AH
Trojan	MRMS	MR	MRMS	MS	MSS	MSS	MSS	MSS	MS	MS	MS	SVS	MRMS	APW
Wallup	MRMS	MRMS	SVS	MR	MSS	S	S	MRMS	MRMS	S	MS	SVS	MS	AH
Wyalkatchem	MS	S	S	S	MR	SVS	MRMS	MRMS	MS	S	MSS	SVS	MRMS	APW
Yitpi	S	MRMS	S	MR	SVS	MRMS	MSS	MSS	S	S	MS	MR	MS	AH

^ - Some susceptible plants in mix, ‡ - Black point is not a disease but a response to certain humid conditions
R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible
T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, - = uncertain

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	Stripe	Leaf					*P. neglectus*	*P. thornei*					
Aurora	R	RMR	R	MSS	MRMS	MR	MS	MRMS	RMR	VS	MRMS	R	MS	Durum
Hyperno	R	MR	RMR	MS	MRMS	MR	MRMS	MS	RMR	SVS	MS	R	MS	Durum
Saintly	MR	MR	MRMS	MS	MRMS	MSS	S	MS	RMR	VS	MS	R	MS	Durum
Tjilkuri	MR	MR	MR	MS	MRMS	MRMS	MSS	MRMS	MR	VS	MS	R	MSS	Durum
WID802	RMR	MR	RMR	MS	MRMS	MRMS	MS	MS	MS	VS	MS	R	MSS	Durum
Yawa	RMR	MR	MR	MS	MRMS	MS	MR	MRMS	RMR	VS	MRMS	–	MRMS	Durum

Triticale	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	Stripe	Leaf					*P. neglectus*	*P. thornei*					
Bison	RMR	R	RMR	R	MR	R	R	R	MR	–	MRMS	–	–	Triticale
Bogong	RMR	MRMS	R	–	MR	R	R	MR	S	MSS	MSS	–	–	Triticale
Chopper	MR	MRMS	R	R	MR	R	R	MRMS	MSS	MSS	S	–	–	Triticale
Fusion	R	RMR	R	R	MRMS	R	R	RMR	MS	MS	S	R	MSS	Triticale
Goanna	R	MR^	MR	R	MR	R	R	MRMS	SVS	–	–	–	–	Triticale
Hawkeye	RMR	MR^	R	R	MR	R	R	MR	MS	MS	MSS	–	–	Triticale
Jaywick	MRMS	MR	R	R	MR	R	R	MR	–	MS	MS	–	–	Triticale
Tahara	RMR	MRMS	R	R	MR	RMR	R	MR	S	MS	MS	R	–	Triticale

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible
Tolerance levels are lower for durum receivals.
^ - Some susceptible plants in mix
‡ 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*	
Bass	MR-S	MS-SVS	MSS	MR-S	S	MSS	RMR	VS	MS	MRMS	MR	MS
Buloke	MS-SVS	MR	MS-S	MS-S	S	RMR	RMR	MS	MS	MRMS	MRMS	MS
Charger	MR-MS	VS	SVS	VS	R	R	RMR	MS	MS	MR	MRMS	MRMS
Commander	MS-S	MS-S	MSS	S	R	MRMS	R	R	MS	MRMS	MRMS	MSS
Compass	MR-VS	MR-MRMS	MRMS-MSS	MS	R	MR	R	R	MS	MR	MR	MS
Fathom	MRMS-S	MR-MS	MR	R-S	R	MRMS	R	R	MSS	MRMS	MRMS	S
Flagship	MS-SVS	MR	MRMS	MS	R	S	RMR	MRMS	MSS	MRMS	MRMS	MSS
Fleet	MRMS-S	SVS	MR	MS	R	MRMS	RMR	MR	MSS	MRMS	MRMS	MS
Granger	MR-S	MR-MSS	S	MS-S	R	R	R	MR	S	MR	MR	MS
Hindmarsh	MRMS-S	MR	S	R-VS	R	MRMS	MR	MS	S	MRMS	MRMS	MSS
Keel	VS	MS	MR	MS-S	R	S	MRMS	R	S	MR	MRMS	SVS
La Trobe	MRMS-S	MR	MSS	R-VS	R	MR	RMR	MRMS	S	MR	MR	MSS
Macquarie	MR-SVS	MRMS	SVS	MR-MSS	S	S	RMR	MSS	MS	MR	MS	MR
Maritime	MRMS-S	R-VS	MRMS	S	R	SVS	S	MS	S	MR	–	MSS
Moby	S	MR	S	MRMS	S	MS	–	MS	MSS	–	–	–
Navigator	VS	MR-MS	MR	R-MR	R	R	RMR	MSS	MS	MRMS	MRMS	MSS
Oxford	R-MR	MR-SVS	MSS	MS-S	S	R	R	MRMS	MSS	MR	MRMS	MR
Schooner	S-VS	MR	MS	MSS	VS	SVS	RMR	MR	S	MS	MRMS	MS
Scope	MS-SVS	MR	MS-S	MS-S	S	RMR	RMR	MRMS	MS	MRMS	MRMS	MSS
Skipper	SVS	MR	MRMS	S	R	MRMS	R	MSS	MSS	MRMS	MRMS	MSS
Westminster	R-MRMS	MR-MS	S	MR	–	R	R	R	MRMS	MRMS	MRMS	MRMS
Wimmera	R-MRMS	MR-S	MS-S	MSS	S	MSS	R	MRMS	MS	MRMS	MRMS	MRMS

* Due to multiple strains of these pathogens, 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* Nematodes
	Stem*	Leaf*	Resistance	Tolerance	Resistance	Tolerance					
Bannister	MR-S	R	VS	I	–	MI	MR-S	MS	MS	S	–
Brusher	MS-S	MS-S	R	MI	MS	I	MR-MS	MS	MS	MS	MR-MS
Dunnart	MR-S	MR	R	MT	–	MT	MR-S	MS	MR	MR-MS	–
Forester	R-S	MR-MS	MS	MI	S	I	MS-S	R-MR	MR-S	MR	–
Glider	MR-S	MS-S	MS	I	R	T	R	R	MR-S	MR	–
Kangaroo	MS-S	MS-S	R	MT	S	MI	MR-MS	MS	MR-S	MR-MS	–
Mitika	MR-S	MS-S	VS	I	S	I	MR	S	MS-S	S	–
Mulgara	MS	MR-MS	R	MT	R	MT	MR	MS	MS	MS	–
Numbat	MS	S	S	I	S	I	S	MS	S	MR	MR
Tammar	MR-S	MR-MS	MR	MT	R	T	MR	R-MS	MS	MR	–
Tungoo	MS-S	MS	R	MT	R	T	MR	R	MR-MS	MR	–
Wallaroo	S	S	R	MT	MS	MI	S	MS	MS	S	MR
Williams	MR-S	R	S	I	–	I	R	MS	MR-MS	MR-MS	–
Wombat	MS-S	MS	R	T	MR	MT	MR-MS	MS	MR	MS	–
Wintaroo	S	S	R	MT	MR	MT	MR-MS	MS	MR-MS	MR-MS	MR-MS
Yallara	S	MS	R	I	S	I	MR-MS	MS	MS	MS	–

* Due to multiple strains of these pathogens, 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
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Disease

Section Editor:
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Section
4

Farming Systems

Farming systems projects on Eyre Peninsula in 2014

Naomi Scholz
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INFO

There are three major farming systems projects currently being delivered on Eyre Peninsula;

- Maintaining profitable farming systems with retained stubble,
- Developing sustainable weed management strategies for the long term viability of farming systems on the Eyre Peninsula,
- Eyre Peninsula Grain & Graze 3.

The projects are strongly linked, with information generated in one project being utilised by another, and vice versa. The following table provides a brief outline of each of the projects.

Title	**Maintaining profitable farming systems with retained stubble**	**Developing sustainable weed management strategies for the long term viability of farming systems on the Eyre Peninsula**	**Eyre Peninsula Grain & Graze 3**
Funder	GRDC	EP Grain Growers Rail Fund	GRDC
Partners	Lead: EPARF SARDI (delivery)	Lead: EPARF, LEADA SARDI (delivery)	Lead: SARDI (delivery) Rural Solutions SA (extension) EPARF, LEADA
Duration	5 years, end 30/06/2018	18 months, end 30/06/2015	3 years, end 30/06/2016
Area covered	Upper EP There is a LEADA project covering lower EP. Part of the GRDC Stubble Initiative, covering the southern grain growing region of Australia. 10 major grower group partners plus CSIRO.	EP	EP Other groups involved are Southern Farming Systems, East SA managed by Ag Excellence Alliance, BCG, and Mallee Sustainable Farming.
Aim	Increased knowledge and skills allowing farmers and advisers to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula.	To examine a range of strategies to set up the region to tackle the threat of herbicide resistance in farming systems, and to examine longer term solutions that involve a range of new and emerging technologies (cultural, chemical and other).	Growers and advisors using processes, tools or packages to design and manage flexible mixed farming systems equipping them with the ability to adopt and respond to changing environment and market conditions to manage risk and generate profits.

Topics to be addressed	The build-up of snails, mice and fungal disease carryover on cereal stubble and increasing in-crop weed infestation. Difficulty of establishing crops into medic pasture residue. Establishment of crops on non-wetting soils.	Management of Barley grass on upper EP and Annual rye grass on lower EP.	Grazing and better managed crops and pastures in the crop rotation and improving farm business decision making skills.
Trial/demo sites in 2014	Lock – Hentschke, comparing crop establishment based on time of sowing, sowing rate, position and depth on non-wetting sand. MAC – South 7, sowing into stubbles, height and in-row vs inter row. MAC – S3S, spray topping pastures. Mt Cooper – Gunn, establishment into pasture residues mown/worked/harrowed/nil. Link site: MAC Airport - crop sequencing	MAC – North 7/8, cross sowing, 6" nudge, pre-em herbicide. MAC – North 1, barley grass herbicide resistance testing, seed bank sampling, weed numbers counted. Minnipa – Heddle, windrows and chaff cart stubble dumps.	MAC – South 7, high vs low input and grazed vs ungrazed mixed farming systems trial. Collection of snail data for Stubble project. MAC - North 12, pasture options demo. Lock – Glover, flexible grazing options demo (cereals and vetch). Penong – Freeman, flexible grazing options demo (cereals).
Outputs to be delivered	Produce guidelines to control pests, weeds and diseases while retaining stubble to maintain or improve soil health, and reduce exposure to wind erosion.	Utilising 2 demonstration farms, develop and demonstrate whole farm weed management strategies.	A series of workshops, case studies, demonstrations and research articles to help growers manage risk and generate profits in mixed farming systems.

Profitable crop sequences in the low rainfall region of upper Eyre Peninsula

Suzanne Holbery[1,2] and Nigel Wilhelm[1]

[1]SARDI, Minnipa Agriculture Centre, [2]Present address, NSW DPI, Hay

RESEARCH

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Paddock History
Prior to 2011 > 10 years cereal
Soil Type
Red sandy clay loam
Plot Size
20 m x 2 m x 3 reps
Yield Limiting Factors
Nitrogen
Phosphorus
Grass weed competition

Key messages

- **A break of two years can produce a better financial outcome than continuous wheat over a four year period of production where there are substantial pressures on wheat performance (eg. grassy weeds).**
- **Wheat yields after a two year break were a significant step up from wheat crops following a one year break, which were in turn, much better than the continuous wheat. Large break crop benefits of 0.5-1.25 t/ha were achieved following a two year non-cereal break phase compared to continuous wheat .**
- **The break crop benefit of a one year break may only last one season if grass weeds are a significant factor. The major benefit of breaks in these long term cereal paddocks was to reduce grassy weed pressures for subsequent wheat crop phases.**
- **The benefit of a two year break had little to do with the phases chosen for those two breaks, providing that excellent grass weed control could be achieved in both.**
- **Many of the most profitable crop sequences over the four year period often started with a two year break phase.**

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-leaved 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. At the same time, this domination of cereals is increasing the need for non-cereal options to provide profitable rotational crops, disease breaks and weed control opportunities to sustain cereal production. Currently, the most common ‘break crop’ is a poorly performing volunteer annual grass dominant pasture. They are often havens for cereal pests and diseases and are seen as having negative impacts on subsequent cereal grain yield and quality. For greater detail of trial management over the past three years refer to articles in EPFS Summaries 2011, p 111, 2012, p 94, and 2013, p 104.

How was it done?

In year four (2014) of the study all the treatments were sown to Corack wheat at 55 kg/ha with 65 kg/ha DAP on 11 May. A deep blade system (DBS) seeder was used as opposed to the knife points used the previous 3 years to address the accumulated stubble that had negatively impacted on establishment the year prior. Five treatments that had not had any legume break phase (2x continuous wheat, vetch/oats mix followed by wheat, oats then canola and canola then oats) in the previous two years also received 50 kg/ha of urea at sowing to compensate for any extra nitrogen deficiency.

From grass weed data in 2013 the decision was made to address heavily infested treatments with a pre-emergence mixture of Sakura @ 118 g/ha and Avadex @ 2 L/ha. The treatments were pea/oat, oat/pea, medic/wheat, pea/wheat, pea/canola, pea+canola/wheat. It was hoped that the continuous cereal treatments and the vetch+oat/wheat treatment would have reduced grass numbers having had Intervix applied in 2013. These three treatments and all remaining treatments received trifluralin @ 1.5 L/ha.

Four days post-sowing all plots were sprayed with chlorpyrifos @ 0.7 L/ha to address observed cut worms in the trial. Treated grain mouse bait was applied to the trial the same day.

On 22 July additional nitrogen was applied in the form of urea. Treatments were assessed using soil mineral nitrogen data and fertiliser application to determine available mineral nitrogen. Treatments with calculated levels of ≤ 100 kg/ha (canola/medic, medic/oats, pea/canola, canola/pea, oats/medic, fallow, medic/canola, medic/regenerated medic & canola) mineral nitrogen received 60 kg/ha urea, whilst treatments with 101-120 kg/ha (pea/oats, pea/wheat, pea & canola/wheat, oats/pea, Angel medic/wheat, Jaguar medic/wheat, sulla, vetch & oats/wheat, canola/oats) received 30 kg/ha. The two continuous cereals treatments and oats/canola had greater than 120 kg/ha mineral N and did not receive any additional fertiliser.

On the 6 August all treatments were visually assessed for the presence of broad-leaved weeds. As a result all treatments excluding oats/medic, fallow, and medic/oats were sprayed with 2, 4-D (2-ethylhexyl ester) @ 0.6 L/ha. On 15 August as a response to observed stripe rust in the district the trial was aerial sprayed with tebuconazole @ 0.29 L/ha.

Grass weeds were measured on 12 September when the wheat was flowering. Dry matter cuts were also taken at this time.

What happened?

Soils

Pre sowing soil water measured in the 0-90 cm profile on 14 April were similar across all treatments (which were all seeded to wheat in 2013 as well).

Following the application of nitrogen in the form of Urea either at sowing in the case for sequences that had not experienced a legume break or either in-crop for the remaining treatments, the total nitrogen available to the crop ranged between 112 and 145 kg/ha. Given that a wheat crop requires approximately 50 kg/ha nitrogen to produce one tonne of grain there was enough N for a 2-3 t/ha yield across all treatments.

Rhizoctonia solani AG8 varied only slightly across the treatments. Levels across all treatments were lower than what is generally required for crop damage and subsequent yield loss.

Table 1 Presence of Rhizoctonia solani AG8 in the soil pre-sowing, soil moisture from 0-.9m pre-sowing, total mineral N present in the soil, nitrogen available to the crop including soil N and fertiliser N, plant establishment counts, flowering biomass in 2014. Treatments in bold had extra N applied with the seed

2014	*Rhizoctonia* solani AG8	Soil moisture 0-90cm	Total mineral Nitrogen 0-90cm	Nitrogen available @ sowing	Plant est. counts	Flowering biomass
2011 outcome / 2012 outcome	7 Apr	14 Apr	14 Apr	11 May	29 May	12 Sep
	log (pgDNA/g)	mm	kg/ha	kg/ha	plants/m^2	t/ha
1 WHEAT grain / WHEAT grain	0.75^{ab}	156	111	145	**81^{abc}**	9.5
2 WHEAT grain / WHEAT grain	1.31^{ab}	156	90	124	**50^{d}**	10.7
3 ANG MEDIC seed / WHEAT grain	1.71^{a}	163	100	126	87^{abc}	11.7
4 VETCH+OATS hay / WHEAT grain	1.32^{ab}	154	81	129	**64^{cd}**	9.5
5 OATS hay / CANOLA grain	0.62^{ab}	158	95	130	**67^{bcd}**	9.6
6 OATS hay / FIELD PEA grain	0.98^{ab}	155	98	123	92^{abc}	11.4
7 OATS hay / EARLY SOWN MEDIC graze	1.42^{ab}	150	82	121	97^{a}	9.7
8 FALLOW / FALLOW	1.56^{a}	148	82	121	92^{abc}	10.1
9 ANG SOWN MEDIC seed / WHEAT grain	1.38^{ab}	152	101	127	91^{abc}	12.3
10 SOWN MEDIC hay / REG MEDIC+CANOLA graze	1.71^{a}	150	85	124	91^{abc}	12.7
11 EARLY SOWN MEDIC hay / CANOLA grain	1.23^{ab}	150	85	124	90^{abc}	12.5
12 EARLY SOWN MEDIC hay / OATS graze	1.84^{a}	157	79	119	91^{abc}	11.2
13 CANOLA grain / FIELD PEA grain	0.22^{b}	162	81	120	92^{abc}	13.4
14 CANOLA grain / EARLY SOWN MEDIC graze	1.31^{ab}	171	73	112	84^{abc}	11.1
15 CANOLA grain / OATS graze	0.79^{ab}	156	82	130	**74^{abcd}**	11.0
16 FIELD PEA grain / OATS graze	1.43^{ab}	159	92	118	91^{abc}	10.5
17 FIELD PEA grain / WHEAT grain	1.63^{a}	179	92	118	96^{ab}	11.1
18 FIELD PEA grain / CANOLA grain	0.77^{ab}	158	81	120	91^{abc}	11.4
19 FIELD PEA+CANOLA hay / WHEAT grain	0.78^{ab}	160	95	120	96^{ab}	11.0
20 SULLA graze / REG SULLA graze	1.73^{a}	133	101	127	91^{abc}	12.2

Production

Establishment counts trended lower in treatments that had not experienced a legume break throughout the sequence (Treatment no. 1, 2, 4, 5, and 15) because of additional nitrogen in the form of urea applied accidentally with the seed at sowing, which resulted in fertiliser toxicity. Although no statistical differences were observed in the flowering biomass it too has trended lower on those same treatments.

Despite the use of frequent and expensive grass selective herbicides in the continuous wheat controls (treats 1 & 2), grassy weeds were blowing out in this fourth season, both in the seed reserves in the soil and in the crop itself during the year (Table 2). The only treatments which had kept a lid on grassy weeds started with two years of a non-cereal (treats 8, 10, 14 and 20).

Grain yield of Corack varied from just over 3 t/ha to nearly 4 t/ha depending on the treatment imposed (Table 3). Quality was largely unaffected by treatment with proteins low (less than 10%) regardless of history and differing N management during the 2014 growing season. A very strong influence on yield of wheat in 2014 was the grassy weed pressure in that treatment. Figure 1 shows that for every 10 grassy weeds in the soil bank, yield of wheat dropped by 200 kg/ha.

Table 2 Weed seed bank annual grasses and in crop grass numbers counted at flowering on 12 September 2014

2014	Weed seed bank plants/m^2										In-crop counts at flowering plants/m^2				
	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses
Treat	13 May	13 May	13 May	13 May	13 May	4 Jul	4 Jul	4 Jul	4 Jul	4 Jul	12 Sep	12 Sep	12 Sep	12 Sep	12 Sep
1	73	7	1	0	**81^{a}**	11	3	5	0	**19**	4	19	38	0	**61**
2	33	18	1	2	**54^{ab}**	8	6	1	0	**14**	2	7	28	4	**41**
3	12	3	2	0	**18^{abcd}**	3	2	0	1	**7**	5	7	35	0	**47**
4	2	42	4	0	**48^{abc}**	6	13	0	0	**19**	1	36	3	6	**46**
5	31	13	2	0	**47^{ab}**	8	6	0	0	**14**	11	8	23	0	**42**
6	11	6	0	0	**17^{abcd}**	9	2	0	0	**11**	7	9	35	0	**51**
7	7	5	1	4	**16^{abcd}**	2	0	0	1	**4**	5	6	56	7	**74**
8	0	5	0	0	**5^{bcd}**	0	2	0	0	**2**	1	5	1	5	**13**
9	18	6	5	4	**32^{abcd}**	1	1	4	0	**6**	6	5	33	0	**45**
10	2	2	0	1	**5^{bcd}**	2	1	1	0	**4**	5	10	3	4	**22**
11	8	1	0	1	**10^{abcd}**	5	0	0	0	**5**	18	2	7	3	**29**
12	6	12	0	1	**18^{abcd}**	1	5	0	0	**6**	10	15	1	1	**28**
13	6	5	0	1	**13^{abcd}**	0	4	0	0	**4**	5	10	7	9	**31**
14	1	7	0	0	**8^{d}**	1	5	0	0	**7**	3	10	3	5	**22**
15	4	5	3	0	**11^{abcd}**	1	2	1	0	**5**	7	7	0	5	**18**
16	6	5	0	0	**10^{abcd}**	0	1	0	0	**1**	7	12	1	9	**28**
17	36	4	0	0	**40^{abcd}**	11	5	0	0	**16**	5	3	25	0	**33**
18	12	30	0	1	**43^{abc}**	3	7	0	1	**12**	14	7	1	1	**22**
19	28	18	0	0	**46^{abc}**	5	1	0	0	**6**	1	6	10	1	**18**
20	3	2	0	0	**5^{cd}**	1	1	0	0	**2**	5	8	2	2	**16**

Table 3 Yield and quality of wheat, 2014

2011 outcome / 2012 outcome	Average yield (t/ha)	Average test weight (g/hL)	Average screenings (%)	Average protein (%)	Average 1000 grain weight (g)
1 WHEAT grain / WHEAT grain	3.3	85.1	3.5	9.2	41
2 WHEAT grain / WHEAT grain	3.3	85.2	3.5	9.1	40
3 ANG MEDIC seed / WHEAT grain	3.7	85.7	2.9	9.1	41
4 VETCH+OATS hay / WHEAT grain	3.4	84.7	3.5	9.8	38
5 OATS hay / CANOLA grain	3.4	85.2	3.3	9.2	41
6 OATS hay / FIELD PEA grain	3.5	85.5	3.0	9.1	41
7 OATS hay / EARLY SOWN MEDIC graze	3.7	85.8	3.2	9.0	40
8 FALLOW / FALLOW	3.7	86.1	3.0	9.2	42
9 ANG SOWN MEDIC seed / WHEAT grain	3.4	85.6	3.0	9.1	41
10 SOWN MEDIC hay / REG MEDIC+CANOLA graze	3.6	85.5	2.6	9.3	40
11 EARLY SOWN MEDIC hay / CANOLA grain	3.6	85.6	2.7	9.4	41
12 EARLY SOWN MEDIC hay / OATS graze	3.6	85.4	2.9	9.5	40
13 CANOLA grain / FIELD PEA grain	3.8	85.3	2.9	9.4	41
14 CANOLA grain / EARLY SOWN MEDIC graze	3.5	85.5	3.0	9.0	41
15 CANOLA grain / OATS graze	3.5	85.1	3.5	9.4	40
16 FIELD PEA grain / OATS graze	3.8	85.4	2.9	9.2	41
17 FIELD PEA grain / WHEAT grain	3.5	85.7	3.3	8.9	42
18 FIELD PEA grain / CANOLA grain	3.7	85.5	2.6	9.1	41
19 FIELD PEA+CANOLA hay / WHEAT grain	3.6	85.5	2.8	9.2	41
20 SULLA graze / REG SULLA graze	3.6	85.2	2.6	9.4	40

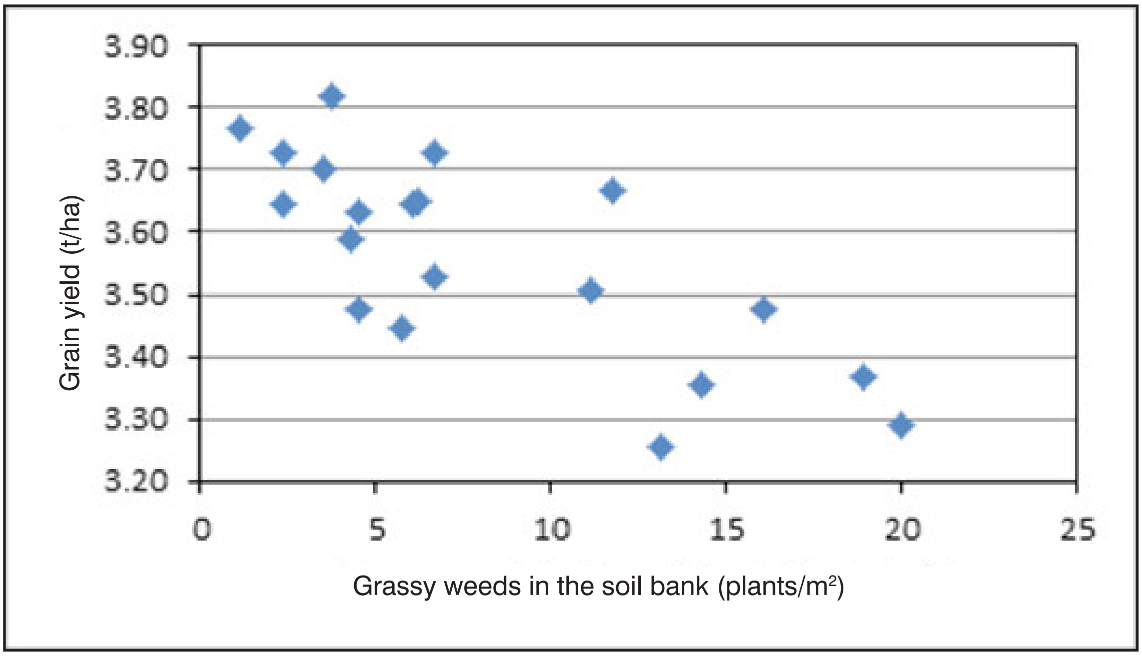

Figure 1 Impact of grassy weed pressure on grain yield of wheat in 2014

What does this mean?

The experience at this trial and several others in the crop sequencing project is that grassy weeds are a very important factor in determining productivity in our low rainfall farming systems and that to have a major and prolonged impact on grassy weed numbers, a commitment to a two year cereal break is necessary. If at least one of these break years are profitable, then this option can result in substantially better profits over the four year period compared to persisting with continuous wheat.

Table 4 Cumulative gross margins of treatments in 2011, 2012 and 2013

2011					2012					2013					Cumulative		
Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	3 yr cumulative GM ($/ha)	Stats
15E	411	a	Canola	G&G	20E	495	a	Sulla	Hay	8W	543	a	Wheat	Grain	15E	1009	a
13W	409	a	Canola	Grain	20W	487	a	Sulla	Graze	13E	487	ab	Wheat	Grain	19E	926	ab
15W	360	ab	Canola	Grain	19E	444	ab	Wheat	Grain	7E	475	abc	Wheat	Grain	15W	913	ab
13E	343	abc	Canola	G&G	3E	442	ab	Wheat	Grain	5E	472	abc	Wheat	Grain	7W	907	ab
7W	306	abcd	Oats	Hay	4W	429	ab	Wheat	Grain	6E	469	abc	Wheat	Grain	20E	839	abc
1W	296	abcde	Wheat	Grain	9E	422	ab	Wheat	Grain	11E	459	abcd	Wheat	Grain	4W	824	abcd
6W	291	abcde	Oats	Hay	17W	413	abc	Wheat	Grain	20E	455	abcd	Wheat	Grain	18W	798	abcd
5W	270	abcdef	Oats	Hay	2W	316	abcd	Wheat B	Grain	15W	442	abcd	Wheat	Grain	20W	762	abcd
2W	266	abcdef	Wheat	Grain	1W	295	abcde	Wheat A	Grain	12W	441	abcd	Wheat	Grain	5W	748	abcd
14W	239	abcdef	Canola	Grain	18W	268	abcdef	Canola	Grain	15E	440	abcd	Wheat	Grain	13W	747	abcd
14E	233	abcdef	Canola	G&G	10W	251	abcdefg	Reg medic/Canola	Graze	14E	438	abcd	Wheat	Grain	3E	743	abcd
4W	159	bcdefg	Vetch/Oat	Hay	16W	221	bcdefgh	Oats	Graze	14W	430	abcde	Wheat	Grain	16W	731	abcd
19E	142	cdefgh	Pea/Canola	Graze	7W	216	bcdefgh	Early sown medic	Graze	12E	428	abcde	Wheat	Grain	2W	727	abcd
18W	122	defgh	Pea	Grain	5W	194	bcdefgh	Canola	Graze	16W	426	abcde	Wheat	Grain	1W	722	abcde
5E	95	defghi	Oats	Graze	12E	189	bcdefgh	Oats	Hay	18W	407	bcde	Wheat	Grain	6W	700	abcde
16W	83	efghij	Pea	Grain	15E	158	cdefgh	Oats	Hay	10W	394	bcdef	Wheat	Grain	14E	699	abcde
6E	83	efghij	Oats	Graze	4E	143	defgh	Wheat	Hay	20W	385	bcdef	Wheat	Grain	14W	688	abcdef
7E	75	fghij	Oats	Graze	12W	123	defgh	Oats	Graze	7W	385	bcdef	Wheat	Grain	7E	663	abcdef
12W	-27	ghijk	Medic	Hay	7E	113	defgh	Early sown medic	Hay	11W	377	bcdef	Wheat	Grain	17W	623	abcdefg
3E	-36	ghijk	Jag medic	Hay	15W	112	defgh	Oats	Graze	6W	360	cdef	Wheat	Grain	13E	622	abcdefg
11W	-47	ghijkl	Medic	Hay	11W	99	defgh	Canola	Grain	13W	355	cdef	Wheat	Grain	5E	585	bcdefg
4E	-62	hijkl	Vetch/Oat	Graze	11E	88	defgh	Canola	Hay	19E	340	defg	Wheat	Grain	9E	571	bcdefg
12E	-70	hijkl	Medic	Graze	6W	49	defghi	Field pea	Grain	17W	340	defg	Wheat	Grain	12E	546	bcdefg
11E	-91	ijkl	Medic	Graze	14E	28	efghi	Early sown medic	Hay	3E	337	defg	Wheat	Grain	12W	538	bcdefg
20E	-111	ijkl	Sulla	Hay	14W	19	fghi	Early sown medic	Graze	9E	314	efgh	Wheat	Grain	10W	500	cdefg
20W	-111	ijkl	Sulla	Hay	5E	18	fghi	Canola	HAY	5W	284	fgh	Wheat	Grain	11E	456	cdefg
17W	-129	jkl	Pea	Grain	13W	-18	ghi	Field pea	Grain	4W	236	ghi	K. wheat	Grain	11W	429	defg
10W	-144	kl	Medic	Hay	8W	-35	hi	Fallow	Graze	4E	225	hi	K. wheat	Grain	6E	331	efg
9E	-165	kl	Ang medic	Hay	13E	-208	i	Field pea	Hay	2W	146	i	K. wheat	Grain	4E	306	fg
8W	-275	l	Fallow		6E	-221	i	Field pea	Hay	1W	132	i	K. wheat	Grain	8W	233	g

Summary of results from economic analysis

How was it done?

Gross margins have been calculated each year for each treatment. Input costs (chemicals and fertiliser) are calculated from invoices received through the MAC farm and include GST. Machinery and maintenance costs are from the Farm Gross Margin and Enterprise Planning Guide, 2011, 2012, 2013, and 2014. Grain prices were taken from the cash price at Port Lincoln Viterra on 1 December or closest date on the year the grain was harvested. Grain classification was determined from the Viterra receival standards for the year the grain was harvested.

The value given to hay crops uses the contracting rate as stated in the gross margin guide for oaten hay production for the corresponding year. Mowing was at a cost of $27/ha, super conditioning was $24/ha, raking was added twice at a cost of $7/ha, baling was $24/ha, and handling costs of $40/ha. Hay prices are estimated based on the quality and the market price as listed in the Stock Journal on 1 December or the nearest date of the year the hay was harvested. Taken into consideration was the fact that Eyre Peninsula has a limited hay market and selling in other regions would incur significant transport costs. To account for this the cost per tonne was downgraded in the calculation. The yield has had 12% added to account for desired moisture content of hay and had 12% removed to account for losses during raking and baling and maintaining cover on the soil.

To put a dollar value on crops or pastures that were mown to simulate grazing the potential stocking rate is calculated by the formula [((pasture grown – 1500 kg/ha)/200) x 50%] where 1500 kg/ha accounts for losses from trampling and residue left to maintain ground cover, and 200 refers to the kilograms of dry matter per dry sheep equivalent consumed over 200 days of winter grazing. Had potential stocking rates exceeded what was realistically possible for the region a cap would have been imposed. As it happened the highest was 10.5 DSE, a high but not unachievable stocking rate and so figures remained un-capped.

Cumulative gross margins are calculated by adding the profits of the three years together (2014 data still to be added).

What happened?

After thinning the treatments to reflect those that were considered a likely break crop option for the upper Eyre Peninsula region, 30 treatments of the original 40 were statistically analysed. The result was that 12 treatments were more profitable after three years than continuing to sow wheat. The overall most profitable rotation with $1009 cumulative over the first three years of the trial is canola grown for grain with an early simulated graze followed by oaten hay before returning to conventional wheat (Table 4) The second most profitable option was a one year break of a canola and field pea mixture with $926/ha. Other one year break treatments grossing higher than continuous cereals were a vetch and oat mixture cut for hay, and Jaguar annual medic also cut for hay, making $824/ha and $743/ha respectively.

In 2011 canola as a grain crop was the most profitable break crop option with $329 for a grain crop with an early graze and $336 for a straight grain crop compared to continuing to crop wheat for grain which made $291. A light graze early in the season made no difference to profitability compared to canola as a straight grain crop. Profits were similar to that of continuing to grow grain wheat and an oaten hay crop. These treatments were significantly better than legume hay and grazing options, and field peas for grain. Medic for seed, field peas for hay and fallow were less profitable than other measured break crop options with losses of greater than $258/ha. All medic options made a loss.

In 2012 the only break crop to make more money than returning to wheat following a 1 year break was the biennial legume sulla, with $487/ha and $495/ha for grazing and hay options respectively. The reason being that once established there are very little input costs the second year, yet you get large quantities of biomass that can be cut for hay or grazed. One year break treatments were more profitable the year after the break when sown back to wheat than having had no break at all.

Canola grain crops were less profitable than grain wheat in 2012 which reflects the lower yields as a result of a below average rainfall season.

Most notable in 2013 was that continuous cereals are the least profitable compared to all other treatments. However there is a varietal effect given that these treatments are sown to the lower yielding variety Kord CLPlus (NVT Results 2013). Input costs were higher than all other treatments with the exception of treatment 5 oats/canola which also received additional nitrogen which increased input costs by $30/ha. The application of Intervix has also contributed to lower gross margin. With 2013 being the first year back to wheat after the two year breaks it puts fallow on top through greater yields as a result of more moisture in the profile.

The hay crops incurred greater input costs due to contracting rates for hay production yet have still turned a profit.

Acknowledgements

We would like to thank Ian Richter and Wade Shepperd for technical expertise throughout the duration of the trial over the past four years. Thank you Chris Dyson for biometric expertise.

Sulla (*Hedysarum coronarium*) broad acre demonstration at MAC

Suzanne Holbery[1,2], Nigel Wilhelm[1] and Mark Klante[1]

[1]SARDI, Minnipa Agriculture Centre, [2]Present address, NSW DPI, Hay

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield:
Potential: 4.0 t/ha
Paddock History
2013: Sulla
2012: V. pasture/chem fallow
2011: Durum wheat
Soil Type
Red sandy loam
Plot Size
9 m x 275 m x 5 reps
Harvested area -
9 m x 15 m x 5 reps

Key messages

- **Weed control prior to sowing is imperative for successful establishment of sulla.**
- **Specific rhizobia inoculant for sulla must be used at sowing for effective nodulation.**
- **Sulla, medic and vetch all increased mineral N, but vetch more than doubled mineral N in one year.**
- **Regular monitoring in early spring will assist in managing pest outbreaks.**
- **There can be a grazing opportunity in the first year if sufficient biomass and flowers have been produced to ensure survival over summer and sufficient plant numbers in the second year.**
- **Sulla production was slow following establishment, but rapidly increased with the onset of warmer spring temperatures.**
- **There was an increase in Rhizoctonia (AG8) inoculum levels with sulla.**
- **There are presently no registered chemicals for weed control in sulla.**

Why do the trial?

The aim of the paddock demonstration was to measure the effects of sulla on soil health and weed burden, determine the financial viability of establishing a two-year break phase within an existing cropping rotation and the feasibility of harvesting the seed for on-farm use.

How was it done?

The barn paddock at Minnipa Agricultural Centre was a grass free pasture in 2012, the year prior to sowing sulla. The paddock was sown on 2 May 2013 using a 9 m air seeder with knife points and 30 cm row spacing. The paddock was divided into five blocks; consisting of three sulla, one vetch and one medic block in 9 m wide seeder widths. Sulla (Wilpena) seed coated with sulla specific peat inoculum was sown at 3 kg/ha at 2.5 cm depth. Vetch (Cummins) was sown at 40 kg/ha and 2.5 cm depth, not inoculated. Medic (Angel) Goldmark® was sown at 3 kg/ha and 1 cm depth. All strips had 9 kg of N and 10 kg of P applied as 50 kg/ha of DAP (18:20:0:0). Broad-leaved and grass selective herbicides and pesticides were applied when required. Additional fertiliser with 10 kg/ha of N and 12 kg/ha S as sulphate of ammonia was applied on 1 July 2013. The vetch areas were significantly reduced in plant numbers due to in crop herbicide damage.

On 2 October 2013, 340 ewes and 445 lambs had access to blocks of sulla, vetch and medic for two days until approximately 10 cm of biomass remained on the sulla plants. The decision to graze was based on better than expected dry matter yields. A block of sulla and vetch was kept un-grazed as a comparison of persistence into the second year.

In 2014, all treatments were left to regenerate/self-seed. There were two applications of broad-leaved herbicide; flumetsulum @ 25 g/ha on 5 May to address marshmallow, and metribuzin @ 300 g/ha on 11 July for thistles and other broad-leaved weeds. The paddock was treated twice with pesticides, once for pests early in the season and the second time to control green peach aphids.

Biomass production was measured on 27 August with a 0.5 m^2 quadrant at four locations per area. Samples were sorted for sulla, vetch, medic, broad-leaved weed species and annual grasses. The separated samples were oven dried at 70°C for 48 hours before recording dry weight.

On 4 September the paddock was cut for hay using a mower conditioner. The hay was left to cure for 24 days to ensure drying of the thick fibrous stems of the sulla plant. Following a raking of the hay on 25 September the hay was baled overnight on 28 September. Feed test samples were collected prior to baling on 24 September and analysed at Agrifood Technology FeedTest laboratory.

At the western end of the paddock, an area of approximately 15 x 9 m area from each sulla run was retained as a standing crop for the purpose of measuring seed production and harvestability. The sulla was not desiccated and was harvested (direct headed) with the farm header on 1 December 2014.

What happened?

Trying to make direct comparisons between the three pastures; vetch, medic and sulla, poses a challenge because sulla is a biennial with a 2-3 year lifespan compared to the annual medic and vetch species. For this reason sulla does not achieve peak biomass production until the second year, once it has established a deep root system. This was reflected in the 2013 dry matter data collected prior to grazing where vetch and medic produced 2.3 t/ha and sulla 1.3 t/ha on 203 mm of rainfall since sowing on 2 May 2013.

Summer rainfall and mild autumn conditions in 2014 resulted in rapid regeneration of pastures early in the season. Table 1 outlines the changes to soil chemistry in the 0-10 cm topsoil from pre-trial 2013 to after one year of pasture options. Most notable were decreases in sulphur despite the application of 12 kg/ha S in the form of sulphate of ammonia on 1 July 2013. Other soil properties changed little.

Table 1 Soil chemistry of 0-10 cm layer of demonstration paddock prior to sowing and post one year break

	2013	April 2014					
	Pre-trial	Grazed in 2013			Un-grazed in 2013		
		Medic	Sulla	Vetch	Medic	Sulla	Vetch
pH ($CaCl_2$)	7.8	7.8	7.6	7.7	8.0	8.0	7.9
Colwell P (mg/kg)	45	47	49	44	42	45	46
Colwell K (mg/kg)	1040	877	910	917	973	867	927
Sulphur KCl_{40} (mg/kg)	5.0	2.6	3.7	2.7	4.5	3.8	2.8
Organic Carbon (%)	1.19	1.16	1.25	1.24	1.43	1.23	1.31

Table 2 Comparison of treatments for Rhizoctonia root disease, soil water and mineral nitrogen to depth in soil

	April 2014					
	Grazed in 2013			Un-grazed in 2013		
	Medic	Sulla	Vetch	Medic	Sulla	Vetch
Rhizoctonia solani AG8 0-10 cm (pgDNA/g)	8	142	<2	5	262	<2
Soil water 0-90 cm (mm)	147	135	158	154	136	168
Mineral Nitrogen 0-90 cm (kg/ha)	146	174	229	296	174	211

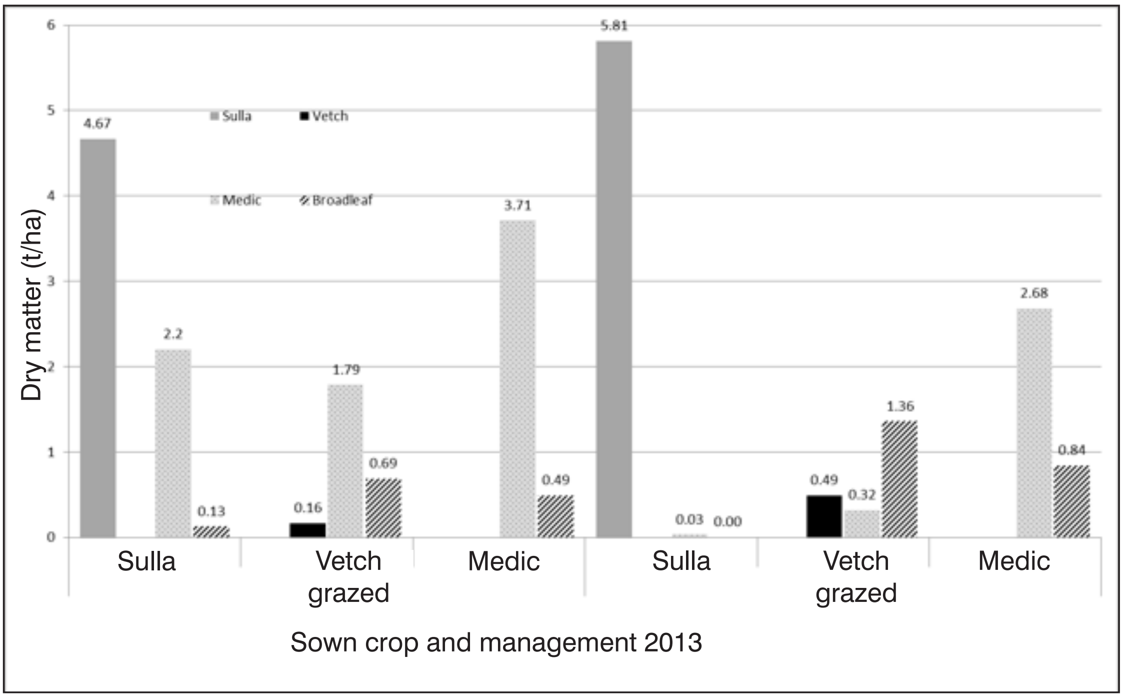

Figure 1 Dry matter production from cuts on the 27 August, 2014. The vetch area was reduced in plant numbers in 2013 by herbicide damage

Table 3 Feed test analysis from samples collected 24 September 2014. Percent composition of samples based on spring biomass cuts collected 27 August

	Grazed (2013)			**Un-grazed (2013)**		
	Sulla 15% medic	**Vetch** 68% medic, 27% b weeds	**Medic** 12% b weeds	**Sulla**	**Vetch** 13% medic, 64% b weeds	**Medic** 22% b. weeds, 7% grass
Crude Protein (% of DM)	14.4	18.5	18.6	15.2	17.6	18.4
Neutral Detergent Fibre (% of DM)	44.4	43.8	42.7	44.1	42.1	43.4
Digestibility DMD (% of DM)	66.6	64.2	64.4	67.6	66.8	63.6
Est. Metabolisable energy (MJ/kg DM)	9.8	9.4	9.5	10.0	9.9	9.3
AFIA grade*	A2	B2	B2	A2	A2	B2

**The Australian Fodder Industry Association (AFIA) has a developed set a national hay grades for domestic and export trade. The grades range from D4 to A1 with A1 being premium quality. The grade is calculated from the crude protein, digestibility and metabolisable energy, as analysed from common quality testing methods. B weeds = broad-leaved weeds.*

Table 2 shows that the incidence of *Rhizoctonia solani* AG8 in the sulla treatments has increased from initial levels of 8.5 pg DNA/g. It has been documented in other research that sulla is susceptible to the AG-2-2 strain of *Rhizoctonia solani* but not affected by the AG8 strain. A separate analysis from the root system of a sulla plant collected 25 July 2014 confirmed that the roots were infected with the AG8 strain. However, no visible Rhizoctonia patches have been observed in the sulla areas.

Prior to the trial being sown in 2013 soil analysis revealed 90 kg/ha of mineral N in the top 90 cm following a volunteer pasture/ chemical fallow in 2012. After one year of either a medic, sulla or vetch pasture, nitrogen levels have increased further. Medic left un-grazed resulted in an extra 206 kg N/ha. Sulla showed no difference in mineral N between grazing or not grazing with an additional 84 kg/ha. Vetch more than doubled mineral N in one year with little difference in grazed versus un-grazed.

Feed test analysis has shown that the crude protein of Sulla was less than that of medic. The neutral detergent fibre, which is a measure of total cell wall content, was similar across the treatments with little variation between grazed and un-grazed, Sulla was slightly higher with figures above 44% of DM compared to 42-43.8% for other treatments. High quality feeds have a digestibility of > 65% of DM in conjunction with protein and fibre content (FeedTest interpretation sheet). The sulla is highly digestible with figures ranging from 66.7-67.6% of DM. In terms of energy, 8 MJ/kg of DM is required for maintenance of adult sheep and 11 MJ/kg for growing lambs or lactating ewes, therefore all treatments met the livestock requirements.

Soil water measurements collected after hay baling on 30 September showed similar levels with between 138 and 140 mm of water remaining in the 0-90 cm profile for the different crops.

The sulla area of approximately 0.06 ha was left to desiccate naturally and was harvested by direct heading using the farm header on the 1 December. There was a significant amount of seed loss due to shattering before harvest. The sulla was successfully harvested using canola settings for threshing and airflow but with wheat screens. The total sulla area produced 48 kg of clean seed which is a yield of 0.79 t/ha, despite pod shattering. The harvested seed was cleaned using a medic harvester and this process also de-hulled the seed, providing a sample which could be used for sowing in the future.

What does this mean?

Implications for commercial practice

The preliminary results suggest that sulla might be a viable break alternative in the low rainfall region of upper Eyre Peninsula. Sulla established well in 2013 in a higher than average rainfall season and the early rainfall events in 2014 resulted in greater dry matter production than self-regenerating vetch and medic stands by September. Sulla is a biennial with a 2-3 year lifespan compared to the annual medic and vetch species so it should have achieved peak biomass production in 2014, once it had established a deep root system. This is reflected in the dry matter data in 2013 where vetch and medic produced 2.3 t/ha and sulla 1.3 t/ha (297 mm Jan-2 Oct), compared to 2014 when sulla averaged 5.2 t/ha dry matter (24 Sept) compared to medic 2.4 t/ha and vetch 1.0 t/ha (390 mm Jan-24 Sept). The success of establishing plants during a below average rainfall year is yet to be determined.

Inoculation of sulla seed at sowing with the specific rhizobia is imperative for effective nodulation. After one year of either medic, sulla or vetch, nitrogen levels had increased, but vetch more than doubled mineral N in one year. Predicta B testing showed an increase in Rhizoctonia inoculum levels with sulla in rotation and further testing confirmed the AG8 strain responsible for Rhizoctonia damage in cereal crops.

Control of broad-leaved weeds is essential both for successful establishment, and to increase biomass production within the 2-3 year break phase. Although some trial work has been done on what chemicals can be sprayed on sulla, there are currently no registered chemicals. In this demonstration flumetsulam was applied to address marshmallow, which resulted in some yellowing of the leaves, but no long term damage. This was followed up with an application of metribuzin with no visible crop damage. Managing pests and diseases is also essential to produce higher biomass, with aphids, powdery mildew and rust all being issues during the season.

In good seasons it is likely that there would be an opportunity for either grazing or hay cut in the first year. However grazing the first year has shown to decrease dry matter, limit the seed set and subsequent self-sown plants in the second year and increase weeds through less competition. The sulla produced feed value similar to the vetch and medic and the hay produced (dominantly sulla) was increasingly accepted by the sheep. Similar to any new or foreign feed source, sheep need to be introduced to sulla slowly to familiarise them with the plant or hay and to also avoid any health issues. Sulla not only is highly palatable with excellent forage and fodder quality, it is also non-bloating and has anthelmintic qualities which may reduce worm burdens.

The cost of purchasing seed at $19.40/kg is a result of a complex de-hulling process requiring specialized machinery to be engineered. At the current price it has been cost prohibitive to most farmers in the region given unpredictable rainfall. It is anticipated that with the streamlining of the de-hulling process the cost will fall within the next few years. A section of the sulla was successfully harvested, yielding 0.8 t/ha with a commercial header, although seed loss was high due to pod shatter. The seed was successfully cleaned using a commercial medic harvester. In 2015 this paddock will return to cereal.

Acknowledgements

Thank you to PGG Wrightson Seeds for providing the sulla seed. We would like to thank Carolyn Dekoning for her expertise and support. Thank you to Bruce Heddle for continued advice and support as well as mower conditioning and Gareth Scholz for baling the hay. Thank you to Ian Richter for technical support. The project was funded by the GRDC "Profitable crop sequences in low rainfall area of south eastern Australia" DAS00119.

Links and references

Sulla Management Package – A handbook produced by SARDI detailing how to establish and manage sulla

http://www.sardi.sa.gov.au/__data/assets/pdf_file/0019/136441/sardi_sulla_booklet_v5.pdf

Eyre Peninsula Farming Systems Summary 2013 p 70.

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The impact of livestock on paddock health

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 3.96 t/ha (W)
Actual: 3.40 t/ha (W)
Paddock History
2013: Wheat
2012: Medic pasture
2011: Wheat
2010: Medic pasture
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Plot Size
3.5 ha
Soil Test
Organic C%: 1.0
Phosphorus: 11-41 mg/kg
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 1 t/ha pasture residue
Perennial or annual plants: Annual
Grazing pressure: High (1.5 DSE/winter grazed ha) and medium (0.75 DSE/winter grazed ha)
Water Use
Runoff potential: Low
Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, N_2O_2, methane): Cropping and livestock

Key messages

- **There has been no evidence of any soil health or production losses with grazing after seven years, irrespective of whether crop or pasture inputs were increased or kept at district practice levels.**
- **In 2014 higher input systems showed how increased inputs and costs throughout the season can result in increased productivity and subsequent profitability.**

Why do the trial?

The majority of farms in low rainfall areas use sheep to provide enterprise diversity, however grazing also offers a range of other system benefits that are generally not accounted for in mixed farming enterprises. Studies have shown that grazing offers a useful tool for managing weeds and pests, improving crop nutrition and yields and providing an option to mitigate risk in pasture crop rotations. In these systems there is a perception of declining performance of the pasture ley, as a result of increasing cropping intensity. As a result, there has been work to show the benefits of increasing crop and pasture inputs, as opposed to district practice crop seeding and fertiliser rates and pasture regeneration from residual seed banks.

A long-term study was established at the Minnipa Agricultural Centre from 2008 to 2014 (EPFS Summaries 2008 to 2013) to assess the impact of grazing on crop and pasture production and soil health and also to evaluate this from a systems perspective. The seven year demonstration with a wheat, wheat, pasture (volunteer and sown annual medic), wheat, pasture (self-regenerating annual medic), wheat and wheat rotation was also established to determine whether productivity could be improved under a higher input system compared to a lower input and more traditional system and what affect this had on soil fertility.

How was it done?

In 2008, a 14 ha red sandy loam (pH_{CaCl} 8) portion of a paddock on Minnipa Agricultural Centre was divided into four 3.5 ha sections. Each section represented a system treatment: low input district practice - grazed, low input district practice – un-grazed, high input – grazed and high input – un-grazed. The pasture and grazing treatments were not imposed until 2010.

In 2014 the trial was sown to Mace wheat on 10 May at 50 kg/ha with 7 kg N/ha and 8 kg P/ha (45 kg/ha DAP) and 70 kg/ha with 13 kg N/ha and 15 kg P/ha (75 kg/ha DAP) for the low and high input treatments respectively. Weed control was imposed on all treatments as required in both summer and during the growing season.

Sampling for pre-sowing soil water content and chemical analysis was completed on 14 April and plant establishment counts were recorded on 3 July. Harvest biomass cuts, yield measurements and grain samples were taken on 31 October followed by post-harvest soil water contents on 5 December to estimate comparative water use efficiency.

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?

Prior to sowing each year, soil phosphorous, nitrogen and organic carbon content have been measured. In 2008, the paddock had an average Colwell P of 28 mg/kg in 0-10 cm, total mineral N of 104 kg/ha to 60 cm deep and average soil organic carbon of 1.2% (0-10 cm). Table 1 presents results for the last three years. Colwell P levels were generally higher in the low input system in both the grazed and un-grazed treatments and there has been a declining P trend in the high input system since 2008. Residual total mineral N figures trended higher in 2013 following the medic rotation and results in 2014 suggest a decline in levels after one year of wheat. Grazed treatments over the past three years have had higher mineral N figures than the un-grazed areas in both high and low input systems, which have also had lower N levels each year since initial recordings in 2008. Soil organic carbon levels are suggesting some decline in the 2014 low input figures, but not between grazing options, and have trended down steadily since the initial year of the study.

Figure 1 presents the 2014 grain yield and estimated water use efficiency figures for the demonstration. Yield results show differences of 0.7 t/ha more for the high input treatment between both the grazed and un-grazed areas. Water use efficiency was significantly higher in the high input treatments, which also produced more plants per m^2 at establishment and protein (av. 9%), screenings (av. 2%), grain test weight, moisture and plant dry matter at harvest results had no significant differences between treatments (data not presented).

Farming Systems

Table 1 Colwell P (mg/kg 0-10 cm), total mineral nitrogen (kg N/ha 0-60 cm) and soil organic carbon (%, 0-10 cm) in April 2012, 2013 and 2014 following wheat, annual medic and wheat respectively

System	Colwell P (mg/kg)			Total mineral nitrogen (kg/ha)			Soil organic carbon (%)		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
Low input - grazed	34	34	36	64	111	78	1.3	1.3	1.0
Low input - un-grazed	30	27	24	59	84	39	1.0	1.2	0.9
High input - grazed	23	18	16	72	118	85	1.2	1.2	1.1
High input - un-grazed	30	22	18	60	74	54	1.2	1.1	1.1

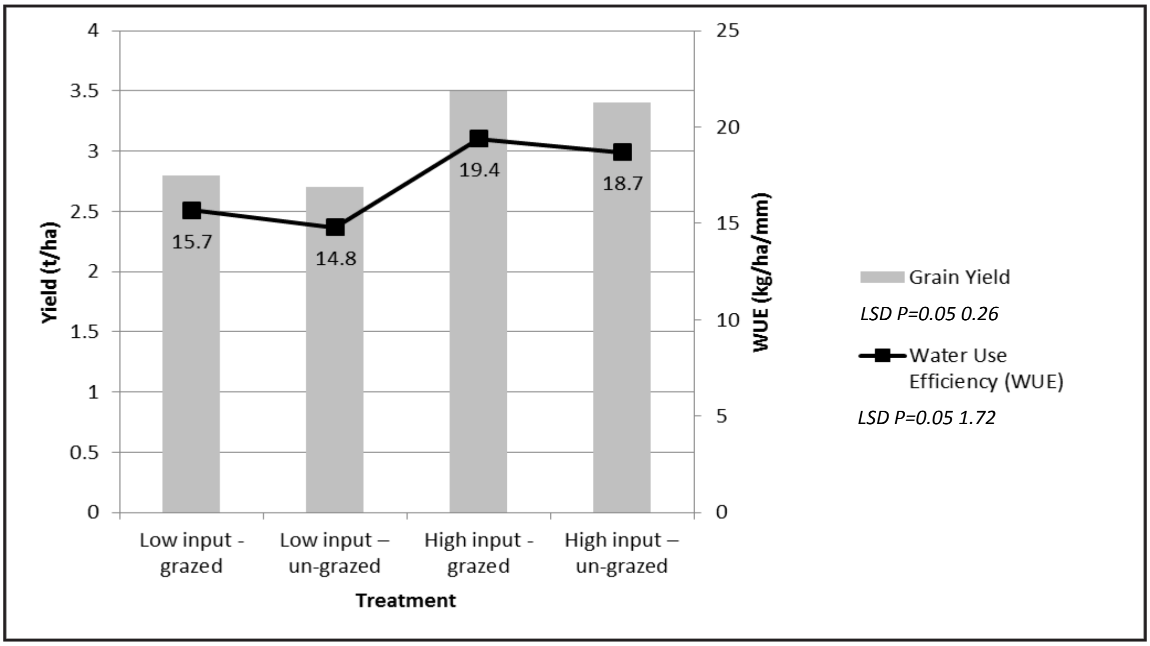

Figure 1 Grain yield (t/ha) and water use efficiency (WUE, kg/ha/mm of plant available water) for 2014 wheat

What does this mean?

Similar to previous years, in 2014 the high input treatment has performed better compared to the district practice low input system in grain yield and water use efficiency. Residual total mineral N figures trended higher in 2013 following the medic rotation and results in 2014 suggest a decline in levels as a consequence of the 2013 wheat. Results from the grazed treatments have shown consistently higher total mineral N than the un-grazed areas in 2012, 2013 and 2014. Concerns that grazing can damage soil structure by reducing soil organic matter from the rotational system and induce increased weed germination have not been observed in this demonstration thus far, in fact the impact of grazing has generally been positive, with measured higher N mineral supply in the last three years of the trial in the grazed versus un-grazed treatments. This could be attributed to an increased rate of nutrient cycling due to the grazing animal.

Increased water use efficiency was measured in the grazed areas, which may be the result of weed control through grazing over summer. Other observed benefits throughout the trial in the grazed treatments include less summer weeds (less spraying required), reduced snail numbers and the added benefit of value-adding to stubbles by grazing. Grazing at the rates imposed has not detrimentally reduced the groundcover due to flattening of the stubble, with a 5% and 1% reduction in groundcover for the low input grazed and high input grazed treatments respectively, and therefore has not increased erosion potential. In a low rainfall mixed farming system sheep can also help growers better manage the economic impacts of seasonal variability; stock are important for resilience and should be considered from a systems perspective as opposed to comparing to a cropping system alone.

The 2014 higher input systems portrayed how increased inputs and costs throughout the season can result in increased productivity and subsequent profitability as a result of higher residual N, higher yields and better water use efficiency. Colwell P levels were lower when compared to the district practice system; however this is likely due to greater use of P by the pastures and crops in the higher input treatments.

Soil organic carbon levels remain largely unchanged in 2012 and 2013 from the initial 2008 measurements; however 2014 results show that in the low input treatments soil organic carbon declined. Soil organic carbon changes are slow. Whether the 2014 figures are a long term trend which could be attributed to less production, thus less biomass decomposed and subsequent cycling in the soil or a short term anomaly will be determined in subsequent years. As livestock graze, they remove the biomass that normally decomposes into the soil and contributes to the carbon pool; however in this trial there have been no measured differences in soil organic carbon between the grazed and un-grazed areas.

Acknowledgements

We gratefully acknowledge the help of Mark Klante and Brett McEvoy for site management and Ian Richter and Wade Shepperd for data collection.

Crop establishment on non-wetting soil

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

RESEARCH

Searching for answers

Location:
Murlong
Stuart Hentschke
Rainfall
Av. Annual: 336 mm
Av. GSR: 250 mm
2014 Total: 352 mm
2014 GSR: 256 mm
Yield
Potential: 3.6 t/ha (B)
Actual: 0.86 t/ha
Paddock History
2014: CL Scope barley
2013: CL Kord wheat
2012: Medic pasture
Soil Type
Non-wetting sandy loam
Plot Size
12 m x 2 m x 3 reps

Key messages

- **Deeper sowing at 3-4 cm achieved better early dry matter and increased grain yield in a later sowing.**
- **Frost damage may have lowered yield with early sowing, but inter-row placement at TOS1 had the highest yield.**
- **TOS 3 placement in row achieved better early plant growth and higher grain yield.**
- **Later sowing reduced brome grass numbers, and the size of the panicles, so it substantially lowered returns to the seed bank.**

Why do the trial?

The project 'Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula' aims to produce sustainable management guidelines to control pests, weeds and diseases while retaining stubble to maintain or improve soil health, and reduce exposure to wind erosion. The major outcome to be achieved is increased knowledge and skills allowing farmers and advisers to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP).

One issue EP farmers identified as a problem with stubble retained systems was sowing into non-wetting sands and the resulting uneven germination. The trial at Murlong (near Lock) was established in 2013 to compare how crop establishment is affected by time of sowing, sowing rate, and seed position and depth on a non-wetting sand.

How was it done?

The trial site was selected at Murlong in 2013 and wheat plots were established with Kord CL wheat @ 60 kg/ha and base fertiliser of 18:20:0:0 @ 60 kg/ha. The site was sprayed with 700 ml/ha of Intervix on 18 June to control small brome grass and capeweed. Urea @ 50 kg/ha was applied on 7 August. The trial was harvested on 13 November with an average yield of 1.78 t/ha and grain quality of 77.8 kg/hL (test weight), protein 11.2 % and screenings 2.3 %.

In 2014 the trial was sown with Scope CL barley at 65 kg/ha and 18:20:0:0 @ 65 kg/ha with three different times of sowing (early, mid and late) on 15 April (TOS 1), 13 May (TOS 2) and 10 June (TOS 3). At each time of sowing there were two sowing rates of 40 kg/ha and 60 kg/ha, two different seed placements; in row and inter row, and two sowing depths of 0-1 cm and 3-4 cm. The treatments were replicated 3 times. Pre-sowing chemical applications were Roundup Powermax @ 1.5 L/ha, Avadex @ 1.5 L/ha and trifluralin @ 1.5 L/ha.

Broad-leaved control was applied using Amicide Advance@ 1.2 L/ha and Lontrel @ 100 ml/ha on 17 June (TOS 1), 14 July (TOS 2) and 25 August (TOS 3), respectively. On 25 August 500 ml/ha of propiconazole was applied over the whole trial for spot form of net blotch.

Stubble load, soil moisture at sowing, plant emergence counts, grain yield, grain quality and harvest soil moistures were measured. The first and second times of sowing were harvested on 10 November and TOS 3 on the 24 November.

Data were analysed using Analysis of Variance in GENSTAT version 16, with covariates used to account for plot position in the TOS blocks, which were analysed independently. Least significant differences were based on P=0.05.

What happened?

The early time of sowing occurred after 13 mm of rain on 15 April. The second time of sowing occurred after 38 mm rain (13 May). In both TOS 1 and TOS 2 the deeper sowing (3-4 cm) resulted in visually better plant growth after 4 weeks than the shallow sowing depth (0-1 cm). The 3-4 cm sown plots had 1- 2 leaves more than the shallow sown plots at that time. The third time of sowing established slowly and looked poor compared to TOS 1 and TOS 2 all season.

The earliest sowing TOS 1 had similar grain yield but higher screenings than TOS 2 (Table 1). This may have been as a result of frost damage at critical growth stages. Frost events in this region (seven events) were recorded between 9 and 20 August and on 16 and 18 September. Other growers had significant frost damage to wheat sown in the last week of April and minor damage to wheat sown in the first week of May.

Table 1 Grain yield and quality as affected by seed placement, depth and sowing rate at Murlong in 2014

		Yield (t/ha)	Plants/m²	Protein (%)	Test weight (kg/hL)	1000 Grain weight (g)	Screenings (%)
TOS 1							
Placement	In-row	0.87	145	9.9	69.4	36.6	11.4
	Inter-row	0.91	134	9.7	69.7	36.7	11.1
Depth	0-1 cm	0.90	159	9.8	69.4	36.1	12.3
	3-4 cm	0.89	120	9.8	69.7	37.2	10.2
LSD (P=0.05)		*ns*	*21*	*ns*	*ns*	*ns*	*2*
Sowing rate	40 kg/ha	0.92	124	9.8	69.3	36.6	11.9
	60 kg/ha	0.86	155	9.8	68.8	36.7	10.6
LSD (P=0.05)		*ns*	*21*	*ns*	*ns*	*ns*	*ns*
TOS 2							
Placement	In-row	1.11	133	10.2	69.7	38.2	8.2
	Inter-row	1.18	129	10.5	69.9	38.2	8.7
Depth	0-1 cm	0.97	128	10.5	69.5	37.2	10.1
	3-4 cm	1.32	134	10.1	70.2	39.2	6.8
LSD (P=0.05)		*0.13*	*ns*	*0.3*	*0.4*	*0.8*	*1.4*
Sowing rate	40 kg/ha	1.12	117	10.5	69.7	37.9	8.7
	60 kg/ha	1.18	145	10.2	69.9	38.6	8.2
LSD (P=0.05)		*ns*	*17*	*ns*	*ns*	*ns*	*ns*
TOS 3							
Placement	In-row	0.57	165	11.0	67.6	34.5	13.8
	Inter-row	0.44	156	11.1	66.7	33.9	15.3
LSD (P=0.05)		*0.04*	*ns*	*ns*	*0.8*	*ns*	*ns*
Depth	0-1 cm	0.48	165	11.1	67.2	34.1	15.0
	3-4 cm	0.53	156	10.9	67.2	34.3	14.1
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
Sowing rate	40 kg/ha	0.51	162	11.1	66.9	34.1	14.8
	60 kg/ha	0.50	159	11.0	67.5	34.3	14.3
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Table 2 Significant interaction of treatment effects in TOS 2

TOS 2 – Interaction effects			
Yield (t/ha)	**(cm)**	**In-row**	**Inter-row**
Depth x Placement	0-1	1.01	0.93
	3-4	1.21	1.43
LSD (P=0.05)		*0.17*	
Protein (%)		**In-row**	**Inter-row**
Depth x Placement	0-1	10.2	10.9
	3-4	10.2	10.1
LSD (P=0.05)		*0.36*	
1000 Grain weight (g)		**In-row**	**Inter-row**
Depth x Placement	0-1	37.7	36.7
	3-4	38.8	39.7
LSD (P=0.05)		*1.1*	
1000 Grain weight (g)		**40 kg/ha**	**60 kg/ha**
Depth x Sowing Rate	0-1	36.6	37.9
	3-4	39.2	39.3
LSD (P=0.05)		*1.1*	

Early dry matter was higher in TOS 2 with greater depth of sowing; 395 g/m^2 at 3-4 cm depth compared to 322 g/m^2 at 0-1 cm. In TOS 3 early dry matter was higher in-row (254 g/m^2) than inter-row (193 g/m^2).

Sowing rate increased the number of plants established in TOS 1 and TOS 2 only. In TOS 1 the 0-1 cm depth also had greater screenings at the end of the season.

The highest yield in TOS 2 was achieved inter-row at the 3-4cm depth. Deeper sowing resulted in greater 1000 grain weight. TOS 3 had the lowest yield and the highest screenings but also the highest protein.

Brome grass numbers were similar regardless of sowing depth, placement or sowing rate. However there were differences depending on the time of sowing with the TOS 1 having an average 14.2 plants/m^2 in crop, TOS 2 having 8.8 plants/m^2 and TOS 3 having 4.5 plants/m^2, indicating greater weed control was achieved with later sowing.

What does this mean?

Deeper sowing at 3-4 cm resulted in less or similar plant establishment but achieved better early dry matter production in TOS 2 and increased grain yield.

- Inter-row placement had the highest yield in TOS 1, but the lower yield than TOS 2 indicates frost damage may have been a factor.
- TOS 3 in-row seed placement achieved better early plant growth and was higher yielding than TOS 3 inter row, but was still much lower than the earlier times of sowing.
- The later time of sowing lowered brome grass weed numbers with smaller seed panicles and hence should have reduced the weed seed bank.

Acknowledgements

Thanks to Roy Latta for establishing this trial in 2013. Thank you to the Hentschke family for having this trial on their property.

Sowing into retained pasture residue at Mount Cooper

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

RESEARCH

Searching for answers

Location:
Mt Cooper
Ian, Robyn and Angus Gunn
Rainfall
Av. Annual: 435 mm
Av. GSR: 325 mm
2014 Total: 470 mm
2014 GSR: 305 mm
Yield
Potential: 4.2 t/ha (W)
Actual: 3.6 t/ha
Paddock History
2014: Wheat
2013: Medic pasture
2012: Barley
Soil Type
Red loam
Plot Size
20 m x 4 m x 3 reps

Key messages

- **The 1.6 t/ha pasture residue had no impact on sowing and plant establishment in drier sowing conditions in 2014.**
- **In 2014 there were no differences in wheat establishment, yield or grain quality due to different pre-sowing treatments with pasture residues.**
- **The wheat stubbles have been harvested at different heights and pasture establishment and will be monitored next season.**

Why do the trial?

The project 'Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula' aims to produce sustainable management guidelines to control pests, weeds and diseases while retaining stubble to maintain or improve soil health, and reduce exposure to wind erosion. The major outcome to be achieved is increased knowledge and skills allowing farmers and advisers to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP).

One issue upper EP farmers identified as a problem was sowing into retained pasture residue with pasture vines causing issues with blockages at sowing and uneven germination. The trial at Mount Cooper was designed to compare crop establishment and production, and weed and pest control effectiveness in the presence and absence of legume pasture residues.

How was it done?

A trial site was selected at Mount Cooper and the pasture residue was measured with an average of 1.59 t/ha of vine and leaf material, which was a lighter pasture for this region given the 2013 season. In early April 2014 pasture residue treatments were imposed: (i) Harrowed, (ii) Mowing to the ground (residue removal), (iii) Cultivate with offset disc and (iv) Nil control.

The trial was sown using a plot seeder with Harrington points and press wheels at 3-4 cm sowing depth. It was sown in drier conditions on 21 May with Mace wheat @ 65 kg/ha and base fertiliser of DAP @ 75 kg/ha sown into the stubble treatments. The treatments were replicated 3 times. Pre-sowing chemical applications were Roundup Powermax @ 1.0 L/ha, trifluralin @ 1 L/ha and 80 ml/ha Hammer. Broad-leaved spray was applied on 29 July using Amicide @ 800 ml/ha and Lontrel @ 100 ml/ha.

The measurements taken were pasture residue and soil moisture at sowing, plant emergence counts, grain yield, grain quality and harvest soil moistures. Data were analysed using Analysis of Variance in GENSTAT version 16.

At the end of the season the stubbles were harvested at different heights, high and low, and the low treatments will be rolled in 2015 to determine the impact of stubble management on medic germination and establishment in the following season.

What happened?

The 2014 sowing conditions in mid-May resulted in dry topsoil and dry pasture vine residues with the soil being cloddy after sowing. The dry pasture residue allowed it to flow through seeder easier than if the residue was wet. In several Nil plots the pasture residue bundled up in some areas however severe blockages and dragging did not occur. There were small medic pasture plants present at sowing which were sprayed out.

There were no differences in wheat plant establishment after sowing into the different pasture residue treatments and no differences in grain yield or grain quality measurements, except 1000 grain weight with the cultivated residue treatment being lower than other treatments in the 2014 season (Table 1).

Table 1 Grain yield and quality as affected by stubble treatments and additional nutrients at Mount Cooper, 2014

Pasture residue treatment	Plant counts (plants/m²)	Harvest index	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	1000 Grain weight (g)	Screenings (%)
Residue harrowed	101	0.43	3.63	10.0	84.7	37.5	2.6
Residue mown	102	0.44	3.56	9.9	84.7	37.4	2.5
Residue cultivated	108	0.43	3.60	10.1	84.3	36.2	3.2
Nil control	108	0.43	3.54	9.9	84.5	37.1	3.0
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*0.8*	*ns*

What does this mean?

In 2014 the 1.6 t/ha medic pasture residue did not cause problems at sowing in drier sowing conditions and there were no differences in wheat establishment, yield or grain quality due to different pasture residue treatments imposed before seeding. However with heavier pasture residue, a different sowing system or different sowing conditions, the plant establishment and yield outcomes may have changed. There were no major weed or pest issues at this site in the 2014 season.

In 2014 the plots were harvested at different heights, high and low, and the stubble in the low plots will be rolled in Jan/Feb 2015 to determine if there are any differences in medic establishment depending on the stubble treatments.

Acknowledgements

Thank you to the Gunn family for having the trial on their property. Thanks to Roy Latta for establishing this trial in 2013.

Farming Systems

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Barley grass in a retained stubble system - farm demonstrations

RESEARCH

Amanda Cook[1], Mark Klante[1], Andy Bates[2], Bruce Heddle[3], Wade Shepperd[1], Ian Richter[1], Brett McEvoy[1] and John Kelsh[1]

[1]SARDI, Minnipa Agricultural Centre, [2]Bates Agricultural Consulting, [3]Minnipa farmer

Searching for answers

Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 4.0 t/ha (W)
Actual: 2.5 t/ha
Soil Type
Red loam

Key messages

- **There were no differences in grass weed numbers in paddock N7/8 between cereal crop treatments imposed of Sakura, East West and North South sowing, cross sowing and '15 cm nudge'.**
- **Propyzamide was used as an alternative chemical option for grass control in pasture.**
- **Weed management of barley grass using narrow windrows implemented at harvest will be assessed in cereal paddocks in 2015.**

Why do the trial?

The GRDC Stubble project aims to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP). Weed control in stubble retained systems is an issue with reduced herbicide efficacy due to higher stubble loads especially for pre-emergence herbicides. Current farming practices have also changed weed behaviour with later germinating barley grass genotypes now being present in many paddocks on Minnipa Agricultural Centre (MAC) (B Fleet, EPFS Summary 2011, p 177). As a part of the stubble project several MAC farm demonstrations were undertaken in 2014 to address barley grass weed issues including later germinating types and barley grass resistance to Group A herbicides within the farming system.

An integrated approach to weed management aimed at lowering the weed seed bank can make use of diverse techniques such as cultivation, stubble burning, in-crop competition using higher sowing rates and possibly row orientation. The seed bank of crop weeds can be reduced within the break phase by hay making, or green or brown manuring. Other techniques used effectively in WA with ryegrass and wild radish have been narrow windrows and chaff carts, however little research has been done on the effectiveness of these approaches with barley grass because of its early shedding of seeds before harvest.

How was it done and what happened?

Four different broad acre management strategies for barley grass and other grass weeds were undertaken in 2014 in paddock N7/8 on MAC.

The paddock was sown on 16 May with Wyalkatchem wheat @ 60 kg/ha and 18:20:0:0 @ 60 kg/ha. The whole paddock was sprayed on 3 March with Roundup Attack @ 1 L/ha + Ester 680 @ 300 ml/ha + Striker @ 100 ml/ha. The whole paddock was sprayed again on 4 May with Roundup Powermax @ 1 L/ha + Ester 680 @ 350 ml/ha + Striker @ 100 ml/ha.

Treatment 1 Sakura - sprayed 15 May with Sprayseed 250 @ 1 L/ha + Sakura @ 118 g/ha and incorporated as per label rate. Not prickle chained as per label.

Treatment 2 East West – sown on 30 cm spacing. Sprayed 15 May with Sprayseed 250 @ 1 L/ha + Diuron 900df @0.28 kg/ha + Triflur X @1 L/ha. Prickle chained 21 May.

Treatment 3 Cross sowing - sprayed 15 May with Sprayseed 250 @ 1 L/ha + Diuron 900df @ 0.28 kg/ha + Triflur X @ 1 L/ha Sown East West at 30 cm spacing with 30 kg/ha seed and 30 kg/ha fertilizer rate then sown North South at 30 kg/ha seed and 30 kg/ha fertilizer. Prickle chained 21 May.

Treatment 4 15 cm nudge - sprayed 15 May with Sprayseed 250 @ 1L/ha + Diuron 900df @ 0.28 kg/ha + Triflur X @ 1 L/ha. Sown North South at 30 kg/ha seed and 30 kg/ha fertilizer and then nudged 15 cm on guidance and sown again at 30 kg/ha seed and 30 kg/ha fertilizer. Prickle chained 21 May.

Treatment 5 North South sowing - sprayed 15 May with Sprayseed 250 @ 1 L/ha + Diuron 900df @ 0.28 kg/ha + Triflur X @ 1 L/ha. Sown North South on 30 cm spacing. Prickle chained 21 May.

Issues encountered with the implementation of these treatments: 15 cm nudge treatment resulted in the machine tending to crab back into the row of the first pass because of hardness of inter row, and implementing treatments 3 and 4, the cross sowing and 15 cm nudge, were time consuming during seeding.

Table 1 Weed counts (plants per m²) in weed management options, 2014

Treatment	Barley grass large	Barley grass small	Rye grass	Wild oats	Wild turnip
Sakura	0.4	0.2	0	0	0
East West	1.0	0.3	0	0	2.2
Cross sown	1.0	0.6	0	0.4	0.4
15 cm nudge	3.6	1.1	0	0.3	3.2
North South	0.5	0.6	0	0	0.22

Grass weeds were assessed within the treatment areas in N7/8 before harvest in a transect across the paddock and counting weed numbers within a 1 m^2 area, with 10 counts per treatment. The 15 cm nudge area was smaller so the distance between counts was approximately 10 m rather than 20 m in the other treatment areas. There were very low weed numbers (Table 1) so the process was repeated across a different transect but with similar results.

N7/8 had lower grass weed numbers than expected in crop this season. This may have been due to the paddock being in pasture phase in 2013 which was spray topped, followed by later sowing in the 2014 program and the use of Diuron 900df with the other treatments imposed at sowing.

S4 Whole of paddock - Propyzamide in Pasture

When spray topping grass weeds in pastures Targa is the commonly used chemical, but other chemical options may be needed to rotate chemical groups to avoid the development of herbicide resistance, so Propyzamide was tried as an alternative. The whole paddock was sprayed on 28 March with Roundup Attack 1 L/ha + Ester 680 @ 300 ml/ha + Striker @ 100 ml/ha for summer weed control, and was then sprayed on 14 July with Broadstrike @ 25g/ha + wetter.

The following treatments were applied on 18 July, a bit later than ideal due to delayed chemical delivery.

Treatment 1 Propyzamide @ 600 g/ha

Treatment 2 Clethodim @ 375 ml/ha + Hasten @ 500 ml/100L water

Treatment 3 Unsprayed (3 m x 3 m area)

Both treatments 1 and 2 had reasonable control of barley grass except some small patches of barley grass which were not controlled. Samples from these uncontrolled barley grass areas have been collected and will be assessed for herbicide resistance. Weed numbers in the unsprayed section averaged 1872 barley grass plants/m^2 and 306 ryegrass plants/m^2.

S7 – Stubble harvest height with grazing and non-grazing systems

S7 background data – In 2008 S7 was divided into 4 treatment areas with sections A & B being low input areas and C & D higher input areas. In 2014 the paddock was sown on 10 May with A & B receiving 50 kg/ha Mace wheat and 40 kg/ha 18:20:0:0 and higher inputs in C & D with 70 kg/ha of Mace wheat and 60 kg/ha 18:20:0:0. Chemical applications applied in this paddock were a summer knockdown on 14 March with Round up Attack @ 1 L/ha + Ester 680 @ 300 ml/ha + Striker @ 100 ml/ha. On 5 May a knockdown of Roundup Powermax Rup @ 1 L/ha + Ester 680 @ 350 ml/ha + Striker @ 100 ml/ha, and on 10 May at seeding Triflur X @ 1 L/ha. On 5 July the paddock was sprayed with Ester 680 @ 600 ml/ha + Zinc sulphate @ 1.5 kg/ha and on 16 August tebuconazole @ 0.29 L/ha.

In 2014 the paddock S7 was harvested at two different stubble heights, high and low in all 4 treatments to monitor in 2015 for any issues with sowing and plant establishment after grazing. This paddock will be monitored in the future to see if there are differences in barley grass and other grass weed seed germination (burial of seed bank), as well as summer weed populations and snails.

MAC Cereal Paddocks – Narrow wind rows - N1 and Bruce Heddle's

The MAC 2366 header was fitted with a narrow windrow attachment made on farm from dimensions obtained from the GRDC website to divert chaff and straw into a 600 mm windrow. The straw chopper was disengaged. There were no issues with windrow attachment during harvest. The MAC farm paddock N1 was monitored this season for barley and rye grass numbers and in the 2015 season burning temperature, seed capture and seed viability will be monitored in the narrow windrows.

Photo of the unsprayed area of MAC paddock S4 as an indication of the barley grass seed bank

Farming Systems

Bruce Heddle and Stuart and Yvonne Scholz jointly use a range of modifications to their 60 Series John Deere harvesters for weed seed capture and management.

- Windrow boards bolted into the choppers to create 600 mm wide rows of both rotor and chaffer output, or rotor output only as required.
- A Riteway 28 cubic metre cart can be attached either directly behind the harvester or offset to the left side as necessary with the use of different hitches.
- A discharge duct can be fitted to the choppers, delivering the output from both the rotor and chaffer to the cart, with the cart towing directly behind the machine. This option is used in light to average crops only – the cart fills too frequently in heavy crops. It has the advantage of maximising the captured stock feed for use in droughts, as well as collecting all weed and crop seeds that exit the harvester.
- A Riteway single chaff blower is fitted to the 9660 to deliver the output from the chaffer only to the cart, with the cart towed in the offset position. The rotor output is then either put through the chopper and distributed as evenly as possible across the paddock, or if weeds that will pass out through the rotor are present (or windrows need to be created to trap snails for burning), then the chopper is disengaged and the windrow boards attached to create narrow windrows.

The system chosen depends on both what is in the paddock on what needs to happen in the following season. One of the most important considerations is whether barley grass seed is present in meaningful amounts above cutter bar height. If there are, then the rotor discharge must be captured, because barley grass seeds (and maybe a proportion of brome grass seeds if present) will not exit the machine via the chaffer. In 2012 and 2014, barley grass was readily captured, while in 2013 it was easily captured in windrowed canola but not captured at all in wheat.

The paddock being monitored at Bruce Heddle's has a long history of snail problems as well as both ryegrass and barley grass, so this year it was sown on 170 mm row spacings with a 100 mm row spread to maximise crop competitiveness. This appeared to result in barley grass heads near to the top of the canopy and noticeable support to the heads, which hopefully reduced the shedding of individual seeds and enabled a greater proportion of heads to enter the harvester. The paddock was harvested as low as possible with the chaffer output being blown into the cart, the chopper disengaged and the windrow boards fitted to create narrow windrows to be burnt in autumn. The crop yielded about 3.5 t/ha and with almost no inter rows, the challenge will to be to hot burn the straw windrows and chaff piles neatly and effectively without burning the whole paddock.

The MAC N1 paddock (within previous high, medium and low production zones) and the paddock at Bruce Heddle's, which has windrows and chaff dumps, have been assessed for grass weed numbers in crop and in the soil bank. The effectiveness of windrowing, chaff dumping, burning temperatures and conditions will be assessed during the 2015 season.

One of the main barriers to barley grass weed seed collection at harvest is the early maturity of barley grass within crops and the shedding of seed before harvest, which will prevent the seed being placed into crop rows for burning. The late germination of seed and the size of these plants may also be an issue as they may avoid harvesting due to low height. A better understanding of temperatures and conditions needed to sterilize barley grass seed will also be researched in conjunction with the Adelaide University weed team.

What does this mean?

The farm demonstrations established on MAC in the 2014 season will be monitored in the future to assess the impact of different management options on grass weed issues in stubble retained farming systems.

Bruce Heddle's header and chaff cart and paddock rows and chaff dumps

Reflections from 5 years R&D on Eyre Peninsula

RESEARCH

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Key message

As a result of research and development (R&D) projects undertaken from 2009 to 2014, Minnipa Agricultural Centre and Eyre Peninsula agriculture has access to an increased level of information and understanding of a range of industry opportunities and issues relevant to the Eyre Peninsula. There is an improved staff capability to deliver a more diverse range of industry projects and expanded collaborative R&D opportunities with an increased number of researchers and investors.

Background

From 2009 to 2014 at the Minnipa Agricultural Centre, I had the opportunity to work in the development and delivery of a diverse range of research and development projects. While not all these projects had immediate on-farm commercial application I believe they played a number of important roles, including;

- training and development of EP based staff,
- lifting of the Minnipa Agricultural Centre and the Eyre Peninsula profile to a wider group of investors,
- MAC collaboration with and introduction to a broader range of R,D&E groups,
- EPARF commencing project management and delivery in their own right, and
- information to induce industry consideration and potential application as immediate, medium or long term opportunities.

The projects with immediate industry application included;

1. wheat cultivar selection based on break of season and time of sowing,
2. fertiliser application strategies and
3. the early season grazing of cereals.

Opportunities to consider for the medium term were within;

4. variable rate fertiliser application,
5. crop sequencing, and
6. perennial pastures.

Projects that had longer term opportunities and implications were;

7. the sustainability of the mixed farming system due to the impact of livestock on soil health,
8. the use of Sheep Genetics Breeding Values as a benchmarking tool to help improve sheep breeding programs,
9. the nitrous oxide and,
10. methane greenhouse gas emissions projects, along with
11. assessing opportunities to increase soil carbon sequestration.

How was it done?

The specific results from the trials have and/or will be extensively reported in the 2009 to 2014 EP Farming Systems Summaries. Good research requires a hypothesis to consider and this article is a brief overview of the accuracy of the hypotheses that were being tested.

What happened?

1. *wheat cultivar selection based on break of season and time of sowing*

The hypothesis was that as the seasonal break was delayed, resulting in a shorter growing season, an earlier maturing wheat cultivar would produce more grain yield than the later maturing types. The hypothesis was tested over 3 years, 2008 to 2010, by sowing each year at approximate 3 week intervals from the seasonal break.

The hypothesis was supported with sowing in May producing higher yields from the early to mid-season varieties, Mace and Wyalkatchem, than the early season variety Axe. Sowing in June gave varied results depending on season, a dry season benefited the early season variety, a wet season the early to mid-season varieties. When sown in July Axe produced a higher yield than Wyalkatchem.

2. *residual P and replacement P opportunities*

The hypotheses for the 2 studies, 2009 to 2012, were (a) adequate residual soil P levels could support a reduction in the annual fertiliser P application rates with no yield loss and (b) an annual replacement rate of 3 kg of P/ha for each tonne of grain harvested would produce comparable yields to a common blanket rate of fertiliser being applied annually.

In both cases the hypothesis was confirmed. High initial soil residual Colwell P levels remained above a critical level and produced similar grain yields with no P applied to treatments which received up to a total of 80 kg P/ha over the 4 years.

A replacement P strategy over 3 seasons produced a similar total grain yield to a common district practice of 10 kg/ha/annum application on both a deep sandy loam and a shallow clay loam. On the deeper soil type the replacement strategy received a similar 28 kg/ha of P to the 30 kg/ha in the district practice treatment. On the shallower soil the difference was slightly greater 22 versus 30 kg P/ha applied over the 3 seasons, which represents a direct saving in input costs with no loss in production.

3. *the early season grazing of cereals*

The hypothesis was that the defoliation of cereals during the vegetative growth stage would not cause a grain yield loss.

The hypothesis was largely confirmed in that defoliation prior to stem elongation in two seasons of very low growing season rainfall (< 100 mm) caused no or very little loss in grain yields that were generally < 1 t/ha. However, some losses have been recorded in cereal crops with yields better than 1 t/ha. The results suggest there are opportunities to incorporate the grazing of cereals (preferably barley) destined for grain production, to fill a winter feed gap, in the low rainfall zone of southern Australia. The series of experiments found that barley can produce up to twice the dry matter, up to the time of defoliation, than wheat or oats.

4. *variable rate fertiliser applications*

This 4 year study hypothesised that the application rate of fertiliser and seed could be adjusted to reflect specific soil type production capacity and provide either a cost saving and/or a production increase.

The trial estimated a gross margin benefit of $6.50/ha/year from varying fertiliser inputs. This was achieved through reducing the fertiliser inputs by almost 50%, a total 75 kg/ha of di-ammonium phosphate and 20 kg of urea/ha, compared to blanket district practice applications over the 4 years. However, the soils were testing deficient in P on almost 50% of the paddock where fertiliser had not been applied for 4 years, indicating a requirement for at least replacement P at the completion of the 4 year study which would reduce the projected gross margin benefit.

If the increased annual on-farm cropped area was increased by a factor of 10 (600 ha) or more likely a factor of 50 (3000 ha) in this region, the estimated benefits from an approximately $20,000 purchase and use of VRT becomes more feasible and the hypothesis supported. Current seeding machinery normally has variable rate capacity included which also reduces the required investment.

5. *crop sequencing*

One hypothesis associated with this study was that a two year phase of break crop would result in improved and ongoing grass weed control compared to a 1 year break crop. The hypothesis was tested by comparing grass populations following a 3 year break crop/break crop/wheat and a break crop/wheat/wheat rotation. The hypothesis was largely proven with only 2 years of break crops resulting in low numbers of grassy weeds in the seed bank after the year 3 wheat.

6. *perennial pastures*

The hypothesis that there were better adapted alternative perennials to specific soil types on Eyre Peninsula than lucerne was tested. The hypothesis was supported with Cullen and Tedera shown to be more productive and persistent than lucerne on shallow constrained alkaline and acidic soil respectively. However both lucerne and sulla were more productive on the better cropping soils of Eyre Peninsula.

7. *the sustainability of the mixed farming system due to the impact of livestock*

This long term study was commenced in 2008 to assess the ongoing sustainability of the mixed cropping and livestock dryland farming system. Following a sequence of low rainfall seasons with associated concerns relating to soil health from livestock interactions, the hypothesis that sheep will impact negatively on sustainability (soil health and productivity) was tested. Current district practise and a higher input system with and without sheep treatments were evaluated.

The hypothesis was disproved. There was no evidence after 6 years, 2008 to 2014, of soil health or productivity decline as a result of the grazing animal. Soil organic carbon contents were comparable with and without grazing. The high input system treatments produced similar cereal grain yields, when both grazed and ungrazed. The high input system produced higher pasture and cereal yields than the low input system but may have been advantaged with good seasonal conditions from 2009 to 2014.

8. *the use of Sheep Genetics Breeding Values as a benchmarking tool to help improve sheep breeding programs*

The three-year project used the Merino sheep flock at the Minnipa Agricultural Centre to demonstrate the genetic benchmarking process that leads to the creation of MERINOSELECT Breeding Values for measured traits (e.g. growth rates, wool production). by Sheep Genetics. The three pronged approach included the use of the Minnipa demonstration flock to engage with ram buyers and breeders, the validation of the technology to the ram breeders plus increased demand for the Breeding Values from their grower clients as a result of the project activities.

The project at Minnipa promoted ways to overcome barriers to new technology and aimed to show how MERINOSELECT Breeding Values could be used as a benchmarking tool. While there has been some increase in merino ram breeder uptake of the technology and more breeders are of the view that the breeding value technology works, some still believe that they cannot justify the additional cost, work and disruption to their current business when few producers are demanding breeding values on the rams they buy.

9. *nitrous oxide greenhouse gas emissions*

Nitrous oxide makes up 20% of Australian greenhouse gas emissions. The hypothesis was that Eyre Peninsula with low to medium rainfall, low soil organic carbon levels and low to moderate crop nitrogen inputs contributes little to the national tally. However, the canola/wheat rotations increasingly common on lower Eyre Peninsula with associated increased levels of nitrogen inputs were considered as possible exception.

There were no measurable nitrous oxide (N_2O) emissions as a result of top-dressed nitrogen and surface soil saturation during the growing season. A summer rainfall event coupled with warm soil temperatures resulted in a measurable level of N_2O emission for a short period while the soil dried. However compared to the emission levels measured from high rainfall long term pasture soils that have been converted into intensive crop production they were minimal.

10. *methane greenhouse gas emissions project*

Cattle and sheep methane gas emissions account for more than 60% of Australia's agricultural greenhouse gas emissions. The hypothesis is that the introduction and use of alternative pastures that extend improved feed value and digestibility over a longer period of the year will reduce methane emissions. To test the hypothesis, the study set out to investigate whether;

a. methane yield is higher from pastures with poor feeding value,

b. increased pasture quality will shorten time to animal turnoff and reduce total methane emission from each unit.

Issue (a) was largely disproved with the preliminary results indicating that the methane yield is lower from pastures with lower feeding values due to slower utilisation and digestion rates. Issue (b) was supported by establishing that the extended availability of an improved feed source does increase the rate of animal weight gain and can result in an earlier animal turn off, and reduce the total methane emission from each unit. However the opportunity to increase the stocking rates due to an extended supply of improved pasture may limit the methane reduction benefit of an earlier turn off because of a higher number of animal units.

11. *assessing opportunities to increase soil carbon sequestration on alkaline soils*

The study was established to consider the hypothesis that the rate of soil carbon sequestration could be increased in alkaline soils if the soil pH could be reduced. Two soil amelioration activities were undertaken in an attempt to reduce the soil pH and test the hypothesis, topdressing gypsum and optimising total legume plant biomass.

While both amelioration activities are reasonably long term the gypsum topdressing has made a measureable impact on surface pH with a trend towards increased carbon sequestration. The hypothesis is being supported so far.

What does this mean?

The research and development undertaken delivers on a number of issues. It confirms under local conditions the previous studies showing the benefit of matching crop maturity type to sowing date. Also the opportunity to graze cereals during their vegetative phase with little or minimal loss in the grain yield has been well documented in other regions.

Utilising residual P and restricting P inputs to levels which have been estimated to have been removed by previous crops and the use of variable rate fertilisations applications have both been shown to be feasible opportunities to reduce input costs without production losses. Industry uptake has not been universal by any means and further development and promotion is required.

Single crop type phases of more than 1 year are being widely considered as the answer to increasing grass weed contamination of cereals. The Minnipa crop sequencing showed support for this approach but it tested only a limited range of crop agronomy or crop types to achieve that outcome. Further assessments with alternative break crops and agronomic management possibly including grazing livestock is required.

Perennial pastures currently have a limited niche on Eyre Peninsula but the study has shown there are productive perennial options for 2 to 4 year weed, pest and disease breaks in lucerne and sulla. On low production shallow cropping land Tedera and Cullen are long term perennial prospects but further development work is still required.

Sheep grazing pastures and stubbles were shown to have no negative impacts on soil health or productivity and this needs to be widely extended to the industry and beyond. To assist in the survival of mixed farming enterprises the sheep industry requires the excitement of new technology. MERINOSELECT is one such tool which may help the industry revitalise but needs ongoing developmental support.

The greenhouse gas and soil carbon studies provide opportunities to help sell best practise farming systems both on their production and environmental benefits. They can assist the region to be able to confidently extend to the wider community that our best practise farming systems, while adding to the nation's wealth, are not causing environmental degradation.

Acknowledgements

All my colleagues from the Minnipa Agricultural Centre and the wider SARDI organisation, the University of Adelaide, CSIRO, EPNRM, EPARF, Rural Solutions, commercial consultants and members of the farming community who lead, collaborated, assisted, supported and expressed interest in the projects.

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Section 5

Nutrition

Is there a preferred wheat or barley variety to grow in a P deficient soil?

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RESEARCH

Key messages

- **At low P and moderate PBI levels relatively high P inputs are required to maximise yields.**
- **Required P inputs at similar starting P levels are driven by PBI.**
- **Replacement P programs should incorporate a measure of PBI in order to effectively balance available P across different soil types.**
- **Barley has slightly greater P requirements than wheat.**
- **Significant yield differences between varieties of wheat and barley could not be attributed to varying P uptake efficiencies.**

Why do the trial?

The aim of this research is to investigate responses to phosphorus (P) fertiliser of common wheat and barley varieties on P deficient soils.

The efficient use of P in broad acre agriculture is an increasing issue due to the likelihood of increased fertiliser prices contributing to greater production costs in the future. Maximising yields on the basis of providing adequate P nutrition can be achieved by applying sufficient amounts of P fertiliser to soils where P is limited. Fertiliser applied to the crop contributes only 5-30% to the crop's total P uptake and therefore the rest of the crop's P requirements need to be supplied from existing soil P reserves. Wheat and barley varieties may vary in their responsiveness to P either by having root traits that increase access to soil P or by more efficient use of the P that is taken up. In combination with different yield potentials external P requirements and phosphorus use efficiency (PUE) could vary.

Identifying varieties that have greater PUE in deficient soil is of great interest to EP farmers due to the relatively low P levels driven by highly P fixing soils in the region. Previous experiments conducted at Minnipa Agricultural Centre (MAC) and Mallala in 2012 and 2013 revealed small significant responses to P applications among various wheat and barley varieties, however no significant differences could be obtained for PUE potentially due to the relatively small yield response obtained (EPFS Summary 2013, p 129). Trials were repeated in 2014 at Condowie and Sherwood where very low P levels were measured in an attempt to generate greater yield responses to P and identify if there are any significant differences in PUE between varieties.

How was it done?

Two replicated field trials using wheat and barley were established at Sherwood in the SE mallee and Condowie in the mid-North of SA. Both sites were at similar low levels of available P as measured by either DGT P or Colwell P compared to their respective critical values (Table 1). The two sites did have contrasting phosphorus buffering index (PBI) values with the heavier soil type at Condowie (neutral pH) approximately double the PBI value of the sandy loam acidic soil type at Sherwood. These two sites provided an excellent opportunity to compared varietal efficiencies in two different soil P absorbing capacities.

Table 1 Mean and spatial variation in available P values for each trial location. Ten cores were taken in 10 plots of each trial and measured separately. DGT P presented as µg P/L, critical value = 52 (47-56, 95% CI), Colwell P and critical Colwell P in mg P/kg. Data are shown as mean ± standard error of the mean

	Sherwood				Condowie			
	DGT P	Colwell P	PBI	Critical Colwell P	DGT P	Colwell P	PBI	Critical Colwell P
Wheat	14 ± 2.0	15 ± 1.0	54 ± 8.0	22	17 ± 2.0	22 ± 2.0	97 ± 3.0	28
CV (%)	40	27	43		37	24	8	40
Barley	18 ± 2.0	19 ± 2.0	42 ± 5.0	20	17 ± 1.0	17 ± 1.0	85 ± 1.0	26
CV (%)	31	37	33		39	22	10	

Table 2 Mean grain yields (gy) across all P rates for each variety at each field site

Variety (Barley)	Sherwood GY (kg/ha)	Condowie GY (kg/ha)	Variety (Wheat)	Sherwood GY (kg/ha)	Condowie GY (kg/ha)
Barque73	3255	2962	Correll	2705	2386
Commander	3151	2962	Gladius	2647	2294
Fleet	3471	2939	Mace	3019	2341
Galleon	2545	2816	RAC875	2756	2344
Hindmarsh	3312	2853	Scout	2583	1802
Yarra	2587	2617	Wyalkatchem	2827	2296
LSD (P=0.05)	*451*	*254*	*LSD (P=0.05)*	*380*	*359*
CV (%)	8	5	CV (%)	8	9

On 23 May (Sherwood) and 3 June 2014 (Condowie), 6 varieties each of wheat and barley were sown at 5 rates of P: 0, 5, 10, 25 and 40 kg P/ha. The varieties sown were selected from a range of current commercial varieties and some old varieties that have been reported to show differences in P responses. The P was applied as triple superphosphate, drilled with the seed at sowing. Early crop growth was assessed by taking biomass samples at three times; 8 July, 24 July and 8 August (Sherwood) and 30 July, 14 August and 25 August (Condowie). The biomass was estimated by measuring NDVI with a Greenseeker™ and calibrating the readings with biomass cuts at each site. At the same time and at harvest, a soil sample was taken in-row from a selection of the 0 kg P/ha plots to measure available P with time.

The P use efficiency (PUE) is defined as the yield at nil P relative to the maximum yield. The P requirement was assessed by fitting a curve through the yield response data and the required P rate was estimated as the rate that gave 90% maximum yield. The economics of returns from obtained yield vs cost of applied P was calculated based on prices of $280/t for APW wheat and $270/t for malt barley, and a fertiliser price of $750/t (DAP) (PIRSA Gross margin guide 2015).

What happened?

Early biomass production of wheat and barley responded significantly to P fertiliser rate (Figure 1). At Condowie there was a linear response to P with no evidence of a plateau in the response, while at Sherwood the response to P started to plateau above 20 kg P/ha.

Significant responses to P applications and significant differences among varieties were obtained for grain yield in both wheat and barley at both sites (Table 2). Despite overall larger responses to P compared to the 2012 and 2013 seasons there was no significant Variety x P interaction in either wheat or barley at either site. In other words, for both wheat and barley the yield differences among the 6 varieties were too small to pick up significant differences in their responsiveness to P. Barley varieties tended to yield higher than wheat especially at Condowie which in part can be attributed to the occurrence of yellow leaf spot at early development for susceptible wheat varieties (Scout, Correll) as the trial was sown into wheat stubble.

Predicted PUE % for both wheat and barley using the previously established DGT database and measured DGT values at the start of each trial were close to those achieved at Sherwood (Table 3). Required P rates estimated using the same DGT database was also in good agreement. At Condowie the predicted PUE and optimum P rates were much lower than those obtained in the experiments (Table 3). Predominantly linear responses to P were obtained for both wheat and barley even up to 40 kg P/ha which could explain why PUE was higher than predicted as optimal yield or maximum yield (Ymax) hadn't been reached which would lower PUE%.

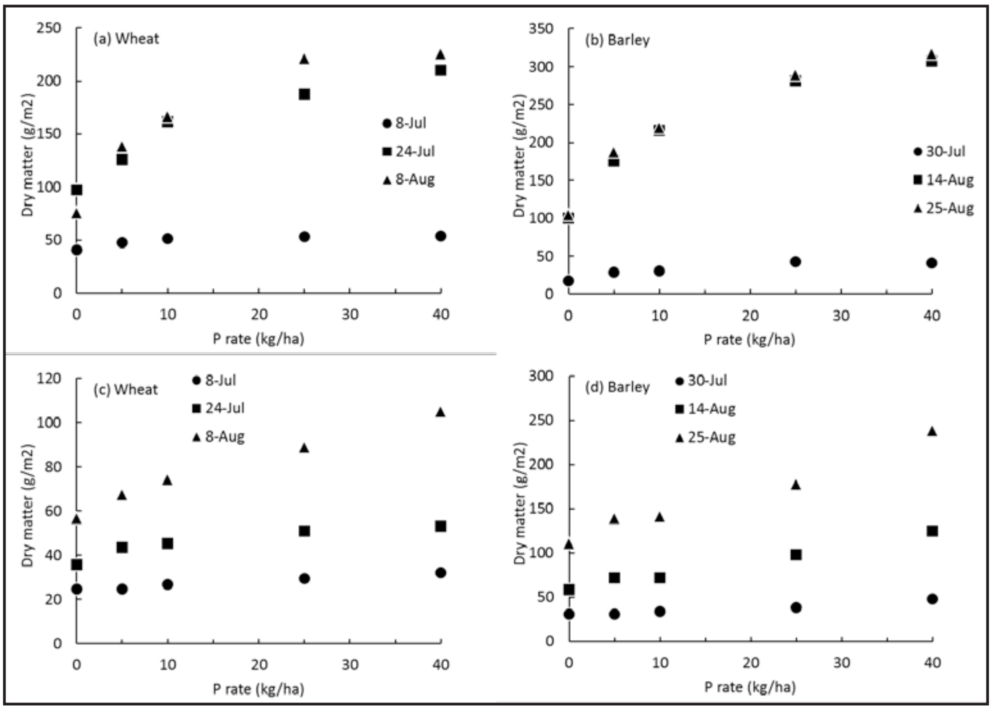

Figure 1 The responses in crop biomass to P in wheat and barley crops grown at Sherwood (a, b) and Condowie (c, d) measured at three times during July and August 2014

Table 3 Predicted responses and required P rates based on measured DGT P values from each site and the established DGT field trial database (2006-2013).*Ymax was not reached and therefore PUE% has been calculated using the yield from the top P rate (40 kg P/ha)

Location	Crop	Predicted PUE (%)	Obtained PUE (%)	Required P predicted (kg/ha)	Required P obtained (kg/ha)
Sherwood	Wheat	54	62	24	20
	Barley	59	59	21	29
Condowie	Wheat	58	71*	20	>48
	Barley	58	83*	22	>48

Despite similar initial soil tests at the two sites (Table 1) responses to P at Condowie were smaller than those at Sherwood and the yield response was linear over the range of P rates. The difference between the sites appears to be driven by P fixation and resulting fertiliser efficiency which has been effectively measured by PBI. Fertiliser requirements at Condowie appear to be at least double that of Sherwood even though both sites had very similar starting available P levels.

While highly significant responses to P were obtained at Condowie the smaller response to P meant that yields at the low P rates were not significantly greater than the control for a number of the varieties and significantly greater yields were only achieved at 25 or 40 kg P/ha. Phosphorus deficiency could therefore be masked if trials on this soil type used rates below 25 kg P/ha and thereby give a false impression that P was not limiting. To date the DGT database has limited field trial data in the very low range <20 ug/L with corresponding moderate to high PBI values (~100) and therefore required P rates haven't been sufficiently tested. While DGT appears useful in highlighting potential deficient P sites it is still very new and requires data for sites like Condowie.

There is a danger that current replacement P programs that attempt to match P removed off paddock in grain products are not flexible to varying fixation abilities of different soil types. Required P rates at these two sites were considerably higher than the replacement P rates required in 2015 based on average grain yields. Using the standard replacement rate of 3 kg P/tonne wheat grain, inputs for 2015 would be approximately 8 and 7 kg P/ha at Sherwood and Condowie respectively compared to predicted higher required rates based on outputs from 2014.

Despite required P rates at Condowie being calculated at the highest rate of P used (40 kg P/ha) or greater, the relatively flat linear response meant that the yields obtained in 2014 at these higher P rates (> 25 kg P/ha) were not necessarily the most economical with current grain and fertiliser prices (Table 4). At Keith economic benefits were obtained above typical replacement rates due to the higher relative efficiency of P applications.

Table 4 Economic analysis performed for the two P response trials based purely on fertiliser cost and yields obtained. Prices used can be found in the text. Economic optimal P rates for each category are highlighted in bold

P treatment (kg/ha)	Fertiliser cost ($/ha)	Returns from yield ($/ha)		Net return ($/ha)	
		wheat	barley	wheat	barley
Condowie					
0	0	542	720	542	**720**
5	19	607	735	**588**	717
10	38	597	747	560	709
25	94	681	793	**587**	699
40	150	715	863	565	713
Keith					
0	0	561	596	561	596
5	19	717	755	698	736
10	38	794	817	756	779
25	94	894	951	**801**	**857**
40	150	907	1003	757	853

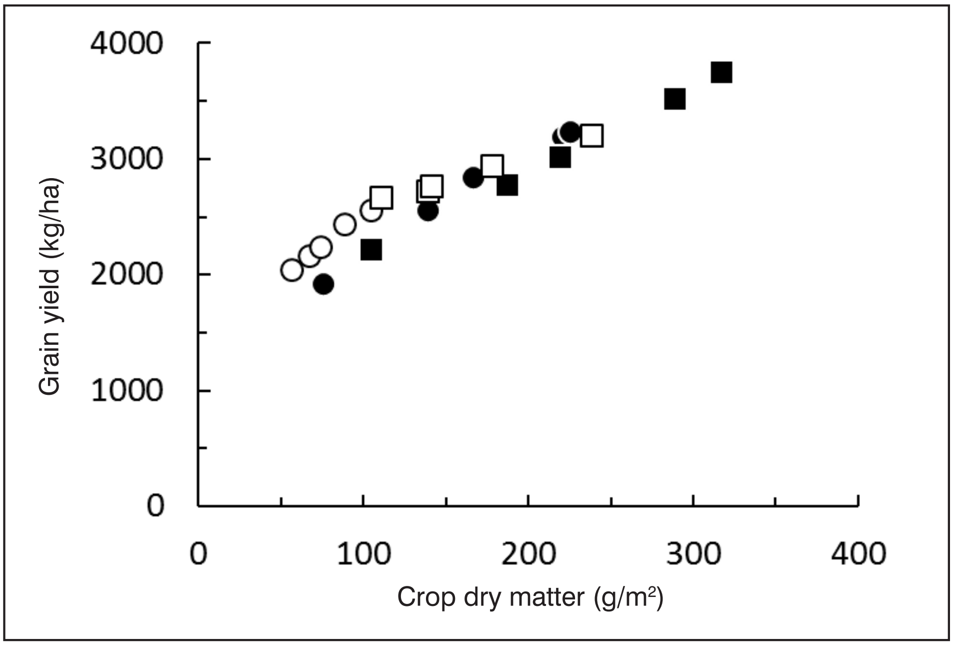

Figure 2 The relationship between crop biomass measured in August and the groan yield of wheat (●,❍) and barley (■, ❑) at Sherwood (●, ■) and Condowie (❍,❑). Biomass was measured on 8 August at Sherwood and 25 August at Condowie

The responses in yield to P were directly proportional to the responses in early biomass in both crops at Sherwood and Condowie (Figure 2). This response appears to be different to N where high rates of N can promote vegetative growth without necessarily increasing yield.

Any difference in PUE between varieties has been difficult to observe due to natural field trial variability, even though greater yield responses were obtained in 2014. Gains in yields through breeding new and improved varieties appear to outweigh any advantage of potentially growing P efficient varieties on P deficient soils. At current prices for fertiliser and grain it would be recommended to achieve maximum yields through sufficient P applications and growing appropriate varieties for the region as opposed to selecting potential high PUE varieties.

Comparison of PUE % and optimal P rates between wheat varieties reveals that higher efficiency (> PUE %) didn't necessarily result in lower external P rates (Table 5). Between sites there was some correlation between varieties requiring lower P rates at Sherwood and lower optimal P rates actually being able to be calculated at Condowie. The linear nature of response at Condowie for all barley varieties does not allow for comparison between sites.

Table 5 Response of each variety to applications of P expressed as PUE% and the corresponding required P rate to reach 90% of maximum yield

Crop	Variety	Sherwood		Condowie	
		PUE (%)	Required P (kg/ha)	PUE (%)	Required P (kg/ha)
Wheat	Correll	66	18	74*	> 48
	Gladius	58	14	82	39
	Mace	57	13	73	44
	RAC875	60	19	80*	> 48
	Scout	49	26	70*	> 48
	Wyalkatchem	42	12	82	43
Overall		*62*	*20*	*71**	*> 48*
Barley	Barque73	74	23	82*	> 48
	Commander	57	16	88*	> 48
	Fleet	59*	> 48	92*	> 48
	Galleon	50*	> 48	79*	> 48
	Hindmarsh	57	21	81*	> 48
	Yarra	49	29	79*	> 48
Overall		*59*	*29*	*83**	*> 48*

**Ymax not obtained due to linear response, yield at highest P rate used to calculate PUE.*
48 kg P/ha the maximum P rate used as the limit which equates to max P (40P) + 20%

What does this mean?

Yield responses to P were associated with promotion of early crop biomass in both wheat and barley. Compared to N, there appears to be less risk of high P rates adversely affecting yields.

Compared to differences in yield among varieties, differences in responses to P have been small. At this stage variety selection should be based on yield rather than any differences in PUE to achieve the greatest return in investment from P.

Phosphorus nutrition levels should be continually monitored especially those on replacement P programs and soil types with moderate to high PBI levels. Unless the relative inefficiency of P applications and the capacity of some soils to fix P have been considered, replacement P inputs on these soil types could be driving down P levels.

More efficient replacement P rates could be obtained if they are adjusted in accordance with PBI levels if they vary significantly within a paddock. We encourage the continued use of farmer strip trials (leave a strip of nil P fertiliser) in combination of with Colwell P and DGT results for on farm validation of the soil tests.

For paddocks with moderate to high PBI levels significant information could be obtained by incorporation of a P rich strip (e.g. 40 kg P/ha) next to the standard rate (10 kg p/ha) to ensure P deficiency is not masked by relatively low fertiliser efficiency.

Acknowledgements

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"Topping up" wheat with foliar phosphorus (P) – field evaluation of when, what and how much?

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Searching for answers

Location: Lock
Rainfall
Av. Annual: 333 mm
Av. GSR: 253 mm
2014 Total: 367 mm
2014 GSR: 249 mm
Paddock History (siliceous)
2014: Mace wheat
2013: Medic pasture lightly grazed
2012: Hindmarsh barley
2011: Wyalkaychem wheat
Paddock History (calcareous)
2014: Mace wheat
2013: Stingray canola
2012: Vetch grazed
2011: Hindmarsh barley
Soil Type
Siliceous sand
Calcareous sand (15% $CaCO_3$)
Plot Size
3 m x 30 m x 3 reps
Yield Limiting Factors
Dry spring, fertility

Location: Cummins
Rainfall
Av. Annual: 421 mm
Av. GSR: 353 mm
2014 Total: 421 mm
2014 GSR: 353 mm
Paddock History
2014: Cobra wheat
2013: Canola 575CL
2012: Mace wheat
2011: Farah faba beans
Soil Type
Deep clay
Plot Size
3 m x 30 m x 3 reps
Yield Limiting Factors
Dry spring

Key messages

- **Previous work suggests that it is possible to increase P uptake in wheat plants using foliar P if the leaves are not too P deficient and a surfactant is used in the formulation, but increases in biomass and grain yield have not been consistent.**
- **The first field experiments were implemented to test when, what and how much foliar P to apply at three sites on Eyre Peninsula (Lock, Edillilie and Cummins).**
- **No responses to soil or foliar applied P in 2014 were measured despite selecting sites with marginal soil test P levels and we think that the dry finish is a major driver for this.**
- **A wider range of formulations will be evaluated and further field testing will be done in 2015.**

Why do the trial?

Recent surveys of grain cropping soils for levels of available P suggest that many soils have marginal to adequate supplies of available P due to build up from previous fertiliser applications. In these soils, the crop requirements for additional fertiliser are marginal and highly dependent on seasonal rainfall and there are opportunities to optimise the management of fertiliser P. We have been investigating whether it is possible to top up P supply with in-season foliar application to the plant in seasons of higher yield potential, and as a result reduce the amount of fertiliser applied at sowing time. In early studies we measured a 25% grain yield response to a foliar P top-up in the growth room in one of the two soils evaluated (McBeath et al. 2012; EPFS Summary 2009 p 158) and in a separate study determined that severely P deficient wheat leaves were not able to take up any foliar applied P (Fernandez *et al* 2014).

This set the background for our hypothesis that the only potential fit for foliar P is as a 'top-up' fertiliser in soils with marginal to adequate P status and in seasons of higher yield potential. With this finding in mind, we have avoided situations of severe P deficiency (e.g. highly calcareous soils). More recently, in laboratory and growth room evaluations, we found that applications of foliar P at booting resulted in a transient increase in plant biomass (65%) and P uptake (33%) that was evident 10 days after the application but not at maturity. We have also determined (in the growth room and only with phosphoric acid as the P source) that although an adjuvant is required in the formulation for the P applied to stick to the leaf and be taken up, the type of adjuvant does not appear to be important, as long as it contains a surfactant and is compatible with the fertiliser. In these experiments, despite higher P uptake when foliar P was applied, there were no differences in the yield of treatments when compared to a control treatment with no foliar P application. Based on these preliminary results and on the support of keen farmers and advisors we implemented some field experiments on Eyre Peninsula (EP) and in the Wimmera in 2014 to test when, what and how much foliar P would be required to influence yield and potentially reduce the inputs of fertiliser P required at sowing. Here we report the results of the EP based field trials.

Location: Edililie
Rainfall
2014 Total: 387 mm
2014 GSR: 287 mm
Paddock History
2014: Wheat
2013: Canola
2012: Pasture
2011: Wheat
Soil Type
Ironstone soil
Plot Size
3 m x 30 m x 3 reps
Yield Limiting Factors
Significant waterlogging in winter followed by a dry spring
Social Practice (for all sites)
Time (hrs): Potentially extra spray pass
Clash with other farming operations: Optimal timing may be compatible with other spray operations but may require an extra pass
Economic
Infrastructure/operating inputs: Potentially extra spray pass, extra fertiliser input and modification of boom for phosphoric acid
Cost of adoption risk: Medium

Table 1 Details of field experiments in the Eyre Peninsula in 2014 where timing, foliar and sowing P rate and adjuvant combined with phosphoric acid as the P source were tested

Location	Soil type	Soil P status*	Sowing P (kg P/ha)	Foliar P (kg P/ha)	Adjuvants	Timing
Replicated Plots						
Edillilie	Ironstone	Marginal	0, 15, 30	0, 1.5, 3	LI700, Hasten, Hyper-STIK	GS 31, GS 39
Lock	Siliceous sand	Marginal	10	0, 1.5, 3	LI700, Hasten, Hyper-STIK	GS 31, GS 39
Cummins	Deep clay	Deficient	15	0, 1.5, 3	LI700, Hasten, Hyper-STIK	GS 31, GS 39
Paddock Test Strip						
Lock	Calcareous sand#	Marginal	10	0, 3	LI700	GS31

**Based on DGT-P #15% W/W $CaCO_3$*

Table 2 Wheat tissue P concentration ± standard deviation where replicated pre and post foliar P application at selected sites

Site	Sowing P input (kg/ha)	#Pre-application tissue P (mg P/kg)	Post 1.5 kg P/ha application flag leaf tissue P (mg/kg)	Post 3 kg P/ha application flag leaf tissue P (mg/kg)
Edillilie	0	4133±306	3533±58	3400±265
	15	4600±265	3467±153	3400±100
	30	5000±100	3500±100	3467±58
Lock-siliceous	10	3433±462	2833±404	3033±208
Cummins	15	*NA	3067±153	3000±265

**NA, not available #sampled at GS31, whole plant*

How was it done?

We had three replicated small plot trials on EP at Lock, Edillilie and Cummins and a further paddock test strip trial on a moderately calcareous soil at Lock. Across these trials we implemented a range of sowing P treatments, foliar P rates, adjuvants and timings but in all cases the foliar P was applied as phosphoric acid (Table 1). Sites with marginal levels of P were selected based on soil P analyses (Colwell, PBI and DGT). Measurements were made of the tissue P concentration both prior to the application of foliar P and after the sprays were applied (sampling leaves that emerged post-spray). In addition, harvest index (quadrat cuts) and grain protein and yield (plot harvester) were all measured.

What happened?

There were no indications that any of the plants were deficient in P, but we were able to pick up some higher tissue P concentrations in response to higher inputs of P fertiliser at sowing at Edillilie (Table 2). After the application of foliar P we sampled the flag leaf (which emerged after the application of the foliar spray) to see if we could measure a difference in plant P content with the two different doses of foliar P, but we did not find any differences (Table 2).

We were not able to measure a significant response to inputs of sowing soil applied or in-season foliar applied P (Table 3). Sites on EP had a very dry finish and we believe that this would have played a significant role in reducing the response to soil applied P in particular. An expanded summary of the results of this project (including Wimmera field trials) are available in the 2014 Adelaide GRDC Advisers Update Proceedings.

What does this mean?

In agreement with the literature (Noack *et al* 2010), we have found responses to foliar P difficult to predict and sporadic. After completing several growth room studies and being able to trace that the foliar product has been taken up by the plant and that it has increased the total amount of plant P uptake (eg. Peirce *et al*. 2014), the ability to achieve a consistent and predictable positive effect on wheat growth appears evasive.

Table 3 Wheat grain yield, protein and harvest index at maturity. As there were no differences between treatments, the mean ± standard deviation of grain yield, protein and harvest index (HI) for each trial are given

Location	Grain yield (t/ha)	Protein (%)	Harvest index (grain Wt/whole plant Wt)
	Replicated Small Plots		
Edillilie	3.5±0.2	13.3±0.8	0.43±0.02
Lock-siliceous	2.7±0.2	10.3±0.4	0.43±0.03
Cummins	8.0±1.0	10.2±0.6	0.48±0.03
	Paddock Test Strip		
Lock-calcareous	2.9±0.2	-	0.45±0.01

Table 4 Phosphorus formulations currently being evaluated in the growth room

P source	N:P:K	pH of applied fertiliser
*Phosphoric acid	0:26.9:0 w/w	1.4
#Ammonium phosphate	12.2: 27:0 w/w	4.3
*Maxi Phos Neutral	7.8:12.5:0 w/w	4.3
*Ammonium polyphosphate	16:23:0 w/w	6.6
*PeKacid	8:22:16.6 w/w	2.2
#Sodium phosphate	0:22.5:0 w/w	6.5
#Potassium phosphate	0:22.8:28.7 w/w	4.4
*Pick	0:9.4:26.3 w/w	8.7

**Commercially available fertiliser #Lab grade reagent*

We are continuing to work to find situations where foliar applied P has a significant impact on grain yield. In preparation for the 2015 growing season we are evaluating a range of formulations besides phosphoric acid in combination with different adjuvants in a growth room experiment comparing the effect of 7 products (Table 4) combined with 3 different adjuvants (LI700, Hasten and Spreadwet 1000) on wheat growth, P uptake and peak biomass. We have included 3 different adjuvants to test whether the form of adjuvant is important for a source of P other than phosphoric acid. Plants are being grown in a highly P responsive soil (known response to increasing doses of soil applied P), with foliar fertilisers applied at flag leaf visible (GS37). The use of an isotopic technique will enable us to trace the recovery of the foliar applied fertiliser.

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Three year evaluation of liquid and granule nutrition packages at Tuckey

Tristan Baldock and Cindy Martin
Cleve Rural Traders

RESEARCH

Almost ready

Location:
Tuckey
Jason & Julie Burton
Rainfall
Av. Annual: 330 mm
Av. GSR: 235 mm
3 Yr Av Total: 319 mm
3 Yr Av GSR: 217 mm
Yield
Potential: (3 yr av.) 3.97 t/ha (W)
Actual: (3 yr av.) 2.29 t/ha (control)
Paddock History
2014: Wheat
2013: Wheat
2012: Wheat
2011: Angel medic pasture
Soil Type
Sandy loam
Soil Test
C_{DGT} 36
Predicted Response (DGT) 81%
Plot Size
50 m x 2 m x 3 reps
Yield Limiting Factors
Early finish

Key messages

- **Liquid N at sowing can improve crop emergence and early vigour, particularly under dry conditions.**
- **The addition of trace elements and flutriafol fungicide does not provide increases in emergence, tillering or final yield.**
- **Burton Brew provided yield and gross margins above that of other liquid NP treatments.**
- **Higher input costs of liquid NP treatments resulted in those treatments being less profitable than traditional granule treatments over a three year period.**

Why do the trial?

The decision to introduce liquid technology to support a grower's granule fertiliser program in 2011 prompted the establishment of split paddock trials in that season, resulting in a \$100/ha gross margin benefit in the liquid NP + granule NP (row support) system over the traditional granule MAP + Urea system used on a farm at Tuckey. This gross margin increase prompted an investigation into what components were responsible for the benefit, thus the establishment of this trial site in 2012. Results from the 2012 season demonstrated yield benefits from liquid fertilisers, with liquid N being a key driver to increased productivity. It was deemed necessary to replicate this trial for another two seasons to determine the outcomes under different seasonal conditions and to determine if there is any cumulative effect of fertiliser treatments.

How was it done?

The trial was established on a uniform grey brown loam top soil over soft limestone subsoil, with a 2012 base Colwell P of 36 mg/kg (sufficient) and nitrate N of 36 mg/kg (sufficient at time, but no individual treatment soil testing was carried out prior to sowing in 2013 and 2014). Sown in May each year with Mace wheat, the replicated trials consisted of a number of liquid, granular, and liquid/granule combination treatments of nitrogen (N), phosphorus (P), trace elements (te) and in-furrow fungicide (fung) designed to establish which of these components has the greater effect on final yields. The treatments are summarised in Table 1. The treatments were identical each year and were sown plot on plot to determine any cumulative effect.

What happened?

Visual differences in emergence and early vigour were observed in the first two years of the trial, with treatments containing liquid N and the complete liquid treatment establishing quicker and demonstrating increased early vigour. This was not observed in the final year, with no clear advantage in liquids under wet seeding conditions. Emergence and establishment was marred in the final season due to inaccurate seed placement caused by pugging of the plot seeder boots, making it difficult to accurately measure emergence. Over the 3 seasons the granular nitrogen liquid phosphorous (granNliqP) treatments were the poorest performers in terms of emergence, whilst the addition of trace elements and fungicide had no impact on emergence and no advantage was evident with full liquid system over full granular system.

Annual tiller counts reflected seasonal variability with treatments containing liquid N providing increased tiller numbers in the dry conditions of 2012 (refer to EPFS Summary 2012, p 112), whilst granule N treatments provided an advantage with high soil moisture in 2013 (refer to EPFS Summary 2013, p 132). Insufficient N due to 2012 crop removal under liquid treatments was thought to contribute to 2013 results, and 2014 demonstrated little difference between treatments in a season where N replacement levels were increased with higher soil moisture. The three year mean suggested that there was no difference in tillering across liquid and granule treatments, although nil fertiliser was penalised severely (Table 1). The addition of trace elements also had little effect, as did the addition of fungicide, however it was found that flutriafol applied to granule fertiliser (MAP) reduced tiller numbers to that of liquid flutriafol applied in furrow (Table 1, treatments 18 and 17 respectively).

Table 1 Three year mean wheat emergence (plants/m²), tiller count (tiller/m²), grain yield (t/ha), Water use efficiency (WUE), (kg/ha/mm) and gross margins ($/ha) in response to fertiliser treatments

Treatment	Treatment descriptor	Emergence (plants/m²)	Tiller count (/m²)	Grain yield (t/ha)	WUE	Gross margin ($/ha)
1	granN granP (T1)	169	249	2.6	9.9	650
2	granN granP +fung -te (T2)	169	249	2.5	9.6	624
3	granN granP -fung +te (T3)	163	253	2.5	9.8	629
4	granN granP +fung +te (T4)	159	253	2.3	8.6	604
5	liqN liqP -fung -te (T5)	173	245	2.5	9.6	547
6	liqN liqP +fung -te (T6)	174	246	2.4	9.6	537
7	liqN liqP -fung +te (T7)	160	254	2.5	9.7	543
8	liqN liqP +fung +te (T8)	165	237	2.5	9.9	556
9	liqN granP -fung -te (T9)	163	250	2.5	9.9	598
10	granN liqP (T10)	154	252	2.6	10.0	577
11	liqN granP -fung +te (T11)	167	251	2.5	9.9	589
12	granN liqP -fung +te (T12)	153	244	2.6	9.9	569
13	liqNliqP +fung +te (T13)	161	245	2.5	9.9	533
14	granN(20) granP(12) -fung -te (T14)	164	245	2.5	9.8	628
15	Burton double (T15)	150	255	2.8	11.1	613
16	liqN liqP(6) +fung +te (T16)	160	232	2.5	9.8	559
17	granN granP(12) +fung +te (T17)	165	260	2.5	9.9	621
18	granN granP +gran fung+H20 +te (T18)	159	235	2.6	10.0	630
19	nil fert (T19)	171	223	2.3	9.1	631
20	nil fert +fung (T20)	162	228	2.3	8.9	614
21	Burton Brew (T21)	157	261	2.6	10.2	660
22	Burton Brew II (T22)	164	232	2.5	8.1	583
LSD (P=0.05)		*12.73*	*21.91*	*0.17*	*0.86*	*34.8*

Note all treatments contain 20 units of N and 8 units of P unless specified otherwise in the description, except 2014 where all treatments had 30 units of N. Granule treatments use MAP + Urea, and liquid treatments use liquified urea and phosphoric acid, excluding T13 which uses UAN and APP. Trace elements (te) consists of Zn and Mn @480 g/ha and Cu @ 193 g/ha as sulphate, except for treatment 13 which is EDTA chelate. Fungicide consists of flutriafol @ 100 g/ha ai as a liquid, except for treatment 18 which has a coating on granule fertiliser (MAP). Furthermore, the Burton Blend contains N-(6liquid+14granule), P-(6liquid+2 granule), Zn Mn 480 g, Cu 193 g, using MAP and Urea for granule components. Burton Double N-(12liquid, 14granule), P-(12liquid+2granule), Zn Mn 1000 g, Cu 420 g, and Burton II N-(12liquid+8granule), P-(4liquid+4 granule), Zn Mn 480 g, Cu 193 g

Favourable seasons resulted in trial yields well over two tonnes per hectare each year resulting in large annual nutrient removals, particularly N. In 2012 liquid N drove yield advantages despite being sown on a medic pasture, whilst it was granule N and liquid P that delivered the highest yields in 2013. Last season mirrored the long term results with all liquid, granule and combination treatments yielding similarly, with nil fertiliser considerably lower. Notably the differences between full liquids and granule district practice seen in 2012, was not realised. Despite benefits of the inclusion of fungicide and trace elements to a liquid system evident in 2012 (data not shown), the addition of trace elements and fungicide did not provide conclusive benefits long term, nor did in furrow liquid fungicide over granule coated.

Differences in grain quality were negligible with no effects on pay grade in 2012, and only Burton Brew and Burton II recording higher pay grades in 2013 due to test weight and screenings. Test weight and screenings again showed differences in 2014, but did not cause an overall change in grade.

Higher yields that favoured liquid treatments in 2012 didn't translate into high profits, and in 2013 liquid treatments suffered poor returns compared with granule treatments, reflective of a lack of yield response. Again in 2014 the lower input costs of granule treatments made them generally more cost effective than full liquids and nil fertiliser, and similar to the combination treatments of liqN granP and granN liqP. However, Burton Brew (T21) remained a standout, out yielding many of the granule and liquid treatments. Overall gross margins told a similar story with the granule system giving higher returns than those treatments containing liquid P (full liquid & granNliqP), and similar to those of nil fertiliser and liqNgranP, and the Burton brew returning more than most other granule and liquid treatments (Table 1).

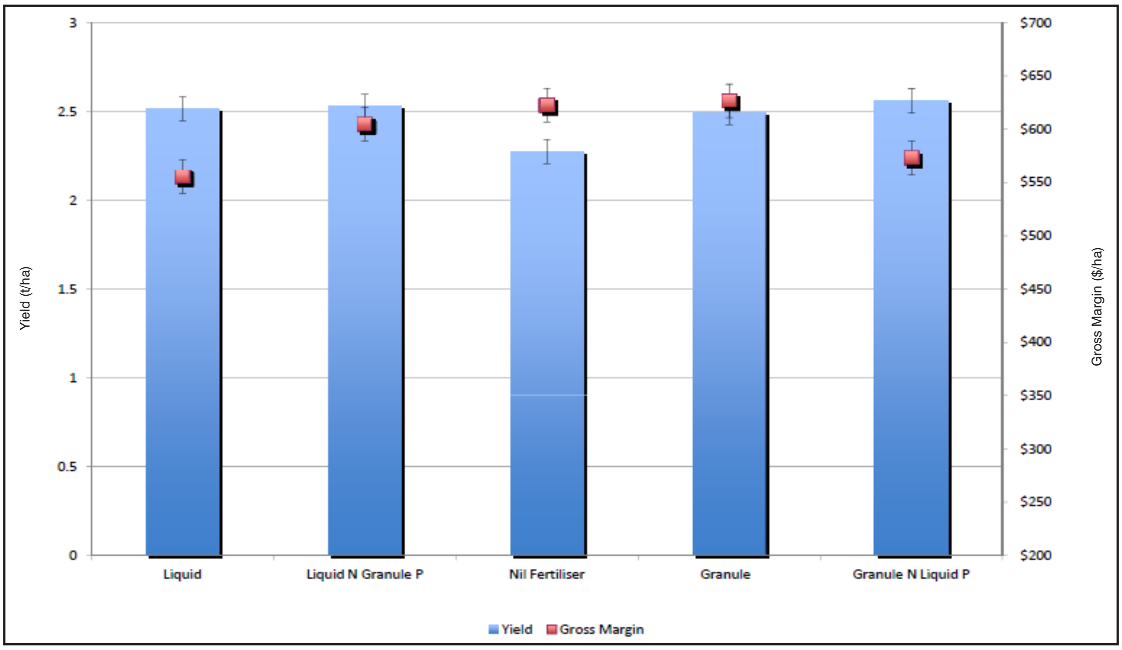

Figure 1 Three year mean wheat yield (t/ha) and gross margins ($/ha) of liquid NP, liquid N granule P, nil fertiliser, granule NP and granule N liquid P treatments. The bars represent the standard deviation about the mean

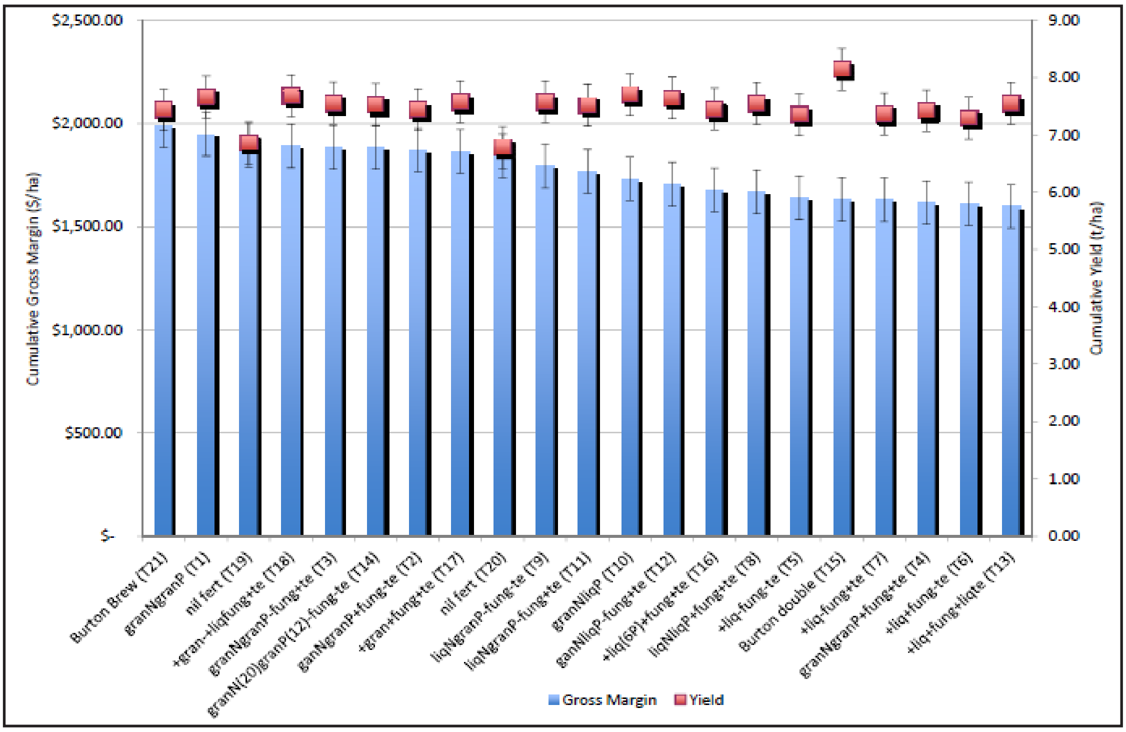

Figure 2 Three year cumulative wheat yield (t/ha) and gross margin ($/ha) of individual treatments. The bars represent the error about the means. Burton II has been removed as was only included in year 2 & 3

What does this mean?

Results from initial split paddock trials near the site and from the first year of this trial suggested the potential for large gross margin gains with row support and full liquids systems over traditional granular fertiliser systems at sowing. Despite these results, it was hypothesised at the onset of this three year trial that full liquid systems would not be a cost effective option, but rather a traditional fertiliser regime enhanced through the use of liquid technology would see the greatest returns to the grower. This trial has so far given some support to that hypothesis in that full liquids have returned poorly over three years, and it has been the 'row support' option of a granular based fertiliser enhanced with liquid N that has given the most marked responses.

Liquid N was a common theme throughout the trial, with year one showing large improvements in crop emergence and early vigour under dry soil conditions, which followed through to biomass gains at mid tillering. The two subsequent seasons delivered similar responses up until tillering, but with good soil moisture levels that would remain throughout winter, granule N treatments performed as well as liquid N treatments in terms of grain yield.

The incredibly high soil moisture levels experienced in 2013 and the winter months of 2014 were contrasting to 2012 and provided an environment favourable for the release and movement of N from granule based fertiliser. Toxic salt effects of granule based fertiliser that can reduce crop emergence in dry conditions were avoided by liquid treatments, making them more favourable in dry start conditions.

In the second year of the trial, liquid treatments experienced severe N deficiency at the beginning of tillering which disadvantaged their development and yield potential throughout. This is thought to be caused primarily by nutrient removal through higher yields in the year prior. It is also hypothesised that the relatively low doses of N coupled with wetter than normal conditions may have caused liquid N to leach more quickly than granule N, although there is no data to support this. A decision was made not to treat individual plots according to nutrient removal, but rather ensure each plot received the same number of units of each nutrient, regardless of fertiliser form, a decision that reduced variability within the trial, but penalised those treatments that initially performed well. To address this in the final season, all plots received an additional 10 units of N at time of sowing, and a further 12 units as UAN mid tillering, taking the total N to 42 units rather than 20 as in previous years. While there was little difference in tillering between liquid and granule treatments over the duration of the trial, it was clear that insufficient nutrition (nil fertiliser) reduced tiller numbers consequently leading to yield penalties.

An expectation at the beginning of the project was that the addition of trace elements would provide some level of improvement in crop vigour and yield potential given the critical deficiencies detected in soil tests and the observed benefit of applying zinc particularly early in the crops life. While advantages were observed in 2012 when trace elements and fungicide were added to liquidNP treatments, this did not continue throughout the duration of the trial with the addition of trace elements having no impact on emergence, tillering or final yield.

The move to liquid fertiliser technology has to have some benefit in yield; it requires an investment over and above that required for traditional fertiliser systems that must have a return. Precursor split paddock trials and 2012 data clearly showed favourable improvements in grain yields under liquid fertiliser, however this was not supported in the subsequent seasons, resulting in the overall performance of liquids being similar to that of traditional granule treatments. Importantly, after three successive seasons a penalty for nil fertiliser is evident, and it can be hypothesised that this is likely due to inputs in each of the individual seasons, and cumulative draw down on soil reserves as a result.

Given the negligible differences in yield between treatments it is logical that there were no differences in final water use efficiency (WUE). The dry season of 2012 showed liquid treatments to be more effective than granules at converting soil moisture into grain yield, again reaffirming the strength of liquids in dry seasons. Overall WUE values were low indicating that the 2013 and 2014 seasons were not limited by water, rather by nutrition or some other factor. Analysis of the three year mean effect of fertiliser form showed that nil fertiliser and traditional granule nutrient input have provided the greatest return given their low input costs. The relatively high costs of liquid treatments, particularly a full liquid, without an improvement in yield, means returns are well down compared with traditional granule systems. The exception to this is when treatments are analysed individually, which shows the Burton Brew, a full liquid treatment supporting a granule system (row support), was one of the highest performers in terms of tillers, yield, WUE and gross margin.

The overall objective of this study was to determine whether the considerable increases in yield and profitability observed in farmer based split paddock trials which compared traditional granule regimes to a row support system using Burton Brew, could be replicated under trial conditions. The outcomes of three years of trials ultimately does not conclusively support these observed benefits, however the Burton Brew has tended to provide increased yields and profits over many liquid and granule treatments. Full liquid systems have not provided a yield benefit resulting in lower bottom line returns over the period, indicating their lack of suitability at this site. No conclusive benefits were seen in the addition of trace elements, nor with the addition of in furrow fungicides, outcomes that tend to dispute what many observe in the paddock. It is likely that an in furrow fertiliser system that incorporates the use of liquid NP, trace elements and fungicide, coupled with granule NP will provide economic advantages over regimes that use granule or liquid alone.

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Charra and Goode fertiliser trial

Leigh Davis and Brenton Spriggs
SARDI, Minnipa Agricultural Centre

Searching for answers

Location:
Charra
Locky and Paul Brown
Charra Ag Bureau
Rainfall
Av. Annual: 303 mm
Av. GSR: 229 mm
2014 Total: 312 mm
2014 GSR: 211 mm
Yield
Potential: 2.15 t/ha (W)
Actual: 1.16 t/ha (W)
Paddock History
2013: Wheat
2012: Spray-topped pasture
2011: Pasture
Soil Type
Brown sandy clay loam
Plot Size
1.5 m x 10 m x 3 reps
Yield Limiting Factors
Sharp finish

Key message

There were very little differences between fertiliser treatments and methods of application at Penong in 2014.

Why do the trial?

Originally this trial was initiated by the local Ag Bureau groups at Charra and Goode to test if there were potential yield responses to be gained by increasing fertiliser rates, testing new products and other sowing techniques like fluid fertilisers. Bryan Smith applied for money through the Eyre Peninsula Natural Resources Management Board (EPNRM) Sustainable Agriculture fund on behalf of the two Ag Bureau groups and a grant was secured to undertake the trial. A further grant was gained to test if there were residual effects on grain production from the treatments applied in 2013.

How was it done?

Mace is the most commonly grown wheat variety in the district, so was selected to sow over the twenty four treatments applied in 2013. Mace was sown on 14 May 2014 at 50 kg/ha with a standard fertiliser rate of 40 kg/ha of DAP (18:20:0:0), apart from the nil treatment which received no fertiliser in 2013 and 2014. Chemicals used were 1.5 L/ha glyphosate + 1.5 L/ha trifluralin + 1.6 L/ha Avadex Xtra + 60 ml/ha Hammer + 500 ml/100L LI700 applied at sowing on 14 May and 650 ml/ha Agritone 750 was applied to control broad-leaved weeds.

What happened?

Mace wheat oversown showed very small yield differences, with a 0.20 t/ha difference between the highest and lowest yield (Table 1). When comparing the yield from 2013 (EPFS Summary 2013, Charra and Goode district fertiliser trial, p 135) the top three yielding treatments last season were the same in 2014.

What does this mean?

Overall there was little effect of the residual fertiliser from the previous year's treatments on grain yield and quality in this trial. This trial has shown that phosphorus or nitrogen are not a limiting factor at this site and could explain why there were little differences in the treatments.

Acknowledgements

Thanks to Paul Brown for the use of his land.

Table 1 Grain yield and quality of Mace wheat oversown on 2013 nutrition treatments at Penong in 2014

Treatment	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
8 kg P/ha EverGol Prime seed treat + 11.5 N urea	1.78 a	10.6	79.2	2.3
Tristan fluid brew (1) @ 41 L/ha 14 N, 14 P, 1.17 Zn, 1.17 Mn, 0.47 Cu	1.77 ab	10.6	79.4	2.3
8 kg P/ha + 11.5 N urea	1.76 abc	10.9	79.7	2.3
0 kg P/ha + 11.5 N urea	1.75 abc	10.4	80.0	2.0
8 kg/ha P Fungicide fluidinfurrow + 11.5 N urea	1.75 abc	10.7	78.0	2.5
8 kg/ha P Vibrance fluidinfurrow + 11.5 N urea	1.73 abcd	10.6	80.1	2.3
40 kg/ha DAP (Control)	1.72 abcd	10.5	79.0	2.3
8 kg P/ha + 11.5 N eNtrench N in furrow	1.71 abcd	10.7	79.0	2.1
36.4 kg/ha MAP	1.71 abcd	10.3	80.1	2.5
8 kg P/ha + 23 N	1.68 abcd	10.5	77.9	2.6
8 kg P/ha 11.5 N N-Pact applied foliar	1.68 abcd	10.8	76.0	3.0
8 kg P/ha +11.5 N urea + Zn foliar	1.68 abcd	10.4	79.8	2.2
14 kg P/ha + 11.5 N urea	1.68 abcd	10.8	78.8	2.3
8 kg P/ha as triple super	1.67 abcd	10.6	78.4	2.4
Phos acid + nitrogen = 8 kg P/ha + 11.5 N	1.67 abcd	10.7	80.5	2.3
8 kg P/ha 11.5 N UAN foliar	1.66 abcd	10.8	78.2	2.3
14 kg P/ha as triple super	1.65 abcd	10.6	79.3	2.4
14 kg P/ha + 23 N	1.65 abcd	10.8	74.4	3.6
Tristan fluid brew (2) @ 50 L/ha 21 N, 7 P, 0.87 Zn, 0.87 Mn, 0.35 Cu	1.62 abcd	10.9	78.3	2.5
Nil fertiliser	1.61 bcd	10.3	78.6	2.6
40 kg/ha DAP + Impact @ 200 ml/ha + 11.5 N urea	1.61 bcd	10.6	77.3	2.6
60 kg/ha DAP	1.60 cd	10.9	76.5	2.6
0 kg P/ha + 23 N	1.58 d	11.0	79.5	2.3
8 kg P/ha Vibrance seed treat + 11.5 N urea	1.58 d	10.6	76.3	2.9
Mean	**1.68**			
LSD (P=0.05)	*0.16*			
CV (%)	6			

Section 6

Section Editor:
Naomi Scholz
SARDI, Minnipa Agricultural Centre

Livestock

Simple steps to "ewe-turn" your lamb weaning percentage

RESEARCH

Jessica Crettenden
SARDI, Minnipa Agricultural Centre

Best practice

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Livestock
Enterprise type: Mixed farming
Type of stock/breed: Merino

Key messages

- **Weaning percentage is a major profit driver in sheep enterprises.**
- **Improvement requires an integrated approach to changes within sheep enterprises.**
- **Changes to management practices don't necessarily have to be more time consuming or expensive. Small changes can make a great difference.**
- **The minimum weaning percent on Eyre Peninsula should be 100%.**

Why do the trial?

Lamb wastage in sheep flocks is a major concern for the Australian sheep industry. Overcoming significant loss of lambs from conception to weaning is considered a key focus for higher rainfall zones, however, it has had less emphasis in lower rainfall regions, including the Eyre Peninsula.

Scanning percentages for summer-joined Merinos are often 120-160% but can result in weaning percentages of only 80-110%. Reduced weaning percentages occur because of a combination of many different factors. Therefore, improving efficiency involves using an integrated approach in order to achieve the best outcome.

How was it done?

The opportunity to improve reproductive efficiency was addressed in a study using the Merino flock at the Minnipa Agricultural Centre by identifying and understanding the timing and causes of lamb losses in 2012, 2013 and 2014 (EPFS Summary 2012, p 120 and EPFS Summary 2013, p 137).

Each year ewes were single-sire joined to rams for six weeks in February/March and subsequently pregnancy scanned for dries, singles and multiples in May. At lambing measurements taken included dam pedigree, date of birth, sex, birth type, birth weight, rectal temperature, lamb vigour and ewe maternal temperament. Deceased lambs were autopsied to determine cause of death. Marking and weaning numbers were recorded in August and September, respectively.

What happened?

Table 1 presents the three years of reproductive performance on the Minnipa flock with an average scanning of 147%. Note: as a consequence of single-sire joining, there was one group in 2014 that had a low scanning percentage of 16 due to a combination of heat and transport stress on the ram. On average, there was a 26% loss of lambs from scanning to weaning. Average survival at weaning was 83%.

The cause of perinatal deaths in this study have been broken down into eight categories shown in Figure 1: dystocia (difficult birth), exposure (hypothermia), starvation (causes other than mismothering), mismothering (secondary death through starvation), premature or 'dead in utero' (lambs born prematurely or dead), predation (primary predation only), other (including injury, infection and misadventure) and unknown (this diagnosis refers to lambs that have been scavenged and unable to be autopsied).

Table 1 Reproductive performance of the Minnipa flock from 2012-2014

Year	No. Ewes joined	No. Lambs scanned	No. Lambs born	No. Lambs weaned	Survival at birth (%)	Survival at weaning (%)
2012	337	540 (160%)	558 (166%)	439 (130%)	103	81
2013	350	534 (153%)	531 (152%)	446 (127%)	99	84
2014	349	442 (127%)	443 (127%)	366 (105%)	100	83
Average	**345**	**505 (147%)**	**511 (148%)**	**417 (121%)**	**101**	**83**

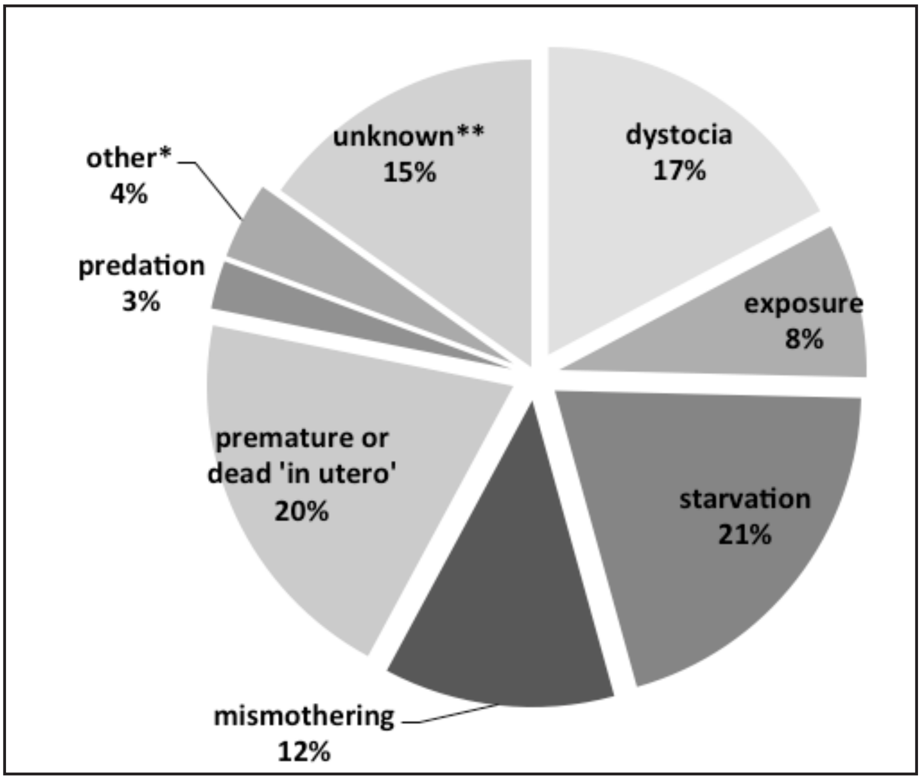

Figure 1 Cause of lamb deaths at the Minnipa Agricultural Centre in 2012-2014
**other includes injury, infection and misadventure*
***unknown diagnosis is from lambs that have been scavenged and are unable to be autopsied*
NOTE: Figure 1 does not include the 82 lambs (out of the total 279 deceased) missing between tagging and weaning

What does this mean?

The average lamb loss between birth and weaning in Australian Merino sheep has been estimated to be more than 30% (Minnipa flock average was 27%) The majority of these deaths occur in the early post-natal period, with more half of all pre-weaning deaths occurring within the first 24 hours. By contrast, the number of ewes that fail to get in-lamb is normally quite low. Weaning percentages tend to be ominously lower than pregnancy scanning percentages in low rainfall areas, yet many sheep producers are not scanning and therefore do not know what they are losing, which is a concern. For a summer joining the expectation of 100% at weaning is not unreasonable on the Eyre Peninsula and should be the minimum target for all sheep enterprises, regardless of breed.

Poor weaning percentages occur because of a combination of many factors starting from pre-joining through to weaning, and the cause of the problem varies significantly from property to property. A collective management package is necessary to obtain the best weaning percentage possible. The outcomes of the lamb survival study at Minnipa show that there are several important aspects to understand about flock management during the reproductive period in sheep enterprises that can be used to improve weaning percentages.

Starvation, mismothering and exposure (SME) are generally referred to as a complex, which typically accounts for approximately 80% of perinatal deaths in the majority of studies conducted in Southern Australia. At Minnipa 41% of lamb deaths were attributed to this complex. In recent research, more dystocia cases have been identified in lamb deaths previously diagnosed as the SME complex; however the initial cause of demise has been credited to brain injury (related to bleeding in the brain caused by difficult birth and lack of oxygen in the birth canal for an extended period of time).

Livestock

Calcium supplements (stock lime) are essential in late pregnancy and throughout lambing as calcium drives ewe birthing contractions and lack of it can lead to dystocia. Fibre is also important to mobilise calcium reserves. Managing lamb birth weights, ensuring sufficient ewe nutrition and regular flock monitoring throughout lambing are other options to assist an easy birthing process.

The most critical driver of lamb survival is ewe nutrition and pregnancy scanning is the initial process by which nutritional decisions need to be made. Many losses are associated with poor sustenance during pregnancy, particularly in late pregnancy and predominantly with ewes carrying multiple lambs. It is simpler, safer and generally cheaper to maintain ewe condition over joining and early pregnancy than to lose it and build it back up. Nutrition at this stage directly affects lamb birth weight, with approximately 70% of a lamb's likelihood to survive governed by its birth weight. Major issues with nutrition include too much feed for singles resulting in dystocia issues, or not enough for multiples leading to problems associated with the SME complex, hence the importance of pregnancy scanning to adjust feed rations. Whether single or multiple pregnancies, matching condition and nutrition through reallocation of resources as well as supplying the correct balance of energy and protein is important to maximise survival, whilst resulting in additional benefits such as better milk supply, more energy for the ewe for labour and lambs less susceptible to predation.

Maintaining nutrition levels during lambing is critical, as the amount of time a ewe spends at the birth site to bond with her newborn governs the lamb's chance of survival, particularly in the first four to six hours. Provision of shelter and paddock allocation is equally important as managing ewe nutrition. Shelter will not only protect lambs from environmental extremes, but will also provide sufficient cover to allow the ewe to give birth uninterrupted and to bond with her lamb(s).

Using genetics in ewe and ram selection can assist in controlling aspects such as lamb birth weight, difficult birthing issues and identifying good mothers. It is essential that ewes and rams are in appropriate condition through sound physiology, good health and nutrition and that the joining period is sufficient to allow two cycles for the ewes (minimum of five weeks). Peak fertility when cycling activity increases in sheep generally occurs between March and May and out-of-season joining may require teaser use or for rams to be left in for an extended time, however a lengthy joining period can be inefficient. Ensuring a regular and up-to-date husbandry program will aid a successful reproductive process.

Primary predation of otherwise healthy lambs is uncommon, although sporadic events do occur. It is essential to control pests to minimise ewe stress and to avoid leaving the lamb vulnerable to primary or secondary predation (secondary predation occurs on lambs that are more likely to die in the absence of predation). This is important especially in the first 24 hours, as ewes tend to give birth during the night or early morning when predators are most active. An integrated approach using control options such as baits, traps, hunting, fox lights and/or guardian animals at least a month prior to lambing is necessary.

Substantial profitability gains can be made through improved weaning percentages, especially when the cost of lamb losses, along with their potential future income is calculated; however there is no single solution to improve reproductive rates in sheep enterprises on Eyre Peninsula. Each producer needs to analyse the causes behind the problem within their flock management program and be willing to implement change – small changes can equal long term investment into the future of a sheep flock. Ignorance and complacency around the issue of lamb wastage are currently major hurdles for the sheep industry, which need be addressed in a timely fashion if considerable productivity and profitability improvements are expected.

Acknowledgements

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EPARF
Eyre Peninsula Agricultural Research Foundation Inc.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SASAG
South Australia Sheep Advisory Group

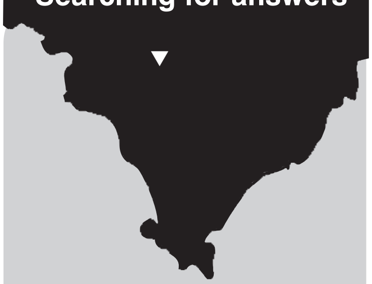
Grain & Graze
Profit through knowledge
EYRE PENINSULA

Reducing methane emissions from improved forage quality on mixed farms

Brian Dzoma[1], Roy Latta[2], Gonzalo Mata[3], Andrew Toovey[3] and Nathan Phillips[3]

[1]SARDI, Minnipa Agricultural Centre,, [2]Dodgshun Medlin, Swan Hill, Victoria, [3]CSIRO Agriculture Flagship, Perth, WA

Searching for answers



Location:
Minnipa Ag Centre
Rainfall:
Av Annual: 325 mm
2014 total: 407 mm
Livestock
Enterprise type: Mixed farming
Type of stock/breed: Merino weaners/hoggets

Key messages

- **Significant differences were observed between forage types in total live weight (LW) gain (barley 2.9 kg vs. sulla 5.1 kg) and the average daily weight gain (ADWG) (barley 81.2 g/day vs. sulla 150.2 g/day).**
- **No significant treatment differences were observed between the barley and the annual medic pasture in terms of total LW gain and ADWG.**
- **Analysis of the production data in relation to methane emission intensity, i.e. the output of methane per unit of production, showed significant differences between the two forages grazed in spring 2013 (barley 2.9 vs. vetch 1.0 L CH_4/hr/100g ADWG).**
- **Methane yield (%) and emission (g/day) increases with digestibility and energy density of the diet.**

Why do the trial?

Australia's livestock industry produces approximately 10% of the national greenhouse gas (GHG) emissions. Livestock emissions make up around 70% of total emissions from the agriculture sector. Methane (CH_4), an end-product of natural digestion from ruminants, is approximately 25 times more potent then carbon dioxide as a thermal warming gas. It accounts for 95% of total livestock emissions with the major sources being beef cattle (60%) and sheep (23%).

Methane emissions from livestock are often closely linked (inversely) to animal productivity, and the key factors that influence methane emissions are: digestibility, crude fibre content and energy density of the diet and feeding intensity. This project will seek to measure comparative animal production, feed quality and quantity and methane emissions in response to current and improved sheep feeding strategies. Ultimately the trial will provide the mixed farming industry with potential options to fill the late-spring and autumn feed gaps with highly digestible forages through which they can improve the productivity and profitability of their sheep enterprise, whilst reducing on-farm emission intensity.

How was it done?

2013 spring (PHASE 1): The trial commenced on 8 November 2013 with 200 mixed sex Merino weaners at an average live weight of 28.2 kg, split equally into groups of 100 animals. Project activity, forage intake and live weight data presented in the EPFS Summary 2013, p 141.

2014 winter *(PHASE 2):* The trial commenced on 12 June 2014 with 100 Merino wether hoggets (2013 July/August drop) at an average live weight of 45 kg split into two groups of 50 animals. Both treatments were replicated twice (Table 1). After a total of 47 days, methane production measurements commenced on 29 July 2014, and were completed over four days with 20 hoggets from each replicate within each group placed in a polytunnel for three hours of gas measurement at the same time (8–11 am) each day.

2014 spring *(PHASE 3):* The trial commenced on 10 October 2014 with 100 Merino ewe hoggets (2013 July/August drop) at an average live weight of 62 kg split into two groups of 50 animals. Both treatments were also replicated twice. After a total of 33 days, methane measurements commenced on 12 November 2014, and were completed over four days with 15 hoggets from each replicate within each group placed in a polytunnel for three hours of gas measurement at the same time (8–11 am) each day.

All methane sampled and measured was analysed in real-time with a sensor, which logged the data onto a computer every 30 seconds. This was performed by staff from CSIRO Agriculture Flagship, Perth, WA. Each sheep group was weighed the day following the polytunnel measurement at 10:30 am after an overnight fast. Pasture cuts were done before and after the hoggets grazed the paddocks to estimate dry matter intake and pasture quality.

Table 1 2014 treatment details

Phase	Treatment	Paddock size (ha)	Sheep per rep	Sowing date	Rep	Grazing dates	Available dry matter (tDM/ha)	Methane measurement date
Winter 2014	young barley crop	2.7	25	4 May	1	12/6 - 7/7	0.44	29 Jul
					1	8/7 - 28/7	1.38	
					2	12/6 - 7/7	0.40	31 Jul
					2	8/7 - 30/7	1.31	
	medic	7.5	25	self sown	1	12/6 - 29/7	0.83	30 Jul
					2	12/6 - 31/7	0.79	1 Aug
Spring 2014	standing barley crop	1.4	25	4 May	1	10/10 - 13/11	3.87	14 Nov
					2	10/10 - 15/11	3.91	16 Nov
	sulla	2	25	20 May	1	10/10 - 12/11	1.71	13 Nov
					2	10/10 - 14/11	1.45	15 Nov

What happened?

Spring 2013 Phase 1 methane results: The average methane emission for the group grazing the standing barley crop was 0.95 L/hr (0.68 g/hr) and was significantly lower ($P<0.05$) than for the groups grazing the vetch crop, with an average emission of 1.81 L/hr (1.30 g/hr, Figure 1). The almost 90% higher emission observed for the vetch group is assumed to be the result of the interaction between higher dry matter (DM) intake, of higher digestibility and higher crude protein content, leading to higher fermentation rates and shorter rumen retention times compared to the sheep grazing the barley crop.

The methane emission intensity was calculated in relation to the average daily weight gain (ADWG) estimates with data presented as L CH_4/hr/100 g ADWG. The average methane emission intensity for the groups grazing the standing barley crop was 2.90 L CH_4/hr/100 g ADWG (2.07 g/hr/100 g ADWG) and was significantly higher ($P<0.05$) than for the groups grazing the standing vetch crop, with an average emission intensity of 1.0 L CH_4/hr/100 g ADWG (0.72 g/hr/100 g ADWG, Figure 2).

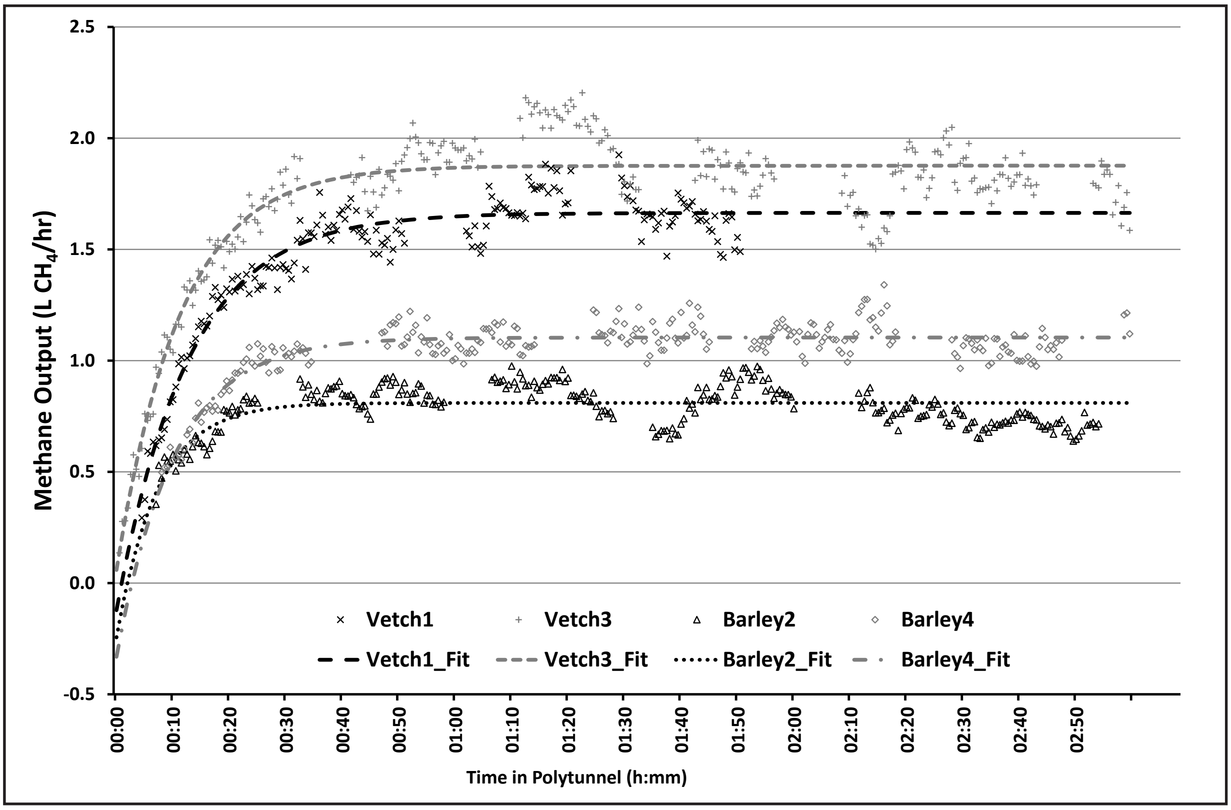


Figure 1 Estimates of methane output (L/hr/head) for the four sheep groups, measured in the polytunnel over three hours

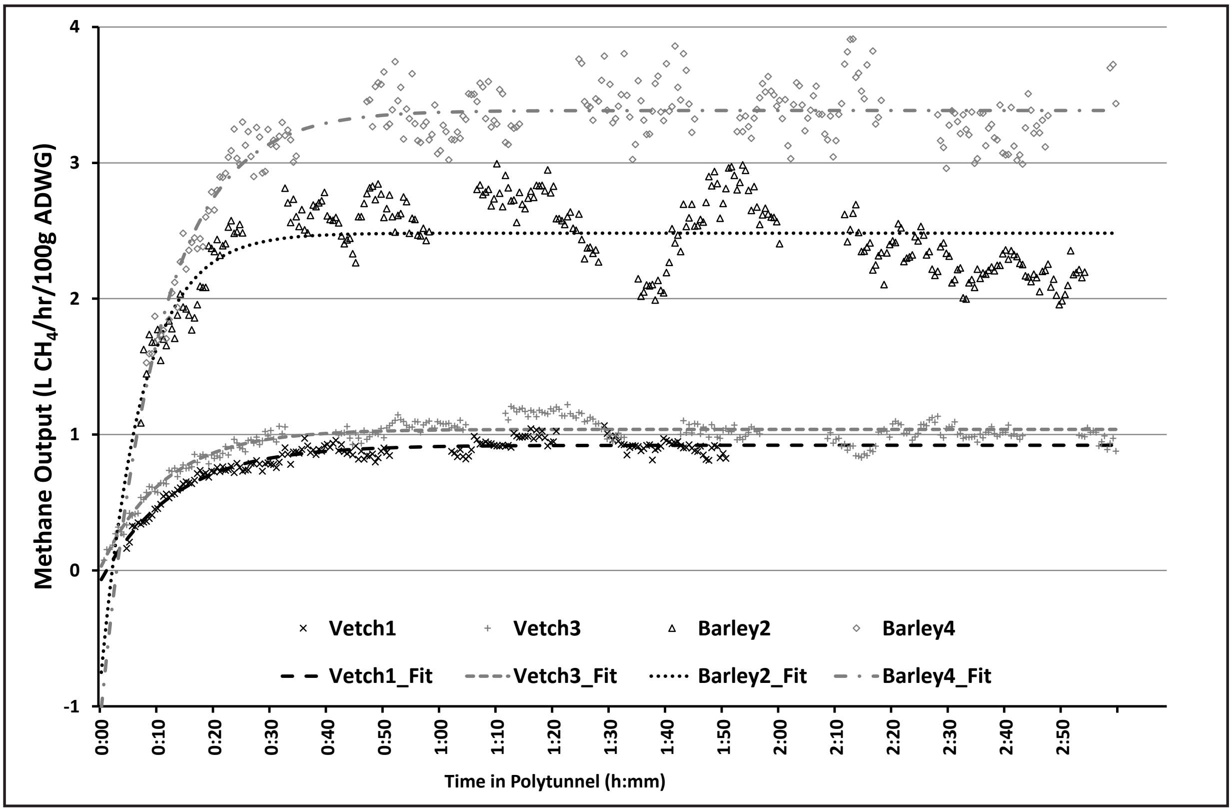


Figure 2 Emission intensity estimates of methane production per 100 g live weight gain (L/hr/100g ADWG)

Winter-spring 2014: Table 2 presents the estimates of stocking rate, dry matter (DM) consumption for the various forages for Phase 2 and 3, and feed quality figures from the DM sampled, after analysis through FEEDTEST Pty Ltd, a commercial laboratory. As one dry sheep equivalent (DSE) represents the consumption of 1 kg of pasture DM, estimates of biomass loss from grazing suggest levels of DM consumption in excess of potential limits of intake by young sheep. It is assumed that a large proportion of the DM loss is associated with trampling, natural breakdown and a component of sampling error.

A statistical analysis of the winter 2014 live weight data indicated that there were no significant differences ($P>0.05$) with the total LW gain and ADWG between the two treatments. Total LW gain was 11.4 kg and 10.7 kg for the 47 days in the paddock; ADWG was 237.7 g/head/day and 219.5 g/head/day for the barley and medic groups respectively (Table 3).

However, 2014 spring LW data indicated a significant response ($P<0.001$) in LW gain and ADWG between the two forage treatments. Barley group hoggets gained an average of 2.9 kg/head while the sulla group gained an average of 5.1 kg/head over the 33 day trial.

Table 2 Forage quality and utilization in 2014

Phase	Stock type/ age	Forage	Stocking rate (DSE/ha)	DM consumption (kg/head/day)	QUALITY		
					Crude protein (%)	Digestibility DMD (%)	ME (MJ/kg DM)
Winter 2014	merino wether hoggets (~12 months)	Barley	9	2.95	23	78.1	11.8
		Medic pasture	3	2.94	27.1	62	9.1
Spring 2014	merino ewe hoggets (~15 months)	Unharvested barley crop	21	3.66	7.3	75.7	11.4
		Barley grain			11.4	90	13.7
		Sulla	15	3.19	15.3	60.8	8.9

Table 3 Mean live weight changes in 2014

Phase		Mean live weight change		Significance	LSD (P=0.05)
		Barley	Medic		
Winter 2014	Stock numbers	40	40		
	Pre-grazing LW (kg)	44.9	44.9	ns	*1.3*
	Post-grazing LW (kg)	56.3	55.7	ns	*1.6*
	Total LW gain (kg)	11.4	10.7	ns	*1.3*
	Daily LW gain (g/head/day)	**237.7**	**219.5**	ns	*25.9*
		Barley	**Sulla**		
Spring 2014	Stock numbers	30	30		
	Pre-grazing LW (kg)	63.0	63.4	ns	*1.9*
	Post-grazing LW (kg)	65.9	68.5	P<0.05	*1.9*
	Total LW gain (kg)	2.9	5.1	P<0.001	*1.3*
	Ave Daily LW gain (g/head/day)	**81.2**	**150.2**	P<0.001	*36.2*

What does this mean?

There was a small difference between the barley vs. annual medic treatment (winter 2014), in relation to feed quality and availability. However there was no significant response in terms of LW gain and ADWG and hence this provides sheep enterprises with two pasture options that ultimately result in the same LW gains, particularly in a good season with good early rainfall to establish the barley. In spring 2014, the sulla group had 85% more ADWG (150.2 g/head/day) than the standing unharvested barley crop (81.2 g/head/day) and was attributed to the fact that the sulla had higher crude protein content (18.1%) than the barley crop (7.7%). Therefore sulla also represents a pasture option that farmers can adopt to fill the late spring feed gap in order to maintain and improve live weight gains in young animals. If a target of 10 kg LW gain to reach market specifications was used, the sheep grazing sulla would require 66 days, while the sheep grazing barley would require 123 days to go to market. This would have large implications for the total emissions between the two groups. We await the 2014 methane output data (from CSIRO, WA) for the barley vs. medic and barley vs. sulla trials.

For spring 2013, in relation to the management options introduced to fill the late-spring feed gap, the production system based on vetch would provide sheep enterprises with the opportunity to turn-off lambs faster e.g. 55 days to reach a 10 kg live weight gain target at 180 g per day growth rate. In comparison, the barley group would require about 300 days to meet the same 10 kg target at 33 g per day. A combination of high digestibility, crude protein percentage and reasonable level of crude fibre for vetch, were key in explaining the increased animal productivity and high levels of methane output, and this consequently resulted in low emission intensity for the vetch group (1.0 L CH_4/hr/100 g ADWG) as compared to the barley group (2.9 L CH_4/hr/100 g ADWG).

Acknowledgements

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Project codes: AOTGR 2 – 0039 Reducing methane emissions from improved forage quality on mixed farms.

Australian Government

working together for a clean energy future

EPARF EYRE PENINSULA Agricultural Research Foundation

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Benchmarking sheep enterprises using Breeding Value technology

Jessica Crettenden
SARDI, Minnipa Agricultural Centre

EXTENSION

Try this yourself now

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Livestock
Enterprise type: Commercial sheep flocks
Social/Practice
Time (hrs): Additional time required for additional measurements and data entry
Clash with other farming operations: Standard practice
Labour requirements: Some additional labour may be required depending on the type of measurements taken
Econimics
Infrastructure/ operating inputs: Computer software and some data collection equipment is required
Cost of adoption risk: Low

Key message

- **Breeding Values can increase productivity and profitability of a livestock business through long term improvement to genetics of the flock by benchmarking performance, continually setting higher targets and monitoring actual progress. The technology can also be used in conjunction with other sheep husbandry activities to increase labour efficiency. To be effective, the use of technology needs to be closely aligned with visual selection and the setting of stretch productivity targets in each individual flock in order to see significant improvement.**

Why do the trial?

The Eyre Peninsula has the proven capacity to produce productive and profitable sheep as a valuable component of the mixed farming system. Current market forces, a longer term consideration of climate change and the likely adaptations to whole farm systems provide a real opportunity for sheep to reinvigorate farming businesses in the area. Merinos have suffered from limited uptake of new technology in recent decades, but there is now good demand for medium wool, meat and restockers. For these reasons, a four year study was undertaken at the Minnipa Agricultural Centre to investigate new sheep breeding technology and management options. The project at Minnipa promoted ways to overcome barriers to new technology and aimed to show how Breeding Values could be used as a benchmarking tool to help set targets and monitor change towards achieving goals in breeding programs.

How was it done?

The project used the Merino sheep flock at Minnipa to demonstrate the genetic benchmarking system that is known as MERINOSELECT created by “Sheep Genetics” (a joint MLA and AWI project).The three main topics covered in the project were; use of the Minnipa demonstration flock to engage with ram buyers and breeders, technology transfer to ram buyers, and, technology transfer to ram breeders.

Over the four years of the study the key activities important for the Minnipa flock to create Breeding Values were demonstrated to breeders. These included mothering-up at birth, measuring body weights, wrinkle scores, wool weights and fat and eye-muscle depths, visual classing, side sampling for fleece quality measurements, ram inspection, ewe allocation and pregnancy scanning. How to efficiently collect and handle the sheep data using new technologies such as electronic ear tags, use of an auto-drafter, electronic scales, barcode reader and printer, stick reader, computer indicator and livestock management software were also demonstrated.

Measurements were submitted to MERINOSELECT for the 2010, 2011, 2012 and 2013 drops at yearling (Y) age (10-13 months). This process subsequently generated Australian Sheep Breeding Values (ASBVs), which are figures that aim to take the environmental effects (such as feed, birth type, seasonal conditions etc.) out of the actual measured trait and thus better reflect the actual genetic merit and potential of an animal. These Breeding Values are valuable productivity benchmarks but must also be complemented with the longstanding traditional visual assessment in order to stay “on track”.

What happened?

The Minnipa flock breeding objective was aimed to specifically increase growth rate (Ywt) (body weight at yearling age), fleece weight (Ycfw) and eye muscle depth (Yemd), reduce breech wrinkle (EBWR) and maintain micron (Yfd) and fat (Yfat). However every flock in the system has the ability to choose their own goals and relative emphasis between traits.

Table 1 Average Australian Sheep Breeding Values (ASBVs) of the 2010-2013 yearlings in the Minnipa flock

Drop Year	Ywt (kg)	Yfd (µm)	Ycfw (%)	Yemd (mm)	Yfat (mm)	EBWR (visual)	DP+*	No. head**
2010	2.0	-0.9	12.5	-0.1	-0.2	-0.3	134.4	361
2011	2.9	-0.5	13.8	-0.3	-0.3	-0.4	134.3	414
2012	3.9	-0.4	14.1	0.2	-0.1	-0.6	137.5	546
2013	5.1	-0.4	16.6	0.1	-0.2	-0.6	142	523
Change	*+3.1*	*+0.5*	*+4.1*	*+0.2*	*0*	*-0.3*	*+7.6*	*NA*

**The Dual Purpose (DP+) index ranks animals on their ability to produce merinos for a dual purpose operation. An index combines the values of several ASBVs into one figure.*

***Number of head represents all animals, including deceased, born in each drop year and submitted to MERINOSELECT*

ASBV results varied throughout the four years of data collection, "bouncing around" especially in the initial years of the project, as the Minnipa flock did not have good early linkage (use of sires with large numbers of progeny) in the MERINOSELECT data base or good internal flock linkage between years.

Over the 4 years this was gradually resolved by increasing the number of well-linked sires. The early data and flock structure at Minnipa was in a similar state to many breeders considering adoption of Breeding Value technology.

A summary of the ASBVs using July 2014 data are represented in Table 1. It shows that the change in ASBVs were in line with the Minnipa breeding objective.

Comparative results for the raw data collected from these years are displayed in Table 2, which shows a differing trend to the ASBV results and the environmental impacts (season, age, birth type, feed etc.) on actual production. A comparison of the results between Table 1 and Table 2 shows the benefits of Breeding Values over raw data for setting benchmarks and monitoring progress. Note the differences in the "Change" data in both tables.

Scanning and lamb marking results for the Minnipa flock have improved over the duration of the project (Table 3). These advances are due to better attention to sheep husbandry rather than genetic improvement. Dam ASBV for Number of Lambs Weaned (NLW) remained constant at 0.

The average ASBVs of the sires and dams used over the duration of the project reflects the Minnipa flock breeding goals and rate of gain in the flock (Table 4 and 5). The gains in their progeny are shown in Table 1. Note that the changes in ASBVs are recorded in Table 4 and 5 twice to reflect change during the project (2010-2013) and change after the project (2014-2015).

Table 5 shows the ASBVs for the dams. As many of the ewes in the early years did not have any recorded data, much of the current data comes from progeny testing (known sire and offspring performance). The rate of gain in the ewes was assisted by the high lambing results and thus high ewe culling that could take place across all ages.

Table 2 Average raw data values of the 2010-2013 yearlings in the Minnipa flock

Drop Year	Ywt (kg)	Yfd (µm)	Ygfw (kg)	Yemd (mm)	Yfat	EBWR (visual)	Y age (av. days)	No. head (Y age)*
2010	50.1	18.1	3.4	30.8	2.9	2.6	318	321
2011	47.1	18.6	3.7	34.7	3.7	2.2	327	394
2012	51.2	17.4	3.6	30.9	2.6	2.9	333	429
2013	46.3	17.5	3.2	27.7	3.0	3.8	312	434
Change	*-3.8*	*-0.6*	*-0.2*	*-3.1*	*+0.1*	*+1.2*	*NA*	*NA*

**Number of head represents only all alive animals born in each drop year and measured at yearling age*

Table 3 Fertility data of the 2010-2013 drop years in the Minnipa flock

			Animal numbers at yearling age					
Drop Year	Dam preg. scanning (%)	Lamb marking (%)	Age (av. days)	No. head	Singles	Multiples	Unknown birth type	Annual rainfall (mm)
2010	126	99	318	321	150	169	2	410
2011	126	121	327	394	96*	178*	120*	404
2012	160	130	333	429	66	344	19	253
2013	153	128	312	434	77	349	8	334

**The 2011 drop year pedigree was measured only through a DNA test; hence the number of unknown birth types due to some animals being sold off before the tests were taken*

Table 4 Average Australian Sheep Breeding Values (ASBVs) of the 2010-2015 sires used in the Minnipa flock

Year	Ywt	Yfd	Ycfw%	Yemd	Yfat	EBWR	DP+	No. head
2010	3.6	-0.9	13.8	-0.3	-0.4	-0.3	139.9	8
2011	5.2	-0.3	16.5	-0.6	-0.5	-0.4	142.3	7
2012	7.1	-0.1	16.1	0.4	0	-0.5	145.3	7
2013	8.2	-0.2	18.7	0.4	0	-0.6	148.9	8
Change	*+4.6*	*+0.7*	*+4.9*	*+0.7*	*+0.4*	*-0.3*	*+9.0*	*NA*
2014	7.8	-0.4	18.9	0.6	-0.1	-0.4	153.1	7
2015*	8.3	-0.3	22.9	0.5	-0.1	-0.4	164.1	8
Change	*+4.7*	*+0.6*	*+9.1*	*+0.8*	*+0.3*	*-0.1*	*+24.2*	*NA*

**shows the ASBVs of the 2015 sires to be used*

Table 5 Average Australian Sheep Breeding Values (ASBVs) of the 2010-2014 dams used in the Minnipa Flock

Year	Ywt	Yfd	Ycfw%	Yemd	Yfat	EBWR	DP+	No. head
2010	0.5	-0.7	11.6	0	-0.1	-0.2	127.6	246
2011	0.5	-0.7	11.7	0	-0.1	-0.2	128	182
2012	1.5	-0.6	12.5	-0.1	-0.2	-0.3	132.8	296
2013	1.7	-0.6	12.7	-0.1	-0.2	-0.3	133.3	296
Change	*+1.2*	*+0.1*	*+1.1*	*-0.1*	*-0.1*	*-0.1*	*+5.6*	*NA*
2014	2.4	-0.5	13.3	0	-0.1	-0.3	135	253
Change	*+1.9*	*+0.2*	*+1.7*	*0*	*0*	*-0.1*	*+7.4*	*NA*

What does this mean?

The Minnipa flock represents a flock similar to many Merino breeders on the verge of joining or those that have just joined MERINOSELECT. It offered an opportunity to demonstrate to local studs some of the vagaries that can occur in the initial years of benchmarking. Despite these challenges, over only three years considerable genetic gains were achieved in increased live weight, eye muscle depth, fleece weight, and reduced breech wrinkle in the Minnipa flock. The project also showed how MERINOSELECT can provide ram buyers with a system to benchmark their flock whilst assisting with ram purchasing decisions. Although the project aimed mainly to demonstrate MERINOSELECT as a genetic benchmarking system and what is involved in its implementation rather than simply validating the use of Breeding Values, the positive genetic changes in the Minnipa flock were an encouraging outcome.

Breeding Values have the potential to increase productivity by more accurately benchmarking performance, encouraging the setting of new targets and monitoring improvements. Much of the technology can also be used to increase labour efficiency. However, for effective use of the technology, it needs to be closely aligned with visual selection and breeding objectives to achieve long term success.

Most of the assessments were taken at young ages and the comparison of the young and older age assessments were not possible in this project. The project demonstrated how the protocols can be adopted into ram breeding businesses and showed the technology has the potential to benchmark with reasonable clarity and progress towards the chosen breeding objective.

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Livestock

Investing better in sheep through ram selection

EXTENSION

Ken Solly
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Key messages

- **Sheep enterprises deserve the same degree of managerial input as does cropping.**
- **Strategic investment in livestock can pay huge dividends.**
- **Learn how to use genetic tools so better ram investments can be made.**
- **Be objective and take the guess work out of buying rams.**
- **Use a measure to manage approach to quantify the gains made by using better rams.**

Why do the trial?

Nothing draws an argument more than the constant debate of the role of sheep on cropping properties. With the demise of 100 million sheep from the national flock it would appear that the croppers have won or are winning the debate, however like all situations there are exceptions to the rule. In lower rainfall districts it is difficult to build stocking rates to the level required to compete with cropping on a gross margin basis, however basing decisions solely on gross margin has its limitations too. Cropping income is greater but more volatile, whereas sheep income can be more reliable. Most farmers fall into either a cropper or stockman category and in many areas sheep become secondary to the crop and this is reflected in the margins achieved. If some sheep enterprises had the same level of managerial input as the crop then predictively the resultant sheep margins would be much higher. Croppers almost universally use an agronomist whereas a sheep consultant would never have set foot on most farms. This said, the sheep may not match the crops, but there may be opportunities to change the ratio of crop to sheep on some properties.

Most mixed farming enterprises currently have a disproportionate amount of capital investment between cropping and sheep. This is well understood given the scale and profitability of each. However, there are also many properties where the investment in sheep has been subsidised by the cropping enterprise. The cropping scale is such that it can justify each of the major expenditures whereas the sheep will never get to the income level required to warrant investment in some of the modern technology.

How was it done?

One area that lamb and wool producers can invest in, regardless of the size of their flock, is in the area of genetics. Regardless of whether you require six new rams per year or sixty, you can invest wisely to a higher level knowing that the returns are there. LAMBPLAN and MERINOSELECT are proven objective measurement systems, resulting in quantifiable gains in both the short and long-term.

What happened?

Those with limited knowledge of Australian Sheep Breeding Values (ASBVs) commonly say it is all well to know the figures but how much can I afford to spend on ram A over ram B? Table 1 goes part way to making that decision. In this example two terminal rams have been chosen on post weaning weight (PWWT, 200 days) for comparison. Ram A is in the top 15 percentile band and is 14 kg above the average when compared to the average ram in 1990 when the current LAMBPLAN was implemented. Ram B is in the 60th percentile and has a PWWT of 11 kg above the 1990 average. A 3 kg difference at 200 days would be difficult to assess by eye.

Because the ram contributes half to the resultant progeny, a 1.5 kg live weight difference in progeny could be expected by using ram A instead of ram B (Table 2). If the lamb carcases dressing percentage is 44%, the progeny from ram A would return 0.66 kg/lamb more carcase weight than the progeny from ram B. Using a joining percentage of one percent (one ram to 100 ewes mated), we could expect around 80 ewes to be joined per ram. At a 100% weaning and using the rams for four seasons, this would result in around 320 lambs sired in a ram's lifetime. 320 lambs that have an additional 0.66 kg carcase weight means an additional 211 kg of lamb carcase weight from ram A over ram B. Priced at $4.20/kg carcase weight average results in a total difference of $887 between ram A and ram B in their lifetime.

***Table 1** Estimating ram values*

	Ram A	Ram B
ASBV PWWT	14	11
Percentile band	Top 15%	Top 60%
Difference in PWWT (A vs B)	+3	
Difference in live weight at time of sale (A vs B)	+1.5 kg	
Predicted difference in carcase weight (44% dressing)	+0.66 kg/lamb	

**shows the ASBVs of the 2015 sires to be used*

Although the income difference has been established between the two rams based on PWWT, it is also important to consider other traits important to your breeding objective when buying the best rams for your flock. If you were to base a decision just on PWWT then it would need to be decided how much of the $887 of additional income from ram A can afford to be spent to secure a ram purchase. To spend all of it would be futile but the fraction you need to spend and have a useful gain left over will depend on many factors. The quality of the ewes to be mated, the state of the market and the appropriateness of the traits used in relation to the target market should also be considered. Typically, the more traits you select for, the less chance you have of optimising any one trait.

Other factors that will impact on your ram buying decision are your ram cost per lamb and the total returns in the lifetime of the ram. Table 3 shows the cost impact of lambs sired and weaned in a ram's lifetime relative to the amount paid for that ram. It must be noted that individual ram cost per lamb can be twice and three times the cost depending on the price paid combined with the potency and longevity of the ram. Ram A lambs return $2.77 per head in carcase value better than ram B which is the $887 gross difference divided by the 320 of progeny.

Table 4 demonstrates the total financial return from lamb carcase weight and skins from progeny in a ram's lifetime using a range of number of lambs sold per ram. Only half of this income can be attributed to the ram but at $4.20 per kg carcase weight and $6 skins it is a substantial amount of income that a ram can influence. In recent times both these prices have been higher which further increases the ram's impact.

What does this mean?

Prescribing a price to pay for a given individual ASBV is not appropriate as other factors come into the decision. This is even more so in maternal flocks where replacements are being bred and retained. Understanding ASBVs in the first instance is essential to you selecting the right ram for your breeding objective and then paying a sensible price. To bury your head in the sand and just go ahead and buy the biggest and best looking ram for a very high price may get your name and photo in the Stock Journal but this decision may not impact your bottom line. If however you buy a later born twin lamb ram that is sound but may not look so grand, has higher ASBVs and you pay hundreds of dollars less, then your bank account should smile back at you. Doing the right thing is always paramount but doing things right is also just as important.

Table 2 Contribution of genetics - half from ram & half from ewe

Number of ewes joined	80
Weaning percentage	100%
Number of years ram used	4
Total progeny per ram	320 lambs
Total predicted gain in carcase weight	211 kg
Average price received per kg carcase weight	$4.20
Difference in income between ram A & B	$887

Table 3 Ram cost per lamb

Ram purchase price	**Lambs weaned in life of ram**		
$/head	**200**	**250**	**300**
$800	4.00	3.20	2.67
$1,000	5.00	4	3.33
$1,200	6.00	4.8	4.00
$1,400	7.00	5.6	4.67
$1,600	8.00	6.4	5.33

Table 4 Total lamb returns in a ram's life

		Number of lambs per ram		
Average carcase weight per lamb	**22**	200	250	300
Total carcase weight	**kg**	4400	5500	6600
Price per kilogram carcase weight	**$**	4.2	4.2	4.2
Dollars returned per ram (and ewes)	**$**	18,480	23,100	27,720
Skin value per lamb/s	**$6**	1,200	1,500	1,800
Total value carcase and skins	**$**	19,680	24,600	29,520

Grazing crops – gambling with the mixed farming system?

DEMO

Jessica Crettenden

SARDI, Minnipa Agricultural Centre

Searching for answers

Location:
Lock
Gus Glover
Rainfall
Av. Annual: 345 mm
Av. GSR: 265 mm
2014 Total: 356 mm
2014 GSR: 240 mm
Paddock History
2013: Pasture (demo 1), wheat (demo 2)
Soil Type
Grey sandy loam
Plot Size
45 ha paddock (demo 1), 48 ha (demo 2)
Yield Limiting Factors
Early finish (both demos) aphids affected early growth (demo 2)
Livestock
Enterprise type: Mixed
Type of stock/breed: First cross Dohne x White Suffolk

Key messages

- **Grazing barley provided substantial feed for the sheep at a time of year when pastures were slow and accordingly it allowed pastures the opportunity for accelerated production. Removing sheep after one graze allowed the crop time to recover to produce an average yield of 2.45 t/ha, with the additional benefit of feed for 1400 DSE over one month.**
- **Grazing the vetch over four months allowed the feed base to establish well and bulk up, providing an exceptional feed source for ewes and lambs. The 5005 DSE had a total of two months of quality feed allowing lambs to be sold directly off the ewes due to their considerable weight gain over this period.**
- **The flexibility of both of these crops offers a variety of in-season opportunities and end-season uses and successful implementation of grazing crops into mixed enterprises can deliver indirect benefits to the whole farming operation.**

Why do the demonstration?

Many mixed farmers have gambled with grazing crops at different times of the year with very diverse results. Numerous aspects determine whether the practice of grazing crops is a success or failure and these variants will also govern the outcome of the crop – grain, graze, hay or a combination of these. No matter how you do it, the next year will never be the same as the last, and similar to farming in general, it comes down to a throw of the dice, plus good, calculated and timely choices.

How was it done?

To help understand the variability involved in grazing crops in mixed farming systems, two demonstrations were undertaken at Lock with barley (Demonstration 1) and vetch (Demonstration 2), which were grazed throughout the growing season to determine how the sheep and cropping enterprises could best fit as a combination (Table 1).

Demonstration 1 was grazed using first cross Dohne x White Suffolk ewes and lambs for 29 days in total with an average of 31 DSE/ha from the 18 June to 4 July 2014. Demonstration 2 was grazed over five different periods from 25 June to 8 September 2014 for 66 days in total using first cross Dohne x White Suffolk ewes and lambs with an average of 21 DSE/ha. In both demonstrations there was no supplementary feed provided throughout the duration of grazing. Sections of the paddocks were fenced off using electric fence to avoid over-grazing, however the 'paddock area' in Table 1 describes the total area grazed.

Biomass cuts were taken from each demonstration pre and post grazing and feed quality was analysed from the pre-grazing samples. Pasture cages (1 m^3) were placed in the paddock to calculate the approximate amount of biomass removed from the paddock as a result of grazing. The grazed barley in Demonstration 1 was sampled on 15 October 2014 for yield and grain quality and was harvested by the farmer and the vetch was completely grazed until only enough biomass to cover the soil remained.

What happened?

Demonstration 1: Sheep were put on the paddock with an average 1.2 t DM/ha feed on offer (FOO) and at post-grazing there was 2.8 and 2.5 t DM/ha of barley biomass remaining in the grazed and un-grazed areas respectfully. The results from the feed analysis report for the barley showed a dry matter of 11.8%, crude protein of 23.2% of dry matter, neutral detergent fibre of 42% of dry matter, digestibility (DOMD) of 74% of dry matter and estimated metabolisable energy of 12 MJ/kg DM.

Table 1 Information for Demonstration 1 and Demonstration 2 undertaken at Lock

	Demonstration 1	Demonstration 2
Paddock area	45 ha	48 ha
Crop type and variety	Fathom barley	Rasina vetch
Sowing date	5 May 2015	15 April 2015
Sowing/fertiliser rates	60 kg/ha with 60 kg/ha DAP	40 kg/ha with 40 kg/ha DAP
2013 paddock history	Pasture (self-sown medic/mixed)	Wheat
Weed control at sowing	(4 May - *grass and broad-leaved*) 1.5 L/ha 540 glyphosate, 100 ml/ha oxyfluorfen, 1.5 L/ha Treflan	(15 April - *grass and broad-leaved*) 1.2 L/ha glyphosate, 100 ml/ha oxyfluorfen, 500 g Simazine
Weed control in-season	(mid-July - *turnip, mustard*) 400 ml/ha LVE MCPA, zinc manganese copper blend, 400 ml/ha propiconizole	(19 June – *grass*) 400 ml Targa (24 Sept – *grass*) 800 ml paraquat
Disease/pest control	(28 Aug - *net blotch, aphids*) 400 ml propiconizole, 150 ml/ha alpha cypermethrin	(19 June – *cowpea aphids*) 200 ml Lemat

There was a large range in yields due to soil variation across the paddock with between 1.8-4 t/ha for the grazed area and 1.3-5.4 t/ha for the un-grazed exclusion cages. The un-grazed area yielded 0.1 t/ha more than the grazed paddock area on average with 2.5 t/ha and 2.4 t/ha respectfully. Grain quality was measured with 4% less screenings after grazing; however no other notable differences were measured.

Demonstration 2: There was an average of 1.1 t DM/ha of FOO prior to grazing the vetch paddock and after the first 21 days of grazing there was 2.0 and 2.1 t DM/ha remaining in the grazed and un-grazed areas respectfully. There was less than 0.5 t/ha of residual biomass on the paddock after the complete 66 days of grazing, therefore sheep were removed to avoid erosion issues. The results from the feed analysis report show that the vetch contained 12.8% dry matter and had higher crude protein content of 30.7% of dry matter, lower neutral detergent fibre of 37.5% of dry matter, lower digestibility (DOMD) of 68.5% of dry matter and lower metabolisable energy of 10.9 MJ/kg DM than the barley.

What does this mean?

Demonstration 1: Using estimated barley growth rates for the 2014 season at Lock of 50 kg DM/ha/day, approximately 1.4 t DM/ha would have been produced in the paddock over the grazing period. Therefore the assumption is that sheep removed approximately 3.0 t DM/ha over the period of grazing, equating to a feed intake of 3.3 kg DM/DSE/day. The quality of the barley was sufficient for young, quick growing lambs and lactating ewes for all results from the feed analysis. Crude protein levels were exceptional, which would have counteracted the fact that for the assumed feed intake, 2.9 kg DM/DSE/day or 88.2% of the feed content would be water, requiring a considerable amount of ingestion of barley to achieve the protein and energy levels required, which is normal for cereal crops in the vegetative phase. However, the key benefit of grazing the barley was that this provided a month of substantial feed for the sheep, equating to 1400 DSE, at a time of year when pastures were slow and thus it allowed the opportunity for pasture reserves to establish for use later in winter.

Due to the size and shape of the paddock, including scrub layout, the area was grazed quite unevenly. Once the barley had recovered after the first graze, the growth stage of the crop posed a risk to yield if grazed (nearing GS30), therefore the paddock was left to target grain production.

Demonstration 2: Using estimated vetch growth rates for the 2014 season at Lock of 80 kg DM/ha/day, during grazing approximately 5.3 t DM/ha would have been produced over this period. Assuming this growth rate, the sheep would have removed approximately 6.2 t DM/ha over the period of grazing, which equates to an average feed intake of 4.5 kg DM/DSE/day. Similar to the barley, the quality of the vetch was sufficient for the requirements of the sheep grazing. Results showed excellent protein and digestibility levels, which offset the large quantity of feed that needed to be consumed to gain the required nutrition due to the high moisture of 87.2% in the vetch. However the nutritive content of the feed would have changed to have a higher percentage of dry matter as this paddock was grazed over a longer period of time and into the spring when the vetch was beginning to hay off, especially with the dry finish experienced in 2014.

The method in which the vetch was grazed (five times for no longer than three weeks at a time), allowed the feed base to establish well and bulk up during the vegetative phase in order to provide exceptional feed value for the ewes and lambs when they needed it most. Visually, the sheep equating to 5005 DSE grazing the vetch did extremely well, allowing lambs to be sold directly off the ewes due to their considerable weight gain over this period. Similar to the barley, other pastures could be relieved from this grazing pressure.

The adaptability of both of these crops offers a variety of in-season opportunities and end-season uses. On any given year, the results of these two demonstrations may have been different according to the choices made with crop agronomy and livestock management as well as seasonal variability, which are the risks that mixed farmers must be willing to accept if attempting to graze crops. The successful implementation of this practice can deliver indirect benefits to the whole farming operation, as observed in these demonstrations. The secondary advantages can include management flexibility, increased stocking rates, business risk mitigation, as well as the implications for weed and disease controls, all which contribute at the whole-farm scale level. Mixed farming is a balancing act - there are both risks and rewards involved, however calculated and timely choices can provide substantial benefits and also supress the risk associated with the integration of livestock and cropping systems through grazing crops.

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Grazing crops in practice

Alison Frischke and Dannielle Ick
BCG, Victoria

EXTENSION

Try this yourself now

Location:
Patchewollock
Rainfall
Nov - Oct total: 167 mm
2014 GSR: 127 mm
Paddock History
Wheat stubble 1000 kg/ha
Soil Type
Clay loam
Plant Available Water
1 mm on 13/2/14

Location:
Jil Jil
Rainfall
Nov - Oct total: 148 mm
2014 GSR: 108 mm
Paddock History
Wheat stubble 1000 kg/ha
Soil Type
Clay loam
Plant Available Water
49 mm on 22/4/14

Location:
Normanville
Rainfall
Nov - Oct total: 239 mm
2014 GSR: 168 mm
Paddock History
Field pea stubble 200 kg/ha
Soil Type
Clay loam
Plant Available Water
67 mm on 25/3/14

Key messages

- **Forage barley variety Moby has vigorous early growth and matures quickly, and should be grazed sufficiently early to enable recovery for a second grazing.**
- **Spring wheat variety Bolac maintained yield when sown early and grazed in 2014.**
- **Winter wheat variety Wedgetail can be sown very early (March-early April) in low rainfall areas to utilise early rainfall, and widen both the sowing and flowering window of crops.**

Why do the trial?

Greater attention is being paid to using late summer rainfall prior to the growing season to increase on farm water use efficiency (WUE). Earlier sowing of a cereal is one way of capitalising on early moisture. Crops emerge quickly and can grow while soils are still warm, giving mixed farmers the opportunity to fill an early winter feed gap for sheep. Cereals provide nutritious feed for all classes of sheep, including high nutrient demand ewes in late pregnancy or lactation and growing lambs.

Previous research undertaken through Northern Victorian Grain & Graze 2 program, together with local experience, has indicated that for low rainfall systems there are three options that will make the most of the grazing crop opportunity: an April sown specific forage type cereal, a mid-late April sown spring cereal, or a March sown winter-type cereal.

Careful crop and animal management is needed to make best use of the different growth types. Growers must respond to each season's conditions in order to provide timely feed for animals, and allow for plants to recover from grazing. Crops may then be used as forage or hay, or be left to mature and fill grain. In 2014, Grain & Graze 3 followed three growers and recorded their experiences.

Aim

To monitor the feed value and grain production from different types of grazed cereal crops in low rainfall Northern Victoria.

How was it done?

Paddocks of cereal sown and managed by farmers were grazed and monitored at Patchewollock, Jil Jil and Normanville (Vic) in 2014. At Patchewollock and Normanville dry matter cuts were taken prior to grazing by sheep to estimate forage value, nutrition and dry matter. Three 2.5 x 2.5 m cages were erected across the paddock to exclude sheep and provide ungrazed crop areas.

At Jil Jil, the adjacent fenced paddocks provided the grazed and ungrazed comparisons. At crop maturity, dry matter cuts of crop were taken at all sites to estimate final dry matter production and grain production.

The Jil Jil and Normanville paddocks were harvested using farm machinery. The crop at Patchewollock was not harvested.

What happened?

Patchewollock

Kevin and Tracey Hynam had sown the forage cereal Moby barley (a fast maturing barley bred specifically for dry matter production) for two seasons and had been impressed by the amount of forage it produced for their sheep. In 2014, Moby barley was sown on 10 April into a 10 ha paddock at 40 kg/ha in 30 cm spacings (as well as four other paddocks sown into existing lucerne stands at a lighter sowing rate of 20-30 kg/ha) after receiving 30 mm early rainfall.

After eight weeks, on 12 June, when plants were 35-40 cm high and had 8-10 tillers, 130 ewes with 100 lambs at foot were allowed into the crop. There was about 0.90 t/ha of dry matter available at that time (Table 1). The sheep remained grazing the paddock until 10 July. The paddock was then broadcast with 50 kg/ha urea the same day the sheep were removed, with the expectation the crop would grow back and provide a second grazing period.

Table 1 Dry matter (DM) production of ungrazed and grazed Moby barley, Patchewollock 2014

Date	12 June	17 July		23 October	
Location	Pre-grazing DM (t/ha)	Ungrazed DM post grazing (t/ha) (t/ha)	Grazed DM post grazing (t/ha)	Ungrazed final DM/ha (t/ha)	Grazed final DM/ha (t/ha)
Cage 1	1.08	2.53	1.20	2.18	0.89
Cage 2	0.51	2.64	1.47	2.43	1.41
Cage 3	1.02	2.13	1.08	2.11	1.12
Average	*0.87*	*2.43*	*1.25*	*2.24*	*1.14*

The 2014 growing season experienced above average temperatures. The warm conditions caused Moby to race through its growth stages. This was more apparent where the crop hadn't been grazed; the crop was taller but visually it also turned off faster. Crop that had been grazed stayed greener for longer and a small amount of green remained in the stalk in October. Very little rainfall was received once the sheep were taken out in July. Unfortunately the crop was unable to recover (Table 1) and was not harvested.

Feed tests measured 18% crude protein, 9.1 MJ ME/kg and 54% NDF. Usually ME levels in Moby are adequate, but in this case the feed test (possibly due to drier conditions) suggests that a supplement would be of benefit if grazing with pregnant/lactating ewes or fast growing lambs.

One of the lucerne-Moby paddocks next to the sheep yards on higher, lighter ground recovered much better after being eaten to the ground, and grew back to about 15 cm high. It was used as a standing hay crop for joining 70 ewes in November, providing another four weeks of grazing. By then it was grazed out. The other lighter soil lucerne-Moby paddocks also performed better and were able to sustain two grazing periods during the season.

A paddock of Scope barley was also grazed by cattle. The grazing period continued for a little longer than desirable, and cattle grazed the crop down to 5 cm. Cattle were taken off at the end of July but, with no further rain, recovery was poor. The grazed Scope barley yielded 0.6 t/ha, half the yield achieved by ungrazed crops. In past seasons, however, Scope has been grazed successfully without the crop suffering a yield penalty.

The Hynams use Moby and Scope according to each paddock rotation. Moby is used only for forage, and often drilled into lucerne stands. It grows faster earlier and develops a more robust plant that can be grazed two to three times. Scope, on the other hand, is predominantly a grain crop, but offers a useful single grazing opportunity.

All types of stock are grazed on the cereal crops. Kevin Hynam has noticed that cattle will graze a paddock more evenly than sheep, but sometimes will pull plants out. Sheep tend to camp in certain areas more than cattle do.

In 2015 Kevin and Tracey plan to drill Moby back into the lucerne country at 30 kg/ha sowing rate, with 50 kg/ha single super. This helps to add bulk to the lucerne stand while providing some phosphorus. Due to the farm's rotations, there will be less Scope barley planted in 2015. The 2014 trial paddock will be sown to Wombat oats which will be harvested and used later for feeding sheep.

Jil Jil

Despite not having had great success with some smaller grazing crop trial areas in the past using early-mid varieties, the McClelland family was keen to try the practice again with some changes to manage grazing risk to grain yield. This time they chose to use a slower maturing variety, aimed for an earlier sowing opportunity, and planned to remove sheep earlier (before GS30).

Bolac wheat had been purchased in 2013 with the intention of early sowing that season, but the opportunity never presented itself. Bolac wheat has a spring habit, is slow maturing (slower than other varieties used on the farm) and has a good disease profile.

The 2014 season began with the required opening rain and the chance to sow was seized. Two adjacent paddocks (40 ha and 90 ha) were sown with the Bolac wheat (AH in Victoria) on 17 April after receiving 46 mm of rainfall between 8-10 April. The crop was sown at 50 kg/ha with 50kg/ha of fertiliser (27:12).

The 90 ha paddock was left ungrazed, while the 40 ha paddock was grazed by approximately 400 ewes for three weeks from 9 to 30 June, at which time the crop was approaching GS30. Sheep were then removed, the paddock top-dressed with 75 kg/ha of urea then left to mature. Crops were harvested on 7 November. The crop recovered well, as moisture was still present at the time. The lower biomass levels were probably advantageous in the long run when an exceptionally dry spring eventuated.

Table 2 Final dry matter production of ungrazed and grazed Bolac wheat, Jil Jil 2014

Paddock location	Ungrazed final DM/ha (t/ha)	Grazed final DM/ha (t/ha)
Western end	1.8	1.1
Eastern end	1.0	0.9
Average	*1.4*	*1.0*

Final dry matter production of the mature crops was lower for the grazed, compared with ungrazed, crop (Table 2). This didn't translate into a yield differences, however, with crops averaging 0.88 t/ha for both paddocks. Grain quality of Bolac met APW specifications for protein, but both grazed and ungrazed crops had high screenings (6–7%).

The early sown slow maturing wheat worked well for McClellands in 2014. These crops yielded 20 per cent better than spring wheats sown in adjoining paddocks. The sheep were able to graze on the crop, letting other pasture areas bulk up, and crop yields were unaffected.

The McClellands will continue to use long season wheats in their sowing variety mix. As well as crops being valuable fodder for the sheep, the practice appeals because they are keen to capitalise on earlier rainfall events with extra varieties to extend their sowing period. A further advantage is that there will be two fewer paddocks to be sown later. In addition, by switching varieties during sowing, they can spread out flowering windows to help to manage the risk posed to crops by frosts.

In 2015, having the seed on hand they will use the spring-type Bolac again, but would consider a winter wheat if a variety with a good disease profile were made available. Grazing will be dependent on the season. They intend to take advantage of the feed potential in situations in which the crop is healthy. Sheep are highly valued as contributing positively to their farm business, providing useful cash flow when cropping seasons are poorer. They are also used to manage stubbles.

Normanville

Geoff and Bronwyn Hunt sowed Wedgetail wheat (APW in Victoria) on 9 March for the first time on their property. Wedgetail has a winter habit and is a slow maturing variety. It was sown into a 10.5 ha paddock following 45 mm on 4 March. Another 9 mm fell on 15 March to help establishment along. The crop was sown with 20 cm row spacings at 28 kg/ha with 30 kg/ha MAP.

When the crop was eight weeks old on 8 May, it was standing 40 cm high and had up to 20 tillers per plant. 154 agisted pregnant and lambing ewes were put into the crop and remained there until 12 June. About 1.5 t/ha of dry feed was available (Table 3), and feed tests measured adequate nutrients for the sheep with 17.5% crude protein, 11.9 MJ ME/kg and 40.4% NDF.

While on the crop, several ewes had lambs. The same day sheep were removed, 40 kg N was applied as UAN, and the paddock was locked up and left to mature.

When sheep were removed from the Wedgetail crop on 12 June, there was still plenty of feed available (8-10 cm high, with 1-2 weeks of grazing potential remaining), but plants were reaching GS31 and the Hunts didn't want to compromise grain yield.

Bronwyn was impressed by the way the crop recovered, which is reflected in the final cut measures for dry matter (Table 3). Grain yield was reduced across the paddock by grazing, the quadrat cuts indicate from 1.23 to 0.94 t/ha. However, actual grazed paddock yields were higher at 1.74 t/ha on average. The crop had some issues with establishment (thought to be residual herbicide following chickpeas), suffered from Crown rot (about 10-20% of the paddock) and some frost damage, but in well-established areas it yielded about 2.2 t/ha. The crop was also short of nitrogen leading up to GS30, but this could not be addressed until the sheep were removed.

A nearby paddock of Grenade sown on 25 April yielded 2.72 t/ha.

The Hunts found the whole grazing crop experience interesting and feel it has potential in their farming system. While they don't own their own sheep, they regularly agist some neighbours' sheep to graze stubbles. They weren't concerned about putting sheep onto their growing crop as they were aware of the theory behind the practice and knew Wedgetail was very capable of recovering biomass. Nevertheless, they were glad to see that reality endorsed theory.

In 2015 the Hunts plan to sow Wedgetail in March again if it rains as it did in early 2014. They feel that if the next sowing rain in 2014 had been in July, the yield of conventional crops would have looked quite different. As it was, they had a perfect start to the conventional year. They will use Wedgetail again as they have the seed on hand already.

Looking to the future, the Hunts would like to see a better adapted winter wheat variety available for their area. They plan to store seed wheat with a winter habit so that if the sowing rules are met early in the year, they will sow one paddock at low rates (due to high tillering potential) to spread risk. However, they are not sure whether they will always graze it; they will make that decision on a year-to-year basis. Though they do not own sheep themselves, this strategy would always be considered as an opportunistic management decision.

Table 3 Dry matter production of ungrazed and grazed Wedgetail wheat, Normanville 2014

Date	8 May	19 Nov			
Location	**Pregrazing DM (t/ha)**	**Ungrazed final DM/ha (t/ha)**	**Grazed final DM/ha (t/ha)**	**Ungrazed grain yield (t/ha)**	**Grazed grain yield (t/ha)**
Cage 1	1.38	6.60	7.15	0.91	0.90
Cage 2	1.50	6.34	6.54	1.39	0.90
Cage 3	1.82	7.57	6.10	1.39	1.03
Average	*1.57*	*6.83*	*6.60*	*1.23*	*0.94*

What does this mean?

Commercial practice on-farm

An early sown cereal crop can provide valuable feed for livestock before legume pastures are ready to be grazed. To get the best value from the cereal crop, sow early to take advantage of early moisture and produce feed sooner. Sow a forage cereal purposely bred for grazing value or a longer season oats or barley in April. Alternatively, sow dual-purpose winter wheat in March/early April or a longer-season spring wheat in April.

Spreading the window of sowing to include earlier weeks during March or April, using slower maturing varieties makes better use of early moisture, reduces pressure at sowing time and helps to spread the flowering period of crops later in the year. These strategies assist growers to manage the use of rainfall across the season and minimise the risk of frost damage during flowering.

Profitability

Improving production by increasing the survival rate of ewes and young lambs, and achieving better growth rates in lambs can be achieved by using a cereal crop to produce fast establishing feed early in the year. The cereal can be sown into existing pasture stands or as a crop that can be later harvested for grain.

Sowing slower maturing varieties early in the season can capitalise on early rainfall and help expand flowering windows, reducing the risk of frost damage.

Acknowledgements

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The effect of grazing intensity on crops

Alison Frischke and Dannielle Ick
BCG, Victoria

RESEARCH

Searching for answers

Location:
Quambatook
Rainfall
GSR (Apr - Oct): 168 mm
Soil Type
Clay loam without sub-soil constraints

Key messages

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

Background

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

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

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

Why do the trial?

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

How was it done?

A replicated field trial was sown using a split plot trial design with time of sowing as main plots and variety x grazing as sub-plots. Winter wheat varieties Rosella and Revenue were sown at time of sowing 1 (TOS1) on 1 April. TOS1 occurred after receiving 50 mm of rain during March, with 10 mm falling just prior to sowing. Mid and short season varieties Scout and Mace were sown (TOS2) on 6 May. TOS2 occurred after 30 mm of rain during April, with 13 mm falling just prior to sowing. All plots established very evenly.

Seeding equipment: Knife points, press wheels, 30 cm row spacing
Target plant density: 150 plants/m^2
Harvest dates: 14 November (TOS1) and 1 December (TOS2)
Fertiliser: Granulock supreme Z @ 50 kg/ha at sowing plus 180 kg/ha of urea (83 kg N/ha) top-dressed in two separate applications.
Pests, weeds and diseases were controlled to best practice commercial standards.

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

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

Using dry matter (DM) and feed tests, dry sheep equivalent (DSE) grazing days were calculated as follows: DSE grazing days = DM (kg/ha) x feed test metabolisable energy (ME) / 8 MJ, which assumes that each DSE requires 8 MJ ME/day.

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

What happened?

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

Grazing value

Early grazing of crops occurred at GS16 when plants were 25-35 cm. Late grazing occurred when plants were at GS30-32 when crops were 40-45 cm tall. All light grazes were to 25 cm, moderate to 15 cm and heavy to 10 cm. Feed tests indicated that all crops had adequate protein, metabolisable energy (ME), and fibre (NDF) to support lactating ewes and growing lambs (16% protein, 11 MJ ME/kg and >30% NDF). As crops matured, or were more intensely grazed, nutrient value reflected the change in plant structure with age and proportion of leaf: stem (Table 1).

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

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

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

Grain value

Rosella: Despite a reduction in anthesis dry matter for later grazed crops, grain yields were unaffected by grazing at any stage or intensity in 2014 (Table 2). The early sowing in April gave Rosella sufficient time in the season to recover and maintain production. However, Rosella yields were poor compared with the neighbouring Early Wheat Trial (av. 1.7 t/ha), for which the reason is unknown. Plants that have lower yield potential need fewer resources to be able to recover and maintain grain yield when grazed.

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

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

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

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

What does this mean?

Commercial practice

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

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

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

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

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

Table 4 Feed value, grain yield and quality of Mace wheat grazed at different growth stages and intensity, Quambatook 2014

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

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

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

On-farm profitability

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

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

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

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Section 7

Section Editor:
Brian Dzoma
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Soils & Tillage

RESEARCH

A survey of soil organic C and dissolved organic C on the upper Eyre Peninsula

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Key messages

- **Soil organic carbon (C) concentrations from paddocks on the upper Eyre Peninsula are comparable to concentrations measured on alkaline soils from the Lower North of South Australia, but higher than those from paddocks in north-western Victoria.**
- **High soil pH was associated with lower concentrations of soil organic C and increased concentrations of dissolved organic C, both of which may restrict soil organic C accumulation.**
- **Increased cropping intensity was associated with lower soil C reserves and this trend appears to be little affected by the type of farming system practised.**

Why do the trial?

This work was undertaken to survey soils on the upper Eyre Peninsula (EP) to measure the concentrations of soil organic C and dissolved organic C.

Despite widespread distribution of alkaline soils in southern Australia, relatively little work has been done to understand the chemistry of soil organic C at high pH and how this may influence the accumulation of soil organic C. Total soil organic C is made up of a number of fractions, one of which is dissolved organic C. Although it is only a small fraction of the total soil C pool, dissolved organic C is the most mobile and reactive of the soil C fractions and it helps to regulate a number of biological and chemical processes in soil. It can be an important substrate for soil microbial growth and is important in nutrient cycling. High pH increases the solubilisation of soil organic C and the amount of dissolved organic C in soils. The purpose of this work was to survey soil organic C and dissolved organic C concentrations in alkaline soils in three regions of southern Australia where alkaline soils occur to document their current levels and examine what factors may influence the levels.

How was it done?

Sixteen commercial paddocks on the upper EP were surveyed in autumn 2013 and 2014. Alkaline soils from the Lower North of SA (Pinery, Mallala, Roseworthy and Hart) and from north-western Victoria were also sampled as part of a wider survey of alkaline soils to allow values to be compared across regions.

Ten samples from a 25 x 25 m grid were taken. The samples were taken to 30 cm depth in 10 cm increments and the samples from each depth were bulked. The soil bulk density was measured from three cores taken from within the sample grid. The soils were dried, ground to pass a 2 mm sieve and the soil C was measured in a Leco CNS analyser. Each soil was measured twice, before (to measure total C) and after treatment with sulphurous acid to remove $CaCO_3$ (to measure total organic C). Dissolved organic C was measured in a filtered solution after extraction in a 1:5 soil: water mixture.

The equivalent mass of soil C in the top 30 cm (total soil C estimated at the same bulk density) was estimated using the total organic C concentrations and the bulk density for each depth. Paddock histories for the last 10 years were obtained from the co-operating farmers.

What happened?

Compared to the other two regions in the survey, the soils on the EP were consistently more alkaline (Table 1). The average mass of soil C in the EP paddocks which averaged 46 t C/ha, was similar to that measured in paddocks from the Lower North, but was higher than that surveyed from north-western Victoria.

Table 1 Mean values for pH, total soil organic C and the equivalent mass of soil C in the top 30 cm from a survey of 16 paddocks on the upper Eyre Peninsula in 2013 and 2014 and means of comparable data from paddocks surveyed in the Lower North of SA and north western Victoria

Eyre Peninsula	pH (H_2O)			Soil organic C (%)			Equivalent mass of C (t/ha)
	0-10 cm	10-20 cm	20-30 cm	0-10 cm	10-20 cm	20-30 cm	
Mean	9.00	9.32	9.50	1.46	1.20	1.20	46
Minimum	8.49	8.89	9.04	0.97	0.45	0.53	26
Maximum	9.64	9.77	9.85	2.23	2.30	2.57	85
Lower North	8.35	8.69	8.97	1.72	1.29	1.06	49
NW Victoria	8.20	8.91	9.27	0.96	0.99	0.83	33

Table 2 Mean values for dissolved organic C and dissolved organic C expressed as a percentage of total soil C from a survey of 16 paddocks on the upper Eyre Peninsula in 2013 and 2014 and means of comparable data from paddocks surveyed in the Lower North of SA and north-western Victoria

	Dissolved organic C (mg/L)			Dissolved organic C (% of organic C)		
	0-10 cm	10-20 cm	20-30 cm	0-10 cm	10-20 cm	20-30 cm
Mean	25.08	23.60	24.40	0.92	1.08	1.11
Min	14.98	11.87	13.86	0.42	0.64	0.55
Max	53.20	41.05	53.30	2.42	2.19	2.21
Lower North	23.5	29.3	29.4	0.74	1.30	1.53
NW Victoria	14.9	15.4	25.7	0.82	0.86	1.62

Dissolved organic C did not change markedly with depth and the values measured in soils from the upper EP were similar to those measured in paddocks in the Lower North (Table 2). Values in the top 20 cm were higher than the average values measured in paddocks from north-western Victoria. When expressed as a proportion of the total organic C, dissolved organic C increased with depth in all three regions, but the change with depth was least in the EP soils.

In the top 10 cm, variations in soil organic C and dissolved organic C were related to variations in pH among the surveyed paddocks. High pH was associated with lower total soil organic C ($r = -0.49$, $P<0.10$, $n=12$) and higher dissolved organic C expressed either in terms of total dissolved C ($r = 0.48$, $P<0.10$, $n=12$) or as a percentage of soil organic C ($r = 0.67$, $P<0.05$, $n=12$). There was no relationship with pH in the lower soil depths.

Among the surveyed paddocks the mass of organic C in the top 30 cm was inversely related to the intensity of cereal cropping over the last 10 years (Figure 1).

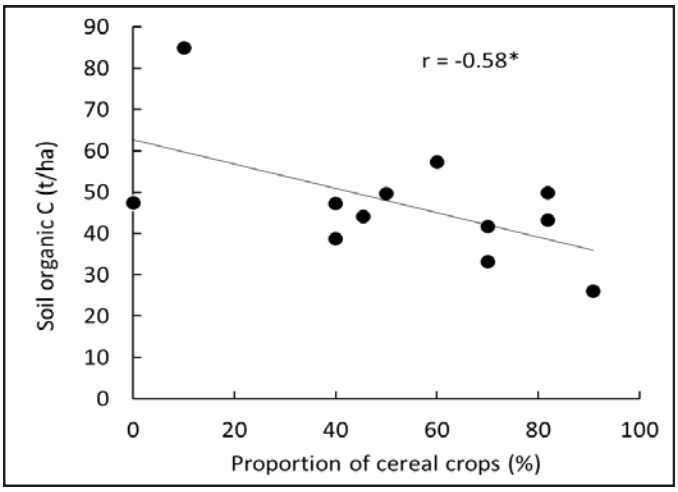

***Figure 1** The relationship between the proportion of cereal crops in the crop rotation over the last 10 years and the equivalent mass of soil organic C among paddocks on upper EP*

What does this mean?

High soil pH in the top 10 cm was associated with lower soil organic C and higher dissolved organic C, both of which may restrict the ability to maintain high soil C reserves. This suggests that the highly alkaline nature of many soils on the upper EP may impose a limitation on soil organic C accumulation irrespective of the farming system used.

Greater cropping intensity was associated with lower soil organic C and lower dissolved organic C. Most of the farms surveyed practice minimum tillage with retention of crop residues, but despite this there was no consistent improvement in soil organic C. The results imply that pasture is a more effective way of maintaining soil C reserves, a result that has been observed in other regions of Australia.

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Stubble and nutrient management trial to increase soil carbon

RESEARCH

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Searching for answers

Location:
Minnipa Ag Centre, South 2/8
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 4.0 t/ha (W)
Actual: 3.8 t/ha
Paddock History
2014: CL Grenade wheat
2013: Mace wheat
2012: Scout wheat
Soil Type
Red sandy loam
Plot Size
12 m x 3 m x 4 reps

Key messages

- **Average trial yield was 3.8 t/ha, close to the potential as identified by Yield Prophet® during the season.**
- **No significant differences in yield were found between stubble treatments (stubble retained, worked or removed) and nutrient treatments (normal practice, normal practice plus additional nutrients to enhance stubble breakdown).**
- **Changes in soil organic matter fractions over the duration of the trial (2012 to 2014) resulting from the stubble and nutrient treatments will be assessed in March, 2015.**

Why do the trial?

The soil organic matter content of Australian soils is either decreasing or remaining stable. Trials have demonstrated that No-Till stubble retention systems are adding to the partially broken-down particulate organic carbon fraction but are not contributing to the stable humus fraction. Without an increase in soil humus the important functions of soil organic matter (i.e. improved soil water holding capacity, increased nutrient supply (N and cations), pH buffering capacity and better soil structure) are unlikely to be realised.

What is humus and how can it be increased?

Humus consists of the remains of bacteria and other micro-organisms that consume and break down plant material returned to the soil from a crop or pasture. This plant material consists mainly of carbon (C). For soil microbes to consume this material they also need nitrogen (N), phosphorus (P) and sulphur (S) otherwise they cannot thrive and multiply. Australian soils are inherently low in nutrients and in most soils there is insufficient N, P and S for soil micro-organisms to rapidly break down the plant material returned to the soil. To increase the stable humus fraction in the soil, we need to supply soil microbes with additional N, P and S; this may have to be supplied as extra fertiliser.

How much N, P and S need to be supplied to stubble to form humus?

Dr Clive Kirkby, from CSIRO, has been working on this question and found that:

- In humus 1000 kg of C is balanced with 80 kg N, 20 kg P and 14 kg S.
- Dr Kirkby argues that for soil micro-organisms to breakdown stubble and form humus, we need to add sufficient nutrients (N, P and S) to feed these micro-organisms.
- For micro-organisms to efficiently break down wheat stubble to humus additional nutrients have to be added. Wheat stubble has a low nutrient:C ratio and one tonne of cereal stubble needs to be balanced with 5.8 kg N, 2.2 kg P and 0.9 kg S.

The DAFF and GRDC funded national trial will examine existing, new and alternative strategies for farmers in the cereal sheep zone to increase soil carbon. The trial will be used as baseline data for carbon accumulation in soils and to:

- discuss the various forms of soil organic carbon (plant residues, particulate, humus and resistant fractions),
- investigate how management affects each of these pools and how humus can be increased over the medium to long term,
- communicate how soil organic matter affects soil productivity (through nutrient and water supply, and improvements in soils structure).

Identical trials are being run by eight farm groups in SE Australia (Victoria: Mallee Sustainable Farming, Birchip Cropping Group, Southern Farming Systems; NSW: FarmLink, Central West Farming Systems; SA: Hart and Eyre Peninsula Agricultural Research Foundation, both through Ag Ex Alliance; and Tasmania: Southern Farming Systems) so information can be collected on different soils and climates in the Southern Region.

How was it done?

2014 was the third year of the trial. The 2013 trial stubble load was determined on 5 February 2014.

Soil samples were collected on 10 February for Yield Prophet® (0-10, 10-40, 40-70, 70-100 cm) to determine soil available nitrogen and soil moisture.

In March the stubble management treatments: (i) stubble left standing, (ii) stubble worked in with single operation of the seeder before sowing (1 March) and (iii) stubble removed by raking and burning (2 March) were imposed.

Nutrient application treatments at seeding were: (i) normal practice for P at sowing and N in crop as per Yield Prophet® and (ii) normal practice PLUS extra nutrients (N, P, S) required to break down the measured wheat stubble. Based on the 2013 stubble load, the extra nutrients (17.5 units N, 2.7 units P and 5.2 units S) required to break down the stubble were applied on 13 February with a rainfall event. The extra nutrients (PLUS treatment) were applied as DAP (18:20:0:0) @ 14 kg/ha, ammonium sulphate (21:0:0:24) @ 22 kg/ha and urea (46:0:0:0) @ 37.5 kg/ha. Treatments were replicated 4 times.

The trial was sown on 30 April with CL Grenade wheat @ 60 kg/ha and a base fertiliser of DAP (18:20:0:0) @ 50 kg/ha. Pre sowing chemical applications were Roundup @ 1.2 L/ha, Trifluralin @ 1 L/ha and a wetter. On 2 June, Intervix was applied at 750 ml/ha with 500 ml/ha Supercharge. Prosaro @ 300 ml/ha was applied on 15 July for Yellow Leaf Spot, and tebuconazole was applied @ 290 L/ha on 21 August on the whole paddock using a plane.

Emergence counts, flowering date, grain yield and grain quality were measured.

What happened?

The mean stubble load calculated from 2013 was 5.7 t/ha and additional nutrient treatments were applied to aid in the breakdown of the stubble to humus.

Emergence counts were taken on 21 May with an average of 131 plants/m^2. Flowering occurred (GS 65 - when 50% of heads have anthers) on 30 August. The trial was harvested on 24 October. There were no significant differences between treatments in yield, test weight, grain weight and screenings (Table 1). There was a small increase in protein for those treatments that received additional nutrients (Table 1).

Table 1 Grain yield and quality as affected by stubble treatments and additional nutrients at Minnipa 2014

Stubble treatment	Nutrition treatment	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	1000 Grain weight (g)	Screenings (%)
Stubble removed	normal practice	3.81	10.6	85.5	42.5	2.7
Stubble removed	normal practice PLUS N,P&S	3.90	10.9	85.3	41.2	3.4
Stubble standing	normal practice	3.55	10.4	85.4	42.6	2.8
Stubble standing	normal practice PLUS N,P&S	3.61	10.7	85.5	41.7	2.6
Stubble worked	normal practice	3.81	10.7	85.0	41.5	2.7
Stubble worked	normal practice PLUS N,P&S	3.96	11.0	85.0	42.9	2.5
LSD (P=0.05)		*ns*	*0.30*	*ns*	*ns*	*ns*

Yield Prophet® was used early in the season (22 July) to predict if extra nitrogen fertiliser was required to achieve potential yield. UAN @ 50 L/ha was applied on 28 July using a broad-acre boom over all treatment plots.

What does this mean?

It is expected that the imposed treatments to increase soil organic matter will take a few years to become noticeable. The trial site was soil sampled for soil organic matter fractions at the start of the trial in 2012, and will be repeated prior to sowing the trial in 2015.

Acknowledgements

Funding for this trial is provided from DAFF and GRDC, and project management through Ag Ex Alliance and EPARF. Yield Prophet® is an on-line modelling service based on APSIM that provides simulated crop growth based on individual paddock information and rainfall, and is registered to BCG.

Effects of gypsum and legumes on soil pH and soil organic C

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Searching for answers

Location:
Minnipa Ag Centre, Paddock S7
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 4.0 t/ha (W)
Actual: 2.5 t/ha
Paddock History
2014: Scope CL barley
2013: Mace wheat
2012: Medic pasture
Soil Type
Red loam
Plot Size
34 m x 2 m x 3 reps

Location:
Minnipa Ag Centre, Airport paddock
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 4.0 t/ha (W)
Actual: 2.5 t/ha
Paddock History
2013: Mace wheat
2012: Kord wheat
Soil Type
Calcareous red sandy loam
Plot Size
10 m x 3 m x 3 reps

Key messages

- **Applying gypsum can reduce soil pH and lower the concentration of dissolved organic carbon (C) to 30 cm depth within a year.**
- **Soils with pH > 9 will benefit most from gypsum.**
- **The solubilisation of soil organic C increased markedly at pH above 8.5.**
- **The availability of aluminium (Al) in soil increases at pH above 9.**
- **There was no significant effect of gypsum on the biomass or yields of crops within 2 years.**

Why do the trial?

Although alkaline soils are widespread throughout southern Australia and are the basis of crop production in South Australia, our understanding of the chemistry and cycling of C in these soils is poor. A survey of paddocks on the upper Eyre Peninsula (EP) showed that the concentrations of soil organic C and dissolved organic C were sensitive to pH, with soil organic C decreasing and dissolved organic C increasing as pH increased (see article this publication). Reducing soil pH may be a means of helping to retain soil organic C.

Many soils on the upper EP have pH values in the top 10 cm greater than 8.5 and this increases with depth. The subsoils can have a pH above 9 with high concentrations of sodium carbonate and are sodic; it is these properties that are especially damaging to plants. Past work on the reclamation of highly alkaline sodic soils has demonstrated that applying gypsum in conjunction with growing legumes can be effective in lowering soil pH. The greatest benefit is achieved by lowering soil pH from very high values (e.g. 9 or above) to about 8.5. Reducing pH further will be difficult because of the high buffering capacity of soils due to calcium carbonate at this pH.

To examine the effect of gypsum on the calcareous soils typical of the upper EP, two rotation experiments were conducted commencing in 2012 and 2013. The aim was to examine the effect of gypsum on soil pH and soil C and whether changes in soil pH could alter productivity of the following cereal crops.

How was it done?

Two short term rotation experiments were run, commencing in 2012 and 2013 on the Minnipa Agricultural Centre. The first experiment was conducted in paddock S7 (Experiment 1) and the second experiment was conducted in the Airport paddock (Experiment 2). Each experiment in the first year was a factorial combination of legume species, input levels and gypsum rates. In the first year three legumes (peas cv Morgan), vetch (cv Morava) and medic (a mix of Paraggio, Caliph and Parabinga) were grown at standard sowing rates (80 kg/ha for peas; 20 kg/ha for vetch and 5 kg/ha for medic) and fertiliser rates (10 kg P/ha for all crops) and at double these rates. All seeds were inoculated with commercially available rhizobia. Three rates of gypsum (0, 2.5 t/ha and 5 t/ha) were superimposed on these treatments. The gypsum was obtained from a local source and had a purity of 60%. The gypsum was spread prior to sowing and incorporated with the sowing operations.

The experiment in S7 commenced in 2012 and wheat (cv Mace) was sown in each plot in 2013 and barley (cv Scope CL) in 2014. The experiment in the Airport paddock commenced in 2013 and wheat (cv Mace) was grown in 2014. In 2012 only legume biomass was measured, while legume biomass and grain yield were measured in 2013. In 2013 and 2014 soil cores were taken in 10 cm increments to 30 cm in each plot to measure pH, soil organic C and dissolved organic C.

In the following cereal crops biomass was measured during the growing season and grain yield was measured by harvesting each plot. Grain quality was measured on the wheat crop after the legume phase. In this report only the cereal yields and protein contents are presented.

What happened?

Effects on legumes growth and yield

Gypsum had no significant effect on the biomass production or the grain yield of the legumes. Increasing P inputs significantly increased biomass production in both trials (by 30% in 2012 and 17% in 2013) but had no significant effect on yield. The grain yield of peas in 2013 was 1.44 t/ha, which was significantly greater than that of vetch (1.15 t/ha).

Soil measurements

The only factor to influence soil pH was the gypsum rate and the effect was consistent in both experiments. Applying gypsum significantly decreased pH in both experiments by between 0.2 and 0.4 pH units, with the largest reduction mainly occurring following the addition of 2.5 t/ha (Table 1). There was a corresponding decrease in the amount of dissolved organic C but soil organic C was not affected (data not shown). The effects of gypsum on pH and dissolved organic C were evident two years after application in the 2012 experiment. The concentration of dissolved organic C increased markedly once pH increased above 8.5 (Figure 1a). The concentration of Al was also sensitive to pH and increased at pH values greater than 9 (Figure 1b).

Table 1 The effects of gypsum applied during the legume phase on the pH and dissolved organic C concentration to 30 cm depth in two experiments. Experiment 1 was commenced in 2012 and measurements were made in the two successive years after applying gypsum, while Experiment 2 commenced in 2013

Gypsum rate (t/ha)	pH (water)			Dissolved organic C (% soil organic C)		
	Depth (cm)					
	0-10	10-20	20-30	0-10	10-20	20-30
	Experiment 1: 2013					
0	8.76	9.17	9.42	0.56	0.76	1.16
2.5	8.76	9.07	9.41	0.45	0.57	1.10
5	8.61	8.98	9.38	0.41	0.60	0.93
F Prob	ns	P=0.025	ns	P=0.03	P=0.018	ns
LSD (P=0.05)		*0.134*		*0.112*	*0.141*	
	Experiment 1: 2014					
0	8.48	8.86	9.03	0.63	0.81	0.96
2.5	8.30	8.40	8.74	0.45	0.42	0.51
5	8.26	8.45	8.68	0.40	0.43	0.46
F Prob	P=0.014	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
LSD (P=0.05)	*0.155*	*0.131*	*0.152*	*0.059*	*0.099*	*0.127*
	Experiment 2: 2014					
0	8.98	9.02	9.10	0.62	1.13	1.71
2.5	8.79	8.89	8.94	0.46	0.55	0.83
5	8.59	8.80	8.90	0.41	0.45	0.76
F Prob	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
LSD (P=0.05)	*0.086*	*0.093*	*0.086*	*0.055*	*0.103*	*0.223*

Effects on cereal yields and protein contents

Table 2 Grain yield of cereals and grain protein concentration of wheat grown after different legumes

Legume (year 1)	Wheat (year 2)		Barley (year 3)
	Grain yield (t/ha)	Grain protein (%)	Grain yield (t/ha)
Experiment 1			
Medic	1.81	11.2	2.78
Peas	1.87	11.2	2.85
Vetch	1.80	11.2	2.81
F Prob	ns	ns	ns
Experiment 2			
Medic	3.40	9.6	
Peas	3.13	9.5	
Vetch	3.04	9.4	
F Prob	P=0.024	ns	
LSD (P=0.05)	*0.262*		

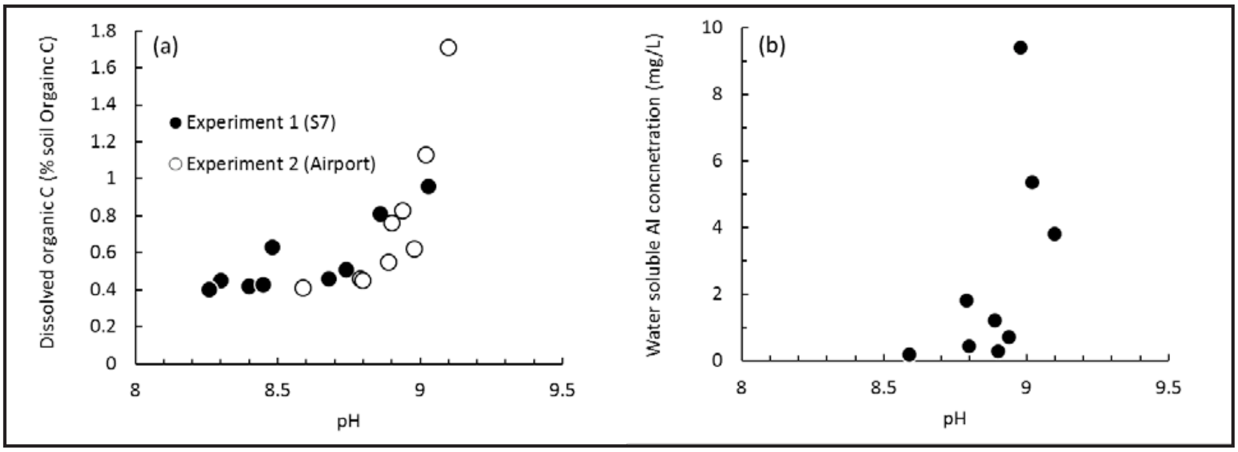

Figure 1 The effects of soil pH on the concentration of dissolved organic C in two experiments and the concentration of water-soluble Al in Experiment 2. The differences in pH were due to the effects of gypsum at three sampling depths

The gypsum treatments did not significantly affect the grain yield of the following cereal crops. The only effect of any of the first year treatments was in Experiment 2 where wheat yields were significantly highest after medic and lowest after vetch (Table 2).

What does this mean?

The pH of the top 30 cm of highly alkaline soils can be reduced within a year by applying gypsum at 2.5 t/ha. As the gypsum used had a purity of only 60%, lower rates of higher quality gypsum could be used to achieve the same result. A target pH in these soils is about 8.5 as below this changes in pH are highly buffered and there is no change in some soil properties (Figure 1). Highly alkaline soils (pH > 9) are the ones that would potentially benefit most from applications of gypsum.

Dissolved organic C is the most labile C fraction in soil. The reduction in dissolved organic C with the application of gypsum may help to stabilise soil organic C reserves.

There was no immediate benefit of the reduction in pH to the growth and yield of crops. It may take more than two seasons to allow any beneficial effects to become evident. Further long term studies are needed to assess whether gypsum can be effective in improving productivity and to measure the longevity of any effects.

There is growing evidence that Al toxicity can be an important limitation to yield on highly alkaline soils. The data suggest that soils with pH > 9 are at greatest risk. The reduction in pH following the application of gypsum reduced the concentration of Al in the soil.

Acknowledgements

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Addressing subsoil constraints to increase organic carbon in Eyre Peninsula soils

Brett Masters and David Davenport
Rural Solutions SA, Port Lincoln

RESEARCH

Searching for answers

Location:
Crossville, Ungarra, and Cockaleechie
Farmer Names
Francis Beinke, Jamie Phillis, Terry Young, Geoff and Jim Holman
Soil Type
Beinke, Crossville – hardsetting sandy clay loam with sodic subsoil layers.
Phillis – Shallow sandy loam over highly sodic red light clay on soft carbonate.
Young, Ungarra – Sand over sodic clay.
Holman, Cockaleechie – Acidic loamy ironstone soil on sodic clay.
Plot Size
Large plot trial (12 m x 8 m) – 3 replicates
Yield Limiting Factors
Early season waterlogging caused by decile 10 April to July rainfall on Ungarra and Cockaleechie sites.
Very low rainfall (Decile 2) from August to October across all sites.
Late sowing and low GSR at Crossville.
Difficulty achieving accurate seeding depth due to uneven and soft surfaces following soil modification treatments.

Key messages

- **Subsoil constraints can be addressed through appropriate soil modification and ameliorant applications.**
- **Results to date have been varied.**
- **Treatments must be appropriate to the soil type and knowledge of the key soil constraints to production is vital in formulating the most appropriate management strategy.**

Why do the trial?

- There are around 40% of soils under agricultural production on EP that have subsoil constraints including bleached A2 horizons and sodic layers that limit crop and pasture production.
- To improve current soil modification practices.
- Deep ripping on poorly structured soils and the addition of clay to sandy soils with bleached A2 horizons can improve production but results have been inconsistent (refer EPFS Summaries 1999, p 72, 2000 p 105, 2005 p 129, 2010 p 154 and 2011 p 166).
- To increase soil organic carbon (SOC) levels of EP soils delivering improved productivity and offsetting carbon dioxide emissions to the atmosphere.

How was it done?

Soils targeted included;

- Duplex sandy soils with infertile A2 horizons
- Acidic ironstone soils with poorly structured subsoil clays
- Red brown earths with poorly structured subsoil soil layers.

Sites were selected by undertaking initial field characterisation sampling undertaken in September 2013. Four replicated trials and three demonstration sites were developed in May/June 2014 (Table 1).

Soil sampling using national protocols was undertaken in December 2013/January 2014 to determine baseline soil organic carbon, nutrition and bulk density (Table 2 and 3).

SOC levels are largely driven by clay content and rainfall. All sites, except for Holman, had SOC values considered to be in the low to moderate range for the rainfall/texture class. SOC and CEC at Young's site are very low in the A horizons (0-30 cm) indicating poor inherent fertility. SOC levels at Holman's are high, however this may indicate low microbial activity due to soil acidity (pH 4.5 $CaCl_2$). Both Phillis and Beinke sites are alkaline with carbonate present in subsurface layers.

Bulk density (BD) is a measure of the weight of soil per cubic centimetres. Soils with BD greater than 1.6 g/cm^3 are generally considered to restrict root growth. High BD can results from physical compaction, high exchangeable sodium and potassium levels, low organic carbon levels and/or highly weathered clay components. Surface BD levels are not considered high. The BD of the 10 to 20 cm soil layer was generally slightly higher than at the surface and in the 20 to 30 cm layer that may indicate physical compaction or increased soil texture and the presence of gravel. High exchangeable sodium (ESP) values were found at the Phillis site.

What happened?

Beinke, Crossville

Gypsum treatments were broadcast early April with organic matter and ripping treatments being applied in the last week of May. A dry start to the season delayed seeding until the middle of June. Dry conditions continued with only 80 mm of rainfall to the end of November. Plant emergence counts taken in early July recorded lower plant density on the ripped treatments than the unripped (Table 4).

Table 1 Summary of replicated trial sites

Co-operator & Location	Soil type	Crop	Measurements	Treatments
Beinke, (FB) Crossville	Alkaline red brown earth	Wheat	Plant emergence, Dry matter, Crop yield	Untreated, surface applied gypsum (5 and 10 t/ha), deep ripping, deep ripping + gypsum (10 t/ha), deep ripping + 10 t/ha gypsum + 10 t/ha organic matter (OM) (pea straw).
Phillis, (JP) Ungarra	Alkaline red brown earth	Barley	Plant emergence, Dry matter, Crop yield	Untreated, surface applied gypsum (5 and 10 t/ha), deep mixing, deep mixing + 10 t/ha gypsum + 10 t/ha organic matter (vetch hay).
Young, (TY) Ungarra	Neutral sand over clay	Canola	Plant emergence, Dry matter, Crop yield	Untreated, spaded, clay spread (250 t/ha clay), deep incorporated clay, deep incorporated organic matter (10 t/ha vetch hay), deep incorporated clay + organic matter (10 t/ha vetch hay).
Holman, (JH) Cockaleechie	Acidic loamy Ironstone	Wheat	Plant emergence, Dry matter, Crop yield	Untreated, surface lime (3 t/ha), deep ripping, deep ripping + lime, deep ripping + lime + organic matter (10 t/ha lupin chaff).

Table 2 Mean SOC, soil pH and cation exchange capacity

	Soil Organic Carbon (%)				Cation Exchange Capacity (CEC) (cmol/100mg)				Soil pH ($CaCl_2$)			
Depth (cm)	FB	JP	TY	JH	FB	JP	TY	JH	FB	JP	TY	JH
0-10	0.9	1.0	0.5	1.6	18	15	2	5	7.5	7.6	6.1	4.5
10-20	0.6	0.6	0.3	0.8	22	29	1	4	7.8	8.0	7.4	4.5
20-30	0.5	0.5	0.3	0.6	22	33	2	6	7.8	8.2	6.6	5.2
30-50	0.4	0.4	0.3	0.3	25	30	17	8	8.0	8.2	8.1	6.0

Table 3 Mean bulk density and exchangeable sodium percentage (ESP)

	Soil Bulk Density (g/cm^3)				ESP (%)			
Depth (cm)	FB	JP	TY	JH	FB	JP	TY	JH
0-10	1.5	1.4	1.5	1.4	2	16	4	2
10-20	1.6	1.5	1.6	1.6	3	21	6	2
20-30	1.4	1.3	1.7	1.6	5	26	15	2
30-50	1.3	1.3	1.7	1.5	11	28	18	3

Soil modification and ameliorant treatments were applied in April and May 2014 prior to sowing (Table 3). Seeding and in-crop management was undertaken with farmer equipment except for the Young trial that was sown using the SARDI small plot seeder. Trial sites except for Phillis were harvested using the SARDI plot header. The mean weight of the harvest runs was extrapolated to grain yield (t/ha). Phillis site was harvested using the landholder's header with grain yield extracted from the header yield monitor.

Dry matter levels were also lower on the ripped treatments except where OM had been added (Figure 1). Although the 5 t/ha of surface applied gypsum treatment had the highest plant density the only treatments that produced significantly higher dry matter were the 10 t/ha surface gypsum and the rip + gypsum + OM treatment.

Grain yield largely reflected differences in dry matter production with these treatments (10 t/ha), (Rip +10 t/ha gypsum +OM) delivering significantly higher yields than all other treatments (Figure 2).

Phillis, Ungarra

Gypsum treatments and organic matter (10 t/ha vetch hay) were spread on the site in the first week of May. Ripping treatments were undertaken on 15 May using a DMR plough with the site sown to Fathom barley on 30 May 2014. Heavy rains prior to ripping resulted in the development of deep wheel ruts on the ripped treatments at ripping. This resulted in poor growth along these wheel tracks throughout the season. Wet conditions to the end of July resulted in some variable waterlogging on the site. Plant emergence counts taken in mid-June showed a variable response to both the ripping and the gypsum treatments (Table 5).

Table 4 Beinke crop establishment, June 2014

	Crop establishment 21/06/2014	
Treatment	**Mean plants/m²**	**% control**
1. Untreated control	113	100
2. Surface applied gypsum (5 t/ha)	126	111
3. Surface applied gypsum (10 t/ha)	117	103
4. Ripped + OM 10 t/ha	103	91
5. Ripped + gypsum 10 t/ha	108	95
6. Ripped + gypsum (10 t/ha) + OM (10 t/ha)	93	82
7. Ripped + 5 t/ha gypsum	115	101
8. Ripped only	101	90

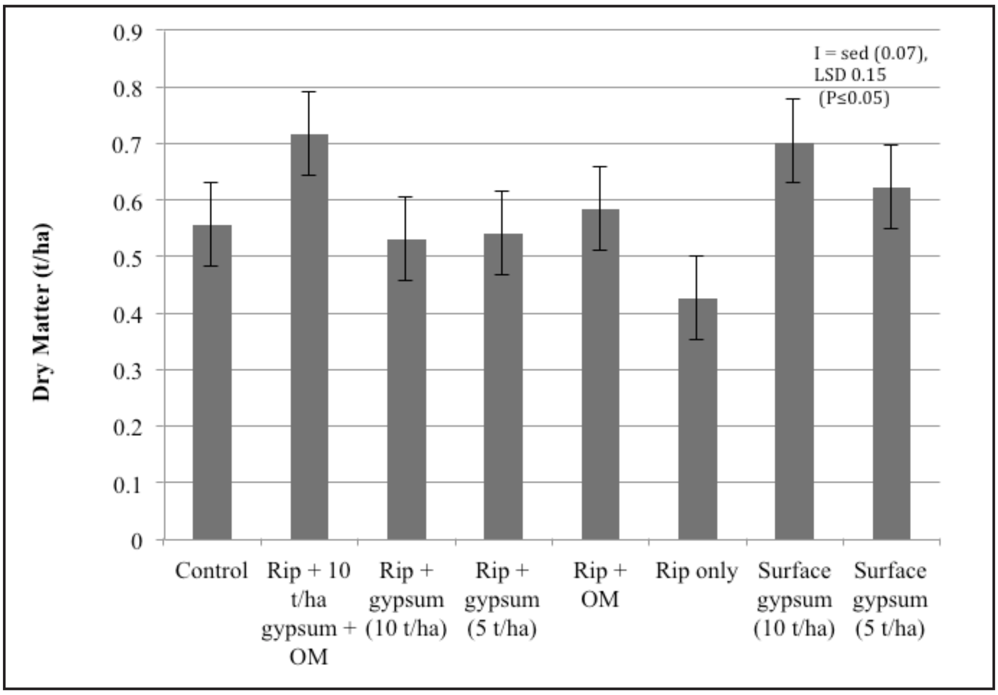

Figure 1 Dry matter cuts taken from Beinke site in August 2014

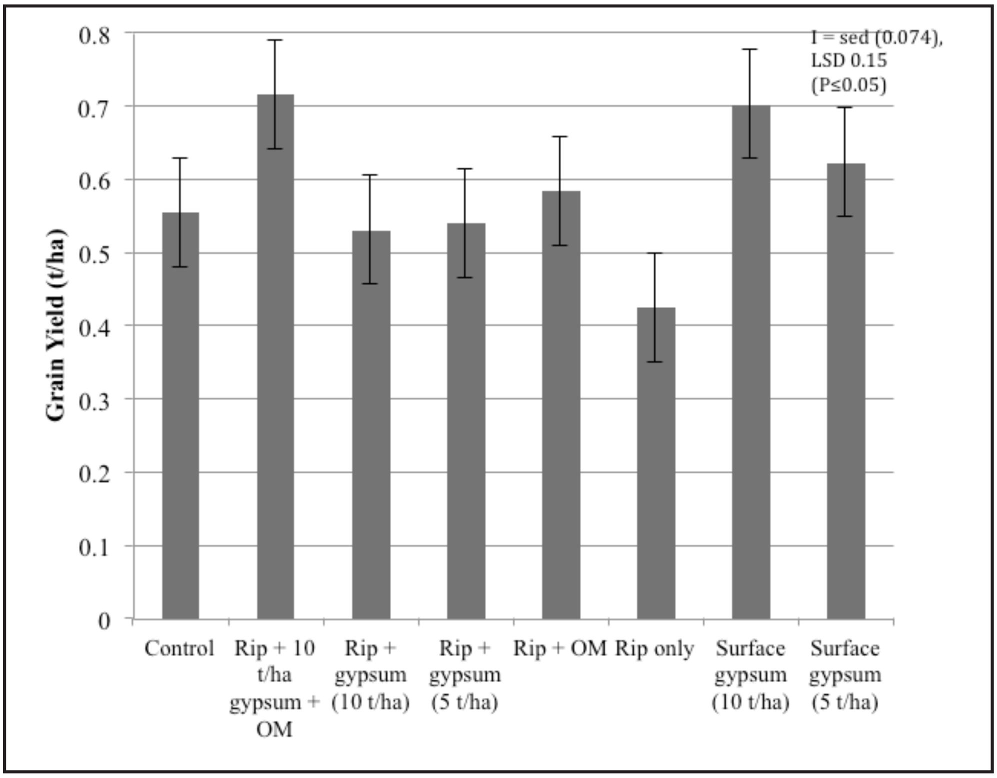

Figure 2 Beinke wheat yields, December 2014

Table 5 Phillis crop establishment, June 2014

	Crop establishment 26/06/2014	
Treatment	**plants/m²**	**% control**
1. Untreated control	139	100
2. Surface applied gypsum (5 t/ha)	145	105
3. Surface applied gypsum (10 t/ha)	153	110
4. Ripped + gypsum 10 t/ha	132	95
5. Ripped + gypsum 10 t/ha + OM 10 t/ha	161	116

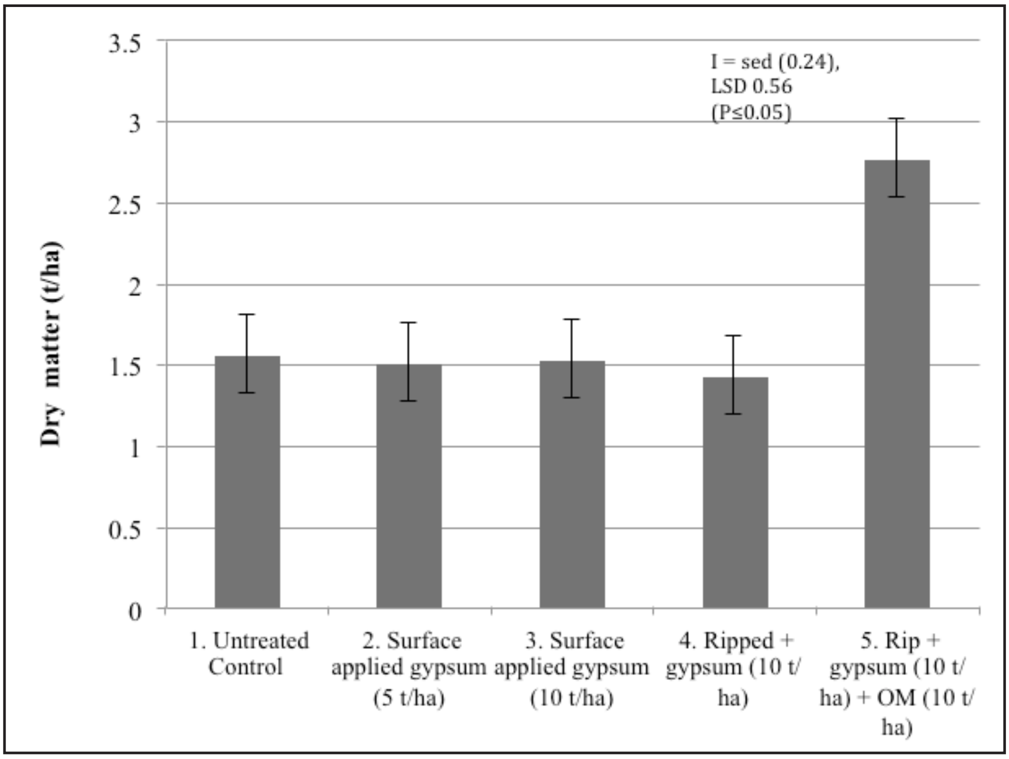

Figure 3 Dry matter cuts taken from Phillis site, August 2014

No significant dry matter differences were recorded except for the ripping, gypsum and organic matter treatment that had almost double the biomass of the other treatments (Figure 3).

The higher dry matter levels did not translate to higher yields (Figure 4). This may be due to very low rainfall from the end of July to harvest. This requires further investigation and this site will be monitored in 2015.

Young, Ungarra

Heavy rainfall post seeding resulted in some water logging and surface water flow (particularly of the shallow clay treatment). Crop also appeared nitrogen deficient when establishment counts were taken. Very low plant densities were observed on the shallow clay and deep incorporated organic matter treatments (Table 6). This might have resulted from the difficulty achieving accurate seeding depths using the small plot seeder on these treatments.

Sustained cool and wet conditions to the end of July resulted in slow crop growth. Exceptionally dry conditions from the end of July to harvest resulted in the canola crop rapidly bolting and flowering. Dry matter cuts were taken in late August with only the deep incorporated clay treatments providing a significant response (Figure 5).

Yield data (Figure 6) showed that the deep clay + organic matter treatment was the highest yielding treatment but was not significantly higher yielding than the spaded clay treatment.

Holman, Cockaleechie

This site required lime to address the low pH in the surface and subsurface layers. Lime and organic matter treatments were applied to the site on 13 March 2014 with ripping treatments undertaken on 10 May using a DMR plough. The site was sown to Cobra wheat on 20 May.

Crop establishment counts undertaken 18 June 2014 showed little difference between treatments. Cool conditions and heavy rainfall to the end of July slowed crop growth and resulted in some variable waterlogging. Although visually the OM and ripping treatments looked better, dry matter cuts on 28 August did not record any significant difference between the treatments (refer Table 7). There was also no significant difference in dry matter and grain yield.

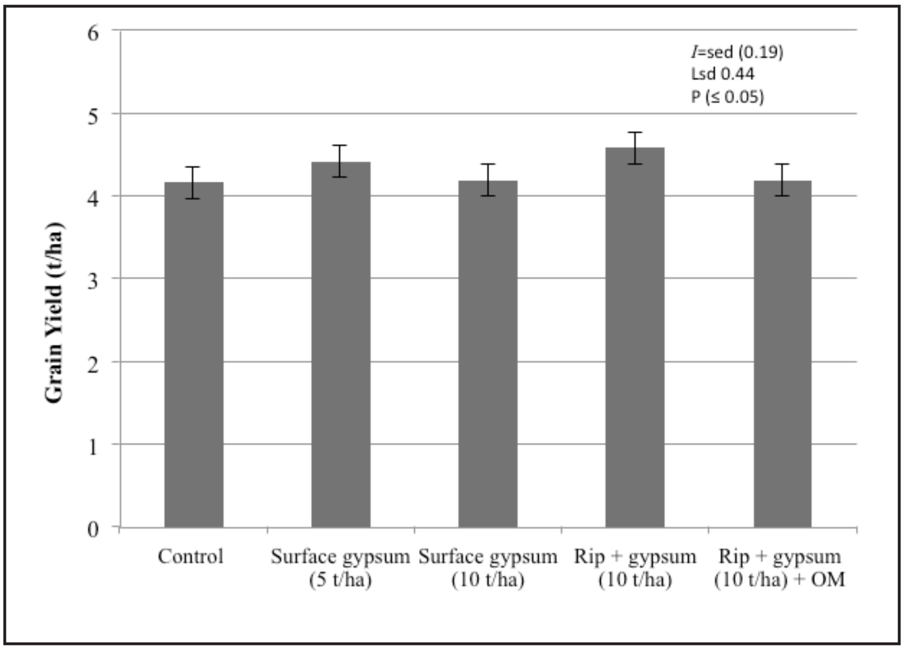

Figure 4 Phillis barley yield, December 2011

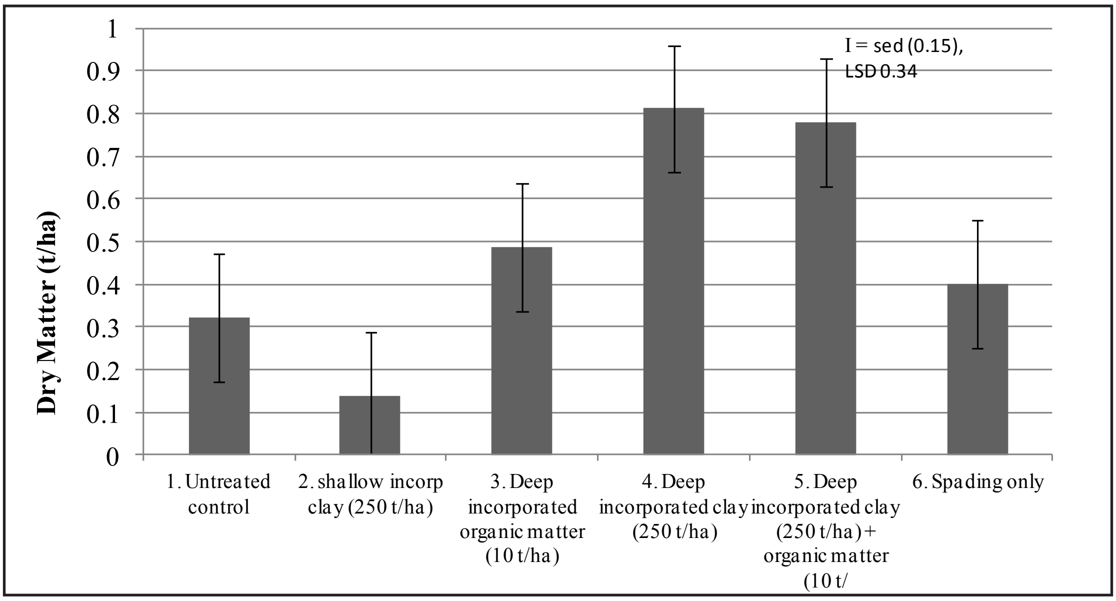

Figure 5 Dry matter cuts taken from Young site in August 2014

Table 6 Young crop establishment, June 2014

	Crop establishment 26/6/2014	
Treatment	**plants/m²**	**% control**
Untreated control	**24**	**100**
Shallow incorporated clay (250 t/ha)	5	21
Deep incorporated OM(10 t/ha)	5	22
Deep incorporated clay (250 t/ha)	30	127
Deep incorporated clay (250 t/ha) + OM(10 t/ha)	27	112
Spading only	24	100

This trial will continue to be monitored in 2015.

What does this mean?

Results from these trials have been mixed. This may be due to a number of factors including:

- Seasonal conditions – waterlogging varied across some sites affecting rigour of data. Also high biomass treatments may have run out of water to deliver increased yield responses. For example, higher dry matter levels on the organic matter treatments on the Phillis site did not translate to higher yields whereas sites which were least affected by the extremes of the 2014 winter cropping season (Beinke and Young sites) did realise increased yields.

Soils and Tillage

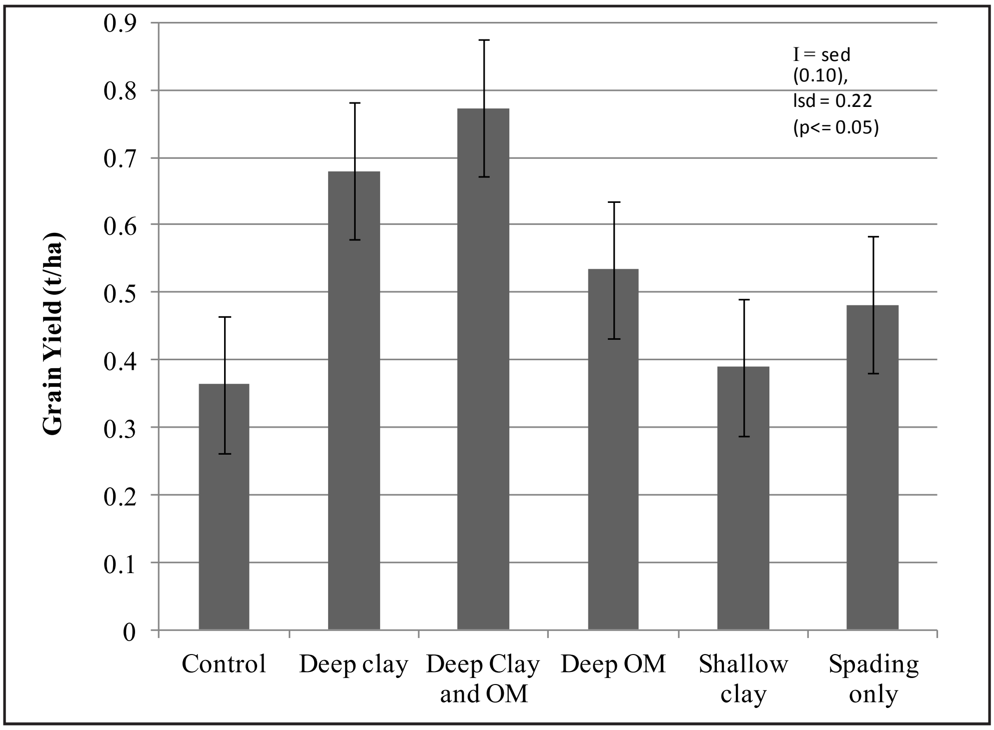

Figure 6 Young canola yields, December 2014

Table 7 Holman crop establishment, dry matter and grain yield results, 2014

Treatment	**Crop establishment 18/06/2014 (plants/m$^{2)}$**	**Dry matter 25/08/2014 (t/ha)**	**Grain yield 26/11/2014 (t/ha)**
Control	186	2.0	2.1
Deep lime (3 t/ha)	185	2.0	2.3
Deep lime (3 t/ha) and OM	176	1.8	2.1
Deep OM (10 t/ha)	161	2.2	2.3
Surface lime (3 t/ha)	173	1.8	2.0
LSD (P=0.05)		*0.72*	*0.39*

- Time since the treatments were imposed and the method of modification – treatments may take more than one season to have an effect. The use of gypsum can have a benefit on soils with sodic subsoils, however the delivery of gypsum to the sodic layer provides some challenges. Where a subsoil layer is sodic ripping on its own will not provide a long term solution to what the best options are for incorporating gypsum to depth.

However, some treatments provide a clear benefit. Results from Young's site supports earlier work which suggest that while clay incorporation into sandy top soils provides yield benefits, further increases can be realised by incorporation of clay and organic matter deeper into the bleached, sandy subsoil horizons.

The incorporation of organic matter has provided a dry matter increase in many trials; however it is not well understood whether this benefit relates to soil nutrition, soil structure or microbial activity. The results from Phillis' site has further highlighted that increased dry matter production does not necessarily translate to increased grain yield, particularly when there is a dry finish to the season. However it does provide the potential biomass to increase production if the season finishes well.

Further monitoring of these sites will occur to further investigate;

- How long before responses from applied soil ameliorants can be expected?
- How long are the potential gains are going to last?
- What are the implications for soil carbon levels?
- What are the costs/benefits of these treatments options?

Acknowledgements

The authors would like to thank the landholders involved in this trial; Francis Beinke, Jamie Phillis, Terry Young, Geoff and Jim Holman. We would also like to thank Rebecca Tonkin, Rural Solutions SA for undertaking statistical analysis of the dry matter cuts and harvest results. This project is supported by Natural Resources Eyre Peninsula through funding from the Australian Government.

Australian Government

Natural Resources Eyre Peninsula

Improving soil structure on hardsetting soils of Eastern Eyre Peninsula

Brett Masters
Rural Solutions SA, Port Lincoln

RESEARCH

Searching for answers

Location:
Mangalo
Joel and Blake Nield, Grant Hannemann, Isaac Gill, Michael Petersen, John Turnbull
Crossville Ag Bureau
Rainfall
Av. Annual: 450 mm
Av. GSR: 375 mm
2014 Total: 400 mm
2014 GSR: 260 mm
Soil Type
Hard sandy clay loam on dispersive red clay and Sandy loam on coarsely structured red clay.
Plot Size
Large plot demonstrations
5 m x 35 m x 2 reps
Yield Limiting Factors
Limited rainfall from the end of July to harvest.

Key messages

- **Deep ripping soils with poorly structured clay subsoils can improve crop performance. However, on soils with sodic subsoil layers better results are achieved through the addition of gypsum.**
- **Knowledge of the characteristics of the soil profile at depth is vital for determining an appropriate and effective management strategy.**
- **High rates of surface applied gypsum can impact negatively on crop growth in at least the season of application.**
- **The development of appropriate and affordable machinery to effectively deliver soil ameliorants into constrained soil layers on a broadacre scale is required.**

Why do the trial?

Poorly structured, hardsetting and sodic soils which can reduce plant emergence, restrict plant root growth and soil biological activity resulting in low water use efficiency are common in the Cleve Hills and district. Understanding of the most effective, practical and affordable means of addressing these constraints is limited. Trials have shown that the use of deep ripping and gypsum applications on soils with sodic subsoil layers can improve production but results have been inconsistent (refer EPFS Summaries 1999, p 72, 2000 p 105, 2005 p 129, 2010 p 154, 2011 p 166).

Constraints result from a number of different factors and appropriate treatments need to be developed.

How was it done?

This project demonstrated the use of disc and deep tillage technologies with and without the addition of soil conditioners such as organic matter and gypsum to effect improvements to soil structure and productivity.

The target soils were loam to clay loam surface soils with highly sodic clay subsoils with increasing carbonate at depth typical of soils of the Cleve Hills. Seven demonstration sites were established in August and September 2013 (Table 1). Tillage treatments included:

- deep ripping to 40 cm using an Ausplow DBS Easy-Till deep ripping plough (2.6 m wide demonstration model on 45 cm row spacings)
- discing (5 m wide offset with ribbed cutting coulters).

Soil ameliorant treatments consisted of organic matter and gypsum treatments as appropriate for the site. At Nield's sites and Hannemann 2 the discs treatments also incorporated crop i.e. green manure. At Petersen 1 and Hannemann 1sites oaten hay (10 t/ha) was applied to the surface prior to discing. Gypsum treatments were applied in spring at these sites and prior to seeding in 2014 at the other sites (Table 1).

Sites were sown by the farmer and treated the same as the rest of the paddock during the season.

What happened?

Heavy rainfall and cold temperatures in early winter slowed growth at all sites and resulted in some waterlogging at Nield and Hannemann sites. Emergence counts were taken on all sites in mid June 2014 (Figure 1). Discing alone did not result in increased crop establishment. On Nield 1 and Hannemann 2 emergence was greater where discs were used to incorporate gypsum and organic matter. The response to the other treatments at crop establishment was variable across the sites. There appeared to be crop establishment benefits from ripping with and without 5 t/ha of surface applied gypsum at Hannemann and Petersen sites. Surface applications of 10 t/ha gypsum prior to soil modification treatments had lower crop establishment figures than at the 5 t/ha rate. This is perhaps due to temporary salinisation around the seed from such a high rate and is not expected to cause an impact beyond the year of application.

Table 1 Summary of demonstration sites established in 2013

Site ID/Location	Crop	Soil Type	Treatments	Measurements
Nield 1, Yabmana	Wheat	Calcareous loam on dispersive red clay (Shallow Cleve soil).	Untreated, Disc (green manure), Surface applied gypsum (5 and 10 t/ha), Disc + gypsum (5 and 10 t/ha)	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Nield 2, Yabmana	Canola	Hard sandy clay loam on dispersive red clay	Untreated, Disc + organic matter (OM) (vetch green manure - low and high), Rip + OM (low and high) Disc + OM + gypsum (10 t/ha), Rip + OM + gypsum (10 t/ha)	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Hannemann 1, Mt Desperate	Wheat	Hard sandy clay loam on dispersive red clay	Untreated, Disc, Rip, Surface OM (10 t/ha oaten hay) Disc + OM, Rip + OM, surface gypsum (5 t/ha spring and autumn applied), Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Hannemann 2, Mt Desperate	Wheat	Hard sandy clay loam on dispersive red clay	Untreated, Disc (green manure lupin crop), Rip, Disc+ Rip, Surface gypsum (5 t/ha and 10 t/ha), Disc + gypsum, Rip +gypsum, Disc + Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Petersen 1, Mangalo	Wheat	Sandy loam on coarsely structured red clay.	Untreated, Disc, Rip, Surface OM (10 t/ha oaten hay), Disc+ OM, Rip + OM, Surface gypsum (5 t/ha spring), Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Petersen 2, Mangalo	Canola	Sandy loam on coarsely structured red clay.	Untreated, Disc, Rip, Surface gypsum (5 t/ha and 10 t/ha) Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Turnbull, Mt Millar	Canola	Sandy loam on coarsely structured red clay.	Untreated, Rip, Surface applied gypsum (5 and 10 t/ha), Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment

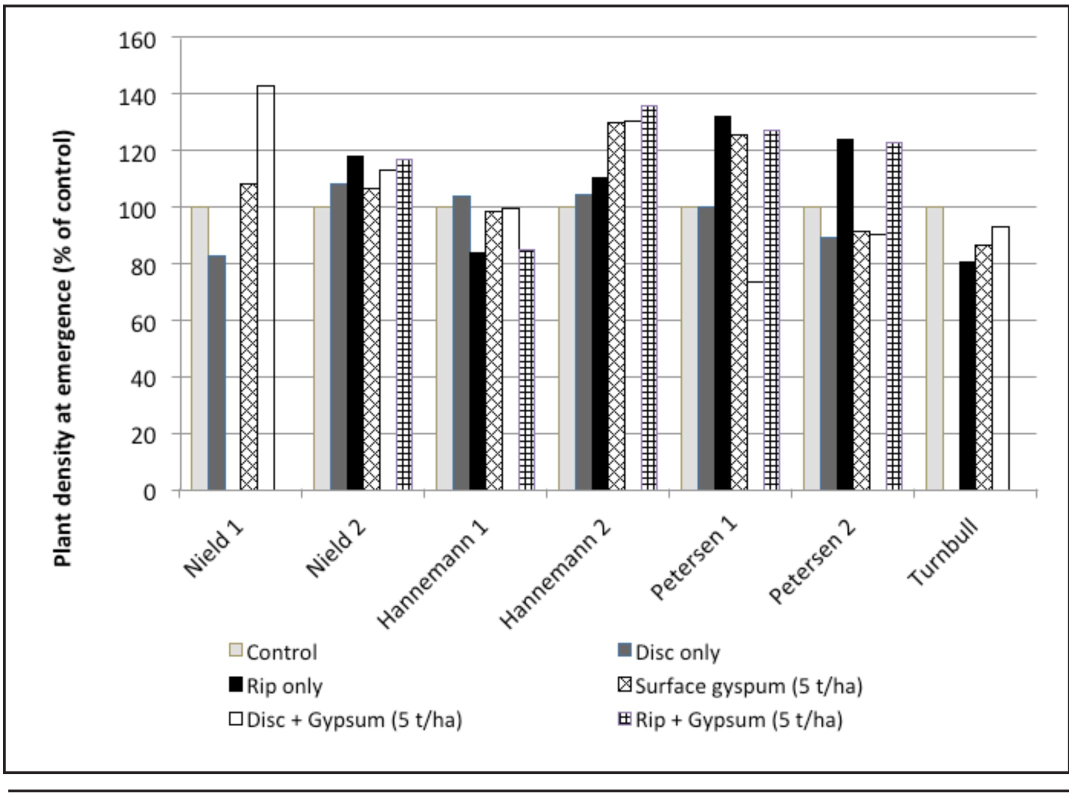

Figure 1 Plant density at crop establishment (% of control treatment), June 2014

Table 2 Dry matter cuts at Nield site 1, August 2014

Nield 1	Dry matter (t/ha)	% of control
Control	**7.3**	**100**
Disc only	7.1	97
Surface gypsum (5 t/ha)	8.2	112
Disc + gypsum (5 t/ha)	9.5	130
Surface gypsum (10 t/ha)	8.5	116
Disc + gypsum (10 t/ha)	9.0	123

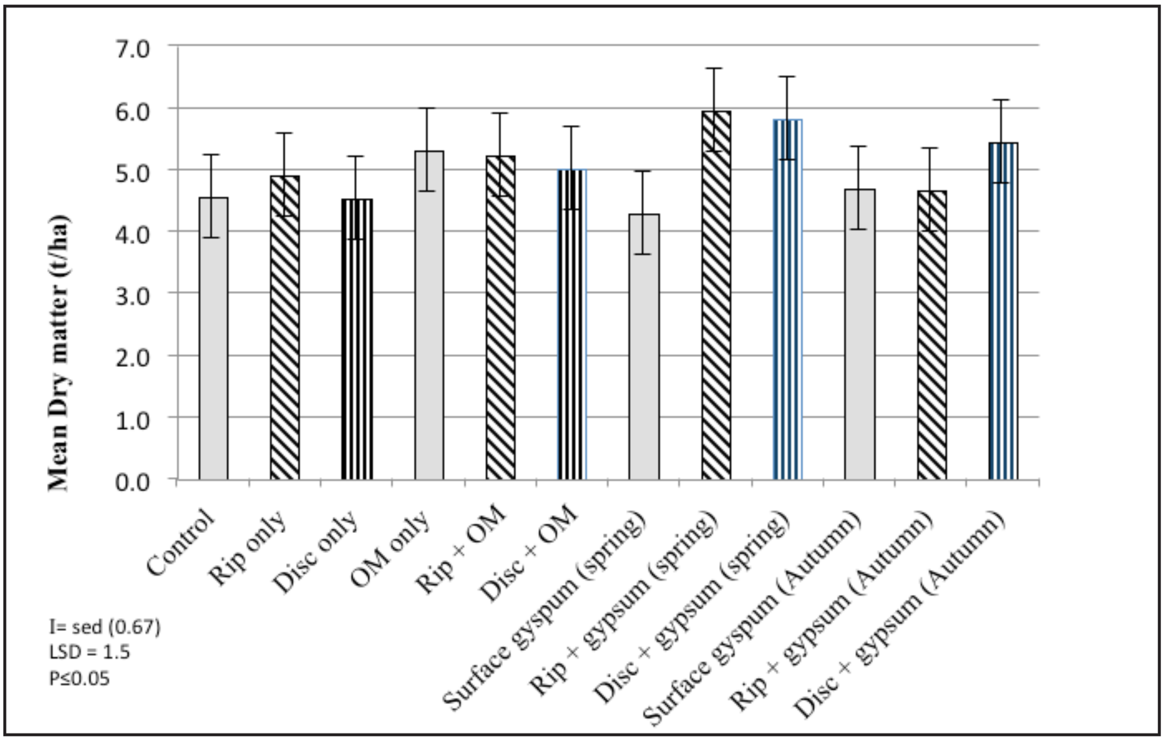

Figure 2 Hannemann 1 dry matter, August 2014

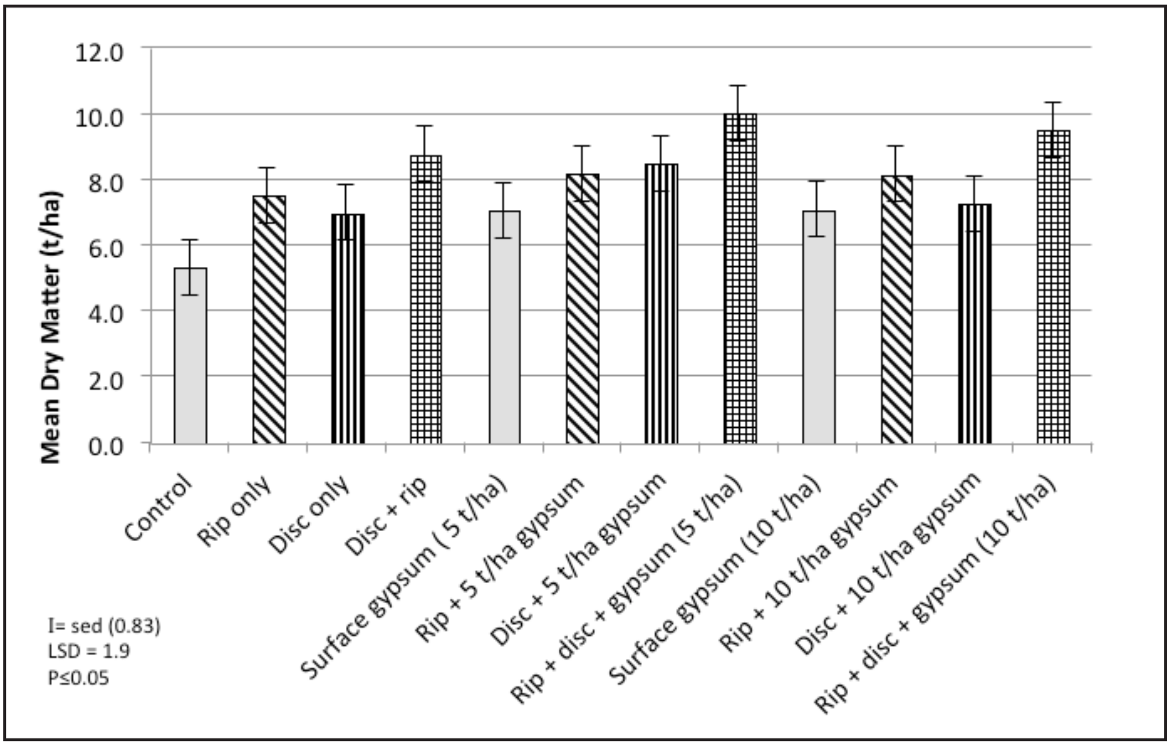

Figure 3 Hannemann 2 dry matter, August 2014

Soils and Tillage

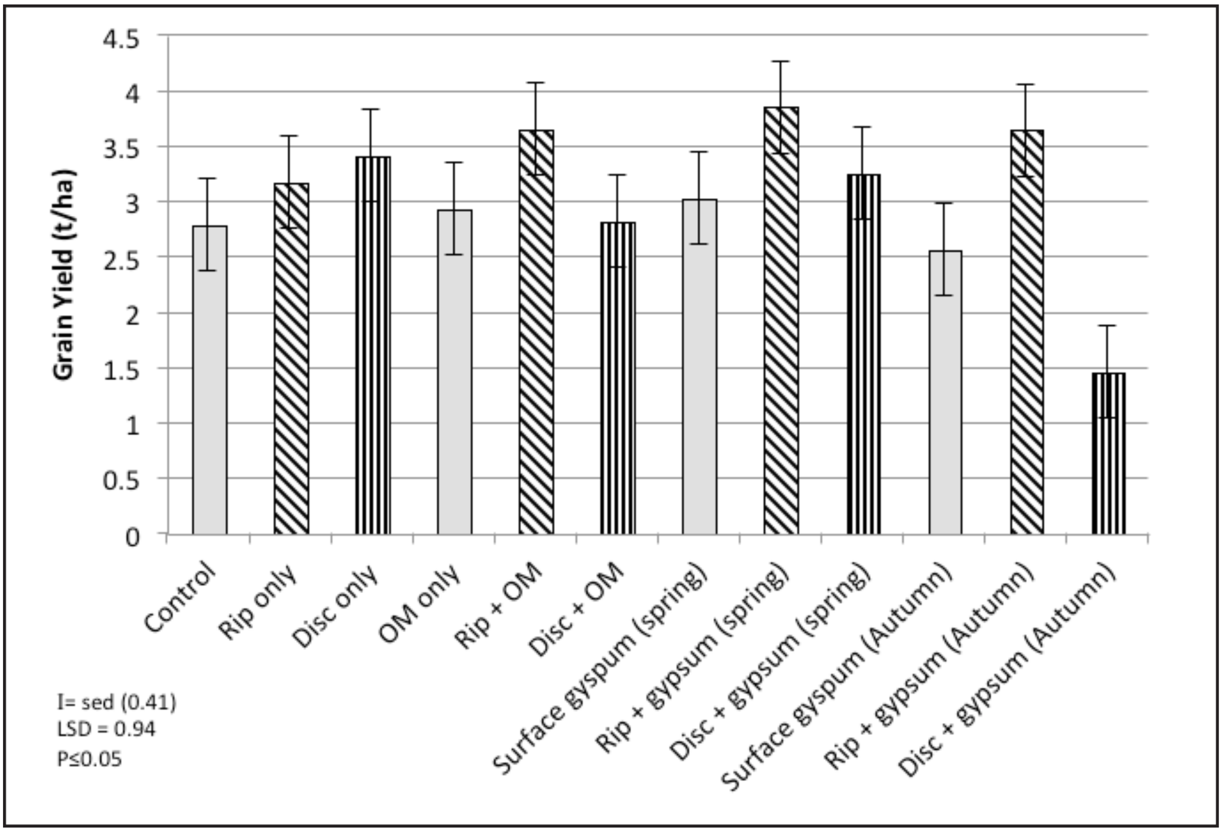

Figure 4 Hannemann site 1 grain yield data, November 2014

Dry conditions from the end of July to harvest caused canola crops (Nield 2, Petersen 2 and Turnbull) to bolt rapidly from rosette stage to flower with little vegetative growth during this period so dry matter was not collected at these sites. Dry matter cuts were taken in the last week of August on the sites sown to cereals. Petersen's wheat site at Mangalo was severely frosted throughout July and early August and dry matter cuts were taken from this site but it was difficult to separate the treatment response from the frost impact.

Dry matter data from Nield 1 indicated some response from the application of gypsum with an increased response when incorporated with discs (Table 2). There was no additional response by increasing the rate of gypsum.

There were no dry matter responses to surface application of gypsum at Hannemann's sites however there was a response where gypsum was incorporated (Figure 2 and 3). Dry matter data and visual observations at the sites indicated slight responses to ripping.

Grain yield data from Hannemann's wheat trial sites was obtained from 3 x 1 metre row cuts and threshing out the grain. Grain weights were extrapolated to give a plot yield in t/ha. Grain yield data reflected the dry matter trends (Figures 4 and 5).

The yield responses from tillage treatments alone were not statistically significant at Hannemann 1. However, ripping with addition of soil ameliorants did deliver significant yield increases (Figure 4).

At Hannemann's second site grain yields from tillage treatments alone were also not significant except on the disc + rip treatments. The addition of gypsum did not generate a higher yield response than the combined ripping and discing (Figure 5).

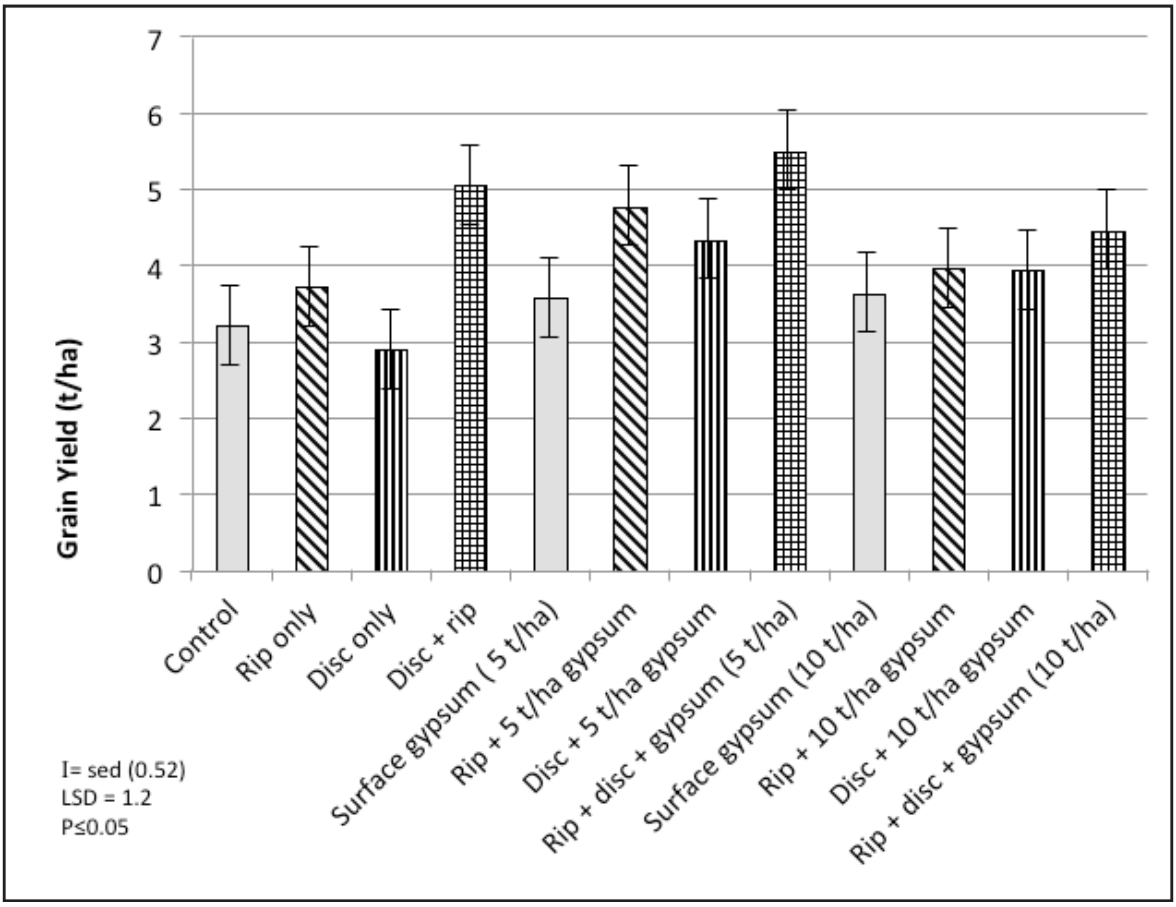

Figure 5 Hannemann site 2 grain yield data, November 2014

What does this mean?

These demonstrations have shown that while production can be increased by a combination of appropriate soil modification practices and the results with the use of soil ameliorants vary between sites and with seasonal conditions. This is consistent with the results of earlier trials.

Gypsum can provide benefit on sites which have sodic layers, however treatment is most effective if gypsum is applied directly into the sodic layers. High rates of gypsum applied at the surface prior to sowing reduced crop establishment. This may be due to localised salinization around the seed at germination and should only be of short duration. The high rate may improve production on responsive soils in future years as soil structure improves.

Ripped treatments evidenced slightly better growth than unripped and disc only treatments. However, dry matter and grain yield increases were greater where the ripping treatment was accompanied with the addition of organic matter or 5 t/ha of gypsum.

These trials have further highlighted results from earlier work that although ripping can be used to break through a compacted layer; where a sodic layer is present it will not provide a long term benefit without the application of an appropriate soil ameliorant.

Further questions arising from these demonstrations are:

- What is the role of deep incorporated organic matter in improving soil structure on hardsetting soils and those with sodic layers?
- How long before responses from applied soil ameliorants can be expected?
- How long are the potential gains are going to last?
- What are the implications for soil carbon levels?
- What are the costs/benefits of these treatments options?

Acknowledgements

The author would like to thank the landholders involved in this project; Joel and Blake Nield, Grant Hannemann, Isaac Gill, Michael Petersen, John Turnbull. I would also like to thank Matt Crettenden (Ramsey Brothers Pty Ltd, Cleve) and Corey Yeates (Natural Resources EP) for their support in establishing the demonstrations sites and Rebecca Tonkin (Rural Solutions SA) for undertaking statistical analysis of the harvest results. This project is supported by Natural Resources Eyre Peninsula through funding from the Australian Government.

Australian Government

Agricultural Bureau of South Australia Inc.
PATHWAY TO IMPROVEMENT

Bentleg tine openers for high speed sowing and low soil throw

RESEARCH

James Barr, Jack Desbiolles and John Fielke

Agricultural Machinery Research Group, University of South Australia

Key messages

- **Soil disturbance caused by tine openers affects the success of no-till seeding operations, influencing issues such as furrow moisture loss, weed seed germination, seeding depth variability across seed rows, crop safety and pre-emergent herbicide efficacy.**
- **Research shows that low rake angle openers increase soil layer mixing and deeper soil delving while slightly reducing furrow backfill. A bevel edge at the leading face increases furrow size and reduces lateral soil throw**
- **Bentleg openers combined with bevel edge features can mostly cancel soil throw and maximise furrow backfill. They offer an unprecedented ability for high speed-low soil throw no-till tine seeders.**

Background

Tine seeders are recognised for their greater soil disturbance at seeding, relative to disc seeders. Aspects of soil disturbance at seeding include furrow size and depth as well as the extent of soil movement or soil throw. The lateral soil throw (sideways movement of soil pushed out of the furrow) is a particularly important parameter to consider in a no-till seeding context. A limited amount of lateral soil throw at seeding is typically desired to mechanically incorporate soil applied herbicides. However, excessive soil throw reduces the furrow backfill, affecting soil cover over the seed, and creates interactions (ridging) between adjacent seed rows, resulting in additional soil cover which increases seeding depth and potentially induces crop damage from herbicides (Figure1). Table 1 outlines plant density losses to trifluralin, showing 20% losses are expectable on seed rows subject to ridging, with up to 45% losses measured in the worst case scenario (high trifluralin rate combined with high speed and shallower seeding). The extent of seed row interactions (ridging) for a given tine seeder is influenced by the row spacing and the operating depth and speed. In practice, this limits the adoption of narrow enough row spacing to maximise crop competition with weeds, and also reduces the machinery work rate at the critical time of seeding. An aspect overlooked in the soil disturbance issues at seeding is the role of furrow opener design features, and how they influence the mechanics of soil movement.

Soil throw and narrow openers: what do we know?

Recent research conducted at the University of South Australia measured the 3-dimensional soil movement (using small clod-like PVC tracers) created by a number of furrow opener geometries. These tracers were pre-positioned within prepared soil bins in a known reference grid pattern and soil movement was calculated by recording the 3D positions of each displaced tracer. The experiments were carried out in remoulded sandy-loam soil bin environment at 8 km/h. The main findings were:

i) All straight openers have an ability to clear the top soil layer out of the furrow centre section, which is a desirable feature with pre-emergent herbicides. This finding explains the reduced weed control along the seed row often found in practice with herbicides incorporated by sowing, as well as the greater seedling vigour observed with tine seeding systems (relative to discs) in Rhizoctonia infested soils, where disease inoculum is concentrated in the top 2-3 cm soil depth layer.

ii) Low rake angles promote soil layer mixing, and the delving of deeper soil into the upper layers. This makes them useful for sowing into a drying profile where moist soil can be brought up into the seed zone for assisting seed germination.

iii) High rake angles create slightly narrower furrows at depth with minimal soil layer mixing.

iv) A chamfered face leading edge reduces both forward and lateral soil throw as well as the surface soil clearing ability, but increases the furrow size and the furrow width at depth. A single-sided chamfer creates an asymmetrical furrow shape.

Figure 1 Visual crop effect of trifluralin damage due to excessive soil throw

Table 1 Experimental results on wheat seedling losses to trifluralin for 2 seed row types in a shallow alkaline clay-loam soil (Desbiolles, 2004)

Extent of Krichauff wheat damage by seed row (plants/m² loss)				
	No soil throw (rear of seeder)		+ soil throw (front of seeder)	
Herbicide rate (Trifluralin 480)	1.3 L/ha	2 L/ha	1.3 L/ha	2 L/ha
6 km/h	-14 *ns*	-30 *	-13 *ns*	-39 *
10 km/h	-17 *ns*	-17 *ns*	-39 *	-63 **
10 km/h + shallow seeding	-11 *ns*	-18 *ns*	-54 **	-85 ***

NB: Untreated ref = 187 plants/m²; 2004 Minlaton - Alkaline clay-loam soil

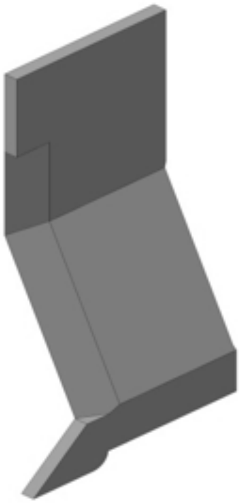

Figure 2 Bentleg geometry

Later research at UniSA also investigated a novel furrow opener geometry referred to as bentleg opener (Figure 2), following the initial 'RT Blade' bentleg furrow opener development by South African farmer Danie Rossouw in 2004. He adapted the well-known Paraplow subsoiler tine design to fit a smaller scale seeder, aiming to manage soil compaction via deep till sowing with improved backfill at furrow depth and reduced soil throw at speed. Previous work at UniSA quantified furrow backfill values in the range of 15-97% when measured in tillage test track environment for a wide number of commercial furrow openers operated at 6 and 10 km/h. The data highlighted the need to properly select and operate openers in a no-till context. The furrow backfill parameter - defined as the proportion of furrow volume filled by loose soil tilth – is best when close to its maximum at 100%.

The bentleg design offsets the shank portion of the opener away from the centre of the furrow where the upheaval of soil is greatest. The shank is connected to the loosening foot via a side leg portion. Additionally, the use of a bevel edge is incorporated to maximise the benefits. This results in an opener that can loosen a large furrow size while achieving 100% furrow backfill and virtually cancelling lateral soil throw and soil layer mixing. Figure 3 shows a pictorial representation of furrow cross-sections contrasting the 'bentleg effect' on soil layer movement to that of a spear-point style opener. In practice, the availability of scaled-down bentleg openers offers an unprecedented opportunity for high speed, low soil throw tine seeding.

Why do the trial?

A field trial was conducted in a dry clay-loam soil at Roseworthy in September 2014 to validate the bentleg findings in a field situation and investigate the potential for higher speed seeding. A selection of straight and bentleg openers was tested at 8, 12, and 16 km/h and at 120 mm operating depth, measuring draft, vertical and side forces, as well as lateral soil throw and furrow backfill using a laser scanning device.

Two straight knife openers (53° and 90° rake angle) were included as controls, while the two bentleg openers evaluated had 45 and 95 mm shank offset values. Selected results are shown in Figure 4. The lateral soil throw quoted represents the equivalent row spacings to ensure limited or no interaction occurs between two adjacent furrows.

What happened?

Under the dry soil conditions, the vertical knife opener significantly reduced the extent of soil throw compared with the 53° rake angle opener. Both bentleg openers further reduced soil throw compared to these straight openers at 8 km/h. At the higher speeds, the 95 mm offset bentleg opener maintained low soil throw, while the 45 mm offset bentleg design displayed a sensitivity to speed, with soil throw at 16 km/h similar to that of the 53° rake angle opener. This showed the design of a bentleg opener must be optimised for its intended use.

The furrow backfill data show the ability of the 95 mm offset bentleg opener to maintain maximum furrow backfill regardless of speed, while the straight openers, from a comparative baseline at 8 km/h, significantly emptied the furrows at faster speed, with backfill in the range of 50-60%. This 'furrow-emptying' feature of straight openers was strongest for the 53° rake angle opener. The 45 mm offset bentleg achieved significantly lower backfill at 16 km/h in line with the increased soil throw.

Overall, the 95 mm offset bentleg design was able to maintain its baseline lateral soil throw at twice the sowing speed while maintaining 100% furrow backfill. The draft force measurements showed the following:

i) The vertical knife opener required approximately 50% more pull than the 53° rake angle opener, demonstrating the known beneficial effect of low rake angle on draft. This draft was also approximately twice that of the bentleg openers, which were able to minimise the pull requirement due to their 45° rake angle leading foot.

ii) Under the dry conditions, the draft force increased with speed for all openers, while the least effect was measured with the vertical knife opener.

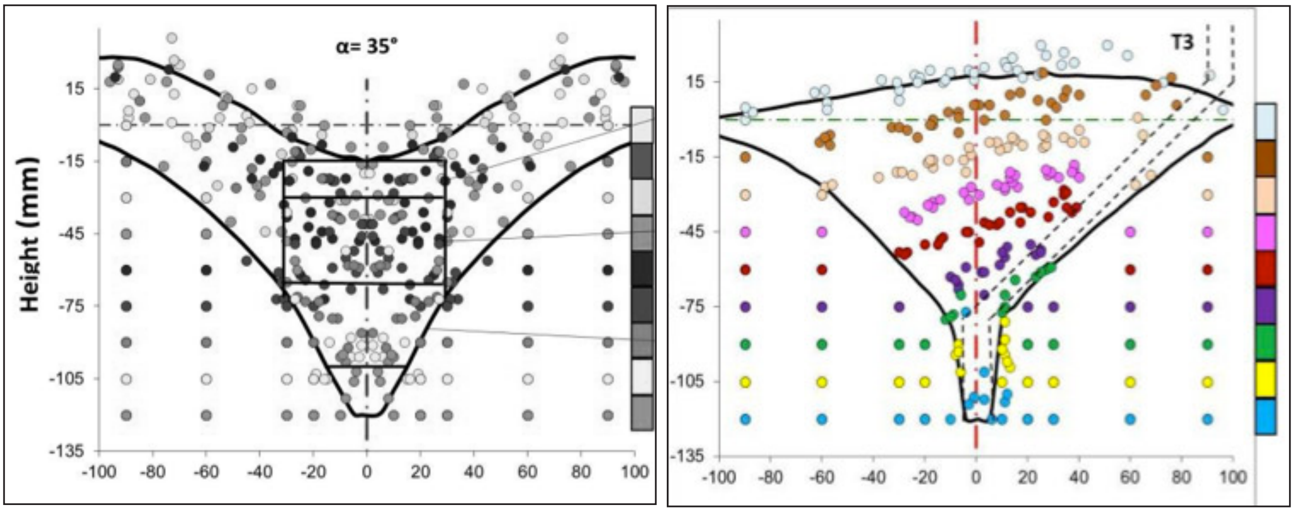

Figure 3 Soil bin studies: Furrow cross-sections showing furrow boundaries, loose tilth and opener outlines, and PVC soil tracers - coloured by depth layer. The tracers were displaced from the initial grid layout in the process of furrow loosening to reveal soil movement – Left: Blunt face, knife opener at 35° rake angle; Right: Bevelled edge, bentleg opener (Solhjou et al, 2012, 2014)

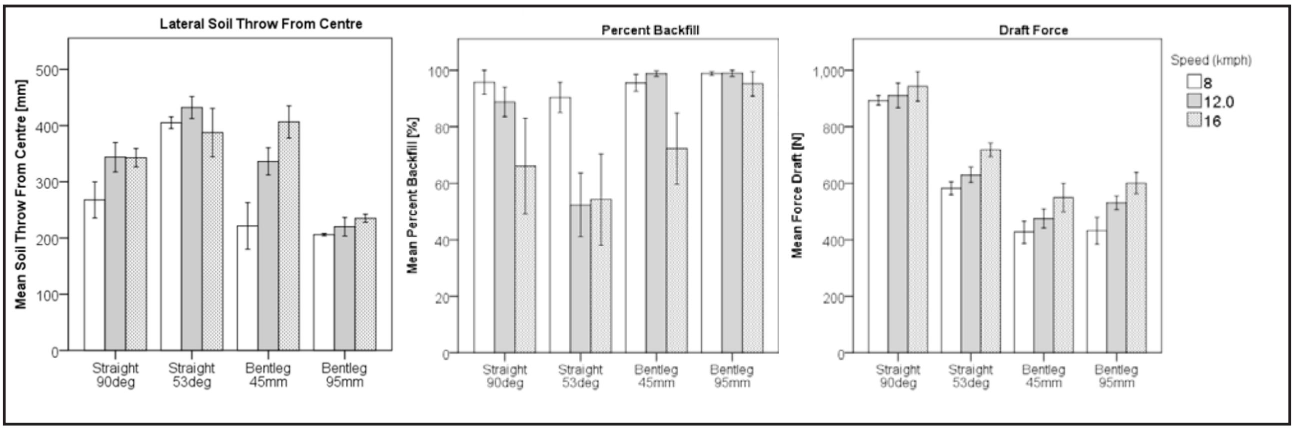

Figure 4 Selected field data for 4 furrow opener geometries (blunt face, straight openers at 90° and 53° rake angle, and chamfered bentleg openers with 45 and 95 mm offset) at three operating speeds (8, 12, 16 km/h)

What does this mean?

The field data acquired to date confirm the great potential benefits of bentleg opener geometries, both in controlling soil throw (and associated crop safety from pre-emergence herbicides) and in minimising draft forces, compared with existing knife and spear point style opener technologies.

Bentleg openers thus represent a new opportunity for optimising the performance of tine seeders and in particular enabling high speed sowing operations, perhaps on the par with disc seeders. Further, the soil handling features of the bentleg opener may achieve specific benefits of low weed seed germination, which would need to be validated in dedicated field studies.

The work also demonstrated the need for additional research to optimise the bentleg opener design, while opportunities exist for further scaling down the design (but not the properties) of this innovative opener, currently sized to operate at 120 mm depth, to suit shallow soils and further minimise power requirements. Current postgraduate studies are underway to further validate - and optimise via modelling - the bentleg opener concept and recommend solutions for the design of an integrated seeding system.

Seeding system solutions for commercial adoption of this technology currently include a split system such as bentleg tine + following disc unit, an approach which was initially used in South Africa for evaluating the RT blade prototype, and also used in limited South Australian trials to date. The benefits of a scaled-down and integrated seeding system would broaden the scope for widespread adoption of this technology.

Acknowledgements

Funding from the GRDC, SAGIT and the University of South Australia for previous and on-going seeding system research is gratefully acknowledged.

GRDC Grains Research & Development Corporation
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Section 8

Sharing Info

Section Editor:
Naomi Scholz
SARDI, Minnipa Agricultural Centre

Managing for profit and risk

EXTENSION

Geoff Thomas
Thomas Project Services, Blackwood

Farmers have been seeking guidance for years as to how they can improve the fit of their various farm systems components to improve profitability and reduce risk. In the past a lot of attention has been placed on agronomic considerations and hence a concentration on varieties, rates, seeding dates and row spacing type work. Similarly with livestock we have seen work on grazing cereals and other crops. While all of this has a place, farmers are now seeking more advice on how they fit the various technologies together to achieve the best effect. That "best effect" no longer just means production as it often did in the past – farmers now see profitability, reduced inputs and management of risk as major drivers.

The LRCP established an initiative funded by GRDC in which local staff worked with farmer groups to develop "model" farms based on real local figures and used this to explore various on farm issues. The intent of the project has been to focus on decision making in terms of profitability rather than productivity alone, taking into account the risks associated with the production and marketing process. Consequently, the project has heavily focused on the economic consequences of decision making. It recognises that each manager will have a different attitude to risk which will in turn influence the decision process. A prescriptive process is not seen as the solution - what works well for one farmer will not necessarily work well for his neighbour.

The project has aimed to improve decision making amongst local farmers by improving the knowledge and understanding of the economic relationships which exist in our farming systems, and improving skills to assess the economic consequences of their decision making in critical areas within their farm business.

The outcomes of the project are complex and vary between regions but it has played an important role in establishing farm business management and decision making as an important area to address. Here is a broad summary of outcomes:

- Farm business skill programs are being demanded by a wide range of farmers and consultants and have now become a core component of most groups and have been developed using a wide range of funding.
- Some regions concentrated on teaching the basics of farm business to younger farmers.
- Two groups have used the project to support about 40 people, gaining the Diploma of Agribusiness.
- Local accountants have been used in the programs adding to their knowledge base and that of farmers and consultants. Both accountants and consultants are seen as key players in the future development of farm business skills.
- Some of the main areas addressed by farmers through the use of local farm models have been:
    - Any analysis of the farm business based on averages is misleading at best and often dangerous. Analysis must take into account the impacts of good and bad seasons.
    - The risk management focus needs to be on methods to limit downside losses in poor years without compromising gains in better years.
    - The merits of buying vs leasing vs share farming.
    - The importance of succession planning and overcoming the barriers to expansion.
    - The best balance between livestock and cropping on farm.
    - The importance of planning cropping programs and inputs according to the different capabilities of various types of land on the farm using the options of crop type/variety, livestock, or leaving paddocks out altogether if early rainfall is limited.
    - The importance of capital investments in managing risk and making the right machinery decisions based on need/reliability and not just on tax considerations.
    - The need for researchers and farmers to assess research outcomes in terms of the impact on the whole farm business in terms of profit and risk.

Using the Mallee analysis by farmers the following "messages" arose, which have application across the entire low rainfall farming zone:

- It is difficult (both financially and practically) to maintain nitrogen inputs in long term continuous cropping farming systems. Profits in the high rainfall seasons are being constrained as farmers are unwilling to fertilise to the levels required to reach potential yields. More 'natural' nitrogen is required in farming systems through more frequent legume phases in paddock rotations.
- Farmers are relying on expensive chemicals to maintain current high input farming systems which is increasing risk. Lower cereal intensities and a greater proportion of break crops and pastures in the rotation are required.
- Livestock play an important role in moderating financial losses incurred from cropping in poor seasons. Businesses that choose to remove livestock need to find alternative methods to reduce risk, such as finding greater off farm income or maintaining higher levels of equity.
- Maintaining investment in machinery is a large cost and increases risk considerably. Generally, a greater critique of machinery investment decisions is required by considering carefully what type of machine is required to reliably complete the task. Shifting a greater proportion of machinery investments into profitable seasons is another strategy to reduce financial exposure in poor seasons.

So where to from here?
There will be further development in two main areas:

- The development of a simple tool for farmers and consultants to use with their own figures to assess various decisions. This is being developed by a team led by Michael Moodie and Ed Hunt based on Mallee and EP data and it will have wide application. It will be validated by Bill Malcolm of Melbourne University before being rolled out in mid-2015.
- CSIRO will also to use the tool to assess research results in terms of their impact on profit and risk on farm. This will be done with the results of the Mallee Karoonda trials but then applied more broadly.

A different take on farming efficiency - carbon farming

EXTENSION

Mark Stanley
Regional Connections Pty Ltd, Port Lincoln

Key message

Five farm consultants based on the Eyre Peninsula are involved in an innovative project aimed at up-skilling 30 independent farm advisers across South Australia, Victoria, and Tasmania, in their carbon farming knowledge so they can support their farmer clients in decision-making.

Carbon Farming is simply farming in a way that reduces greenhouse gas (GHG) emissions or captures and holds carbon in vegetation and soils. It is managing land, water, plants and animals to meet the triple challenge of landscape restoration, climate change and food security.

The driver of carbon farming - climate

As the planet warms, the tropics are expanding towards the poles, pushing rain bearing weather systems away from South Australia causing an April to June drying. Stronger high-pressure systems over SA prevent cold fronts bringing winter rain. We are seeing earlier maturing of crops and more frosts. Expect to see stronger El Nino and La Nina events. There will be a drying trend from weaker cold frontal systems but we will experience more variability such as flooding during La Nina events.

A huge amount of carbon dioxide (CO_2) is stored in the oceans and in soil. Skeptics will say that humans only put out a small amount of the total CO_2. The problem is that we are influencing a system previously in a state of approximate equilibrium. Increasing the greenhouse gases is like slowly turning up the tap into a full bath of water until it overflows.

The oceans have warmed, accounting for more than 90% of the extra energy stored by the earth's system since 1971. More La Nina events since 2000 are pushing more of the heat from the surface into the ocean depths. This has slightly slowed the rises in surface air temperatures since 2000 compared to the 1980s and 1990s. Some people find it difficult to reconcile this recent reduction in temperature rise with the warnings about climate change. But the only thing that explains the long-term trend is the greenhouse gas increase. There is a lag of 30-100 years between the CO_2 level increase and the warming it produces. The changes we see now are a reflection of 1970s and 1980s CO_2 emissions. It will be beyond 2100 before we see the full effect of what we are emitting now.

Climate variability verses climate change - the wave and the tide

One way to think about climate variability and climate change is to consider a sandcastle on a beach which is affected by both the waves (year-to-year variability) and the tide (long-term climate change). The damage to the sandcastle is always the wave, but in a rising tide there are more damaging waves. Farmers are well aware of climate variability and have all experienced runs of good years and poor years. Although this understanding of variability is a strength, the focus on waves can mean that we miss the change in the tide. In simple terms, the role of the tide relative to waves is clearer in temperature than rainfall.

The target to reduce GHG emissions

Of Australia's national emissions of CO_2, agriculture contributes 17%. In comparison, other industry emissions are electricity (35%), other stationary energy such as heat and steam (16.6%) and transport (15%). The Australian Government's target is to reduce emissions by 5% of 2000 levels by 2020. The challenge for agriculture is to meet the target without compromising farm profitability and food security. While the financial incentive for reducing greenhouse gas emissions is currently small, there are productivity incentives.

Effects of climate change on agriculture

There is likely to be seven main changes in the climate that will affect broadacre agriculture:

Mean temperatures: Average temperatures will become warmer which means that crops will grow faster. Warmer conditions will also impact weeds, pests and diseases which will lead to different challenges in plant protection, depending on how they adapt.

Extreme heat: As mean temperatures increase there is a higher chance of extreme heat events. These spring heat events are a greater worry than the change in mean temperature.

Frost risk: Although minimum temperatures are expected to increase, it is harder to be definitive about frost events. Spring frosts in the Australian grains belt are often radiation frosts associated with clear night skies. If the region was to experience a drying in spring, the frequency of frost could increase. The changes in weather patterns associated with climate change may lead to more frequent inflows of dry cold polar air. A further complication is that the quicker development and emphasis on early planting can lead to flowering in the frost window.

Rainfall: Rainfall is the most uncertain aspect of climate change for the crop livestock systems in southern Australia. Climate models suggest continued decreasing late autumn and winter rainfall across southern Australia but are unclear about trends for summer and early autumn rainfall.

Rainfall intensity: A changing climate is likely to deliver higher rainfall intensity across all of Australia, but in southern Australia this is coming from a low base.

Evaporation: Much of the change in evaporation over winter in southern Australia will be linked to changes in rainfall. Evaporation is driven by radiation and cloud cover so a decrease in rainy days means higher potential for evaporation.

CO_2 in the atmosphere: The amount of growth per unit of water will increase with higher CO_2 levels because of improved transpiration efficiency - however scientists' confidence is higher in the lab than the field for the observation. Weeds and pests will also benefit from higher CO_2.

Farmer attitudes to climate change response

More than 500 farmers responded to a survey as part of the *Building Farmer and Advisor Knowledge in Carbon Farming* project to measure their current motivation and attitudes towards carbon farming and application of carbon farming knowledge.

Financial implications and a lack of understanding were the top two reasons given as to why farmers in south-east Australia are not implementing strategies to reduce greenhouse gas emissions on their properties. Other barriers included a lack of skills, the time it takes to make such a change and resourcing, such as staff.

Responses showed farmers did not generally believe there were benefits for their businesses by reducing greenhouse gas emissions on their farms. Only 30% of those surveyed believed that greenhouse emissions were definitely causing the climate to change. However most believed that human activity was the cause of greenhouse gas emissions increasing.

What can be done to reduce on-farm GHG emissions?

Reduce nitrogen losses and increase nitrogen use efficiency

Nitrous oxide (N_2O) is a potent greenhouse gas. When it comes to reducing global warming, removing one N_2O molecule from the atmosphere is equivalent to removing 300 CO_2 molecules. About 1% of applied nitrogen fertiliser is emitted as N_2O, depending on the farming system, climate, and management. There are two main ways that N_2O is emitted – nitrification and denitrification, although more is lost through denitrification (saturated/water-logged soils).

Most of Australia's N_2O comes from agricultural soils. Losses of nitrogen (N_2) are difficult to measure because it is quickly diluted in the atmosphere. However, N_2O is easy to measure and is a good indicator of nitrogen use efficiency. High losses of N_2O indicates inefficiency in a farming system. Soils with high N_2O emissions mean there is excess N in the system, and/or poor soil physical condition.

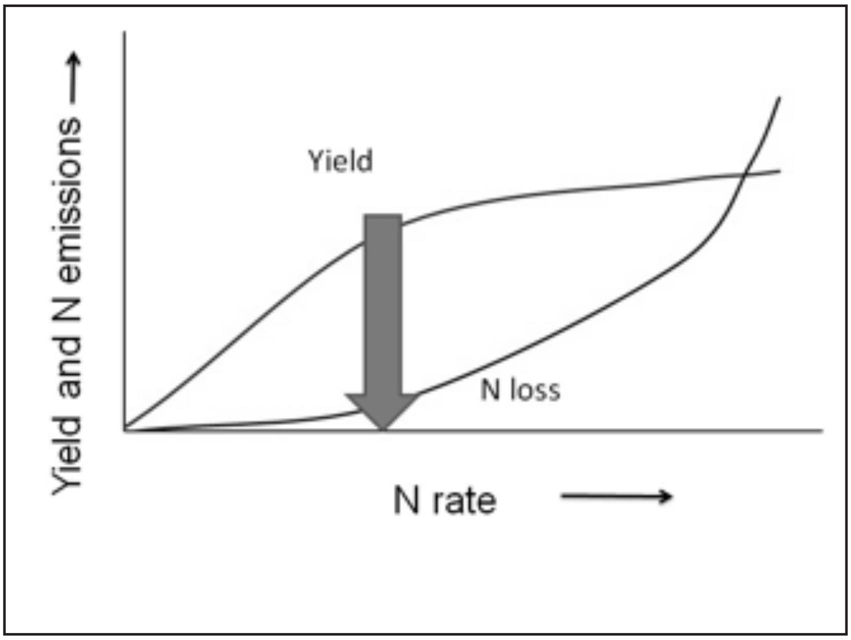

Figure 1 Optimising yield and nitrogen emissions by nitrogen rate

Improving nitrogen use efficiency

Building soil organic carbon means nitrogen is being built up as well. There is an optimal rate of nitrogen that maximises yield and minimises nitrogen loss (Figure 1). Nitrification inhibitors can potentially reduce N loss, but they are not cost-effective at present. Organic sources of N (legumes) that mineralise slowly are better than large amounts of mineral N in soil that could be lost at any point if the crop has not taken it up. Fertiliser N can be kept for later in the season when plants have used available sources. In soils that regularly waterlog, 'drip-feeding' N by regular application is the best way to ensure it is not lost.

Methane management in extensive livestock enterprises

Methane (CH_4) has 23 times the global warming potential of carbon dioxide (CO_2). Methane remains in the atmosphere for about 70 years and then gets broken down to CO_2. In livestock, methane is produced as a by-product of ruminant digestion. Microbes in the rumen ferment carbohydrate as plant fibres are digested, releasing hydrogen in the process.

There are a range of management options to reduce methane emissions. Some are easy to put in to practice but have a lower overall impact on emission reductions, while others will take longer to implement but may have a higher impact.

Dietary additives: Feeding fats and oils can reduce emissions by 3-4%. These include canola, soybean, sunflower, fish/sunflower oil and flaxseed oil. Feeding nitrates, such as calcium nitrate, reduces emissions. Nitrates reduce methane production by providing an alternative chemical pathway for hydrogen as the rumen breaks down plant fibres.

Improve productivity: Increasing productivity through improved feed conversion reduces emissions intensity. The end result can be improved weaning rate, weaning weight and rate of gain.

Genetics: Researchers have found some animals are more efficient feed converters because they have more active rumen microbes, producing less methane.

Rumen manipulation: Research is continuing into the different reactions between microbes and how the rumen deals with hydrogen when breaking down plant fibres.

Useful resources

Building Farmer and Advisor Knowledge in Carbon Farming Project –
www.carbonfarmingknowledge.com.au

Methane Research Cluster -
http://www.csiro.au/Organisation-Structure/Flagships/Sustainable-Agriculture-Flagship/Livestock-Methane-Research-Cluster-Methane-Cluster.aspx

National Agricultural Nitrous Oxide Emissions Research in Australia –
www.n2o.net.au

The Climate Institute –
www.climateinstitute.org.au

The Carbon Farming Initiative –
www.mycfi.com.au

BOM's El Nino Watch –
www.bom.gov.au/climate/enso/tracker/

CSIRO Understanding Climate Change –
http://www.csiro.au/Outcomes/Climate/Understanding.aspx

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Building Farmer & Advisor Knowledge in Carbon Farming

Why sustain biodiversity in the agricultural landscape?

EXTENSION

Dr Greg Kerr

Natural Resources Eyre Peninsula, Port Lincoln

Key message

The greater the diversity of species with healthy populations in and around your farm the more free ecosystem services you receive.

After years of agriculture in Australia there are still many mysteries about how this land works and how best to care for it. The shifting patterns of weather and wildlife, and the ever changing effect of European settlement make understanding the Australian landscape an ongoing challenge. This is true for the most experienced and observant farmer.

Increasing farming intensity has resulted in a simpler rural landscape on EP. Farms are bigger, paddock size is bigger and much non-crop habitat has been removed. Intensive farming has a low fallow ratio and generally a high use of inputs such as capital, labour, or heavy use of pesticides and fertilisers relative to land area. Through widespread use of intensive farming, biodiversity is being lost across rural landscapes. Most remaining plants and animals are now found on paddock edges and in non-crop habitats.

Our region's biological diversity or 'biodiversity' is the range of all life forms and how they are spread across the land. It includes the natural communities and the variety of different plants, animals, and microorganisms they contain. It also includes the variety of genes in their populations. Importantly, it is not just a list of species but how they depend on each other.

So, why would farmers want to change what they do when the growing world demand for food creates key economic openings? The world population will approach 10 billion people by 2050. The United Nations Food and Agriculture Organization (FAO) estimates a need to grow 60% more food (c.f. 2005/2007 levels) to meet this demand. This could see the value of our food exports grow by 140%. Surely we need to produce more food and farm more land not less!

The confronting reality is that human activity (e.g. land clearing, fragmented and isolated bushland remnants, weeds and pest animals, livestock grazing, soil cultivation and fertilisation, and altered fire management) is causing species loss both in Australia and across the globe. Because of the extent of land they own, rural land holders can play a critical part in halting and reversing native plant and animal loss. If farmers can decrease external inputs/costs, while looking to a more sustainable future on their land, why not?

Fast Facts

Eyre Peninsula has kept an average 43% (2,188,000 ha) of its original plant cover. A quite high value when compared with other intensively farmed regions. But, most (56% or 1,229,000 ha) is found on private land, outside of conservation reserves or heritage agreements. This remaining bush is highly fragmented e.g. there are over 16,000 patches smaller than 20 ha in size.

Nine of the 511 vertebrate and three of the 1900 plant species on EP 200 years ago are now extinct, 63 animal and 231 plant species face a high risk of extinction, 118 and 596 are rare.

As such, it is rural land holders who can play a critical part in halting and reversing the loss of native plants and animals.

Species loss is not always easily seen and understood. The decline is rarely dramatic, our reference point is limited and changes with time, and our idea of how much change has taken place blurs. To those who trust their eyes, groups like birds are thriving in the rural landscape. But, since white settlement the story has been one of winners as well as losers. Most Australians notice the common large aggressive birds such as magpies, currawongs, cockatoos and corellas that are displacing the quieter ones.

Why would farmers want to conserve native species on farmland?

Farmers have a strong connection to their land. It's a part of who they are. The aesthetic and intrinsic qualities of native bush and wildlife make a farm home.

Increasing species diversity improves the ability of farm ecosystems to gain resources, make biomass, break wastes down to recycle nutrients, maintain fertile soils, control populations, store carbon dioxide and maintain genetic diversity. It can increase the ability to resist pests and diseases. Where biodiversity is kept at a high level, ecosystems are better able to work with change. They recover functions more quickly after a shock such a drought, fire or weed outbreak. These are all factors critical to a profitable and successful farm.

Native plants, animals, fungi and microbes provide essential ecosystem services as 'free' inputs to farming production. Where diversity is low we scramble to address these changes through artificial means at a cost.

Vegetation and its role in controlling salinity, erosion, stream stability, and the impact of wind on soil moisture or stock productivity have been long understood by farmers.

Native organisms cycle nutrients and so provide fertiliser! These nutrients come from the release of minerals in the soil's organic matter, through bacteria fixing nitrogen from the air, or through recycling. As an example, arbuscular mycorrhizas are a key group of soil fungi that greatly add to crop production and ecosystem sustainability [1]. They live within the plant roots of 80% of plant families, improving growth by helping them obtain soil phosphorus (P) and other essential bound mineral nutrients. They also stabilise soil aggregates, help prevent erosion, and alleviate plant stress. The beneficial effects of these fungi on plant performance and soil health are essential for sustainable management of farming ecosystems.

Some 84% of the approximately 300 commercial food crops depend on insect pollination. Modern commercial crop production depends on managed honeybee introduction and less on the wild insects living around the paddock edge. Worldwide there is clear evidence of recent declines in both wild and domesticated pollinators and parallel declines in the plants they pollinate [2]. The possibility of honey bee population collapse due to known threats (e.g. varroa mite) adds value to wild pollinator services. Australia is fortunate to be the only continent not yet affected by this mite. There is very real potential for it to arrive and spread here. A diverse group of wild pollinators helps maintain pollination success under changing environmental conditions.

Non-crop (natural) habitats save many natural enemy species (e.g. predatory insects and spiders) of farm crop pests. Spiders are critical to the control of thrips and red-legged earth mites. The irony of spraying to kill these pests is that we also kill the natural predators. Across the landscape, natural habitats in the land use mosaic provide year round refuge and maintain healthy populations of these natural predators. These habitats can be native grasslands, herblands, shrublands or wooded habitats. Where they lie next to crop paddocks there is more natural predator activity. When pest prey species start to increase in number natural predators respond quickly, moving into the crops and controlling them. This reduces yield loss without the undesirable impacts resulting from chemical pesticide use, providing both environmental and economic benefits to the farmer. Why would you pay for biological control when you can get it for free?

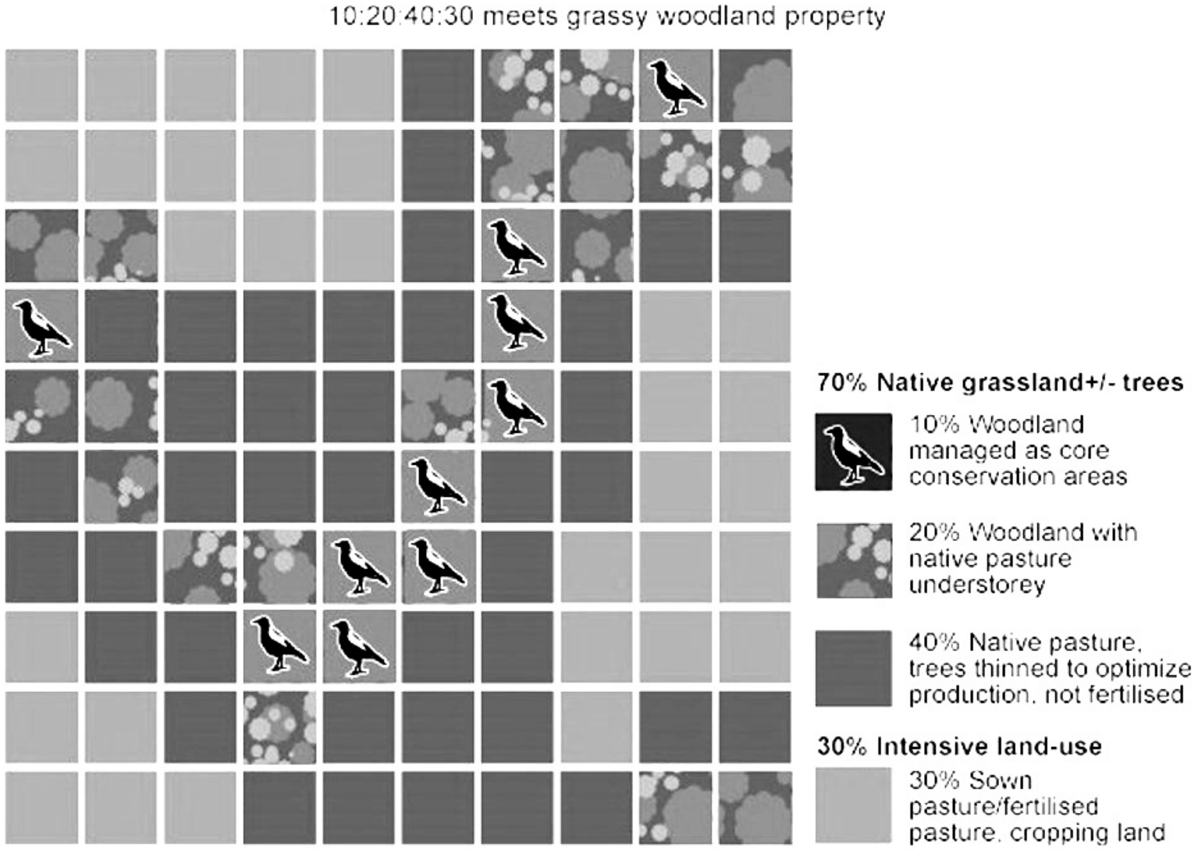
As a community we make choices about which parts of the natural system to retain, with far reaching effects. Dingoes are a threat to our stock, so we removed them. Fair enough, but with this benefit there are many costs. Native herbivores, such as kangaroos and wombats, flourish and move freely across the landscape. Red foxes, feral cats and rabbits become abundant. Land managers have to play the role of apex predator, controlling these animals at a significant cost. What is less evident is the impact of these over abundant animals on our bushland. Some countries like the United States of America and many in Europe have come up with a national approach to restoring apex predators and associated benefits, but this is something beyond the farmer's control. This article is about things that farmers can do on their farms and together with their neighbours.

So how can a farmer help to keep biodiversity in an intensively used farming landscape?

Farmers design the pattern of land use on their farms. The question is, can you sit down with neighbours and look at the types and extent of land use across the landscape and plan for the medium to long term. Plan to protect existing habitat and, where possible, value add. To retain biodiversity you need to increase native habitat above 30% of the landscape, minimise fragmentation, modify grazing practices and reduce fertiliser input.

How much native habitat is enough? Less intensive ways of farming help native species to coexist. At the same time the native species provide benefits to the farm systems. Where intensive farming occurs, it needs to be part of a mixed landscape in order to keep a high diversity of native plants and animals in the area [3]. This means the intensively farmed site is placed within areas of less intensive production as well as among areas of native vegetation. So, to get the best for flora and fauna out of farming landscapes you can move towards [4]:

I. a minimum 10% core natural vegetation managed for biodiversity conservation;
II. a minimum additional 20% natural vegetation managed under low intensity production systems;
III. a maximum of 30% allocated to intensive production systems; and
IV. the balance between natural vegetation (min 30%) and intensive production (max 30%) given to moderate intensity production systems.



An idealised map of a grassy woodland property following the 10:20:40:30 guidelines, while allowing maximum intensive land-use (30%) and grazing (90%).

While farming landscapes in the pastoral and high rainfall zones of Australia could potentially meet most of these guidelines, very few in the cropping-sheep zone do. Modifying farms in the cropping-sheep zone to meet these guidelines is feasible. Policy and markets that support bio-sequestration of carbon could bring about land use change that, if appropriately targeted, could much improve retention of native biodiversity in the farming landscape [5].

So can you revegetate those stream lines on your property, or the recharge zone for groundwater that's causing you salinity problems lower down? What can you do with carbon credits? It doesn't take much to make a difference!

There is an extensive body of research to support these ideas. An excellent starting point is to read the book Nature and Farming by David Norton and Nick Reid.

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Acronyms and Abbreviations

ABA	Advisory Board of Agriculture
ABS	Australian Bureau of Statistics
ADWG	Average daily weight gain
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
DEWNR	Department of Environment, Water 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
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
HLW	Hectolitre Weight
IPM	Integrated Pest Management
LEADA	Lower Eyre Agricultural Development Association
LRCP	Low Rainfall Collaboration Project
LSD	Least Significant Difference
LW	Live weight
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
RD&E	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
SASAG	South Australian Sheep Advisory Group
SBU	Seed Bed Utilisation
SED	Standard Error Deviation
SGA	Sheep Genetics Australia
SU	Sulfuronyl Urea
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:

RHIZOCTONIA RISK LEVELS

The RHIZOCTONIA decision tool has been developed to enable farmers to evaluate their Rhizoctonia cereal root disease risk level depending on previous crop rotation, management decisions, timing in the cropping season and the environmental conditions.

For further information contact Amanda Cook, SARDI, Minnipa Agricultural Centre, (08) 8680 5104, amanda.cook@sa.gov.au

PREVIOUS CROP TYPE

- GRASS FREE CANOLA AND BREAKCROPS — LOWER RISK
- GRASSY PASTURES OR BREAKCROPS (Grass controlled early June in pasture) — MEDIUM RISK
- CEREAL — HIGHER RISK

HARVEST

CHECK CEREAL CROWN ROOT DAMAGE IN CROP

DROUGHT IN PREVIOUS SEASON — HIGHER RISK

SUMMER AUTUMN RAINFALL — LOWER RISK

Control weeds within 3 weeks, as host Rhizoctonia and inoculum will increase

Soils wet for 3 days to increase microbial activity and reduce Rhizoctonia inoculum

PREDICTA B TEST

IF UNSURE

PRE SOWING

SOWING

IN CROP

LOWER RISK FACTORS

MANAGEMENT

Adequate nutrition and trace elements (P N Zn)
Pre tillage or working with points below the seed
Sowing 3cm
Control green bridge within 3 weeks of season break
Consider fungicide options
In crop - Additonal N and trace elements as required

ENVIRONMENTAL

Early season break with warm soils

HIGHER RISK FACTORS

MANAGEMENT

Low nutrition and deficiencies (P N Zn)
Low disturbance seeding systems
Deeper sowing
No green bridge control
Soil compaction layers
SU chemical use

ENVIRONMENTAL

Late season break and cold soils - N tie up
Early moisture stress
Lighter soils / non wetting soils

HARVEST

CHECK CEREAL CROWN ROOT DAMAGE IN CROP

www.eparf.com.au

SAGIT

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