WESTERN AUSTRALIA

MONDAY, 21 FEBRUARY
TUESDAY, 22 FEBRUARY
TUESDAY, 1 MARCH
THURSDAY, 3 MARCH
TUESDAY, 8 MARCH
THURSDAY, 10 MARCH

2022 GRAINS RESEARCH UPDATE, Perth

Program Book

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Proudly convened by:

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Grain Industry Association of Western Australia

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#GRDCUpdates

Welcome — GRDC Grains Research Update Perth proceedings

Welcome to the 2022 annual Grains Research and Development Corporation (GRDC) Grains Research Update, Perth — Western Australia's premier grains research forum.

This year's Perth Updates will be delivered for the first time in a completely virtual format, with full-day sessions on February 21 and 22 and half-day sessions on March 1, 3, 8 and 10.

It's disappointing that the COVID-19 pandemic has impacted our ability to host these updates across a face-to-face setting, especially considering how valuable the event's networking opportunities are to growers and industry. I can assure you though, the quality of information and research set to be presented at the Updates won't be diminished by the online format. We have made it as easy as possible for everyone to attend.

These free virtual events will provide attendees across the state access to the latest research, technology, market development and management innovations to improve the productivity and profitability of the grains industry.

GRDC Senior Regional Manager – West, Peter Bird

As a flagship GRDC event, the Grains Research Update, Perth, is critical in enabling growers, advisers, researchers and industry service providers to share knowledge to further the state's thriving export-focused grain industry, projected to be worth more than $8 billion in 2021/22.

Adding to this, 2021's record breaking harvest, estimated by the Grain Industry Association of Western Australia (GIWA) to be more than 24 million tonnes, has left the grains industry ideally placed to look at opportunities to invest in further improvements to increase the sustainability and profitability of farms and the wider industry.

This positive outcome has capped off a busy year at GRDC, with a number of initiatives and investments set to deliver future returns to WA growers.

In April the new National Oat Breeding Program was announced, which will be propelled into a new era under the leadership of commercial breeding company InterGrain, with co-investment from GRDC, AgriFutures and the WA state government.

The $11.5 million commercial breeding program will provide new varieties for milling and hay oats, along with a broad genetic base equipped to respond to the changing needs of Australian growers and exporters.

Evolving the way we approach applied RD&E with the Australian grain growing community has, and will continue to be, a major focus for GRDC.

In July we announced changes to the National Grower Network (NGN) model, which will see GRDC move to a more voluntary, inclusive and community-based approach.

The new system will have a more extensive geographic reach with direct local touch points and will utilise GRDC-branded forums and other mechanisms for identifying grower issues that are accessible to everyone.

The GRDC Western Regional Panel is a key part of this process, interacting with GRDC's Grower Network, farming systems groups and other interested parties to identify RD&E ideas and investment options.

I'd like to recognise the Perth Grains Research Updates program committee for the significant time and effort they have invested into ensuring the program best aligns with grower priorities.

Lastly, I extend my sincere thanks to GRDC Western region staff, GRDC Western Panel, and event convenor GIWA for their hard work, dedication and agility in bringing together this fantastic virtual offering.

So please sit back, get comfortable and prepare to explore the latest knowledge, innovation and research in the grains industry through the virtual GRDC Grains Research Update, Perth.

Peter Bird

GRDC SENIOR REGIONAL MANAGER – WEST

2022 Grains Research Update, Perth

Hosted by:

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

There are no event sponsors however the GRDC would like to acknowledge the commitments of the following organisations.

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Need Information?

Online sessions

This year the Grains Research Update, Perth will take place virtually over six days during February and March. Registration for the livestream series is FREE and you only need to register once to receive access to all six sessions.

Please mark a placeholder in your calendar for the sessions.

Each session will be recorded and uploaded to the GRDC website shortly following the event days, unless not approved for online publication.

- **Monday, 21 February — Plenary presentations**
- **Tuesday, 22 February — Plenary presentations**
- **Tuesday, 1 March — Nutrition/Nitrogen from Legumes**
- **Thursday, 3 March — Crop Protection**
- **Tuesday, 8 March — Canola/Cereals — wheat, oats and barley**
- **Thursday, 10 March — Soils/Pulses**

Attending virtually

Reminders will be sent a day prior to the allocated event day. On the day of each event, you will receive an email containing a link to access the livestream event. ***This email will be sent to the email address that you provided at registration***. Be sure to check your Inbox and spam folder for this link. The link will take you to a webpage where you will attend the session automatically via Zoom.

Attendees will have the opportunity to ask questions after each presentation using Slido.com.

How to ask a question?

- On your handheld device or laptop, go to Slido.com
- Enter the Event Code '**GRDCUpdates**'
- When it's time for Q&A, submit your question/s for the Chair to ask of the presenter
- Due to time constraints, not all questions will be asked.

Tech troubleshooting tips

If you have any issues throughout the day, feel free to contact us on **08 6262 2128** or via email at researchupdates@giwa.org.au

Session breaks

Each event day has allocated breaks for you to re-charge and re-group. The breaks range from 15 to 30 minutes.

Virtual viewing habits

We know that sometimes sitting at your desk (or wherever you may be) for a long period of time can become quite uncomfortable. We have put together some viewing habits for you to utilise throughout the event days:

- Take advantage of the session breaks. Go for a short walk, get a drink, or have a stretch.
- Alternate between sitting and standing.
- Check your posture and adjust your monitor, laptop, or phone frequently.
- Keep a bottle of water handy to stay hydrated.

Presentations and papers

The Program Book contains summaries of presentations included in the 2022 Grains Research Update, Perth. This allows you to select which presentations you wish to attend virtually and provides key points for each presentation.

Attendees can access all complete papers in support of presentations at the Perth Update via the GRDC website **https://grdc.com.au/resources-and-publications/grdc-update-papers** when available.

Late papers will be made available on the GRDC website immediately following the event days, unless not approved for online publication.

Sessions are being recorded and will be made available on the GRDC website following the event. You will receive a link by email to access these.

Keep in touch

@GRDCWest **@theGRDC**

Join the conversation: **#GRDCUpdates**

We value your Feedback

We aim to continually improve each Research Update event by listening to your thoughts. You can help us by completing the evaluation polls on slido.com at the end of each session.

How to do a poll?

- On your handheld or laptop, go to **Slido.com**
- Enter the Event Code '**GRDCUpdates**'
- When the session nears the end a poll with pop up

Your involvement is very much appreciated.

2022
GRAINS RESEARCH UPDATE, Perth

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Program DAY 1 — Monday 21, February

Plenary presentations

9.00 am	**Welcome and 'Seed of Light' presentation** – Darrin Lee, Chairman GRDC Western Panel
9.15 am	**Opening and future directions of GRDC** – John Woods, Chairman GRDC
9.40 am	**Greenhouse gas emissions of Australian grain production** – Maartje Sevenster, CSIRO
10.05 am	**Q&A with John Woods, GRDC and Maartje Sevenster, CSIRO**
10.15 am	**BREAK**
10.30 am	**Carbon neutral grain farming by 2050 – an example in calculating net emissions for a broadacre farm and strategies to reduce net emissions** – Mandy Curnow, DPIRD
11.00 am	**Market Outlook for the WA grains industry in 2022 and the longer term – challenges and opportunities** – PANEL DISCUSSION WITH: Nathan Cattle, Clear Grain Exchange; Jason Craig, CBH; Cheryl Kalisch-Gordon, Rabobank; John Orr, Premium Grain Handlers; and Richard Simonaitis, AEGIC
12 noon	**BREAK**
12.30 pm	**Australian soft wheat for Asian markets** – Ken Quail, AEGIC
1.00 pm	**Wheat agronomy management – managing risk versus potential** – Dion Nicol, DPIRD
1.30 pm	**Blackleg control in the upper canopy of canola crops** – Steve Marcroft, Marcroft Grains Pathology
2.00 pm	**BREAK**
2.15 pm	**Forewarned is Forearmed – new BoM tools for weather forecasting and climate services for agriculture** – Dale Grey, Agriculture Victoria
2.45 pm	**Lessons for growers from the hyper yielding crops and high rainfall zone farming systems projects in WA** – Nick Poole, FAR Australia
3.15 pm	**Day 1 concludes**

This program may be subject to change.

DAY 2 — Tuesday 22, February

Plenary presentations

9.00 am	**Gene editing: Building breeding 4.0 for growers and the grains industry** – Catherine Feuillet, Chief Scientific Officer, INARI, USA
9.40 am	**The interaction between wheat establishment timing and pre-emergent herbicides choice on annual ryegrass seed production** – Mike Ashworth, AHRI, UWA
10.10 am	**The fit of long coleoptile wheats in WA grain farming systems – observations from the 2021 growing season** – Michael Lamond, SLR Agriculture
10.40 am	**BREAK**
11.00 am	**Optimising fertiliser application – what level of precision can we achieve?** – Craig Scanlan, DPIRD
11.30 am	**Fertiliser strategies in response to higher prices** – PANEL DISCUSSION WITH: David Cameron, Farmanco Management Consultants; Peter McEwen, Agri-Access; James Easton, CSBP; Elizabeth Petersen, UWA; and Craig Scanlan, DPIRD
12.30 pm	**BREAK**
1.00 pm	**Tips for canola establishment** – Jackie Bucat, DPIRD and Matt Nelson, CSIRO
1.30 pm	**Oat varieties for 2022 and the new national oat breeding program** – Allan Rattey, InterGrain
2.00 pm	**BREAK**
2.15 pm	**Mice control** – Steve Henry, CSIRO
2.45 pm	**Why bother with artificial intelligence in agriculture? Because it can improve fertiliser management** – Jonathan Richetti, CSIRO
3.15 pm	**Day 2 concludes**

This program may be subject to change.

Program DAY 3 — Tuesday 1, March

NUTRITION	
9.00 am	**Carbon farming in WA** – Richard Eckard, University of Melbourne
9.30 am	**Potassium rundown in the Western grains region – where, why and what does it mean for crop yields** – Richard Bell, Murdoch University
10.00 am	**Does optimum wheat phosphorus requirement change with sowing time and conditions in WA?** – Mark Gherardi, Summit Fertilizers
10.30 am	**NEW RESEARCHER SNAPSHOT: The power of flux towers for measuring crop productivity and water use** – Caitlin Moore, UWA
10.45 am	**Session concludes**

NITROGEN FROM LEGUMES	
11.00 am	**Cereals after pasture legumes have higher grain protein levels** – Robert Harrison, CSIRO
11.25 am	**Profitability, costs and risks associated with establishing annual pasture legumes in cropping rotations** – Dean Thomas, CSIRO
11.50 am	**Optimising nitrogen fixation in legumes through improved rhizobia strains** – Ron Yates, DPIRD
12.15 pm	**NEW RESEARCHER SNAPSHOT: Soil moisture mapping in agricultural fields using electrical conductivity sensing** – Hira Shaukat, UWA
12.35 pm	**Day 3 concludes**

This program may be subject to change.

DAY 4 — Thursday 3, March

CROP PROTECTION	
9.00 am	**Ice nucleating bacteria and frost** – Amanuel Bekuma, DPIRD
9.25 am	**How well does assessment of outer florets of wheat heads following frost(s) relate to grain yield at the end of the season?** – Brenton Leske, DPIRD
9.50 am	**AHRI herbicide resistance update 2021 – most significant results from the field to the lab** – Roberto Busi, AHRI UWA
10.15 am	**NEW RESEARCHER SNAPSHOT: Electric weed control in Australia** – Miranda Slaven, DPIRD
10.35 am	**BREAK**
11.00 am	**Advances in controlling brome and barley grass** – Gurjeet Gill, University of Adelaide
11.25 am	**Maximising crops and minimising weeds with smart phase farming** – Yaseen Khalil, Kalyx Australia
11.50 am	**Yes, no, maybe – getting value from herbicide resistance testing** – Fiona Dempster, AHRI, UWA
12.15 pm	**Determining yield loss in canola following sclerotinia stem rot infection** – Sarita Bennett, CCDM, Curtin University
12.40 pm	**NEW RESEARCHER SNAPSHOT: Spraying for yellow leaf spot in wheat – will you lose money?** – Anna Hepworth, DPIRD
1.00 pm	**Day 4 concludes**

This program may be subject to change.

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Program DAY 5 — Tuesday 8, March

CANOLA	
9.00 am	**Effect of seed singulation and seeding rates of canola on yield and competition against ryegrass** – Glenn McDonald, University of Adelaide and Glen Riethmuller, DPIRD
9.30 am	**Canola pre-breeding for heat tolerance** – Sheng Chen, UWA
10.00 am	**Spring versus winter canola phenology across Australia – new insights for WA growers** – Jeremy Whish, CSIRO
10.30 am	**Session concludes**

CEREALS – wheat, oats and barley	
11.00 am	**Understanding the fit of winter wheats for WA environment** – Brenda Shackley, DPIRD
11.25 am	**Pre-harvest sprouting management begins at seeding** – Jeremy Curry, DPIRD
11.50 am	**Growing a future for oats** – Ross Kingwell, AEGIC
12.20 pm	**NEW RESEARCHER SNAPSHOT: Genetic solutions to enhance spikelet fertility and grain plumpness during heat stress at flowering in barley** – Camilla Hill, Murdoch University
12.40 pm	**Day 5 concludes**

This program may be subject to change.

DAY 6 — Thursday 10, March

SOILS	
9.00 am	**New Soil Water Repellence reference book** – SoilsWest
9.15 am	**The combined influence of micro-water harvesting, deep ripping and gypsum on yield of barley in sodic soils** – Wayne Parker, DPIRD
9.40 am	**Sand and gravel mulches for sodic soils** – David Hall, DPIRD
10.05 am	**NEW RESEARCHER SNAPSHOT: Improving the understanding of soil water behaviour in re-engineered soil profiles** – Kanch Wickramarachchi, DPIRD
10.20 am	**NEW RESEARCHER SNAPSHOT: Efficacy of pre-emergent herbicides on renovated soil** – Bowen Zhang, DPIRD
10.35 am	**On farm experimentation – developing robust analysis for paddock scale trials** – Julia Easton, Curtin University, Luke Dawson, CSBP and Nathan Eaton, NGIS Australia
11.00 am	**Session concludes**

PULSES	
11.00 am	**Faba bean agronomy** – Mark Seymour, DPIRD
11.25 am	**Double break crop sequences with high value legumes – awesome when it rains!** – Nathan Craig, West Midlands Group
11.50 am	**Understanding and managing sclerotinia in lupins** – Ciara Beard, DPIRD and Pippa Michael, CCDM, Curtin University
12.15 pm	**Recent and impending changes to chemical MRL's in markets** – Gerard McMullen, National Working Party on Grain Protection
12.40 pm	**Day 6 concludes**

This program may be subject to change.

THE 2020-2022 GRDC WESTERN REGIONAL PANEL

February 2022

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CHAIR – DARRIN LEE

Mingenew/Dongara, Western Australia

Darrin Lee was appointed to the Western Region Panel in 2014 and was appointed Panel chair in 2018.

He has been farming in Western Australia's Northern Agricultural Region for more than 20 years, with property now at Mingenew and Dongara. Darrin has a keen interest in digital agriculture and has a background in banking and finance. He is a past member of the CBH Group Growers Advisory Council and a previous Board member of Mingenew Irwin Group. Darrin is passionate about family, rural life, food production, technology, and agriculture in general.

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DEPUTY CHAIR – JULES ALVARO

Merredin, Western Australia

Jules Alvaro is a director of a broadacre, predominantly cropping business in Nokaning WA. Jules has also been involved in off-farm industry roles including as a Western Region Panel Member since 2015, a non-executive director on the boards of Partners in Grain (now Rural Edge) and Agricultural Women Wheatbelt East, and is currently on the Muresk Institute Advisory Committee. Jules is an alumni of Leadership WA's Signature Leadership program. She is a graduate of the Aust. Institute of Company Directors and has completed the General Manager Program at the Australian Graduate School of Management (AGSM) at the University of New South Wales Business School.

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JULIET MCDONALD

Coorow, Western Australia

Juliet is a Coorow grower and also works for Summit Fertilizers as an Area Manager. Juliet has a passion for agriculture having worked as a sales agronomist with Elders, area manager – Kwinana West, for GrainPool, marketing manager with Coorow Seeds and research agronomist and extension officer with the WA Department of Primary Industries and Regional Development. Juliet holds a Bachelor of Science in Agriculture from University of Western Australia and is qualified as a Fertcare® Accredited Adviser.

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ROHAN FORD

Binnu, Western Australia

Rohan and his wife Carole farm east of Binnu growing wheat, lupins and canola in a low rainfall zone with highly variable precipitation. They have been using controlled traffic farming methods for 20 years. The Fords have also been involved in trial work and projects related to a variety of areas that help to improve farming outcomes and increase knowledge. Rohan is also involved closely with the local grower group, holding various positions over many years and helping to provide mentoring for younger farmers.

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SUZANNE WOODS

Calingiri, Western Australia

Suzanne Woods is an owner of Emdavale Farms, a 3400-hectare mixed farming enterprise in Calingiri, north-east of Perth. Oaten hay comprises 50 per cent of the cropping program, with the remainder being wheat, barley, canola and lupins. The business operates a small cattle and sheep enterprise as well as a farm contracting business, concentrating mostly on mowing, baling and carting hay and straw. Suzanne is a founding shareholder in Hay Australia, a large export hay company and is a director of the Australian Fodder Industry Association and Regional Early Education and Development Inc. She sees R&D as the key to ensuring that Australian farming businesses and communities continue to be at the forefront of new technologies and applications.

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GARY LANG

Wickepin, Western Australia

Gary, a grower for 37 years has grown the farm from a 1000ha Merino stud enterprise to a 5600ha cropping-focused business. He grows wheat, barley, oats, canola and lupins across 87 per cent of the farm, Gary was a catalyst in initiating frost research confirming that high levels of stubble could increase frost damage to grain crops. He is the president of the Facey Group and was previously the grower group's cropping coordinator, secretary and vice president.

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JOHN BLAKE

Albany, Western Australia

John is a research and development consultant with Stirlings to Coast Farmers and an adviser in Western Australia's northern, central and southern agricultural regions. He has led RD&E projects with GRDC, MLA, National Landcare Program and Royalties for Regions investment. John has a degree in Agricultural Science from the University of WA and has extensive skills in agricultural sustainability, diagnostics for precision agriculture and farming systems analysis.

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NATASHA AYERS

Vasse, Western Australia

Tash is the co-founder and managing director of AgriStart, a WA company connecting key players in the agri-food innovation space. She has an agricultural scientist background, with a PhD in plant biology and a Bachelor of Science in Agriculture, and has qualifications in university teaching, research commercialisation and leadership. She is a graduate of the Aust. Institute of Company Directors. She is an experienced trainer and facilitator and has spent the past seven years leading strategic research and innovation projects in WA.

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RICHARD WILLIAMS

Perth, Western Australia

Richard has worked across the Australian grain supply chain in operations; market research and big data analysis; strategic planning; stakeholder management and international customer relations. His own consultancy business groIQ published big data research findings internationally. He has recently returned to the CBH Group in a logistics quality planning role. Richard has a PhD from Curtin University and a Bachelor of Agricultural Science from the University of WA.

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DAN MULLAN

Perth, Western Australia

Dan Mullan, a wheat breeder with InterGrain is committed to delivering improved grain technology to growers. He spent his early career with CSIRO and the International Maize and Wheat Improvement Centre (CIMMYT), which provided him with excellent skills in high level science and a global perspective of RD&E. Dan regularly engages with Australian grain end markets to understand and extend information about market requirements. He maintains a close working relationship with researchers, breeders and management groups across Australia and the global plant breeding community. His focus is on improving the stability and profitability of the Australian grains industry.

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DR PETER CARBERRY

Toowoomba, Queensland

Peter is general manager of GRDC's Applied Research , Development and Extension business group. Prior to joining GRDC, he was director-general of the international Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, India. Previously he had spent 29 years with CSIRO as a research scientist.

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2022 GRAINS RESEARCH UPDATE, Perth

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PLENARY PRESENTATIONS

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PLENARY PRESENTATIONS

Note: Presenters are listed. Where there are multiple authors of papers full authorship should be taken from the final papers, located on the GRDC website at **grdc.com.au/resources-and-publications/grdc-update-papers**, as and when they become available.

By clicking this icon, found at the bottom of every presentation summary, you will return to this contents page:

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NUTRITION

NITROGEN FROM LEGUMES

Day 4 – Contents

CROP PROTECTION

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Day 6 – Contents

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Day 1 – Monday 21 February

Plenary Presentations

Welcome and ‘Seed of Light’ presentation

Darrin Lee, Chairman, GRDC Western Panel

Darrin Lee was appointed to the GRDC Western Region Panel during 2014 and was appointed Panel Chair during 2018. He has been farming in WA’s Northern Agricultural Region for more than 20 years, with property now at Mingenew and Dongara. Darrin has a keen interest in digital agriculture and has a background in banking and finance. He is a past member of the CBH Group Growers Advisory Council and a previous Board member of Mingenew Irwin Group. Darrin is passionate about family, rural life, food production, technology, and agriculture in general.

Opening and future directions of GRDC

John Woods, Chairman, GRDC

John is partner and manager of a broadacre agribusiness based in northern New South Wales and southern Queensland. He has responsibility for all business aspects, including financial management, production and crop husbandry, marketing and logistics, resource management and work health and safety.

He is also Chair of R&R Hire Services in Queensland.

John has a long history of working collaboratively with a range of public and private organisations in the development, extension and adoption of new technology.

He was Chairman of the Science Advisory Group of the National Agricultural Monitoring System (NAMS) between 2005 and 2009, and a member of the NAMS Advisory Reference Group and Steering Committee. He also spent six years, to 2005, on the National Rural Advisory Council.

John was Chairman of ChemCert Training Queensland from 2002 to 2004 and has held positions with Cotton Australia and Farmsafe Queensland.

Greenhouse gas emissions of Australian grain production

Maartje Sevenster, CSIRO

As part of CSIRO's Climate Smart Agriculture group, Dr Maartje Sevenster works on the quantification of direct and indirect impacts of agriculture and other economic activities. The aim is to make this kind of information accessible to a range of stakeholders so they can improve decision making. Maartje's main area of expertise is Life Cycle Assessment (LCA) which provides a framework to quantify environmental, social and economic impacts of a system. Agriculture and food are both driving climate change and strongly impacted by it, and the goal is to make the role of externalities, such as ecosystem services, in problems as well as solutions, more visible.

Maartje is leading projects focusing on improving environmental accounting for Australian agriculture, developing the Farmprint tool and working with a broad group of stakeholders on defining a common greenhouse-gas accounting methodology. As part of the Trusted Agrifood Exports mission, she is leading an evaluation of the increasing role of sustainability metrics in trade and market access. Maartje was on the board of the Australian LCA Society for eight years until 2021.

Summary

Key points include:

- Potential to increase production without significantly increasing overall on-farm emissions, improving emissions intensity by 20 per cent, is possible by optimising N applications based on seasonal conditions and rotations.
- Improved N management is a clear option to reduce greenhouse-gas (GHG) intensity but by increasing production by 30-40% would result in an industry wide emissions increase.
- Monitoring and improving the GHG intensity of our grain production systems is critical to remain competitive in global markets and provide evidence of Australia's low-emissions credentials.
- On-farm emissions (Scope 1 in Abstract) comprise 61% of total emissions, most of which comes from application of lime and fertiliser (26%), denitrification losses (20%) and fuel use (11%).
- Fertiliser is the largest contributor (38%) to GHG emissions both from the production and the use of fertiliser.
- The GHG emissions intensity of Australian grain crops is relatively low, producing around 315 kg CO^2 equivalent per tonne of grain with regional differences evident.
- To achieve reduction in overall absolute emissions, with increasing production, significant reductions of emissions associated with the production of fertilisers and other inputs will be needed.

Australian agriculture has defined ambitious climate change objectives, such as in the *2030 Roadmap of the National Farmers' Federation*, which aim to contribute to Australia's emissions reductions. Emissions reductions also keep our commodities competitive in export markets that increasingly require evidence of low-GHG emissions credentials. GHG credentials are established using GHG accounting to estimate the GHG's emitted directly or indirectly by a farming enterprise or emitted in a chain of processes resulting in a particular product. At sector level, establishing GHG baselines provides a reference to estimate GHG emissions reductions associated with climate change mitigation strategies.

Climate change mitigation strategies also need to be assessed for GHG emissions reduction potential to guide the Australian grains industry towards a low GHG emissions future. This is important because it will allow the grains industry to contribute to state/national emissions reduction targets and ensure access to key international markets is maintained.

(Continued on following page...)

GRDC commissioned this study to establish a detailed and robust GHG emissions baseline for the Australian grains sector and explore mitigation pathways that maintain or increase production. An estimate of the GHG emissions associated with grain production during 2005 was developed based on management practices and production statistics for that year (a static baseline) based on 25 leviable crops; wheat, barley, oats, maize, triticale, millets, cereal rye, canary seed, lupins, fieldpeas, chickpeas, faba beans, vetch, peanuts, mungbeans, navy beans, pigeon peas, soybeans, cowpeas, lentils, canola, sunflowers, safflower and linseed. The same approach was used to develop an estimate of current emissions for industry and used data for 2016 because that was the most recent year with the required data available. The study also developed a dynamic baseline that estimated the business-as-usual scenario over the period 1991–2019 using APSIM simulations of common rotations used in grain production systems on a regional basis. The emissions reduction potential of a number of strategies (Table 1 in Abstract) was assessed by either running APSIM models with modified management or by undertaking a static assessment using different emissions factors.

Click here for additional information on what the GRDC is doing on GHG emissions for the grains industry.

Reference

Australian Grains Baseline and Mitigation Assessment

Maartje Sevenster[1], Lindsay Bell[2], Brook Anderson[2], Hiz Jamali[3], Heidi Horan[4], Aaron Simmons[5], Annette Cowie[6], Zvi Hochman[4]

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Carbon neutral grain farming by 2050 — an example in calculating the net emissions for a broadacre farm and strategies to reduce net emissions

Mandy Curnow, Department of Primary Industries and Regional Development

Mandy is based in the Livestock Directorate of the Department of Primary Industries and Regional Development (DPIRD) Albany office, working predominantly in the sheep industry for the last 20 years. Prior to this, Mandy led a number of projects as part of the '*Doing More with Agriculture*' program that introduced Farmers Markets, Community Builders, Diversifying Agriculture and leadership training programs. She started in the department in catchment planning and landcare and still retains an interest in environmental management.

Co-managing the family's Merino breeding enterprise developed Mandy's knowledge and interest in sheep management and reproduction. This interest and passion for the sheep industry has led Mandy into; research as part of the highly successful Lifetime Wool project; the development of many tools in sheep management; and the designing and rollout of adoption programs.

Recently Mandy has taken on driving DPIRD's activities around farm and industry carbon accounting in the agricultural sector, specifically livestock, and assisting producers to understand carbon budgeting.

Summary

Greenhouse Gas (GHG) accounting takes place at many different levels from state and national, industry and at the farm gate. Each has its own set of questions to be answered and value in providing a benchmark on progress (or otherwise) towards the community and consumers expectations towards lowering GHG emissions and global warming.

At the farm gate there are several tools that support producers in understanding and the opportunities to mitigate their GHG product emissions. It is important to understand the limitations of these tools but also their value in identifying 'hotspots' in emissions so that effort can be focussed on areas where the biggest impacts can be made. Cropping enterprises in WA generally have higher emissions than eastern state counterparts, mainly due to higher inputs such as nitrogenous fertilisers. Emissions from cropping enterprises are generally higher for canola and lowest for legumes. Our opportunities to sequester carbon in low rainfall, high temperature environments are often less than other states, making the task of offsetting emissions more difficult. There are, however, some real opportunities to do so and the goal of carbon neutrality for the cropping enterprise is within reach for most grain producers.

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Market Outlook for the WA grains industry in 2022 and the longer term — challenges and opportunities

A PANEL DISCUSSION WITH: **Jason Craig,** CBH Group; **Cheryl Kalisch-Gordon,** Rabobank; **John Orr,** Premium Grain Handlers; and **Richard Simonaitis**, AEGIC

Hosted by: Nathan Cattle, Clear Grain Exchange

Nathan Cattle

Clear Grain Exchange

Nathan Cattle is the Managing Director of Clear Grain Exchange. Nathan grew up on a family farm at Lake King Western Australia before venturing on a career in grain markets. He has held roles as a consultant, trader, market analyst, and head of NZX limited's Australian operations before becoming the Managing Director of Clear Grain Exchange in December 2016. He holds a bachelor of economics and bachelor of agricultural science with first class honours from the University of Western Australia, has completed his ASIC RG 146 in derivatives and foreign exchange, has a graduate diploma of applied finance from Kaplan Professional, and is a graduate of the Australian Institute of Company Directors course. Nathan has a deep understanding of market operations and is passionate about improving market efficiency to help determine price while also creating a safe, secure and seamless digital ecosystem for all participants to transact grain.

Jason Craig

CBH Group

Jason was appointed Chief Marketing and Trading Officer in April 2012 and is responsible for CBH's Marketing and Trading and Fertiliser divisions. Jason has vast experience in international trade, supply chains, shipping, food processing and agricultural inputs. He has held previous roles as President Director with PT Eastern Pearl Flour Mills (Indonesia) and in various marketing and trading roles with the Grain Pool (now CBH Marketing and Trading).

Jason holds a Bachelor of Commerce in Banking and Finance, Postgraduate in Applied Investment and Finance and attended the Advance Management Program at INSEAD. Since 2015 Jason has been a board member of Grain Trade Australia and the Chair of the Grain Trade Australia, Trade & Market Access Technical Committee.

(Continued on following page...)

Cheryl Kalisch Gordon

Rabobank Research Food & Agribusiness

As part of the Rabobank Global Grains & Oilseeds Strategy team, Cheryl is responsible for forecasting key grains and oilseeds pricing and the Australian crop and trade outlook and analysing global trends. Cheryl also engages with rural and corporate clients on strategic issues and is the lead author of Rabobank reports on the Australian Feed grain Squeeze, the Black Sea Region Grains Outlook, Opportunities from De-bulking, the impact of Trade Wars on the grains sector and Getting Granular with Plant-Based Meat Alternatives. Prior to joining RaboResearch in early 2017, Cheryl spent four years as the Trade and Economics Manager at the grain farmer representative organisation, Grain Growers. In this role Cheryl was responsible for the economic evaluation of policy and negotiation of grains outcomes in the China-Australia Free Trade Agreement, the Trans-Pacific Partnership, and the Indonesia-Australian Comprehensive Economic Partnership Agreement and at the WTO, on behalf of Australian grain farmers. Cheryl has extensive experience in the grain industry and the broader Australian agriculture sector, including working as a trading assistant, consultant, and lecturer at the University of Sydney. Cheryl has a PhD in Economics and grew up on a cropping farm in New South Wales.

John Orr

Premium Grain Handlers

John Orr is the Managing Director at Premium Grain Handlers, an integrated grain production, storage, cleaning, container packing and export business, with facilities in WA and Melbourne. Prior to establishing Premium Gain Handlers in Fremantle during 1995, John worked at the Grain Pool of WA. John grew up on a family grain/sheep farming operation and completed an Associate Diploma in Agriculture; Batchelor of Business Degree; Post Grad Diploma in Business Management and Master of Business Administration.

Richard Simonaitis

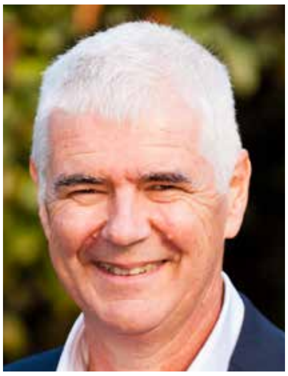
Australian Export Grains Innovation Centre

Richard Simonaitis has broad experience in export-focused commodities industries, having worked in logistics and product quality roles in the iron ore industry and in senior management roles in the grain industry across logistics, operations and marketing and trading. With the CBH Group, Richard led the national Accumulations Team for five years.

Richard has a strong understanding of grain growers, the grains industry across Australia and of the markets Australian grain is sold into. He also has international experience developing several grain infrastructure projects in Indonesia. Richard is an inaugural board member of the Australian Grains Institute capacity building project, a fellow of the Australian Rural Leadership Foundation, a Member of the Australian Institute of Company Directors and has a Graduate Certificate in Business with the University of Western Australia (UWA). He is on the Grain Trade Australia Trade and Market Access Committee, the Wheat Quality Australia Wheat Classification Council and is part of the Grains Industry Market Access Forum.

Australian soft wheat for Asian markets

Ken Quail, Australian Export Grains Innovation Centre



Ken has worked in agricultural research for 40 years. His work has taken him to more than 30 countries and provided him with some amazing experiences and a unique perspective on Australian grain exports.

Ken spent his early career working on crop physiology with CSIRO and then moved to AWB to focus on grain quality and markets. Later working with BRI Australia he honed his understanding of the impact of grain quality on food processing and final products. With Grain Growers and now the Australian Export Grains Innovation Centre (AEGIC) he has continued to build connections between growers, industry, international markets, and cereal researchers.

Summary

There is a significant market for soft wheat in Southeast Asia, with an estimated demand for more than two million tonnes by 2030.

Drought on the west coast of the United States of America has left Southeast Asian flour millers seeking alternatives to Soft White Wheat (SWW) from the USA for cookie applications.

Low protein Australian Noodle Wheat (ANW2) provides an immediate, short-term supply solution to meet Asian market demand for soft wheat. WA is well placed to meet the long-term demand for soft wheat in Asia, with this market opportunity providing growers with a new low protein crop option.

Work on the development of soft wheat lines that provide a viable option for WA growers, and meet market requirements, continues as a long-term supply opportunity.

Wheat agronomy management — managing risk versus potential

Dion Nicol, Department of Primary Industries and Regional Development

Dion Nicol is a wheat physiologist and agronomist with DPIRD based at the Merredin Dryland Research Institute. Dion possesses expertise in plant physiological responses to abiotic stresses and nutrition, agronomy and on-farm experience in the eastern wheatbelt. Dion is the wheat commodity leader at DPIRD, sits on the GIWA Wheat Council and is an Adjunct Lecturer with the School of Agriculture and Environment at UWA.

Summary

With high 2022 input prices, but likely above average grain prices, wheat variety choices may significantly improve profit outcomes. An overview of the GRDC National Variety Trial data is still showing the fast-maturing Vixen is the top yielding variety over the last four years, Scepter is still among the top performers as the mid-fast maturity and Rockstar is remaining the highest yielding in the mid-slow maturity. The relative risk and opportunity of varieties will be presented from this data and available agronomic information of the varieties.

Across the DPIRD time of sowing datasets, optimum flowering periods relate most consistently to water availability and peak biomass over multiple seasons more than frost and heat events. Therefore, variety and sowing time choices, while never perfect, can improve the overall potential with considerations of risk across a range of scenarios.

Deep sowing of wheat is often touted as an opportunity to better control germination date and a heavy focus of this subject is a wheat varieties' coleoptile length, however, soil conditions and seeder-setup are critical for ensuring relative risks of poor establishment and yield impacts. Other factors often interact, for example, flowering time was found in several trials to be delayed by deep sowing. An overview of the likely risks and opportunities will be discussed.

Reference

Wheat variety and agronomy decisions – managing risk versus potential

Dion Nicol, Jeremy Curry, Brenda Shackley, DPIRD

Blackleg control in the upper canopy of canola crops

Steve Marcroft, Marcroft Grains Pathology

Steve Marcroft has been working on diseases of canola for the past 25 years and has developed many of the cultural practices currently used in Australia to minimise the impact of blackleg. Steve leads the field-based components of the research carried out by Marcroft Grains Pathology in collaboration with the University of Melbourne. Marcroft Grains Pathology also do work on the national blackleg ratings, blackleg resistance groups (genetic of resistance), fungicide efficacy work, fungicide resistance, upper canopy blackleg management and the BlacklegCM App.

Prior to establishing Marcroft Grains Pathology 18 years ago, Steve worked for SARDI at Minnipa, South Australia, for four years on low rainfall canola production. He also worked for Agriculture Victoria for seven years in the canola breeding program.

Summary

Key points include:

- Blackleg Upper Canopy Infection (UCI) is caused by the same source of spores that cause normal blackleg crown canker. That is, the previous season's stubble is the most important source of infection.
- If infection occurs prior to the 3–5 leaf growth stage crown canker will result. If infection occurs during the early flowering growth stage and crops develop to first flower early in the growing season, then UCI will result. Crown canker and UCI are unlikely to both be severe in the same growing season.
- UCI is a recent issue as it is a result of sowing and flowering times moving 20–30 days earlier than in the past.
- If crops commence flowering later in the growing season, UCI can still occur, but it will not cause any yield loss regardless of disease severity.
- Effective major gene resistance will stop UCI from occurring.
- Recent findings have shown that quantitative blackleg resistance is likely to slow or even stop UCI development, but cultivar UCI resistance ratings have not yet been developed.
- If UCI occurs and causes yield loss fungicides applied at 30% bloom will provide economic responses.
- The skill in predicting yield returns from fungicide application is determining if UCI is likely to cause yield loss.

Reference

Upper canola blackleg — epidemiology and management

Steve Marcroft[1] and Angela Van de Wouw[2]

[1]Marcroft Grains Pathology; [2]University of Melbourne

Useful resources

- NSW DPI Winter Crop Variety Sowing Guide (Disease updates, variety resistance, fungicide products).
- SclerotiniaCM App for iPad and android tablets

Forewarned is Forearmed — new BoM tools for weather forecasting and climate services for agriculture

Dale Grey, Agriculture Victoria

Dale Grey is a Seasonal Risk Agronomist with Agriculture Victoria where he has worked for 27 years. Dale provides agronomy, climate and weather analysis for farmers, agribusiness, government and the media across Southeast Australia and has been interpreting climate models from around the world every month since 2008. He is the author of the *Fast Break* climate newsletters for Victoria, South Australia, Tasmania and southern New South Wales and produces a monthly YouTube climate update. For the last three years Dale has worked as part of a large multidisciplinary team on the *Forewarned is Forearmed* project, gathering insights on hot, cold, wet, dry extreme forecasts from the Bureau of Meteorology (BoM) ACCESS model.

Summary

New forecasts from the BoM ACCESS model have been developed to give insight to hotter, cooler, wetter or drier conditions out weeks, fortnights and months. This work bridges the gap between weather forecasts good out to seven days and the climate forecasts that go out to three months.

The predictions of extreme weather events are specifically looking at the chances of receiving decile one and two events, or decile nine and ten events. It is hoped these forecasts will allow growers to plan farm operations in the murky zone past the weather forecast, for planting, harvesting, topdressing and haymaking logistics. Predictions are available for rainfall, maximum and minimum temperature.

The new products are seamlessly embedded into the existing BoM ACCESS graphical forecasts and have a 'point at your location' feature. For the first time ever, growers will be able to get a quintile (five section) forecast for rainfall to provide better detail to the current bimodal (two section) chance of above median forecast. The forecasts are constructed every day using the most recent three days of forecasts to provide a total of 99 separate model runs. This allows the variability of the model to be plotted in a probabilistic fashion.

As with all probabilistic forecasts they never tell you exactly what will happen but show the range of odds of various amounts of rainfall or temperature occurring. When all the model runs are stacked up in a particular direction, users can be confident that the overarching climate and weather setup is causing that to happen; but just like 100:1 chances can win horse races, so too can unlikely events occur in weather and climate.

Many times though, forecasts show a great spread (or neutral) forecast which some people falsely interpret as average being the most likely. This is not correct, as such forecasts more correctly show that anything is possible! Forecasts such as these are not worth agonising over.

The *Forewarned is Forearmed* project was funded by the Federal Government's Rural R&D for Profit program and included contributions from the grains, dairy, red meat, pork, sugar, wine and cotton industries. The project was enacted by a large consortium including BoM, University of Melbourne, Monash University, University of Southern Queensland, SARDI, Agriculture Victoria and Birchip Cropping Group. Industry stakeholder groups were used to provide continued feedback on the actual forecast products and their visual appearance.

Lessons for growers from the hyper yielding crops and high rainfall zone farming systems projects in WA

Nick Poole, Field Applied Research Australia

Nick Poole has more than 38 years' experience as a research agronomist, in Australia, New Zealand and the United Kingdom. Nick is now based in Geelong, Victoria, as the Managing Director of Field Applied Research (FAR) Australia; an applied research and extension organisation serving the cropping industry in Australia. Nick started his career working for Arable Research Centres in the UK and moved to the southern hemisphere during 2003 working in both New Zealand and Australia. His specific interests are farming systems research, disease and canopy management, crop establishment and challenging the current boundaries of wheat productivity worldwide.

Summary

Key points include:

- Ameliorated sandplain soils that were deep ripped to a depth of 800mm were associated with yield increases of approximately 0.5t/ha in wheat and a cost benefit ratio of just less than $2 return for every $1 spent.
- Winter wheat cultivars extend our ability to sow early (early – mid-April) on large acreages, however, with yields of 6-8t/ha (2020 and 2021) high rainfall zone (HRZ) project results have to date shown no difference in yield between the best winter and spring cultivars on ameliorated soil in a frost-free environment.
- Increased inputs, particularly nutrition have been the key to cost effective yield increases in wheat trials over the last two seasons, whilst in barley both disease management and nutrition hold the key to higher output in seasons of higher yield potential.
- The principles of canopy management are more applicable to the increased yield potentials of ameliorated soils and to maximise crop yields in the better seasons of the WA HRZ.

The aims of the project were to examine the productivity and profitability of cereal crops sown in mid-April as part of a soil ameliorated farming system, and to examine the suitability of April sown winter versus spring germplasm on sandplain and forest gravel in coastal HRZ regions of WA to increase productivity.

The results from the HRZ project in 2020 and 2021 illustrated that there was a significant yield advantage of 0.45 and 0.47 t/ha respectively to deep ripping to a depth of 800mm on a deep sandy duplex prior to establishing wheat. With ripping costed at $80/ha and grain at $310/t, soil amelioration produced an approximate return of just under $2 for each $1 spent (assuming benefits were only apparent for one year). Although APSIM modelling of the Esperance research site clearly shows a yield advantage to sowing winter wheat over spring wheat in mid-April, results to date have indicated no difference in yield in this relatively frost-free environment, despite spring wheats flowering in August prior to the recognised optimal flowering window of mid-September. In 2021 plot yields of wheat and barley in project trials achieved of 7–8t/ha at Esperance and 7.5–9t/ha at Frankland River. Side by side trials planted on the same site in mid-April have shown no yield advantage to winter wheat cultivars over spring wheats sown in mid-May at the Esperance research site. Increased expenditure on inputs, particularly nutrition has been the key to higher yields in wheat in WA trials over the last two seasons, whilst in barley disease management and nutrition hold the key in seasons of higher yield potential such as 2021. Although N rates of 180–225kg N/ha have been associated with the highest yields in our research projects in WA, increasing N fertiliser levels above 200–225kg N/ha has failed to give higher grain yields in other HYC project research, indicating that there will be a limit to just how much yield can be generated by routinely applying more artificial N fertiliser.

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After two seasons, deep ripping sandplain soils has shown to be cost effective. Winter wheat cultivars extend our ability to sow early (early – mid-April) on large acreages, stabilising flowering dates from a larger sowing window preventing cereal crops from flowering too early in frost prone environments. However, HRZ project results with yields of 6-8t/ha has to date shown no difference in yield between winter and spring germplasm sown on ameliorated soil in a frost-free environment despite flowering up to one month apart from early sowing. To date there has been no evidence from side-by-side trials on the same site to suggest that mid-April sown winter wheat is higher yielding than mid-May sown spring wheat, although APSIM modelling suggests it is possible and faster developing winter wheats may be required.

Reference

Lessons for growers from the Hyper Yielding Crops (HYC) and High Rainfall Zone (HRZ) Farming Systems projects in WA

Nick Poole[1], Kenton Porker[1], James Rollason[1], Tracey Wylie[1] and Jeremy Curry[2]
[1]Field Applied Research Australia; [2]DPIRD Esperance

Day 2 – Tuesday 22 February

Plenary Presentations

Gene editing: Building breeding 4.0 for growers and the grains industry

Catherine Feuillet, Inari, USA

Catherine Feuillet is the Chief Scientific Officer at Inari, leading a team of scientists focused on unlocking the full potential of seed to help build a more sustainable food system. Combining AI-powered predictive design and multiplex gene editing, Inari is deciphering and engineering plants' most complex systems to dramatically increase yield and reduce water and fertiliser needs.

Prior to joining Inari, Catherine led the international effort to sequence the bread wheat genome as founder and co-chair of the International Wheat Genome Sequencing Consortium (IWGSC). She also led the team at the Institut National de la Recherche Agronomique (INRA) in France that first cracked the genetic code of the largest wheat chromosome. She then went on to become the head of trait research at Bayer CropScience.

Catherine received her Ph.D. from the Paul Sabatier University in Toulouse (France) and spent 10 years in Switzerland for postdoctoral studies and as assistant professor at the University of Zurich. Her research has garnered her multiple awards and recognitions, including being elected the French 'golden woman of the year for research' in 2008 and receiving the 'Prix Foulon' from the French Academy of Sciences in 2009. She received the Legion of Honour in 2010, was elected a Fellow of the American Association for the Advancement of Science in 2011 and received the 'Prix J. Dufrenoy' from the French Academy of Agriculture in 2012. Catherine has supervised the work of more than 30 masters, PhDs and postdoc scientists and published more than 120 scientific papers in peer reviewed journals and books.

Summary

Historically, plant breeding and management improvement have together enabled significant progress in our ability to provide food, feed, and fibre to a rapidly growing population. In recent decades, however, agricultural production has faced critical challenges that classical breeding methods have not been able to address in a timely and efficient manner — namely, the rapidly changing climate. In addition to enhancing yield, protecting harvest, and improving quality, plant breeding should also help address the environmental impact of crop production and at a pace that keeps up with fast-evolving conditions. It is essential that we: (i) develop new varieties that ensure optimal crop performance with a minimal use of natural resources and input in very rapid cycles; and (ii) do so with a business model that enables all farmers to access technologies adapted to their needs.

Plant breeding has always benefited from advancements in science and technology, from Breeding 1.0 (incidental selection by farmers) to Breeding 2.0 (development of the science of breeding) to Breeding 3.0 (linking phenotypes with molecular information to support and accelerate breeding decisions). Today, we are at the beginning of a new era, Breeding 4.0, which is described by Wallace et al[1] as the genome-wide ability to combine any known alleles into desirable combinations. It is enabled by the convergence of novel technological revolutions such as genome editing and artificial intelligence, combined with the genomics revolution that enables us to produce large amounts of data at

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reasonable costs. This represents a unique opportunity to address and embrace the complexities of improving crop performance, in a cost- and time-effective manner through (i) accelerated gene/causal sequences discovery in crops; (ii) increased power to be predictive rather than prescriptive, enabling the design of ideotypes for optimal performance in local conditions; (iii) sped up breeding cycles and increased accuracy of selection; and (iv) the ability to better leverage and create novel genetic diversity.

Breeding 4.0 is under way, with genome-edited crops already in the pipeline of public and private entities and several recently approved for commercialization in South America and Japan[2]. The vast majority of genome-edited products to date have been obtained through single gene deletions; however, crop improvement requires a more sophisticated editing strategy that will enable the modification of many genes at the same time and perform different types of modifications such as deletion, insertion, gene expression modulation, and gene replacement. Inari Agriculture[3], the SEEDesign™ company, is developing a unique technology platform that captures the latest advancements in genomics, genome editing and artificial intelligence to perform predictive design and advanced multiplex gene editing. Our objective: to develop resilient seeds that require fewer natural resources and inputs, in a drastically shorter time at a lower cost than current approaches.

While wheat is now fully benefiting from the genomics revolution – in particular since the achievement of a high-quality reference genome for bread wheat[4] – it has not yet captured the full benefits of Breeding 4.0. Inari aims to change that. We are committed to deploying our SEEDesign technology platform to dramatically enhance wheat's yield potential and secure the crop's long-term viability.

[1] JG. Wallace, E Rodgers-Melnick, and ES. Buckler- 2018- Annual Review of Genetics, Vol. 52:421-444

[2] J Menz, D Modrzejewski, F Hartung, R Wilhelm and T Sprink. 2020. Front. Plant Sci., https://doi.org/10.3389/fpls.2020.586027

[3] https://www.inari.com/

[4] International Wheat Genome Sequencing Consortium, 2018, Science 361, (6403):eaar7191

Reference

Genome Editing: Building Breeding 4.0 for Growers and the Grain Industry

Catherine Feuillet, Chief Scientific Officer, Inari Agriculture

WEED smart
every weed every seed
every farm every year

The WeedSmart Big 6

Weeding out herbicide resistance in winter & summer cropping systems.

The WeedSmart Big 6 provides practical ways for farmers to fight herbicide resistance.

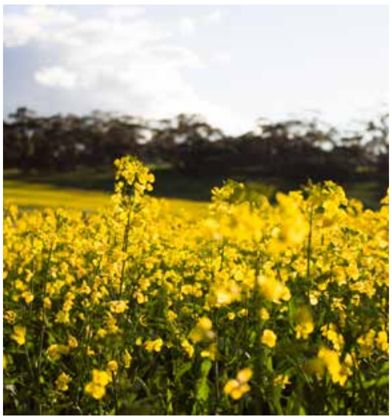
How many of the Big 6 are you doing on your farm?

We've weeded out the science into 6 simple messages which will help arm you in the war against weeds. By farming with diverse tactics, you can keep your herbicides working.

Rotate Crops & Pastures

Crop and pasture rotation is the recipe for diversity

- Use break crops and double break crops, fallow & pasture phases to drive the weed seed bank down,
- In summer cropping systems use diverse rotations of crops including cereals, pulses, cotton, oilseed crops, millets & fallows.



Mix & Rotate Herbicides

Rotating buys you time, mixing buys you shots.

- Rotate between herbicide groups,
- Mix different modes of action within the same herbicide mix or in consecutive applications,
- Always use full rates,
- In cotton systems, aim to target both grasses & broadleaf weeds using 2 non-glyphosate tactics in crop & 2 non-glyphosate tactics during the summer fallow & always remove any survivors (2 + 2 & 0).

Increase Crop Competition

Stay ahead of the pack

Adopt at least one competitive strategy (but two is better), including reduced row spacing, higher seeding rates, east-west sowing, early sowing, improving soil fertility & structure, precision seed placement, and competitive varieties.

Double Knock

Preserve glyphosate and paraquat

- Incorporate multiple modes of action in the double knock, e.g. paraquat or glyphosate followed by paraquat + Group 14 (G) + pre-emergent herbicide
- Use two different weed control tactics (herbicide or non-herbicide) to control survivors.

Stop Weed Seed Set

Take no prisoners

- Aim for 100% control of weeds and diligently monitor for survivors in all post weed control inspections,
- Crop top or pre-harvest spray in crops to manage weedy paddocks,
- Consider hay or silage production, brown manure or long fallow in high-pressure situations,
- Spray top/spray fallow pasture prior to cropping phases to ensure a clean start to any seeding operation,
- Consider shielded spraying, optical spot spraying technology (OSST), targeted tillage, inter-row cultivation, chipping or spot spraying,
- Windrow (swath) to collect early shedding weed seed.

Implement Harvest Weed Seed Control

Capture weed seed survivors

Capture weed seed survivors at harvest using chaff lining, chaff tramlining/decking, chaff carts, narrow windrow burning, bale direct or weed seed impact mills.

WeedSmart Wisdom

Never cut the herbicide rate – always follow label directions
Spray well – choose correct nozzles, adjuvants, water rates and use reputable products,
Clean seed – don't seed resistant weeds,
Clean borders – avoid evolving resistance on fence lines,
Test – know your resistance levels,
'Come clean. Go clean' – don't let weeds hitch a ride with visitors & ensure good biosecurity.

The interaction between wheat establishment timing and pre-emergent herbicides choice on annual ryegrass seed production

Mike Ashworth, Australian Herbicide Resistance Initiative, University of Western Australia

Mike Ashworth is a research agronomist working within the Australian Herbicide Resistance Initiative (AHRI) located at the UWA. Mike studied Engineering, Agricultural production and Weed science before working as a field agronomist. Mike currently conducts research on agronomic opportunities to improve the control of multi-herbicide resistant weed populations in dryland crops and lectures at UWA on conservation agriculture and crop protection.

Summary

It has long been advised that delaying seeding of weedy paddocks in order to maximise the weed control effectiveness of knockdown (glyphosate/paraquat) applications results in optimal weed control. However, with the development of more pre-emergent residual herbicides for use in no till farming systems, early seeding may now be the optimum weed control strategy. When crops are sown early into increased soil temperatures, crop growth rates are increased, increasing their competitive advantage against weeds. However, earlier crop seeding into warm soils can also make weed control more problematic as residual pre-emergent herbicides may degrade faster, reducing their effectiveness. This research aims to investigate the effect of wheat time of sowing and seeding rate, on the effectiveness and degradation of pre-emergent herbicides commonly used to control annual ryegrass in no tillage farming systems.

The fit of long coleoptile wheats in WA grain farming systems — observations from the 2021 growing season

Michael Lamond, SLR Agriculture

Michael is the CEO of SLR Agriculture, a boutique agricultural RD&E business with strong links to growers through the footprint of the Synergy and other agronomy extension networks. Michael is a hands on, experienced agronomist with business management and board experience. He is a proven leader with extensive field trial management experience across Australia with a history of quality results and high strike rate of successful research projects in Agronomy, Plant Breeding and Biotechnology. He has experience across most areas of crop production in WA and the winter crop regions across Australia and has been a leader of several privately owned agricultural Research and Development businesses since 1992.

Michael is on the GIWA Oilseeds Council and previous board member and author of monthly GIWA Crop Report. Michael is previous GRDC Western Panel Member and chair of the NVT advisory committee.

Michael was the National Leader Agronomy for Eurofins from 2013–2016, Director and Principal Plant Breeding and Biotechnology Agrisearch from 2002–2013, Director/Research Agronomist Michael Lamond and Associates 1999-2002, Director/Research Agronomist Lamond Burgess and Associates 1996-1999, Director/Research Agronomist Farmanco research and Development Consultants 1992–1996.

Summary

This GRDC project concentrated on the risks and benefits associated using long coleoptile wheat. The trials focused on the long coleoptile trait impact on time to emergence, soil temperature, planting depth and their combined effect on crop establishment in the targeted environments.

The major objective of the project was to provide a business case to growers of the risks and benefits long coleoptile wheats offer them. The field trials compared existing systems of establishment with sowing following an opportunistic rainfall event that would not normally be sown into as well as main season plantings. The data gathered will form the validation of the technology in dollar benefits to growers.

Varieties with Rht18 gene were compared with traditional wheat varieties grown in WA and elite breeder lines selected with longer coleoptiles. There were six trial site locations in WA during 2021. One was sown at the end of March in York specifically to gain detailed emergence data under heat. This was not planned to be harvested as the genetic material in the trial was not suited for very early planting. The other main four sites were sown in April (3) and May (1), these all had the same varieties and measurements taken including planned harvest. One site was sown in June at Bodallin at the request from growers in the low rainfall regions to give them a look at shallow and deep planting.

The trials were seeded with an 8 Tyne DBS plot seeder. The closing plate was extended to full depth and an extra tube added to seed delivery boot to position the seed at 120mm for the deep sowing. The closing plate was lifted, and the extension tube removed leaving the ripping point at the same depth for the shallow sowing treatment.

(Continued on following page...)

The main findings and themes of the project included:

1. Wheat varieties with the Rht18 gene emerged from the deep sowing (120mm) with more plant numbers per square meter and produced more tillers than those without the Rht18 gene under a range of soil types, sowing dates and moisture profiles at seeding.
2. Wheat varieties with the Rht18 gene emerged from the shallow sowing (40mm) with more numbers per square metre and produced more tillers than those without the Rht18 gene where there was furrow fill and/or transient waterlogging at emergence.
3. Wheat varieties with the longer coleoptiles without the Rht18 gene emerged from the deep sowing with more numbers per square metre and produced more tillers than those with shorter coleoptiles and where there was furrow fill and/or transient waterlogging sown shallow, the varieties with longer coleoptiles also emerged with more plants per square meter and produced more tillers than those with shorter coleoptiles.

The main advantages observed from the sites in the 2021 growing season were found to be:

1. Seedling emergence with furrow fill from wind or rainfall events was improved with the long or longer coleoptile varieties, particularly where there was pre-emergent herbicide interaction.
2. Ability to chase moisture down from an autumn rainfall event gave a growth stage advantage over sowing dry.
3. Ability to emerge is main season plantings where there was a full moisture profile or transient waterlogging.
4. Demonstration of the biological/growth habit differences observed between short, long and longer coleoptile varieties sown deep and shallow.

Michael will highlight observations from the 2021 growing season and discuss the main observations from the project. He will also touch on observations made that were not considered initially in the project scope, such as improvement where there was furrow fill from wind or rainfall, particularly where there was pre-emergent herbicide interaction, improvement in emergence where there was transient waterlogging and the impact of early crop vigour with lines with the Rht18 gene. These observations have implications for main season plantings as well as early season opportunistic plantings which was the initial reason for the project to be initiated.

Optimising fertiliser application — what level of precision can we achieve?

Craig Scanlan, Department of Primary Industries and Regional Development

Craig has 20 years' experience working in nutrient management in grain production in WA. Craig began his career working in decision support for nitrogen and potassium fertiliser, and then undertook further study at UWA to complete a PhD. Since that time, Craig has worked in a series of research projects on nutrient management and currently leads two GRDC projects. He has adjunct positions at UWA and Murdoch University and is working across organisations as part of the SoilsWest collaboration.

Summary

Optimising the application of nitrogen (N), phosphorus (P) and potassium (K) fertiliser is an ongoing challenge because grain producers are attempting to address multiple objectives. Grain producers are trying to strike a balance between maximising their gross margins at a paddock or enterprise level, maximising the chance of capitalising on good years by removing nutritional constraints to yield and minimising the overall financial risk to their business in poor years. This presentation examines one of these objectives; the precision in rate required to maximise gross margins from N, P and K fertiliser.

Analysis suggests a low level of precision of N, P or K fertiliser is sufficient to maximise net return from fertiliser. Based on the case studies presented, fertiliser rates that are ± 20, 5 and 15kg/ha of the predicted optimum for N P and K are likely to fall within the 90% confidence interval of the optimal rate.

Economic analysis also suggests that the magnitude of grain yield response to fertiliser has a greater impact on the optimal rate than grain or fertiliser price. It showed that the optimal rate increases as the level of yield response increases, and the sensitivity of optimal rate to grain or fertiliser price decreases. Fortunately, the influence of yield response on optimal rates can be assessed using current decision support tools used by fertiliser advisors by assessing different scenarios of target yield and soil and residue nutrient supply.

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Fertiliser strategies in response to higher prices

A PANEL DISCUSSION WITH: **Peter McEwen,** Agri-Access Australia; **James Easton,** CSBP; **Elizabeth Petersen,** UWA; and **Craig Scanlan,** DPIRD

Hosted by: David Cameron, Farmanco Management Consultants

David Cameron

Farmanco Management Consultants

David is an agronomy consultant and principal at Farmanco. He has been working across rainfall zones in the eastern wheatbelt and the Northern Ag Region for 25 years since completing his Ag Science degree at UWA. He has been based in Moora since 2003 where he is involved in cropping operations of his own. David's interest in grains and agricultural extension has lead him to work with rice in Cambodia, which he is looking forward to resuming once travel becomes possible again.

Peter McEwen

Agri-Access Australia

Peter McEwen is the founder and Principal of Agri-Access (WA) Pty Ltd (AAWA). AAWA was established in 2012 to provide fertiliser pricing advice, and pricing awareness for WA growers highest cost input. AAWA has more than 180 farmer clients who purchase in excess of 180,000mt of fertiliser.

Peter graduated from the UWA with a Bachelor of Science Degree with First Class Honours in Chemistry. He also holds a Graduate Diploma in Engineering (Chemical) and a Company Directors Course Diploma. Peter is a Fellow of the Australian Institute of Company directors. Peter commenced employment with CSBP during 1980 and held management positions in production, distribution and personnel management. He joined Summit Fertilizers in 1992 and held the position of Managing Director/CEO until 2010. He was a Director of Fertilizer Australia 1997–2010 and Chairman 2003–2007.

James Easton

CSBP

James is a Senior Agronomist at CSBP, where he has worked for more than 30 years since graduating from UWA with a degree in Agricultural Science, with Honours, in 1987. James has enjoyed his long association with the Company's Field Research program. Results from the trials have highlighted many opportunities for improving nutrient use efficiencies and making more profitable fertiliser decisions. He will share some agronomic tips to help growers deal with the increased fertiliser prices.

Elizabeth Petersen

University of Western Australia

Liz has worked within the agricultural sector in Australia and internationally for the last 25 years. After completing her undergraduate degree, Liz worked as an Economist with the DPIRD (formerly Agriculture WA) in Albany. She moved to Perth in 1997 to complete her PhD and then to Canberra in 2000 to work as a Post-doctoral Fellow and Fellow at the Australian National University. Liz returned to Perth in 2003 to establish a consulting firm, Advanced Choice Economics Pty Ltd. She has led almost 100 consultancy projects over the last 20 years and held part-time specialist appointments at DPIRD from 2013 to 2018.

Liz is currently Director and Principal Applied Economist at Advanced Choice Economics Pty Ltd, Adjunct Senior Lecturer at UWA and Senior Research Fellow at the University of Queensland.

Craig Scanlan

Department of Primary Industries and Regional Development

Craig has 20 years' experience working in nutrient management in grain production in WA. Craig began his career working in decision support for nitrogen and potassium fertiliser, and then undertook further study at UWA to complete a PhD. Since that time, Craig has worked in a series of research projects on nutrient management and currently leads two GRDC projects. He has adjunct positions at UWA and Murdoch University and is working across organisations as part of the SoilsWest collaboration.

Tips for canola establishment

Jackie Bucat, Department of Primary Industries and Regional Development, and **Matt Nelson,** CSIRO

Jackie is a Research Scientist at DPIRD, with a recent focus on early seeding for canola, where she is also the canola commodity lead.

Summary

Recent DPIRD research has shown that a successful canola crop can be sown from mid-March in WA. Early sowing is likely to be increasingly suited to WA due to alleviating climate change effects: reduced incidence of opening rains, reduced growing season rainfall, higher temperatures and hot spells that are becoming more frequent, longer and hotter. However early sowing has higher risks, including establishment, follow-up rain, frost, predation and disease.

Establishment was reduced with early sowing, even though sites were irrigated. Current research investigated the effect of temperature and moisture on early canola establishment. 2021 Research evaluated canola establishment in the laboratory, in hand sown plots at South Perth and in field plots near Greenough. Key results will be presented.

Reference

Canola establishment with early sowing

Jackie Bucat[1], Salzar Rahman[2] and Stephanie Boyce[3]
DPIRD South Perth[1], Northam[2], and Geraldton[3]

Matt Nelson, CSIRO

Matthew has had a varied and interesting career so far. His first taste of science research was during a summer job during 1993 at the world's oldest agricultural research institute (Rothamsted) in the United Kingdom, where he supported canola and linseed crop pathology projects. Matt had the opportunity to spend two months in Mongolia during 1996 where he assisted a local botanist to survey the impact of over-grazing by sheep and goat herds in the newly privatised stock industries that had previously mean managed by communes. Matt's first job after completing his PhD was as a molecular breeder with Seminis Vegetable seeds in Enkhuizen, the Netherlands during 2001. He then joined UWA in 2002 where he had a dual role as an academic pre-breeder and a commercial breeder with Canola Breeders WA Pty Ltd. During 2015, he moved to the UK to take up a position at the Royal Botanic Garden, Kew (UK) based at the Millennium Seedbank where he worked to harness the diversity available in crop wild relatives for crop improvement (mainly white lupin and carrots). Matt joined CSIRO during 2018 to lead a national program of canola improvement. His work focuses on the effective use of international canola varieties and wild relatives for improving the productivity and adaptation of Australian canola.

(Continued on following page...)

Summary

A nationwide survey (outlined below) of canola growers and agronomists identified marginal soil moisture and variable seeding depth as two key factors leading to poor canola establishment. The project identified several international varieties with enhanced vigour and/or longer hypocotyls, which emerged from 50mm sowing depth in the field better than all five current Australian canola variety controls. As a result, rapid and accurate screening methods have been developed for breeders to accelerate the development of canola varieties with improved establishment potential.

The aims of the *Genetic improvement of canola establishment* project were to understand the key genetic factors contributing to successful canola establishment, and to provide canola breeders with improved genetics from overseas varieties and selection tools to accelerate the breeding of varieties with better establishment potential.

A survey of 63 growers and agronomists provided insights from their experiences of canola establishment. This, along with a comprehensive review of the international scientific literature, pointed to two potential targets to breed canola varieties with improved establishment potential: longer hypocotyls and enhanced early vigour. Reducing the potential for secondary vigour was also considered a potential target. The team developed new lab-based methods to measure these traits in a panel of 100 international open-pollinated and 28 Australian (mostly hybrid) varieties. They identified international varieties that matched or exceeded the vigour and hypocotyl traits in current Australian hybrids. They also found low but detectable levels of secondary dormancy in some Australian varieties. The methods proved highly repeatable and are recommended for use in canola breeding programs. They tested the lab-based results in four field experiments in WA and NSW in 2021. A key finding was that international accessions identified in lab-based tests as being highly vigorous and/or with long hypocotyls emerged significantly better from deeper sowing (50mm depth) than the five current Australian varieties tested. These encouraging results will be tested again in field experiments in WA and NSW planned for 2022.

The results indicate that enhanced early vigour and longer hypocotyls are promising target traits for breeders to develop varieties with improved established at conventional sowing depths, and which can potentially be sown deeper than current varieties.

Reference

Genetic improvement of canola establishment

Matthew Nelson[1], Jose Barrero[2], Mark Cmiel[2], Andrew Fletcher[1], Ian Greaves[2], Trijntje Hughes[2], Andrew Toovey[1], Karen Treble[1], Alec Zwart[2], John Kirkegaard[2], and Greg Rebetzke[2]

[1]CSIRO Agriculture and Food, Floreat, Perth, Australia; [2]CSIRO Agriculture and Food, Black Mountain, Canberra, Australia

Oat varieties for 2022 and the new national oat breeding program

Allan Rattey, InterGrain

Allan Rattey is InterGrain's foundational oat breeder for grain oats and oaten hay targeting all regions of Australian. Before joining InterGrain during 2018, Allan was lead wheat breeder for Dow AgroSciences in Australia, where he was accountable for the company's national plant breeding structure and science.

As a plant breeder Allan has actively pursued his keen interest in leveraging technology applied in global crops, including corn and soybeans. He has successfully implemented synergistic strategies within Australian wheat breeding during career with CSIRO, Dow and InterGrain. Allan has also contributed significantly to local research, particularly with his involvement in sponsored genomic research at AVR.

Prior to joining Dow, Allan worked with CSIRO as the national gateway breeder and trait pre-breeder and as a sugarcane breeder with BSES in Northern Queensland.

Summary

Key points include:

- InterGrain have increased Oat breeding scale, efficiency and field-testing capacity whilst decreasing variety release times for faster industry adoption of improved genetics.
- InterGrain has applied high-end phenomics for biomass (r ~0.4-0.7) and hay colour prediction.
- InterGrain will invest and collaborate locally plus globally to build Oat genomic capacity.

The aim of the project was to transition national grain and hay oat breeding to InterGrain for increased rate of genetic gain per industry dollar invested.

During 2021, InterGrain doubled the size of National Oat breeding activities. Following industry collaboration, field testing environments used were targeted to great reflect industry practice and maximise genetic potential. For example, InterGrains' Stage4 trial at Holt Rock was sown 28th April and yielded 4.8t/ha, compared to the co-located NVT sown at 'normal time' which yielded 2.0t/ha.

InterGrain will deploy high through-put 'plant breeding machinery'; e.g., robot seed packer, high yielding summer nurseries, plus leverage existing company partnerships, e.g., scale with trial service providers, AVR genomics, Phenomic groups, to further increase scale and efficiency whilst reducing selection pipeline timelines. During 2022/23, we will release 3-5 new varieties with improved purity for various targets of the Australian Oat industry.

Oat variety choices for 2022 will also be discussed.

InterGrain will continue to engage with all aspects of the Australia oat industry and exporters to ensure breeding targets are relevant with clear value propositions. InterGrain will drive increased rates of genetic gain through state-of-the-art breeding platforms and breeding efficiencies.

Acknowledgments

InterGrain gratefully acknowledges the amazing industry support from SARDI, GRDC and AgriFutures to facilitate timely transition of data and seed for planting to ensure a successful 2021 season.

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the author would like to thank them for their continued support.

Reference

Oat varieties for 2022 and new national breeding program

Dr Allan Rattey, InterGrain Pty Ltd

GRDC Project Code Number: IGP2103-001AWX

Mice control

Steve Henry, CSIRO

The Rodent Management team at CSIRO is working on a portfolio of projects that encompasses the development of spatially explicit predictive models; the role of pastures as refuge habitat for mice; using genetic technology to understand mouse populations and disease profiles; and the development and implementation of the most effective control strategies to reduce the impact of mice.

Steve's research involves monitoring mouse populations to predict future mouse population outbreaks; investigating the efficacy of ZnP to enhance the success of control strategies; and understanding the ecology of mice in zero and no-till cropping systems to inform the development of more effective control strategies.

Steve believes that understanding farming systems is a critical component of developing better control strategies to reduce the impact of mice. All this work is focused on delivering more effective tools to reduce the impact of mice in cropping systems.

Summary

Favourable climatic conditions in WA during 2021 led to excellent crops, they also resulted in excellent conditions for mice. A large part of the WA cropping zone was seriously impacted by mice from sowing through to harvest. As is often the case in good seasons frost played a role in reducing yields for some growers and the climate contributed to a bountiful but logistically difficult harvest. The outcome of this is that growers are faced with managing stubbles that contain lots of food and shelter for mice.

This presentation will cover:

- The implications of high levels of residual food in stubbles.
- Establishing an environment in stubbles that is unfriendly to mice.
- The importance of monitoring mice to understand to magnitude of the mouse problem.
- Applying strategies to limit the impact that mice will have next sowing.

GRDC investments have enabled CSIRO to work on projects aimed at minimising the impact of mice in crops. Steve will provide a summary of the data from these projects and the implications of the results of this work for ongoing mouse control strategies.

Why bother with artificial intelligence in agriculture? Because it can improve fertiliser management

Jonathan Richetti, CSIRO

Jonathan's background is in agricultural engineering with honours. Jonathan was recognised as the third best undergraduate student. During his doctoral studies in 2015, he was a statistics lecturer at West Parana State University. During 2017, Jonathan was a Visitor Researcher Scholar at the University of Florida, working with soybean crop modelling and remote sensing applied with AI for regional yield estimates. This work was awarded the best graduate presentation at the 2017 Agronomy Society of America conference in the remote sensing section. After defending his thesis during 2019, Jonathan joined CSIRO as a postdoctoral fellow. At CSIRO, Jonathan is developing the next generation of sensor-based decision systems for agriculture.

Summary

Key points include:

- Artificial intelligence algorithms can improve nitrogen decision making over current methods. The current limitation is the availability of data.
- An effort is needed to integrate data sources and farm data to aid farming decision making. Building such a database is one of the main challenges for the community.

This work aims to clarify the possible uses of Artificial intelligence (AI) in farm management, particularly the use of machine learning to improve N fertilisation management in wheat.

The most important variable was the ratio between farmer and rich strips of normalised difference vegetation index (NDVI). Other important variables included the ratio between farmer and rich strips of normalised difference red-edge vegetation index (NDRE), the available mid-season N in the soil, and the ratio between farmer and low strip with NDRE. On average, the AI model generated an additional $9/ha profit over and above the farmers' management. However, similarly to precision agriculture, if there is no yield variation in the paddock, you might not need AI! A caveat is that the data used to train the AI model had comparatively few observations compared to the research studies. AI's main ability is to capture patterns in the data. Farmers and consultants often have much more than a couple of seasons of experience. Expanding the AI algorithm to different seasons and places will improve the algorithm's ability. In time, AI decision support systems will improve.

Vegetation indices are not enough to make an N decision. They are only useful when coupled with on-farm experimentation. Other variables, such as soil N, are also important to a certain extent. Secondly, and most importantly, AI methods with enough data (many observations of key variables) can improve mid-season N management by reducing the errors and biases if there is enough yield variability and, therefore, increasing the profitability of the decision. Finally, AI can be deployed into any farm and enhance the N decision making prowess of the entire industry.

Reference

Why bother with Artificial Intelligence in Agriculture? Because it can improve fertilisation management

Jonathan Richetti, CSIRO

Day 3 – Tuesday 1 March

Nutrition

Carbon farming in WA

Richard Eckard, University of Melbourne

Richard Eckard is Professor and Director of the Primary Industries Climate Challenges Centre, University of Melbourne, a research centre addressing the impacts of a changing climate on agriculture. His research focuses on carbon farming and accounting towards carbon neutral agriculture, managing extreme climate events and options for agriculture to respond to a changing climate.

Richard is a science advisor to the Australian, New Zealand, UK and EU governments, the International Livestock Research Institute and the Food and Agriculture Organization of the United Nations on climate change adaptation, mitigation and policy development in agriculture. Richard was recently named on the Reuters list of the world's 1000 most influential climate scientists.

Summary

Growers should build soil organic matter for the right reasons. Growers should bank the inherent productivity benefit of improved soil health and not sell their soil carbon, as they will need this asset for the day when they might need to table it against the balance of their greenhouse gas (GHG) emissions to meet supply chain demand.

Potassium rundown in the Western grains region — where, why and what does it mean for crop yields

Professor Richard Bell, Murdoch University

Richard was raised on a dairy farm south of Margaret River. His university studies focused on plant nutrition, and initial research was predominantly on micronutrients. Subsequently after joining Murdoch University during 1990 as a lecturer to teach soils, Richard's research diversified to include dryland salinity, soil acidity, soil management, and potassium (K) nutrition of crops, as well as agronomic, soils and cropping systems research in South East and South Asia. More than 50 PhD/ MSc students have been involved in this research. Richard became a Professor at the university during 1997 and currently teaches crop and pasture science for undergraduates.

Summary

Farming systems, especially those with the dominance of cropping, have been running negative K balances for decades in the Western Grains region. This resulted in K deficiencies emerging very early for crop and pasture production on deep sands and, later on, duplex soils.

Wide-scale depletion of plant-available K in soils is occurring in WA, with up to half of soil samples falling below the critical K level in the coastal plain south of Geraldton and up to 25% in other regions. A survey of 184 fields from the WA grains belt in 2010–2015 showed that average K inputs per paddock-year were 4.6, 4.1 and 4.3kgK/ha in the Northern, Central and Southern Agricultural Regions, respectively. By comparison, grain harvests remove 5–10kg K/ha, based on current yields and grain K contents of 4–5kg/t in wheat and barley, 8.8kg/t in lupins and 9.2kg/t in canola.

There is also emerging evidence of K responses on loamy soils, which was demonstrated by crop responses to K differences caused by crop residue windrows in 2019–20 and by higher K fertiliser rates on loamy soils in 2021. The loamy soils, classified as Kandosols or Dermosols, contained >80mg K/kg at 0–10cm, which is above the critical range of 43–57mg/kg for Kandosols (yield >3t/ha). By contrast, soil Colwell K levels below 10cm were lower than the critical range at the North York and East Beverley sites, where there was a wheat yield response compared with nil-K supply in treatments with 25/25 split, 100 and 200kg K/ha.

The red and brown loamy earth soils where K deficiency is emerging cover almost 600,000ha. While higher rates of K application are required for sustainable cropping, a more holistic approach to crop K nutrition would improve K use efficiency and cropping profitability. The use of deep-rooted crops to take up K from subsoils, deep or split applications to maximise fertiliser K use efficiency, and adequate supply of other nutrients, particularly N, are management options available at present.

Reference

Soil K rundown in the Western grains region – where, why and what does it mean for crop yields?

Richard Bell[1,2], Qifu Ma[1,2], Craig Scanlan[2,3,4], and Andreas Neuhaus[5]

[1]Centre for Sustainable Farming Systems, Food Futures Institute, Murdoch University; [2]SoilsWest, Murdoch University, [3]DPIRD; [4]UWA School of Agriculture and Environment; [5]CSBP Limited

Does optimum wheat phosphorus requirement change with sowing time and conditions in WA?

Mark Gherardi, Summit Fertilizers

Mark has more than 20 years' experience in forestry, carbon farming and agricultural production and has been managing nutrition trials and building the Field Research program for Summit Fertilizers for the last eight years.

Mark has a love and a historic connection to growing things on solid foundations, stemming from an Italian family heritage in market gardens, forest products and concrete trucks. His passion for plant nutrition was seeded when has asked his Nonno why he was burying cow manure under the tomatoes and his Nonno answered, "they grow fast to get away from the smell".

Summary

Key points include:

- Early sowing is well associated with increased yield crop potential, but when soil moisture was adequate for crop emergence, optimum phosphorus (P) applications at sowing for wheat yield varied with sowing time, from low in April-sown crops to high in June-sown crops.
- The effect was seen in early-mid and mid-late maturing wheats, in high and low rainfall years, in healthy and marginal P status soils and is somewhat counter-intuitive to common practice of increasing inputs to support a high yield potential.
- The results suggest opportunities for fine tuning on-farm management of P inputs for efficiency and improved yield outcomes and have implications for advisory and decision support systems based on P response data that have not factored sowing time into field trial interpretations.

Mark was involved in an investigation into the application of studies and methodologies from the eastern states to P supply in wheat crops at different times of sowing in WA.

As a general observation, yields were greatest in April or May sown wheat, with significant yield penalties evident by delaying sowing until mid-June. Yield increased in response to increasing P application rate. Increases were greater as the crop was sown later and were observed for both varieties and in both years.

Differences in P responses were primarily due to depression of yield with nil P applied at later sowing times, indicating decrease in plant available soil P pool and/or decrease in capacity of plants to access, take up and utilise the P from the labile soil pool. Taking the near-maximum yield point from fitted P response curves (90% or 95%) gave distinctly different optimum fertiliser P application requirements for each time of sowing.

The difference in optimum P requirement between the start and end of an 8-to-9 week April-June sowing program is in the order of 10–15kg P/ha, and the requirement for applied P appears to be lower when the early sowing times correspond with a higher April monthly rainfall. Notably, finding lower required P input to achieve near-maximum yield occurred in Decile 1 and in Decile 10 rainfall seasons and in both healthy and marginal P status soil.

(Continued on following page...)

The project found that opportunity may exist for wheat growers sowing into conditions of good soil moisture in April and early May, to decrease P inputs while still achieving near-maximum growth and yield potential. Coupled with shifting P resources to crops sown later in the season may have a proportionately greater impact on increasing yields and contribute to an overall improvement in yield and returns across a cropping program than maintaining stable P throughout sowing.

The opportunity relies on utilisation of the residual soil P pool and careful management and monitoring will be important due to risk of high P removal rates with early sowing.

Reference

Does optimum wheat phosphorus requirement change with sowing time and conditions in WA?

Mark Gherardi[1], Sean Mason[2], Saritha Marais[1], Jack Pages-Oliver[1]
[1]Summit Fertilizers; [2]Agronomy Solutions

NEW RESEARCHER SNAPSHOT: The power of flux towers for measuring crop productivity and water use

Caitlin Moore, University of Western Australia

Having grown up on a farm in Gippsland, rural Victoria, Caitlin has always had a love of agriculture and the great outdoors. This passion has taken Caitlin on many adventures around the world, and now to WA to pursue her research and life goals.

Caitlin was awarded her PhD from Monash University during 2017. From there, she moved to Champaign, Illinois USA to commence as a Postdoctoral researcher at the University of Illinois Urbana-Champaign. In the US, Caitlin worked to improve understanding of food and bioenergy cropping system function in response to climate variability. Caitlin returned to Australia in 2020 to commence as a research fellow, now lecturer, at UWA, where she is continuing her research in both agricultural and environmental science fields.

Summary

Key points include:

- Crop productivity and annual carbon budgets can be calculated using the net ecosystem exchange (NEE) of carbon dioxide measured by flux towers.
- Crop water use (i.e. evapotranspiration) measured alongside crop productivity can be used to understand water use efficiency and compared to annual rainfall.
- With a long-term focus, flux towers can collect multiple years of data, which can be used to understand how crop productivity changes in response to climate variability.

The aim of the project was to demonstrate how flux towers can be used to improve understanding of crop productivity and in determining whether the system is storing carbon over the long term.

Measuring how much carbon dioxide and water is exchanged between cropping systems and the atmosphere over time improves our understanding of crop productivity, particularly in response to climate. Results presented will be from an ongoing research project at the UWA Ridgefield farm, where an eddy covariance flux tower was installed during 2015. This tower has been measuring carbon and water fluxes at half hourly resolution since this time, showing clear periods of carbon uptake and water loss during the growing season. Results may also include examples from the USA showing the longer-term value of flux towers for understanding crop biochemical cycling and soil carbon storage.

By measuring carbon dioxide and water exchange between crops and the atmosphere over time, we are understanding more about the climate drivers of crop yield and water use, triggers of crop stress, and accounting for carbon storage in the system. Despite their value for agroecosystem monitoring, very few flux towers are operating in WA agricultural systems. By demonstrating the power of flux towers for quantifying carbon and water fluxes at field scale, this limitation may begin to be overcome with additional support from interested groups.

Reference

The power of flux towers for measuring crop productivity and water use

Caitlin Moore[1,2], Jason Beringer[1], Tim Lardner[1]

[1]UWA School of Agriculture and Environment; [2]Institute for Sustainability, Energy and Environment, University of Illinois

Day 3 – Tuesday 1 March

Nitrogen from legumes

Cereals after pasture legumes have higher grain protein levels

Robert Harrison, CSIRO

Rob grew up in Wongan Hills, WA. After finishing his studies, Rob worked on farms firstly in the northern hemisphere then in WA, with enterprises consisting of multiple aspects of farming including dairy, livestock, forage and cereal production. During 2016, Rob started at Murdoch University's then Centre for Rhizobium Studies (CRS) where he gained valuable research experience in rhizobiology, nitrogen transformations and pasture legume selection and ecology. In the five years he was there, Rob ran field and glasshouse experiments and co-authored multiple research papers before transferring to the CSIRO in the middle of 2021. In recent years Rob has been involved in two main national projects: the Nitrogen Fixation Program (NFP) and Dryland Legume Pasture Systems (DLPS). In the DLPS he oversees two outputs: i) pasture breeding and selection; and ii) quantifying the benefits of pasture legumes in the cropping system.

Summary

The DLPS investigated the impact of new pasture legumes on subsequent cereal crops. It aimed to determine if biologically fixed nitrogen (N) from elite pasture legumes can increase grain protein levels in dryland farming systems across multiple soil types in WA.

Field trials containing fallow, continuous cereal and legumes such as serradella, vetch, medic and trigonella were studied in rotation with cereals at three markedly different soil types and climates (across dryland WA). All ex-legume treatments in rotation sustained or exceeded cereal protein levels of continuous cereal rotations with less synthetic N (u/ha) applied. Although cereal protein levels were diluted and lower in 2021, the ex-legume plots were still significantly higher than continuous cereal plots. Optimal synthetic N rates applied to cereals can be estimated by farmers with similar rotations in the agronomic zones studied.

The study found:

- Cereals following pasture legumes in a rotation have higher grain protein levels.
- Cereal yield was the most responsive the year after fallow.

Pasture legumes grown across three markedly different climates can increase cereal grain protein levels. Also, efficient-fixing pasture legumes (i.e., serradella, vetch and trigonella) used in rotation with cereals can allow farmers to hedge on undersupplying N without significantly compromising yield and protein in high demand years while reducing the chance of oversupply in years of low demand.

Reference

Cereals after pasture legumes have higher grain protein levels

Robert Harrison[1,2], Tom Edwards[3], Chris Poole[2], Ron Yates[2,3]

[1]CSIRO; [2]LRS, Murdoch University; [3]DPIRD

Profitability, costs and risks associated with establishing annual pasture legumes in cropping rotations

Dean Thomas, CSIRO

Dean Thomas is a farming systems modeler in the CSIRO Agriculture and Food research program. He is interested in the profitable integration of cropping and livestock systems and has worked across a range of projects, including saltland pastures, grazing stubbles, livestock sensors, diet selection and animal nutrition. This research paper reports the economic benefits and risk of establishing phases of new annual pasture legume species. Dean is originally from a mixed farm at Ravensthorpe and has worked a livestock systems scientist with CSIRO since 2008. Prior to joining CSIRO, Dean worked for CBH as a seasonal worker and graduate trainee.

Summary

The next generation of annual pasture legumes in farming systems has increased the flexibility and performance of pasture phases. The economic performance of novel annual pasture legume and crop rotations using the LUSO bioeconomic model was investigated, focusing on break crop effects that may persist across multiple years. The study demonstrated productive legume-based pastures are a profitable and low risk option in mixed farming rotations. These pastures have a dual role in supporting a self-replacing Merino enterprise and by reducing biotic stress and nitrogen input costs for subsequent cropping phases.

By including a novel annual pasture legume phase, profit was increased during under the least profitable seasonal conditions, compared with cropping-only phases. However, where scenarios had low biotic stress and used current (historically high) prices for wheat, canola and nitrogen fertiliser there was no downside risk benefit from annual legume pastures.

The study assumed that the establishment of productive high-quality pastures is always successful, producing high quality livestock feed and fixed N during each pasture phase including the establishment year. If pastures are ungrazed in the establishment year, or all years, there is a large reduction in profit.

This research supports the potential for a greater role for novel annual pasture legumes combined with sheep in low-medium rainfall agricultural regions.

Reference

Phases of novel annual pasture legumes are a profitable and low risk option in low-medium rainfall regions

Dean Thomas, Chris Herrmann, Robert Harrison, Bonnie Flohr, Roger Lawes
CSIRO Agriculture and Food

Optimising nitrogen fixation in legumes through improved rhizobia strains

Ron Yates, Department of Primary Industries and Regional Development

Over the last 27 years, Ron Yates has been involved with industry-focused national research programs to increase profitability and sustainability of dryland farming systems through optimising biological N fixation of agricultural legumes. Currently he manages two 5-year projects based at Murdoch University that include the western components of the Commonwealth funded Dryland Legume Pasture Systems (DLPS), and the GRDC supported National Fixation Program (NFP) project. He has achieved consistent high quality scientific research outcomes that have resulted in more than 50 peer reviewed scientific papers.

Ron has a dual position as a senior research scientist in the Farming Systems Innovation (FSI), DPIRD, and holds a principal research fellow appointment at the Legume and Rhizobium Studies (LRS) group, Murdoch University. He is acknowledged within WA grains and livestock industries, and nationally for expertise in research and extension in rhizobiology, legume agronomy, legume pasture breeding and dryland farming systems. He is a steering committee member (WA representative) for the Australian Nitrogen Fixation Society.

Summary

Key points include:

- An elite rhizobia strain (WSM4643) has provisionally replaced the present Australian commercial inoculant group E/F strain (WSM1455) for the inoculation of field peas, vetch and lentils.
- The new strain will be commercially available for the 2023 season after final quality checks by Australian inoculation manufacturing companies in 2022.
- The improved strain will provide growers with a robust inoculant that enables field peas, vetch and lentils to nodulate and increase N fixation on infertile, acidic soils.

The project evaluated strain WSM4643 for the replacement of the present Australian commercial inoculant group E/F that will enable associated legumes to achieve improved N fixation on soils with infertile, acidic soils.

Analysis of nodulation, peak biomass, seed yield and %Ndfa determined that the legume seed (field peas, vetch or lentils) inoculated with the new rhizobia strain WSM4643 demonstrated statistically significantly higher values or equivalent in performance when compared to the current Australian commercial strain WSM1455 (group E/F). All legume seed not inoculated in the trials attained very low nodulation in the extremely acidic soils and resulted in lower values for all other measurements.

Legume seed inoculated with WSM4643 exhibited a consistent increase in nodulation, biomass, N fixation and seed yield when compared to the current commercial strain. The trial results highlighted the extreme importance of inoculation and the production gains that growers can achieve through administering superior rhizobial strains.

These results combined with similar field experiments trialling strain WSM4643 around southern Australia have been compiled to make a successful case to provisionally replace the commercial inoculant group E/F strain (WSM1455).

Reference

Optimising the growth and nitrogen fixation of legumes through the use of improved rhizobia strains

Ron Yatesa[2], Chris Poole[2], Robert Harrison[2,3], Tom Edwards[1,2], Emma Steel[2]

[1]DPIRD; [2]Legume and Rhizobium Studies, Murdoch University; [3] CSIRO Agriculture and Food

NEW RESEARCHER SNAPSHOT: Soil moisture mapping in agricultural fields using electrical conductivity sensing

Hira Shaukat, University of Western Australia

Hira Shaukat is a 4th year PhD candidate working with Ken Flower and Matthias Leopold at the School of Agriculture and Environment, UWA. Her research is focused on soil mapping in broadacre farming using non-invasive and mobile electromagnetic induction sensor, particularly in relation to the soil moisture availability in rainfed agriculture. Hira has recently published work in *Agriculture Water Management* and she is further working on a project with Cooperative Research Centre for Honey Bee Products (CRCHBP) and the Department of Industry, Science, Energy and Resources (Grant #20160042) for potentially integrating high value native medicinal shrubs in cropping system. Hira is an international candidate from Pakistan and was awarded with an Australian Government Research Training Program (International) and University Postgraduate Scholarship for her PhD in Australia. Prior to joining UWA, Hira was working in a multinational agribusiness company with the profile of working closely with farmers for introducing new hybrid varieties and implementing global sustainability projects.

Summary

Knowledge of real-time spatial distribution of soil moisture has great potential to improve yield and profit in agricultural systems. Recent advances in non-invasive electromagnetic induction (EMI) techniques have created an opportunity to determine soil moisture content with high-resolution and minimal soil intrusion. So far, EMI has mainly been used for homogenous soil conditions, which are not common in agriculture and is mainly validated by excavated pits or calibration models using soil samples on a transect.

This study converts time series apparent electrical conductivity data recorded with a Dualem 1Hs EM-meter for two surveys of variable moisture conditions (dry and wet season) with 2475 and 2174 data points over 5.4ha, in a field with a contrasting vertical soil profile into spatiotemporal management zones. A least square inversion algorithm was used to determine electrical conductivities for individual soil layers of 0–0.5m, 0.5–0.8m and 0.8–1.6m. A laboratory experiment under controlled conditions developed electric conductivity vs. volumetric water content relations with power law functions for required soil depth slices with R2 values between 0.98 and 0.99. Subsequently, EMI data were converted to volumetric water contents for each layer and predictions were spatially displayed.

Average percentage difference between inverted and measured apparent conductivities was between 25–27% resulting in 19–23% difference in volumetric soil moisture prediction. These EMI based soil moisture predictions were compared with neutron moisture meter measurements, with Pearson R values of 0.74 and 0.95 for the wet and dry surveys, respectively.

The method is robust and offers a comparatively fast method to estimate the soil moisture status in fields and to subsequently make informed management decisions.

Reference

Quasi-3D mapping of soil moisture in agricultural fields using electrical conductivity sensing

Shaukat[1], Flower[1,2], Leopold[1,2]

[1]UWA School of Agriculture and Environment; [2]UWA Institute of Agriculture

Day 4 – Thursday 3 March

Crop protection

Ice nucleating bacteria and frost

Amanuel Bekuma, Department of Primary Industries and Regional Development

Amanuel is originally from Ethiopia. He has worked for Ethiopian Institute of Agricultural research for eight years and received AUSAID scholarship to study his PhD in Australia. Amanuel completed his PhD at Murdoch University during 2017 and his dissertation focuses on rhizobium and nitrogen fixation. He joined Western Crop Genetics Alliance group and then DPIRD during 2018 to work on barley heat stress project. Currently, Amanuel is leading a COGGO funded project which focuses on bacterial induced frost injury to cereals in WA.

The work to be presented today elucidated seed as a potential source of ice nucleating bacteria (INB) and revealed the presence of variation among wheat genotypes for the number of resident INB which may open a new frontier in frost research.

Summary

Key points include:

- Ice nucleating bacteria (INB) are seed-borne and to minimise the risk of INB infection in subsequent seasons, frosted grain should not be kept for seeding purposes.
- Wheat genotypes sown early and exposed to severe grain frost (>80%), host more than 100-fold more INB compared to the late sown wheat genotypes exposed to very mild grain frost (<5%) in the same year.
- Seed-borne INB population varies among wheat genotypes potentially modulating the frost risk profile of wheat genotypes.
- qPCR-based testing is a promising method for quantification of INB from frost affected grains.

The aim of the study was to test whether seed could be a potential source of INB and to understand if wheat genotypes and the environment determine INB population size.

Frosted grains harbour more INB population than unfrosted grain. Early sowing usually increases the likelihood of overlapping frost events with the susceptible stage of wheat plants. At present, the correlation between INB population and percentage of frosted grain is not understood. For instance, it is not clear if the presence of INB on the seed caused the frost or if frost affected seeds provide favourable conditions for opportunistic INB to flourish. Frosted grains also have a high sugar content, potentially serving as a nutrient source for INB and other microbes. The cause and effect of the presence of INB on frosted grains needs to be investigated further.

When sown early and exposed to moderate level of grain frost (5–20%), seed-borne INB population size varies among wheat genotypes. However, the variations were masked when either sever or very mild frost conditions prevails during grain filling. The qPCR-based quantification of ice nucleation gene (inA) was in good agreement with viable plate counting of INB. The qPCR assay was effective in quantifying inA gene copy number from grain samples exposed to moderate to severe levels of frost events during grain filling.

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Grain frost seems to favour INB colonisation on the seed surface but the number of INB populations varies depending on wheat genotypes and the severity of the frost damage. For instance, Wyalkatchem showed high levels of INB present on the grain when exposed to a moderate level of frost damage and there were significantly less INB present on Young under the same conditions. An increased level of sugars in frosted grains and plant tissue in response to cold exposure might hold the key to understand the link between INB colonisation and genetic tolerance. The role of seed borne INB in repopulating the subsequent crop and sustaining the frost cycle for the next crop remains to be investigated. In the meantime, growers are advised to avoid keeping frosted grain for seeding purposes to reduce frost risk. The use of both molecular and microbiological techniques will be a powerful tool in detection and quantifying seed borne INB population with prospects for the technique to be used in other environmental samples.

Reference

Wheat genotypes differ in seed-borne ice nucleating bacterial (INB) population

Amanuel Bekuma[1], Esther Walker[1], Brenton Leske[1], Chaiyya Cooper[2], Rebecca Swift[2], Sarah Jackson[1], Ben Biddulph[1]

[1]DPIRD; [2]Curtin University

GRDC Project Code Number: COGGO#2: 2019

How well does assessment of outer florets of wheat heads following frost(s) relate to grain yield at the end of the season?

Brenton Leske, Department of Primary Industries and Regional Development

Brenton Leske comes from a mixed farm at Cascade, WA, and has been working in the agricultural industry since 2014. Brenton started at the Department of Primary Industries and Regional Development during 2014 and begun working on GRDC projects with a particular focus on the impact of frost on cereal crops. During 2017 he commenced a PhD to understand differences in varieties susceptibility to frost damage. Brenton completed his studies during 2020 and has returned to DPIRD to join the abiotic stress group working with Dr Amanuel Bekuma. Brenton is focused on bringing agronomic management strategies to growers for whom frost is a business risk.

The research he will be presenting today is from his PhD project and will explore frost damage, its measurement, and the grain yield impact.

Summary

Key points include:

- Proximal grains in wheat spikes are key determinants of grain yield when exposed to frost, but distal grains can play a minor role in compensation if the season permits.
- Measurement of frost damage should continue to assess the sterility of proximal florets to determine the extent of damage to wheat crops.

The aims of the project were to determine the contribution of all grains in the wheat spike to grain yield when damaged by frost, and compare grain set and grain size in Cutlass, Scout and Wyalkatchem with known differences in their performance under frosts after spike emergence

There was a negative relationship between the sterility of both proximal (G1 and G2) and distal (G3 and G4) grains to grain yield. The contribution of grain position to spike weight and ultimately grain yield was most for G1 and G2, followed by G3 and then G4. Contributions by each grain position varied with sowing date and floret sterility level. Under low floret sterility (mid-May) the weight of grain in proximal positions G1 and G2 contributed over 70% to the total spike grain weight. Under high floret sterility (4, 40 and 65%) in mid-April (when grain frost damage was observed) the relative contributions of grain positions to total spike grain weight increased slightly in both G1 and G2 for all cultivars by 1–2.7% compared to mid-May, except for Wyalkatchem G2 (-1.3%). Grain weight contributions of proximal grains were 2–3 times greater than distal weights in Scout and Cutlass; Wyalkatchem had two to five times greater contributions from proximal positions to distal positions. In all sterility scenarios, the proximal grains contributed the most to spike grain weight and thereby grain yield. Therefore, measurement of frost damage in proximal florets is sufficient for determining the level of frost damage within a crop and using this to determine if the crop should be cut for hay or left to harvest the grain.

(Continued on following page...)

The project found that growers should continue to monitor crops for frost damage, particularly when their local weather station records screen temperature below 2°C. The extent of damage can be determined by assessing; i) the number of sterile/damaged anthers and/or ovules within the outmost florets of the spike to calculate a percentage of sterile florets; and ii) the number of spikes that have symptoms of frost damage from a transect of frost prone parts of the landscape. The recovery of crops damaged by frost events varies with the amount of soil water available to plants, the potential for spring rains and the any of growing season left. Compensation via new tillers is possible if frosts occur early on in August and average or above average rain occurs in spring, however late frosts in September and early October with below average rainfall often result in either no new tillers or tillers than do not go on to form grain. Increases in grain size within the spike is possible, however this only occurred once in four different sowing times in our trials in a medium-high rainfall environment, therefore the likelihood of this occurring is low.

Reference

How well does assessment of outer florets of a wheat head following frost(s) relate to grain yield at the end of the season?

Brenton Leske, DPIRD

AHRI herbicide resistance update 2021 — most significant results from the field to the lab

Roberto Busi, Australian Herbicide Resistance Initiative, University of Western Australia

Roberto conducts research on the evolutionary dynamics of herbicide resistance — to discover and understand why and how weeds can evolve resistance so fast. Over the past six years, his research has focused on the impact of using low herbicide rates, and in a world first, established that persistent use of the pre-emergent herbicide Sakura (pyroxasulfone) at low rates can lead to rapid resistance evolution in Lolium rigidum. Roberto is the GRDC-funded activity Leader of the Herbicide Technology and weed resistance evolution.

Summary

During 2021 AHRI led a research project aimed to demonstrate to WA growers and advisers the value of proactively testing for herbicide resistance in key weed species: ryegrass, brome grass, barley grass, capeweed and wild radish. Results from 50 farms across WA highlight the effectiveness of a glyphosate+clethodim mixture on resistant annual ryegrass; the increase of potential group H/27 resistance in wild radish; and the high efficacy of carbetamide on brome and barley grass.

Profitable, smart farming entails knowing your enemy well, which is best achieved by regular herbicide resistance testing of key troublesome weeds. Testing reveals emerging threats to herbicide performance and best herbicide treatments to stop them in their tracks.

Annual ryegrass

This study confirms the absence of evolved resistance to paraquat but reports an increasing and concerning level of glyphosate resistance (13% samples). When glyphosate is used in combination with clethodim (resistance in >30% samples tested) resistance to either herbicide stand-alone is significantly reduced (only 3% samples tested). Resistance frequencies to pre-emergence herbicides were approximately 15% (trifluralin), 5–8% (prosulfocarb and bixlozone) and <1% (pyroxasulfone and cinmethylin). The ability of ryegrass to evolve resistance to herbicide mixtures or sequences is significantly less, reinforcing the recommended practice of mixing modes of action. In year 1 of a three-year field trial, bixlozone (Overwatch) was the most effective herbicide, whereas pyroxasulfone (Sakura) was the safest to the wheat crop. **AHRI Lab:** *Metabolism studies on populations with reduced sensitivity to cinmethylin have shown that ryegrass has the potential to detoxify cinmethylin in the same way as wheat does*.

Wild radish

There is significant resistance (>50% of samples tested) to herbicide groups B/2, F/12 and I/4 in wild radish. Herbicide mixtures (Group 6, 12, 4, 27) such as diflufenican+bromoxynil, diflufenican+picolinafen+bromoxynil+MCPA or pyrasulfutole + bromoxynil remain effective with a low level of resistance (<15%). There is no resistance to group G/14 herbicides and glyphosate. Group H/27 resistance remains relatively low, but it appears to be an increasing problem. Pyrasulfotole + bromoxynil resistance was confirmed in a field trial. **AHRI Lab:** *Early translocation studies have suggested that pyrasulfotole may be less mobile in resistant populations, but this needs to be confirmed.*

Brome grass, barley grass and capeweed

The resistance status of brome and barley grass is remarkably similar with about 30% resistance to sulfonylureas and <5% resistance to imidazolinones, clethodim or quizalofop. The pre-emergence herbicide carbetamide (available from 2022) has shown 100% efficacy on both species. **AHRI Lab:** *Work-in-progress has revealed for the first time the genetic basis of resistance to FOPs and DIMs in brome grass (ACCase mutation). A low level of resistance was found in capeweed in response to metosulam stand-alone. No resistance was found to glyphosate (all three species), paraquat (brome and barley grass) or clopyralid (capeweed).*

NEW RESEARCHER SNAPSHOT: Electric weed control in Australia

Miranda Slaven, Department of Primary Industries and Regional Development

Miranda joined the Northam DPIRD crop protection team as a Research Scientist during May 2021 to determine the applicability of electric weed control technology within Australian systems. Prior to this Miranda worked in the Office of the Honourable Alannah MacTiernan, Minister for Agriculture and Food; Regional Development; Hydrogen Industry providing administrative support.

Miranda has a double major in Agriculture and Environmental Science from UWA and is continuing her studies by undertaking a Master's of Agricultural Science specialising in soil science and plant nutrition.

Summary

Key points include:

- In an Australian first, DPIRD will begin trialling electric weed control technology during the 2022 WA growing season.
- Weed morphology will have a large impact on application efficacy.
- International companies are currently seeking to certify the technology in Australia.
- Within Australia, the potential uses are predicted to be during fallow, for inter-row control, as well as crop topping or weed wiping.

The aims of the study were to determine the efficacy of electric weed control in WA conditions and the potential uses in Australian agriculture; which weed species are likely to be easiest to control with electricity, the electric weed control machinery currently available on the international market and how it is being applied on farm.

Electric weed control sends an electrical current through the plant's shoots and roots, as well as the soil. This creates a pressure build-up that ruptures the plant cells' membranes, killing the plant. Electrical resistance is influenced by the plant's species, morphology, and age, as well as the soil conditions and machine and parallel objects. Theoretical morphology studies have indicated that weed species with root and shoot systems with a high surface area and level of branching are likely to have reduced mortality from electric weed control. Results of a pot trial indicate that volunteer crops and grass weeds will be hardest to control based on these factors. The international market for electric weed control covers a wide range of uses including those which will be applicable in Australia such as weed control during fallow as well as crop topping or weed wiping where weeds are taller than the crop. While machinery has also been developed for inter-row weed control in horticulture, large-scale applications in the broadscale agriculture are not yet feasible due to low application speeds.

Finding alternative weed control strategies to chemical measures is important in Australia due to increasing rates of herbicide resistance and the negative social opinion of herbicides. Electric weed control has the potential to be integrated into current weed management programs. However, its efficacy is highly variable depending on species' morphology and its applicability in Australian systems, while theorised, is yet to be determined.

Reference

Shock Treatment: Australian Electric Weed Control

Miranda Slaven and Catherine Borger, DPIRD Northam

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

SHOCK TREATMENT: AUSTRALIAN ELECTRIC WEED CONTROL

Miranda Slaven and Catherine Borger, *DPIRD, 75 York Road, Northam, WA 6401*
Email: Miranda.Slaven@dpird.wa.gov.au

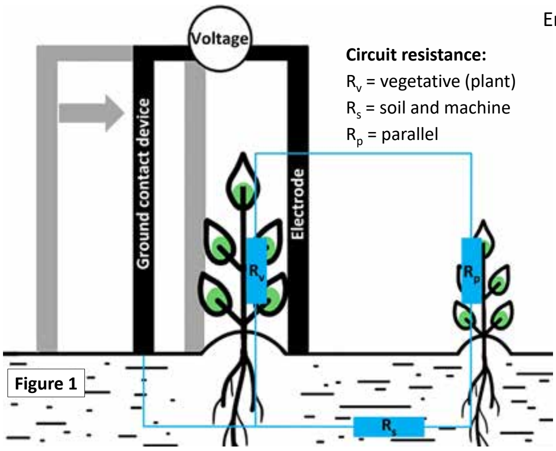

Figure 1

Background

Electric weed control functions by forming an electric circuit following the contact of the plant with the machine's electrode with the current travelling through the plant's shoots and roots as well as the soil (Figure 1) (reviewed in Vigneault et al., 1990). The current transforms into heat energy within the plant's cells, vaporising water and other volatile liquids, creating a pressure build-up that ruptures the cells' membranes and kills the plant (Diprose et al., 1980). The amount of energy transmitted to a single plant, and the resulting damage severity, will depend on electrode contact time, electrical voltage and the plant's electrical resistance (Vigneault et al., 1990). Electrical resistance is influenced by the vegetation's species, morphology, and age, as well as the soil conditions (Bauer et al., 2020).

Weed Morphology and Anatomy

Theoretical morphology studies have indicated that weed species with root and shoot systems with a high surface area and level of branching are likely to have a reduced mortality rate as only a portion of the plant tends to be killed and regrowth can occur from the undamaged section (Diprose et al., 1980). Results of a pot trial (Figures 2 and 3), indicate that volunteer crops may be harder to control than weeds due to their comparably high surface area and level of branching. Further, within the weed species analysed, grasses are expected to have lower mortality when compared to broadleaf species for similar reasons. On a cellular level, higher cellulose and lignin content, specifically in the epidermis, increases cell resistance to bursting during application (Vigneault et al., 1990). It is noted that these factors will very with plant age and stress level, and that DPIRD is commencing an Australian first research project in 2022 to determine the technology's applicability in WA.

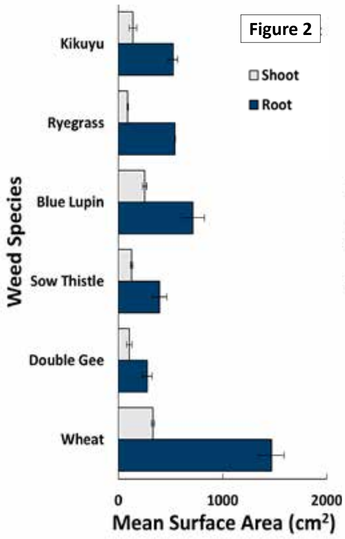

Figure 2

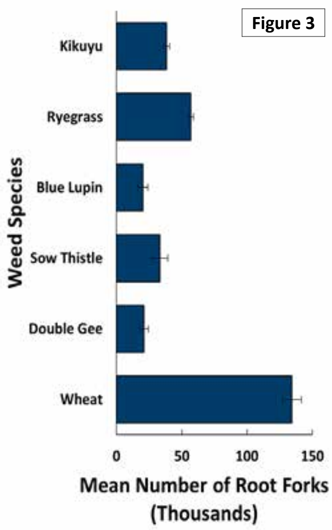

Figure 3

International Machinery Examples

Machine	Use	Speed (km/h)	Width (m)
1. Weed Zapper	Tall weeds in row crops	4.5 - 5.5	3.65 - 18.29
2. NUCROP	Pre-emergent control and crop desiccation	6.0 - 8.0	12.00
3. XPS	Inter-row weeds in vineyards and orchards	Up to 4.0	1.52 - 4.84
4. XPU	Sidewalks/roadsides and industrial areas	Up to 4.0	1.20

Australian Applications

As a non-selective weed control strategy, electric weed control is most likely a fit for use during fallow periods, as well as in non-cropped or urban and industrial areas. There may also be potential to develop large scale units to target weeds in the inter-row of grain cropping and horticultural systems. However, shielding would be necessary to prevent crop damage. Where the weeds are taller than the crop, it is possible to use electric weed control to achieve a crop topping or weed wiping effect as currently utilised by the Weed Zapper. However, low application speeds limit current machines to small scale weed control.

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Acknowledgements

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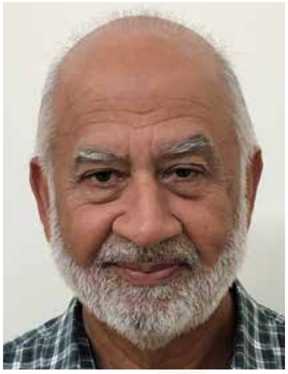
Advances in controlling brome and barley grass

Gurjeet Gill, University of Adelaide



After completing a PhD at UWA, Gurjeet joined the Weed Science branch of the Department of Agriculture and Food, WA (DAFWA, now DPIRD) in South Perth during 1985 as a Research Officer. After working for DAFWA for more than 10 years, Gurjeet moved to the University of Adelaide in 1996. He has been successful in securing many GRDC funded projects over last 20 years. His research interests include weed seed biology and behaviour of weed seedbanks, crop-weed competition, development of weed suppressive wheat cultivars, understanding adaptive behaviour of weeds, herbicide resistance and integrated weed management.

Summary

Key points include:

- Research indicates large differences in seed dormancy between brome and barley grass populations; high seed dormancy populations are more difficult to control with pre-sowing knockdown herbicides and delayed crop sowing.
- Brome grass seedbank tends to persist for three years and barley grass for two years. Therefore, single year management programs are unlikely to prevent rebound in populations of these weeds.
- Presence of resistance to group A/1 herbicides is still relatively low but, in some regions, resistant populations have been responsible for control failures.
- Integration of higher crop densities (seed rate) with effective herbicide options has been consistently successful in minimising crop yield loss and reducing seed set of brome grass.

The aims of the project were to identify weed traits responsible for increasing incidence of brome and barley grass in cereal crops in southern Australia; and quantify benefits of integrating non-chemical tactics such as sowing time and crop density with herbicides to improve weed control.

On farm populations of brome and barley grass can possess very different levels of seed dormancy, which can have a large effect on the depletion of weed seedbank by knockdown herbicides and success of delayed sowing for weed control. Many growers underestimate persistence of seedbanks of brome and barley grass and often expect elimination of weed populations by a single season of effective weed control. Long-term success in weed population management needs carefully developed multi-year management plans otherwise their populations can rebuild rapidly. Even though herbicide resistance levels in brome and barley grass are still much lower than ryegrass, populations with resistance to group A/1 and group B/2 have been identified. Integration of higher crop density with combinations of pre-emergent and post-emergent Intervix® was found to prevent brome grass seed set and crop yield loss. The effectiveness of delayed sowing for brome grass control was strongly linked to seed dormancy status of the population and often reduced crop yield.

The project found brome grass and barley grass populations can be effectively managed by the combination of pre-emergent and post-emergent herbicides. However, the performance of post-emergent herbicides can be compromised by the presence of resistance to group A/1 and group B/2 herbicides. Effectiveness of tactics such as delayed crop sowing can be strongly influenced by seed dormancy level of weed populations.

Reference

Advances in controlling brome and barley grass

Gurjeet Gill and Ben Fleet, University of Adelaide

GRDC Project Code Number: 9175134, UA00156, 9176981

Maximising crops and minimising weeds with smart phase farming

Yaseen Khalil, Australian Herbicide Resistance Initiative, University of Western Australia

Yaseen Khalil is a Kurd from north east Syria. Yaseen received his Bachelor of Science degree from the Plant Protection Department, Agricultural Engineering Faculty, Aleppo University in Syria. There, he also received his Masters in History of Applied Science. Yaseen worked for International Centre for Agricultural Research in Dry Areas (ICARDA) for five years as a research assistant and then as a research associate on an Australian Centre for International Agricultural Research (ACIAR) funded project to develop conservation agriculture in northern Iraq and Syria. Yaseen received an ACIAR John Allwright scholarship to undertake his PhD at UWA. He commenced his PhD program during July 2014. GRDC funded a three-year Post-Doc fellowship where Yaseen was offered a job as Research Associate with AHRI/UWA. Yaseen is currently a Research Agronomist with Kalyx Australia, based in Geraldton.

Summary

Key points include:

- Herbicidal and cultural control options applied later in the weed lifecycle, such as weed wiping using glyphosate, spray-topping using paraquat, mowing prior to ryegrass flowering followed by spray-topping, biomass cutting for hay/silage production, incorporation of green biomass into the soil (green manuring), and the non-selective use of glyphosate to kill all plants prior to ryegrass flowering (brown manuring) were effective at reducing annual ryegrass seed production by more than 80% compared to the untreated control.
- The highest serradella yield was achieved following the application of flumetsulam applied post-sowing/pre-emergent with the second greatest serradella seed production following propyzamide and/or imazethapyr treatment.
- Paraquat, especially when used at the heading stage of ryegrass, reduced the ryegrass seed production to <2.5% of the untreated control (weedy control).
- The application of glyphosate or paraquat was effective at reducing ryegrass seed production, however these treatments also greatly reduced serradella seed production, making these treatments unsuitable in self regenerating pastures.
- The early intervention of weed controlling options in serradella significantly reduced the number of ryegrass and capeweed compared to those at late intervention options.
- Results of three-year rotational trial showed the highest ryegrass seed produced with the continuous wheat rotations at both sites, which further negatively impacted the wheat yield compared to wheat in other rotations.
- Alongside the chemical fallows, serradella phases were the best in reducing the ryegrass seedbank inputs.

This project focused on pasture management to decimate weed seed banks during a pasture phase and increase the productivity and profitability of the subsequent crop phase.

The project found that weeds such as annual ryegrass have the adaptive capacity to vastly decrease the profitability of cereal-sheep farming. Legume pasture phases offer a profitable non-cropping phase to control ryegrass through diverse herbicide and non-herbicide weed control techniques. The value of a pasture phase for weed management increases at (i) higher ryegrass seed burdens, and (ii) where herbicide resistance constrains the efficacy of in-crop weed control options. The single weed control options applied late in the growing season were the most effective

(Continued on following page...)

tools in reducing the annual ryegrass seed production. Early intervention strategies of weed management in serradella phase significantly reduced the ryegrass numbers, but not the biomass. Late intervention strategies were the most effective approach to stop the ryegrass from setting the seed and significantly reduced the seedbank size. Serradella phases (mainly two and three years long) were as good as the rotations with chemical fallows and oats followed by GM canola, in driving down the seedbank size of annual ryegrass in the farming systems.

Reference

Maximising crops and minimising weeds with smart phase farming

Yaseen Khalil*[1], Mike Ashworth[1], Roberto Lujan Rocha[1], Angelo Loi[2], Zhanglong Cao[3], and Hugh Beckie[1]

[1]AHRI, UWA; [2]DPIRD; [3]Statistics for the Australian Grains Industry (SAGI WEST), Curtin University

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GRDC Project Code Number: 9176958 / UWA1811-003RTX

Yes, no, maybe — getting value from herbicide resistance testing

Fiona Dempster, University of Western Australia

Fiona Dempster has been employed as a Research Fellow with UWA, School of Agriculture and Environment for the last 10 years. During this time, Fiona has received funding from two National research programs, Bushfire and Natural Hazards Cooperative Research Centre, Rural R&D for Profit, DPIRD, GRDC and MLA. Her work is primarily decision-making tools, valuation and behavioral economics applied to farming systems, natural hazard management and biodiversity policy. Fiona has also undertaken consulting projects for the Australian Farm Institute. Recently, Fiona was appointed Deputy Director of the Centre for Agricultural Economics and Development, based at UWA.

Summary

Australian growers have responded to the ongoing evolution of herbicide resistance in weeds by adopting new practices and alternative herbicide options to prolong the effectiveness of important herbicides. One such practice is the use of testing services, which allow growers and their agronomy advisers to submit weed seed samples and confirm the resistance status of weed populations, through laboratory trials. The economic value to the grower from knowing the resistance status of weed populations is the ability to effectively control weeds with cheaper herbicides and have a quantitative efficacy estimation of a wider range of herbicide options / mixtures. Yet there is industry concern that testing services are underutilised.

This study addressed the following research questions: i) what are the perceived benefits, extent and reasons for growers and adviser using herbicide resistance testing? ii) do growers and agronomists correctly assess the status of weed resistance status?

The study involved collecting annual ryegrass and wild radish weed seed samples for testing across 128 paddocks (over 44 farms) in the Western region. Grower's perception of resistance status (susceptible, developing and resistant) for each sample, for 12 herbicides, was reported through an online survey. Advisors' perception of resistance status for each farm was also reported through an online survey. Twenty-five growers and 15 agronomists from the Western grain growing region were surveyed. The resistance status perceptions reported by each grower in the survey were compared against the actual resistance test result for each paddock sample taken. Agronomists' perceptions were compared against the resistance status average for each of the 44 farms.

Quantitative descriptive analysis was used to describe herbicide resistance test outcomes and primary survey data. Test results found that a large proportion of the weed samples collected are susceptible to resistance (80%) with 8% resistant. Survey results indicate that 60 percent of growers have undertaken herbicide resistance testing in the past 10 years, although usually not regularly and often facilitated by the advisor. Time constraints at sampling time was the most common limiting factor for growers to adopt herbicide resistance testing. The majority of growers (88%) used visual observation of surviving weeds was the main source of information for determining resistance status.

The study provides the following key messages:

1. Growers make correct assumptions of herbicide resistance problems in ryegrass 67% of the time. Observations are less accurate (44%) for wild radish probably due to a much greater discrepancy in weed control efficacy delivered by herbicide stand-alone products vs herbicide mixtures.
2. There is a tendency for growers and agronomists to directly associate poor weed control in the field with herbicide resistance: this can drastically limit the range of cost-effective herbicide options used for weed control.
3. In general growers and agronomists' assessment of resistance status is reasonably accurate, however there are instances where accurate testing information adds value to long-term weed management.

Determining yield loss in canola following sclerotinia stem rot infection

Sarita Bennett, Curtin University

Sarita moved from the United Kingdom to Perth during 1995, where she took on the role as a researcher in legume genetic resources and pasture ecology at UWA. During 2003 she moved back to the UK to the University of Wales Bangor as a research agronomist in flax and hemp. During 2006 she returned to Perth to join the Future Farm Industries CRC as the Pasture Theme Leader in saltland pasture ecology as part of The Sustainable Grazing in Saline Land Initiative.

In 2010 she was employed at Curtin University as a Senior Lecturer in Farming Systems Agronomy. Since being at Curtin she has developed research projects in both crop and pasture systems. She is currently the Discipline Lead for Agriculture and Food and is the Project Leader for the project 'Agronomy and management of sclerotinia stem rot in canola and pulses' at the Centre for Crop and Disease Management.

Summary

Key points include:

- Canola plants display significant levels of plasticity, or environmental adaptation, and therefore have the ability to compensate for plants that are no longer competing for resources around them. Yield loss within an sclerotinia stem rot (SSR) infected canola crop is therefore not clearly related to the percentage of infection within the crop.
- At 15% SSR within the crop, there is no yield loss in the final crop. The level of infection in which yield loss occurs in canola varieties varies with different growth habits.
- The level of infection at which it becomes economic to spray will be discussed, recognising that spraying only when it is economic to do so for yield protection, does not account for contribution of sclerotia to the soil from infected plants and thus increasing the infection risk in subsequent years.

This presentation will briefly describe the yield loss experiment on undertaken at Avondale Farm, Beverley looking at the potential impact of sclerotinia stem rot in canola as the levels of disease increase. It will provide details of varieties included, how the increase in disease levels were simulated in the field and the times of simulation.

The results will be presented looking at the impact of increasing levels of sclerotinia across the four canola varieties, and the impact of time of infection on yield loss. A simple economic analysis will show the value of spraying at different levels of disease.

The presentation will finish with a discussion on balancing the economics of spraying with control of sclerotinia in future years of the disease, and the risks of single year management strategies.

NEW RESEARCHER SNAPSHOT: Spraying for yellow leaf spot in wheat — will you lose money?

Anna Hepworth, Department of Primary Industries and Regional Development

Anna is an applied statistician and bioeconomic modeller. They have spent most of their research career working in human health — in such diverse fields as breastfeeding, asthma, and cerebral palsy — before joining DPIRD during 2017. Anna works within the crop protection portfolio developing decision support tools for foliar disease management in broadacre crops. Existing tools that Anna has contributed to are YellowSpotWM and StripeRustWM for wheat, and Blackspot Manager for field peas. They are currently working on a model for net blotches in barley.

Summary

Key points include:

- YellowSpotWM is the newest of a family of decision support tools intended to support decision making on the most cost-effective use of fungicides during the growing season.
- The easy-to-use interface will be familiar to users of our group's previous tools: StripeRustWM, PowderyMildewMBM, SclerotiniaCM and BlacklegCM.
- Released during the 2021 growing season, it is available for both Apple and Android mobile phones and tablets.
- A range of outcomes are summarised for the user in terms of potential crop loss to disease, net return, and potential yield for single or multiple fungicide spray scenarios.

This study looked at using mobile technology to provide an in-season decision support tool that assists agronomists and growers in making fungicide management decisions for yellow leaf spot of wheat.

Results from the YellowSpotWM tool are presented for two contrasting situations looking at the economic return for one or two foliar fungicide sprays. For a low disease pressure situation, with a moderately susceptible variety planted in rotation, the most likely net return is a loss in both spray scenarios. In a high disease pressure situation, with a susceptible variety planted into wheat stubble, the most likely net return is a gain. How large a gain depends on several factors, some of which are shown. In all cases the tool shows a range of likely outcomes.

The YellowSpotWM tool has been designed to provide site and season-specific information to grain growers to inform their management decisions. The straight-forward user interface allows input of user observations and knowledge of the paddock. These can be combined with output from a location-specific weather-driven disease maturation model. To minimise data usage, the disease maturation model is incorporated into an API endpoint of a weather database.

The tool generates a distribution of plausible outcomes. The model was calibrated against historical data and released to industry during the 2021 season.

Reference

Spraying for yellow leaf spot in wheat – will you lose money?

Anna Hepworth[1], Fumie Horiuchi[1], Adam Sparks[1], Ciara Beard, Geoff Thomas[2], Rebecca O'Leary[1], Art Diggle[1], Jean Galloway[3]

DPIRD [1]Perth, Geraldton, [2]Kensington, [3]Northam

Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

YellowSpotWM

A decision support tool for managing yellow leaf spot in wheat

- ✓ A decision support tool to help weigh risks when managing Yellow leaf spot in wheat
- ✓ Quickly assess and compare management options
- ✓ Works in the field without network connection
- ✓ Quick and easy to represent conditions in any paddock
- ✓ Presents the results in dollar terms

Available for iPhones and iPads or Android phones and tablets

Yellow leaf spot lesions on wheat

Yellow leaf spot on leaves in wheat

Yellow leaf spot appears as tan elongated lesions with yellow margins and leaf dying back from tip

Example from YellowSpotWM showing expected net return from one or two applications of fungicide to manage yellow leaf spot in wheat

This initiative is supported by the Grains Research and Development Corporation. Development and support has been provided by a collaboration of Department of Primary Industries and Regional Development, Western Australia and Agriculture Victoria.

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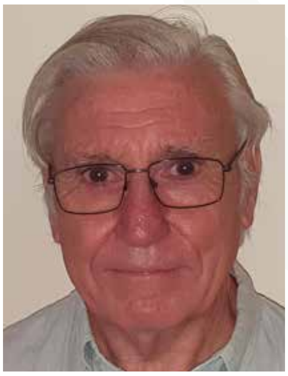
Day 5 – Tuesday 8 March

Canola

Effect of seed singulation and seeding rates of canola on yield and competition against ryegrass

Glenn McDonald, University of Adelaide and **Glen Riethmuller,** Department of Primary Industries and Regional Development



Glenn started his research career working on the agronomy of irrigated wheat in the Namoi Valley, New South Wales. Then in the late 1980s he worked with the Victorian Department of Agriculture, Horsham, on a high rainfall cropping project; the aim of which was to improve crop yields in the western districts of Victoria. The work examined time of sowing and long season wheat, waterlogging, nitrogen management and rotations. He then moved to the Department of Agronomy at the (then) Waite Agricultural Research Institute, Adelaide, where he has remained to this day. While with the University, Glenn's interests and projects have included N and P nutrition, genetic improvement in saline and sodic soils and micronutrient nutrition. Over the last four years he has led a project on optimising plant establishment for improved yields and profit in the southern and western regions.

Summary

Key points include:

- Precision planting did not significantly improve establishment of canola but consistently increased the uniformity of crop stands.
- Yield response to precision planning is variable but results suggest small improvements are feasible at similar or lower plant densities to conventional sowing.
- Economic responses to lower plant densities with precision planting were more frequent at yields less than 1 t/ha. At higher yields precision planting often resulted in higher gross margin but at similar optimum plant densities as conventional sowing.

The aim of the project was to compare the effect of precision planting and conventional sowing on the establishment, growth and yield of canola.

In nine field trials conducted in SA and Victoria over four seasons, mean crop establishment ranged from 50% to 90%. Precision planting often resulted in lower establishment, especially at sowing densities greater than 30 seeds/m^2 Precision planting consistently increased the uniformity of crop stands. The coefficient of variation for interplant distance fell from 90–100% with conventional planting to 60–70% with precision planting. Early growth (measured as NDVI) and biomass at podding were unaffected by sowing method, with plant density being the main driver of differences in crop biomass.

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Average yields ranged from 0.56t/ha to 3.51t//ha among the experiments. Significant responses to plant density occurred in all except three experiments. In these experiments grain yield did not vary with plant density, which ranged from less than 10 plants/m^2 to 40–45 plants m^2. In the remaining experiments grain yields generally declined below 30 plants/m^2.

The effect of precision planting on the yield response to plant density varied considerably among the experiments. Precision planting had no effect on yield (three trails), tended to increase yields at low plant densities (two trials) or increased yields at all plant densities (four trials). Overall site-treatment combinations, the average yield benefit of precision planting was 6%. An additional treatment in 2021 using hand-thinned plants to achieve a uniform plant stand achieved higher yields than the precision planting treatment, suggesting poor crop establishment may still limit the effectiveness of precision planting.

Higher gross margins (GMs) were achieved from precision planting in six experiments, and these ranged from an extra $8/ha (site mean yield = 1.44t/ha) to $234/ha (site mean yield = 3.51t/ha). At sites with average yields less than 1 t/ha the higher GMs were achieved at a sowing rate 0.6kg/ha lower than the conventionally sown treatment. This was equivalent to about 10 fewer plants/m^2. With yields higher than 1 t/ha higher GMs were achieved at similar optimum sowing rates to the conventionally sown treatment. In two experiments there was no difference in GMs or a loss of $34/ha with precision planting.

The project found that precision planting increased the uniformity of crops and resulted in small, albeit inconsistent, yield increases in canola. Savings in seed input costs and improvements in profitability were more commonly found when yields were less than 1 t/ha and in these situations sowing rates could be reduced by about 0.5kg/ha or 10 plants/m^2. While these results are encouraging, at this stage it is unclear if the small gains and inconsistent responses warrant the adoption of the technology. Further work is required to understand the main environmental and management factors that determine the agronomic benefits of precision planting and to improve the seeding technology for Australian conditions.

Reference

Responses to precision planting of canola in SA and Victoria

Glenn McDonald[1], Rebekah Allen[2], Genevieve Clarke[3], Ashley Amourgis[4], Jack Desbiolles[5], Stefan Schmitt[6], David Minkey[7]

[1]University of Adelaide; [2]Hart Field Site Group; [3]Birchip Cropping Group; [4]Southern Farming Systems; [5]University of South Australia; [6]Agricultural Consulting and Research; [7]WANTFA

Glen Riethmuller, Department of Primary Industries and Regional Development

Glen started at Merredin during 1982 on an 'energy in tillage' project and since then, has worked on wheat row spacing, improved wheat and canola establishment, lupin and lentil harvesting, precision farming with yield mapping, injecting lime on a deep ripper, semi-leafless field pea harvesting, weed control in wide row lupins, controlled traffic farming, deep ripping canola harvesting techniques and water harvesting on sodic soils.

Summary

Key points include:

- Singulation significantly increased canola yield with low canola density in the presence of low numbers of annual ryegrass compared to conventional seeding.
- Singulation significantly reduced annual ryegrass head numbers compared to conventional seeding.

The aim of this experiment was to test if perfect spacing canola, using precision sowing, improves yield and competes against ryegrass better than a conventional seeder.

Canola emergence was less for the cone seeder (averaging 63%) than the precision planter (averaging 96%, Wintersteiger Mono planter using a vacuum plate singulation system). While there was moisture at seeding it was sown in a drying profile indicating that seed depth control was probably better with the precision planter.

Overall, the experiment yield average was 1.5t/ha which was affected by some frost damage. In the absence of annual ryegrass, the precision planter only yielded 18% higher at low (10 plants/m^2) canola densities than the conventional seeder. While in the presence of annual ryegrass, the yield of the precision planter was 18% higher than the cone seeder with a low population of ryegrass but not at the higher weed population.

While the annual ryegrass plant numbers were not affected by seeding system or canola seed rate, the head numbers were significantly less (36%) with the Mono averaging 2.1 tillers per emerged ryegrass plant compared to 3.3 tillers with the cone seeder.

The project found that singulation had a yield benefit at low seeding rates in the absence or presence of low annual ryegrass numbers. Couple this with a reduction in ryegrass head production makes precision planting a potential technology for expensive seed, such as hybrid canola at low seeding rates.

Growers with conventional seeding systems can maintain yields and good weed competition with robust seeding rates and crop establishment.

Reference

Effects of singulation and seeding rates of canola on yield and competition against annual ryegrass

David Minkey[1], Glen Riethmuller[2], Glenn McDonald[3], Jack Desbiolles[4]

[1]WANTFA; [2]DPIRD; [3]University of Adelaide; [4]University of South Australia

Further information

McDonald et al (2021) *The agronomic value of precision planting technologies with winter grain crops*. GRDC Updates (Adelaide). https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2021/02/the-agronomic-value-of-precision-planting-technologies-with-winter-grain-crops

Canola pre-breeding for heat tolerance

Sheng Chen, University of Western Australia

Sheng obtained his PhD during 2000 from Huazhong Agricultural University, China. After graduation he worked at the University of Montpellier, France, where he investigated the expression of aquaporin (water channel protein) gene family under salt stress. He had three years of research experience on the regulation of plant defence gene expression in CSIRO Plant Industry. Sheng joined Professor Wallace Cowling's canola group at UWA during 2005 and since then, has been working on canola germplasm evaluation and utilisation, with particular interest in the physiology and genetics of canola tolerance to drought and heat stress.

Sheng is currently leading a national research project on heat tolerant canola funded by GRDC. He has published 35 research papers in international journals including Nature Genetics, Molecular Plant, Plant Physiology, Frontiers in Plant Science, Theoretical and Applied Genetics, Plant Phenomics and Food & Energy Security etc.

Summary

Key points include:

- Trials at controlled environments are crucial for establishing the protocol of heat tolerance screening and for identifying heat tolerant germplasm.
- Field trials using portable heat chambers provide a bridge between controlled environment trials and multi-environmental field trials.
- Multi-environmental field trials validate the heat tolerance of putative heat tolerant germplasm and provide evidence of the wide-spectrum or regional adaptation status of these germplasm in Australia.

Trials at controlled environments, field trials using portable heat chambers, together with multi-environment field trials, pave a path from the evaluation of heat tolerant germplasm to the demonstration of heat tolerance in farmer's land in Australia.

A new prototype heat-stress facility was established for large-scale heat tolerance screening of canola germplasm based on results of experiments conducted at UWA since 2013. Broad genetic variation in canola for heat tolerance existed in 200 genotypes based on their ability to set seed on main stem as well as whole plant yield after the simulated heat wave. Some genotypes performed better than three OP cultivars (43C80, Tanami and AV Ruby) and two hybrid cultivars (Ignite and Diamond). YM11, a heat tolerant canola line originally from China, showed highest seed yield among 200 genotypes under both control and heat stress conditions during 2020.

During 2020, heat tolerance of 30 selected genotypes was validated in field trials with five times of sowing and two replicates at each time of sowing in irrigated field trials at Narrabri and Leeton, NSW. Results aligned with UWA prototype screening, with three genotypes (YM11, Charlton-NCA18, Yudal) performing well. During 2021, field testing of selected genotypes was repeated at four sites (Leeton and Condobolin, NSW; Kerang, VIC: Dongara, WA).

Novel, portable heat chambers have been used to assess heat tolerance of canola in field environments since 2017 at NSW DPI, Wagga Wagga and capturing data on heat tolerance of varieties in natural field environments. In these chambers, daily temperatures up to 35°C are imposed for a few days while keeping moisture and nutrient levels at optimum levels. Heat stress imposed using these chambers has significantly reduced seed yield, harvest index and seed number per pod in canola varieties which were selected from multi-location trials. So far, wide genetic variation in heat tolerance has been observed with a few promising lines with good mean yield and good heat tolerance.

Reference

Canola pre-breeding for heat tolerance: from controlled environment facility to the field

Sheng Chen[1], Rajneet Uppal[2], Suman Rakshit[3], Kadambot Siddique[1], Wallace Cowling[1]

[1]UWA; [2]NSW DPI; [3]SAGI, Curtin University

GRDC Project Code Number: UWA1905-007RTX

Spring versus winter canola phenology across Australia — new insights for WA growers

Jeremy Whish, CSIRO

Jeremy Whish is a Principal Research Scientist with CSIRO Agriculture and Food and is based in Brisbane Queensland. He uses simulation modelling and on-farm research techniques to investigate ways of improving production and resource use in Agricultural systems. His work on systems modelling has led to him conducting detailed studies of flowering in canola and pulses crops

Summary

Ensuring canola flowers at the optimum time is the key to achieving maximum productivity. Knowing when a new cultivar will flower in an environment is always a challenge. Two recent GRDC projects have focused on the phenological development of canola, with the ultimate aim of being able to use genetic testing and simulation modelling to inform when a new cultivar will flower in any environment. In the process of achieving this goal, new methods of assessing cultivars have been developed.

Pacific Seeds is one company that is working with CSIRO to adopt these methods of assessing their pre-release canola cultivars. Their aim is to ensure they can deliver an integrated management package for all their new material. Through this process and testing it is hoped to better match cultivars for sowing dates, management practices and environments.

Day 5 – Tuesday 8 March

Cereals – wheat, oats and barley

Understanding the fit of winter wheats for WA environment

Brenda Shackley, Department of Primary Industries and Regional Development

Based at DPIRD, Katanning, Brenda has more than 30 years' experience delivering wheat agronomy research and extension. She currently coordinates the statewide trial series 'Capturing early sowing opportunities for wheat' and is involved in updating and development of Flower Power. Brenda coordinated the compilation of DPIRD's WA Crop Sowing Guide in 2019, 2020 and 2021.

The research presented is from the 'Capturing early sowing opportunities for wheat' trial series and winter wheat trials co-ordinated by Dion Nicol and Jeremy Curry, other members of the wheat agronomy team.

Summary

Key points include:

- Illabo was the most competitive winter wheat variety sown mid-April in the longer growing season environments of WA.
- Current winter wheats were typically still flowering too late, even when sown in early April, suggesting the need for earlier flowering winter type varieties for the medium to lower rainfall areas.
- Agronomic recommendations are listed to maximise the performance of winter wheat in WA.

The aim of the project was to assess commercial and potential winter and spring wheat varieties for their suitability (yield, phenology and dry matter production) to early sowing opportunities in WA.

Flowering date is critical for wheat yield, with flowering required to occur within an optimal period to minimise the effects of frost, heat and drought on yield. Even with an early to mid-April sowing, the winter types (namely DS Bennett and Illabo) had a late flowering date which was associated with the lower grain yields.

Although the winter wheats achieved the highest yields sown mid-April at Katanning and Dale, they were not significantly higher than some of the mid-slow spring wheat varieties. At these sites, the highest yields were achieved by mid-slow spring wheats sown late April. Winter wheats were not competitive at Mullewa or Grass Patch.

The slower developing winter wheats, such as DS Bennett b and Illabo are more suited to the cooler and medium to high rainfall environments in WA which have a longer growing season and/or an increased risk of frost i.e., Katanning and Dale. The later flowering dates of the winter types made them less suited to the warmer environments of Mullewa, Merredin or Grass Patch.

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A late March sowing opportunity at Gibson found mid-slow spring wheats to yield the highest, followed by the quicker winters. Significantly lower yields were obtained by the slower winter types due to high levels of take-all. Indicating that in environments where frost, heat and drought are less relevant, flowering date is not as critical as potential yield (set by yield components) and other factors such as disease resistances.

Sowing date and flowering date analysis show a large gap of suitable varieties between the winter and spring types which can flower in the optimum flowering period when sown prior to late April.

The research continues to highlight the need for a variety which is better suited for early April or earlier sowing opportunities in WA. While winter types have an extended growing period when sown in early April, maximum yields are almost always achieved by mid-slow spring varieties sown in late April to early May. Winter wheats generally flower too late for maximising yield potential even when sowing in early/mid-April. The role of winter and slow or mid-slow maturing wheat varieties are currently undervalued in the WA cropping system.

To maximise the performance of winter wheat in WA, a number of recommendations are made.

Reference

Understanding the fit of winter wheats for WA environments

Brenda Shackley, Jeremy Curry and Dion Nicol, DPIRD

Pre-harvest sprouting begins at seeding

Jeremy Curry, Department of Primary Industries and Regional Development

Jeremy started working for DPIRD during 2015 in the GRDC and DPIRD funded wheat and barley agronomy projects. Through these projects, he carried out research trials on wheat and barley varietal choice and best practice management in the Esperance Port Zone. Since 2019, Jeremy has worked across wheat, barley and canola on a number of DPIRD and GRDC funded projects including High Rainfall Zone Cropping, Hyper Yielding Crops, Modelling Late Maturity alpha-amylase, and Wheat Agronomy projects.

One constant through his seven years with DPIRD has been the research he has carried out looking at pre-harvest sprouting and low falling number in wheat. Today, Jeremy will present the key findings from this work and the implications for how growers can manage their crops to limit risk.

Summary

Pre-harvest sprouting is a quality constraint to wheat production that can occur in all wheat growing areas but occurs on a sporadic basis. If a standing crop is exposed to rainfall near maturity, germination of the grain can be induced resulting in a reduction in its quality. In WA, grain suspected of being affected by pre-harvest sprouting is subject to a Falling Number test at receival, with a Falling Number of over 300 required for most milling grades.

While PHS incidence is significantly influenced by the amount of rainfall a crop receives, the severity of damage (level of germination and reduction in Falling Number) caused by this rainfall can vary markedly based on the maturation stage of the crop and the variety grown.

Field experiments (2015–2021) have utilised a number of wheat genotypes and environments (through sowing date and trial location) to understand how wheat varietal susceptibility and environmental conditions interact to cause PHS and low Falling Number in wheat.

The key findings of these experiments include:

- There is a large range in susceptibility to pre-harvest sprouting in current wheat varieties, and growers should understand the risk profile (Falling Number Index rating) of a new variety before adoption.
- PHS can occur prior to the crop reaching harvest maturity, and the prevalence of this occurring is increased through early crop maturation (such as is caused by early [e.g., April] sowing).
- Growers can best manage their risk of PHS through choosing an appropriate variety (maturity and PHS susceptibility) for their sowing date, ensuring these align appropriately for their environment.

The research undertaken was made possible through the DPIRD funded 'WA Crop Sowing Guide' project (2019–) and the GRDC/DPIRD funded 'Tactical Wheat Agronomy for the West' project (2015–2019). The author would like to thank them for their continued support. Many thanks to Chris Matthews and Helen Cooper (DPIRD Esperance) for their technical expertise and to Kevin Young (GxE Crop Research) for his continual support.

Reference

Pre-harvest sprouting management begins at seeding

Jeremy Curry, DPIRD

Growing a future for oats

Ross Kingwell, Australian Export Grains Innovation Centre

Ross Kingwell is a respected agricultural economist; the author of more than 130 journal articles and book chapters, and more than 300 conference papers and policy reports. He is chief economist in AEGIC, a professor in the School of Agriculture and Environment at UWA, and a leader of a small group of economists in DPIRD.

Ross chairs the Australian Farm Institute's research advisory committee. He has been a co-editor of the Australian Journal of Agricultural and Resource Economics (AJARE) and is a former president and now distinguished fellow of the Australasian Agricultural and Resource Economics Society.

Summary

When assessing the likely future for oats for WA grain farmers, the international outlook for oats was examined.

Globally, human consumption of oats is increasing, albeit modestly in most cases and the global oats market is expected to grow annually by up to five per cent over the next five years. Australia is regularly the second largest global exporter of oats (raw and processed), supplying about 10–15 per cent of world trade, behind the behemoth of Canada (75 per cent of world oat trade). However, over 80 per cent of Canada's exports of raw oats and oat products is sent solely to the USA. Moreover, oat production in the USA and Canada is continuing to be constrained by very strong demand for competing rotational crops, especially soybean and canola.

Australia is the fourth largest global exporter of processed oats and there appears substantial opportunities to grow this volume. China is the fastest growing oat market globally and is rising in significance as a destination for Australian oats. Recent gains in oat food and beverage consumption are expected to continue with the increased global prevalence of 'diseases of affluence', such as diabetes, obesity and heart disease, driving consumers to seek the health benefits of oats as an alternative to staples such as rice. The ability to include oats in traditional foods (e.g., noodles) or to mimic traditional foods (e.g., oaten rice) suggests ongoing value-adding opportunities for oats.

An interim challenge remains, however, to avoid over-supply of oats from Australia which exposes farmers to their oats being priced mostly for feed purposes.

A five-year $11.5 million investment in oat breeding, announced in 2021, will help generate higher-yielding, market-orientated varieties drawn from a wider gene pool. In addition, AEGIC has developed innovative oat products and has identified commercial partners to extend the local and international demand for oat-based food products, particularly focusing on the emerging need for healthy grains in Asia.

Agronomically, oats are a preferred crop option in frost-prone areas.

WA is geographically and climatically well-placed to be a reliable source of exportable surpluses of oats (raw and processed). In addition, oat producers are well-supported by breeders, industry organisations and processors to help Australia be a strategically preferred source of supply to growing markets in Asia. All these positives, however, need to be tempered by the fact that, as a minor grain with growth prospects in food and feed uses, oats is always subject to price risk downside if ever over-supply leads to its pricing principally being based on feed grain markets.

NEW RESEARCHER SNAPSHOT: Genetic solutions to enhance spikelet fertility and grain plumpness during heat stress at flowering in barley

Camilla Hill, Western Crop Genetics Alliance, Murdoch University

Camilla Hill is an agricultural scientist with 12 years' experience in crop genetics research. From 2014 to 2015, Camilla worked as a Postdoctoral Research Fellow in barley functional genomics at the University of Melbourne. She joined Murdoch University during 2015 and has since worked in the area of barley genetic improvement as part of the Western Crop Genetics Alliance, an initiative between Murdoch University and DPIRD. She was awarded the 2019 GRDC Postdoctoral Research Fellowship, and the 2021 Murdoch University Vice Chancellor's Excellence in Research Award (Early Career). Her expertise includes research into genetic improvement of cereal grains to deliver on-going benefits to the grains industry.

Summary

Key points include:

- Adapting crops to warmer environments is a priority to maintain or enhance yield.
- Heat stress resulted in 5–20% fertility reduction in Australian barley varieties.
- New germplasm, genes, and haplotypes with superior spikelet fertility under heat were identified.
- Enhanced heat stress tolerance of reproductive organs using genetic approaches has the potential to overcome heat stress- induced yield losses in crops under current and future hotter climates.

The aims of the project were to: i) uncover of the full range of genetic diversity present for spikelet fertility in current germplasm; ii) understand the relationship between fertility rate and grain plumpness under heat stress; iii) identify varieties with superior spikelet fertility compared to currently available germplasm; and iv) deliver marker assays for tracking the inheritance of alleles in breeding material.

Field trials (Wongan Hills) and combined glasshouse heat chamber trials (Murdoch University) of a global barley panel of 500 varieties were conducted in 2019 and 2020. Data for 20 agronomic traits including spikelet fertility, grain plumbness, and screenings were collected in all field and birdcage trials at full maturity. Heat escape and earlier flowering were successful strategies to mitigate heat damage and resulted in higher grain fertility and grain quality traits. Varieties that flowered during heat stress periods recorded on average 5–20% lower spikelet fertility compared to those that flowered outside the stress windows. Large differences of more than 80% regarding spike and spikelet fertility were detected in Australian varieties. Targeted re-sequencing of the entire barley panel identified over 13,000 genetic variants across 130 spikelet fertility and heat-tolerance related genes. Abundant genetic variation for heat stress tolerance exists in Australian germplasm pools. Association mapping was conducted using a quality-filtered molecular marker set, and 673 strong marker-trait associations in total were detected for spikelet fertility across all trials. Superior haplotypes for spikelet fertility under heat stress were identified for 18 candidate genes and based on this information ca. 100 new markers were developed. The identified superior haplotypes and the barley varieties carrying these superior haplotypes can be used for haplotype-based breeding to develop next-generation barley cultivars with enhanced spikelet fertility under heat.

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The project found that the barley flowering stage is very sensitive to high temperatures which significantly decrease fertility and seed-setting rate, leading to severe grain yield losses. Spikelet fertility at high temperature is a valuable screening tool for heat tolerance during the reproductive phase. Early flowering consistently outperforms late flowering under heat stress for a range of agronomic traits. Based on decreased spikelet fertility, several research lines but only few cultivars maintain spikelet fertility after heat stress compared to control conditions. Genetic information of heat-tolerant and sensitive varieties screened in this project will be used to improve spikelet fertility of the next generation of barley cultivars.

Reference

Genetic solutions to enhance spikelet fertility and grain plumpness during heat stress at flowering in barley

Camilla Hill[1], Sharon Westcott[2], Lee-Anne McFawn[2], Debbie Wong[3], Xiao-Qi Zhang[1], Brett Chapman[1], Gabriel Keeble-Gagnère[3], Kerrie Forrest[3], Matthew Hayden[3], Tefera Angessa[1], Chengdao Li[1,2]

[1]Western Crop Genetics Alliance, Murdoch University; [2]DPIRD; [3]DJPR

Day 6 – Thursday 10 March

Soils

New Soil Water Repellence reference book

SoilsWest

The combined influence of micro-water harvesting, deep ripping and gypsum on yield of barley in sodic soils

Wayne Parker, Department of Primary Industries and Regional Development

With a distant farming background Wayne began working for DPIRD during 2002. Many and varied roles during this time has seen his imagination sufficiently captured to remaining with the same company for this period.

Wayne has enjoyed working with leading growers, researchers and consultants in the northern agricultural region and around the state with the Department since 2002. A background in lupin and pulse crop development, resistant weed management and multiple soil constraints has given him a good understanding of the west Australian broadacre farming system. Currently researching ways to reduce soil constraints to root growth and improve crop water use efficiency on soil types throughout WA.

Summary

The trial was conducted to investigate the potential of an additive response from deep ripping in combination with water harvesting mounds and minor volumes of in-furrow gypsum in remediation of sodic, alkaline clay soil.

The high rainfall experienced during 2021 was integral in reducing any treatment effects this season. Deep ripping did not increase rooting depth and the low amounts of gypsum were insufficient to provide the 'electrolyte effect' to give localised flocculation. Yield was decreased with deep ripping. Previous experiments with covered mounds show positive yield increases. Uncovered mounds sown at 375mm provided less yield when compared to non-mounded plots at 220mm. On the basis of these results ripping remains unrecommendable for these soil types.

Further work is required to better understand the likelihood of success with mounding and low rates of gypsum to improve yield on sodic, alkaline clays.

Sand and gravel mulches for sodic soils

David Hall, Department of Primary Industries and Regional Development

David was a Soil Scientist with the New South Wales Department of Primary Industries for 10-years, before moving to a role at DPIRD, Esperance, during 1993. David grew up in suburban Gippsland with family ties to commercial forestry. Early career mentoring taught him to think about what an ideal soil is and what needs to change to achieve this. This has been the focus of David's 39-year career in soil management across a range of soils and locations from heavy sodic clays in central NSW to the sandplain soils in WA. David is currently managing the GRDC funded sodic and transient salinity soils project within DPIRD.

Summary

Up to 40 percent of rainfall can be lost through surface evaporation in dryland farming systems in WA. This is exacerbated where water infiltration is impeded as in the case of sodic soils. Sand and rock mulches have been shown to increase productivity of sodic soils in China, Oman and Pakistan. However, their use in broadscale dryland cropping in Australia has not been investigated.

This paper reports on three farmer scale mineral mulch trials established near Ravensthorpe. Two trials investigated gravel (0 and 3–7cm thickness) on a red alkaline loamy duplex soil and one sand mulch trial (0, 2 and 4cm thickness) on a highly dispersive grey alkaline loamy duplex soil. The sand mulch trial also had gypsum split plot treatments (0, 2.5 and 5t/ha) and was the only trial to be fully replicated. The trials were designed to assess mineral mulches on crop production in 2020 and 2021. It also reported on the effects of thickness of gravel mulch (0, 2, 4, 6, 8cm) on soil water evaporation and soil temperature in a glasshouse experiment conducted in 2021.

The team found that 2cm of sand or gravel can significantly increase grain yields by 0.5 to 1.8t/ha. The yield increases are associated increased emergence, tillering and grain weights. In field sites we measured increased surface water storage and in glasshouse experiments measured a 61mm reduction in soil evaporation in the red alkaline clay soil. The thermal properties of the gravel mulch were investigated but we could not find temperature differences between the mulched and unmulched treatments. It was suspected that the mineral mulch may also protect the surface soil structure from crusting and hard setting associated with rain drop impact. Hence the improvements in water storage are likely to be a combination of increased water infiltration and reduced soil evaporation. On the highly dispersive sand mulched site, the application of gypsum was as effective if not more effective than sand in increasing crop production.

The application of this technique will be limited to farmers who have on farm supplies of sands or gravels within carting distance of their sodic clay soils.

Reference

Mineral mulches improve water relations and yields on sodic clay soils

David Hall[1], Peter Daw[2], Lloyd Burrell[3], Rushna Munir[4], Wayne Parker[5]

[1]DPIRD, Esperance; [2]Farmer, Ravensthorpe; [3]Farmer, Mt Madden; [4]DPIRD, Merredin; [5]DPIRD, Geraldton

NEW RESEARCHER SNAPSHOT: Improving the understanding of soil water behaviour in re-engineered soil profiles

Kanch Wickramarachchi, Department of Primary Industries and Regional Development

Kanch Wickramarachchi has experience in research, technical, and training within soil science, cereal chemistry, Pathology, and entomology within DPIRD and the University of Adelaide since 2011.

As a Development Officer in Soil Science and Crop Nutrition Portfolio at DPIRD, Kanch is currently working on a DPIRD/GRDC co-funded project, '*Re-engineering Soils to Improve the Access of Crop Root Systems to Water and Nutrients Stored in the Subsoil*'. Her main contribution is to carry out laboratory and glasshouse-based experiments to provide the experimental underpinning needed to establish the mechanisms underlying improved grain yields in re-engineered soil profiles experiments in the field. This includes conducting a series of glasshouse experiments by removing some of the environmental variables allowing closer examination of the combined influence of soil constraints such as acidity, compaction, non-wetting, sodicity.

Kanch's prior international experience includes Integrated Pest Management in Commercial Tree Nurseries and teaching and research experience in academia.

Summary

Knowledge on soil water balance of re-engineered soil is limited. This presentation will summarise the findings on effect of different amelioration practices, available for farmers to alleviate surface water repellence of sandy soils, on surface evaporation, evapotranspiration at early crop growth and water infiltration and soil water storage in sandy soils. This will improve the grower's understanding, enabling them to select suitable for their condition. A glasshouse experiment was conducted to investigate the effect of re-engineering soil profiles on evapo-transpirative loss and soil water storage.

Five different re-engineered soil profiles were constructed to represent:

1. control with non-wetting topsoil,
2. surface claying
3. mouldboarding
4. spading
5. claying followed by spading.

Evaporation measurements were taken from bare soil surface under controlled ambient conditions. A wheat crop was grown for six weeks to measure above-and below-ground biomass and water use efficiency.

NEW RESEARCHER SNAPSHOT: Cracking the code of group H cross-resistance in wild radish

Bowen Zhang, Australian Herbicide Resistance Initiative, University of Western Australia

Bowen Zhang has been studying agricultural science at UWA since 2017. He finished his bachelor's degree during 2019 and will complete his master's degree in 2022. During February 2020, Bowen started to undertook master's project at UWA with AHRI to work on the evolving wild radish herbicide resistance in WA. Bowen has been working in the glasshouse and agronomy labs to quantify resistance levels.

Summary

Key points include:

- Weed management following soil amelioration (spading or mould boarding of water repellent soils) requires special considerations
- Soil tillage in water repellent soil can increase preemergent efficacy.
- Some preemergent herbicides, such as Sakura® (pyroxasulfone 480g/L), were more efficient than other herbicides such as Treflan®, regardless of soil properties.
- Soil amelioration can stimulate weed growth in the absence of preemergent herbicides.

The aim of the study was to investigate the efficacy of pre-emergent herbicides following amelioration (spading or mould boarding) of water repellent soil.

Results indicated that the efficacy of pre-emergent herbicides varied with the type of chemical used, their rate, and soil amelioration method. The results of two screenhouse experiments suggest that Sakura® (pyroxasulfone 480g/L) was more effective in controlling weed emergence and growth compared to Treflan® (trifluralin 480g/L), Arcade® (prosulfocarb 800g/L) or Avadex Xtra® (tri-allate 500g/L). Spading and mouldboarding allowed better shoot and root growth in the absence of pre-emergents. Although weed control efficacy of pre-emergents was variable under different amelioration methods in the screenhouse experiments, field trial data confirmed that pre-emergent efficacy markedly increased after spading and mouldboarding of water repellent soil.

Effective weed control with pre-emergent herbicides following soil amelioration requires a clear understanding of how the chemicals interact with the crop residue, crop, soil, available moisture, and microbes. This research will give a good insight into efficacy of different pre-emergents in different amelioration methods and aid in formulating better weed management strategies.

Reference

Efficacy of pre-emergent herbicides on ameliorated soil

Bowen Zhang, Sultan Mia, Tom Edwards, Gaus Azam, and Catherine Borger, DPIRD

On-farm experimentation — developing robust analysis for paddock scale trials

Julia Easton, Curtin University, **Luke Dawson,** CSBP and **Nathan Eaton,** NGIS Australia

Julia Easton, Curtin University

Julia joined Curtin University during 2019 to lead the Curtin for Agribusiness Profitability (C4AP) Initiative within the Centre for Crop and Disease Management. C4AP brings together expertise from farming systems, spatial science, GIS, big data, actuarial science and agribusiness to visualise farm data at spatial scale and support data-driven decisions about land use optimisation, risk and return on investment and agricultural production in a water-limited environment. Julia is also the WA Node Leader for Food Agility CRC, and held a number of roles in the GRDC West office from 2013–2019, working with the Western Panel, growers, advisors and researchers. She was the Research Manager of Future Farm Industries CRC from 2007–2013 and worked as a Research Officer in the Centre for Legumes in Mediterranean Agriculture from 2003–2007, on GRDC projects in pulse pre-breeding. Julia did her PhD research on Plant Tissue Culture of Western Australian Seagrass at Edith Cowan University.

Luke Dawson, CSBP

Luke grew up on a broadacre cropping farm in the eastern wheatbelt at Warralakin. He has always been passionate about agriculture and working for CSBP has allowed him to develop a keen interest and passion for soil and crop nutrition. Luke is particularly interested in maximising the efficiency of fertiliser products applied as well as exploring the benefits of variable rate applications to maximise returns to our growers. He has been involved in the Food Agility OFE project since its inception. Luke has taken on various roles within hi 18-years at CSBP including Area Manager, District Manager and Senior Agronomist, and has been the Senior Agronomist since 2016.

Nathan Eaton, NGIS Australia

Nathan is an Executive Director at NGIS Australia. He has 20-years' experience in the geospatial industry servicing clients across a wide range of sectors including resources, agriculture, utilities, government and transport. More recently Nathan has worked on a range of international projects focused on Sustainable development goals including climate change, biodiversity, sustainable sourcing and disaster risk reduction. Nathan specialises in partnering with organisations to operationalise geospatial solutions including strategic consulting to solution implementation. Nathan has led teams in delivering a number of projects that have been internationally recognised as game changing initiatives including the Pacific Island Mapping Sea Level Rise Exposure project which received a United Nations Momentum for Change award at the Paris Climate Change conference.

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Summary

Key points include:

- Small plot trials have and continue to be of significant value to growers and researchers. However, farm innovation occurs at large scale and the variability present in the paddock means outcomes of small plot trials do not always translate to paddock scale outcomes.
- Experimental designs and statistical analysis tools designed for small plot trials are not suited to paddock scale trials and new designs and statistical methods are required that account for spatial variability. Geographically weighted regression analysis allows a quantitative approach to understand how crop yield varies in response to treatments such as fertiliser in a spatially variable environment.
- The development of both trial design and statistical methodologies for large scale experiments has also resulted in greater insight into the role of paddock management zones to extend the outcomes from trials to other production areas, driving whole-farm productivity and profitability.

The study aimed to develop new data analytics methods for farmer-implemented trails that account for spatial variability across paddocks including a pre-commercial, semi-autonomous trial analysis tool.

The Geographically Weighted Regression (GWR) analysis method (Evanset.al.,2020) was tested in more than 50 farmer-led, paddock-scale trials with CSBP fertiliser, WANTFA, Gillami Centre, MADFIG, DPIRD and others using a co-innovation model with farmers, agronomists and researchers. The best results were achieved where research questions were clear and developed by the whole team, paddock history was collected as early as possible and taken into account as part of the design, analysis and interpretation of the results. Multiple engagements with the trial throughout the season by the team ensured continued investment in the outcome and supported the interpretation of results. Results from a series of trials conducted at Nokaning WA over three years provided an excellent case study of the process and analysis of paddock scale, on farm experiments. Running fertiliser strips through management zones combined with GWR analysis informed tactical and seasonal management decisions. Incorporating analysis of return on investment (i.e., fertiliser costs) and predictions of yield if the treatment was applied to the entire paddock enabled the potential to extrapolate findings from the trial area to larger areas of the farm. In partnership with NGIS Australia, the On Farm Experimentation analysis tool, developed in R by the research team has been translated to Earth Engine for a commercial market.

The key to success in the project was bringing together the farmer, grower group, researcher and agronomists. Together, the team was able to understand the problem, design the research questions and translate the research findings into data-driven decision making, giving more confidence to those gut-instinct and observational learnings and subsequent decisions that growers inherently make. This shared learning has been highly valuable across the project team and improved the adoptability of the methodology and technology.

References

On-farm experimentation – developing robust analysis for paddock scale trials

Julia Easton[1], Luke Dawson[2], Nathan Eaton[3], Fiona Evans[4], Angela Recalde-Salas[5], Danielle Gale[5], Stan Mastrantonis[5], Art Diggle[6], Tanya Kilminster[7], Mark Gibberd[1]

[1]Curtin University; [2]CSBP Fertiliser; [3]NGIS; [4]Murdoch University; [5]Curtin University; [6]DPIRD; [7]Grower Group Alliance

Further information

Evans, FH, Recalde Salas, A, Rakshit S., Scanlan, CA and Cook, SE. Agronomy 2020, 10(11), 1720. https://doi.org/10.3390/agronomy10111720

Day 6 – Thursday 10 March

■ Pulses

Faba bean agronomy

Mark Seymour, Department of Primary Industries and Regional Development

Mark started working for DPIRD, with Wal Anderson on wheat agronomy project as a technician, based in South Perth during 1987. In 1988 he moved to Esperance to work on lupin which expanded into working on all the other grain legumes — in particular, field pea. During 2010 Mark switched to the dark side and worked on canola, helping to support the industry as it expanded into lower rainfall regions. He is currently back working mostly on pulse helping to support pulse breeders in their early generation testing of lentil, field pea, faba bean and chickpea.

Mark is the project leader of GRDC/DPIRD's co-investment 'High Value Pulses – Raising awareness, optimising yield and expanding the area of lentil, chickpea and faba bean in WA'.

Summary

Key points include:

- Foliar fungicide application on WA faba bean crops can be safely delayed until flowering begins, even if chocolate spot is present at low levels earlier in the season.
- An alert system using in-crop monitors is being developed which may provide increased confidence in making fungicide application decisions – supporting the decision not to spray.
- In high rainfall/risk areas the 'alert' system may need modification to take into account extended periods of very high humidity and 'discounting' temperature.
- PBA Bendoc is rated 'S' for chocolate spot and may not be the best variety in high rainfall/high humidity regions. PBA Amberley would be a better choice.

The aim of the project was to demonstrate the effectiveness of different fungicide timing options on chocolate spot management and evaluate a new spray decision support tool.

In a field experiment at Kojonup where we evaluated four fungicide strategies — Nil fungicides, recommended procedure (two sprays, from flowering onwards), Regular spray (four sprays, from early July onwards) and spray based on an Alert system (one spray based off humidity/temperature sensor).

Chocolate spot remained at very low levels until late-August, when an increase in disease incidence and severity was noted to have occurred over a two-week period. By that time the regular spray treatment had received three foliar fungicides, the recommended procedure (flowering onwards) had received one foliar fungicide and the other treatments had not been sprayed.

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Red alerts, following 12-hour periods of exceeding the threshold temperature (15°C) and humidity (>95%), were received on the 10th and 11th September and the alert treatment was sprayed with a fungicide on 14th September. Four weeks later the final disease rating of the season was performed on 18 October. Disease levels had increased markedly by this time across all treatments. The regular spray plots had significantly less disease than the alert treatment, and the recommended procedure (flowering onwards) was in between. The regular spray plots showed discrete lesions on leaves compared to the nil plots which had larger lesions and defoliation of some plants.

Yield across this trial averaged 1.6t/ha, which was quite good considering disease severity was quite significant by the end of the season. There was a clear yield advantage when using any of the foliar fungicide strategies compared to nil fungicide. The alert treatments yielded almost double the nil fungicide treatment. This shows the impact that one, strategically timed, fungicide application can have in a faba bean crop.

From early-July through until the end of August long periods of relative humidity higher than 100% within the crop canopy were measured. During periods of such high humidity the botrytis fungus can release spores at low temperatures, although it will occur more slowly than it would at the ideal temperature of 15–25°C. Thus, weather conditions in 2021 were ideal for the development of chocolate spot even without reaching the 15–25° temperature range to trigger the alert system. This can help explain why more alerts from the system being tested were not received and hence, why disease in the alert plots was not as well controlled and yield not as high as the plots that received regular foliar fungicides in 2021. The alert system is still being developed and appropriate parameters refined. Based on our results in WA in 2021 and from other states where very high humidity over long periods of time has led to high disease levels at lower temperatures than expected, modifications to the alert system will be made by SARDI. There is confidence that these modifications will enable alerts to successfully guide spray decisions even in seasons of unusually high rainfall and humidity such as 2021.

It is also reassuring to note that, although the regular spray treatment had lower disease severity than the WA recommended practice treatment did early in the season, by the end of the season the disease severity and seed yield between these two treatments was the same. This reaffirms our recommended practice for WA faba bean crops to begin receiving foliar fungicide applications from flowering onwards and that fungicides applied earlier than this may be unnecessary in this environment.

Interestingly the NVT Faba bean experiment was in the same paddock, and it received two early fungicide sprays in June and a well-timed Aviator Xpro spray in late August. In the NVT experiment PBA Bendoc produced a yield of 1.9t/ha whilst PBA Amberley with a resistance rating to chocolate spot of MSMR produced 3.1t/ha, indicating in this high-risk area PBA Amberley would be a wise choice.

Reference

Faba bean agronomy update — chocolate spot management in faba beans at Kojonup in 2021

Mark Seymour and Stacey Power, DPIRD

Double break crop sequences with high value legumes: awesome when it rains!

Nathan Craig, West Midlands Group

Nathan completed a PhD during 2016 on the organic matter and nitrogen dynamics of crop rotations under no-tillage at UWA. Prior to this, Nathan completed a Degree in Agriculture at the University of Adelaide, South Australia in 2000.

Nathan has been in the role of Executive Officer at West Midlands Group since December 2017 and is responsible for overseeing the delivery of an innovative research, demonstration, and extension program across the West Midlands region of WA. Nathan has been self-employed for most of his career, spending seven years managing the family mixed-farming operation in Victoria through a time now fondly referred to as the 'millennium drought'. Nathan also established Zero Till Farm Services, a disc seeding services and agronomic consultancy business based in the Southeast of South Australia.

Summary

Key points include:

- Grain yield of chickpea following canola ranged between 0.2–4.4t/ha across two contrasting rainfall seasons.
- Early emergence of chickpea in mid-April was an effective strategy to increase grain yield and led to an increase in grain yield ranging from 0% to 285% depending on season and site location.
- Focus on a well-planned agronomy package to ensure the best chance of maximising profitability with chickpea in any season.

This project evaluated the profitability of a double break crop rotation during the 2020 and 2021 seasons across the Wheatbelt of WA. The aim was to demonstrate that a double break crop rotation where a high value legume (chickpea) following canola can provide effective weed control and an increase in soil nitrogen, while also being highly profitable. The importance of early seeding (mid-April) versus late seeding (mid-May) was also evaluated as a tool to increase grain yield across six sites in the Wheatbelt of WA.

This study was conducted across two polar opposite years for grain production where 2020 was a well below-average rainfall year and 2021 was an above-average year. In addition, the development of the agronomy package during this study provides an excellent contrast of what happens when: a) when you get everything right (and wrong), and b) the potential of chickpea in an above-average and below-average season.

Stored soil moisture was patchy across all sites during the 2020 season, and this affected the early establishment of chickpea and increased the presence of weeds at each site. Chickpea growth was also impacted by the following agronomic reasons: poor weed control from a base-level herbicide package (compounded by poor crop establishment), and sub-soil acidity. Grain yield for the 2020 season ranged between 0.6 to 1.5t/ha for chickpea sown in mid-April and 0.2 to 1.5t/ha for chickpea sown in mid-May.

Learning from our experience in 2021, the following agronomic changes were made in 2021: a well-planned herbicide, insecticide, and fungicide package, change of variety to CBA Captain (from PBA Striker), and selection of sites that had stored subsoil moisture and absence of soil acidity. Chickpea growth and weed control was excellent, and grain yield ranged between 2.5 to 4.4t/ha for sites sown in mid-April and 1.15 to 2.5t/ha for chickpea sown in mid-May. A key tool in achieving high grain yield was the early emergence of chickpea in mid-April sowing window and this was easily achieved in the 2021 season where there was stored soil moisture, and some April rainfall events.

The project found that there is significant potential to increase the productivity and profitability of break crop rotations using early-sown chickpea across the Wheatbelt. The success of this approach relies on stored soil moisture (without subsoil constraints) or early rainfall to provide timely emergence, and a well-planned agronomy package to ensure that weeds, insects, and disease are adequately controlled in each season.

Understanding and managing sclerotinia in lupins

Ciara Beard, Department of Primary Industries and Regional Development, and **Pippa Michael,** Curtin University

Ciara Beard, DPIRD

Ciara has spent more than 20 years working on research and extension in broadacre crop pathology with DPIRD. From her start in cereal diseases where she was mentored by Rob Loughman, to canola sclerotinia research, and now sclerotinia in lupins, Ciara is an experienced and respected researcher in the Geraldton port zone. She is passionate about conducting field research and sharing the results and new strategies with the grains industry to minimise losses to crop diseases. Ciara has played a key role in several state and national crop disease projects which have delivered significant disease management packages and tools to the grains industry. Ciara is currently leading the project 'Sclerotinia management for narrow leaf lupin crops in WA farming systems' (DAW2104-002RTX) funded by GRDC it is a collaboration between DPIRD, CCDM and the Mingenew Irwin Group with WA lupin growers.

Pippa Michael, Curtin University

Pippa has conducted pest management research in WA farming systems since 2003, focusing initially on weed ecology and management before moving to plant pathology during 2016. She has been involved with several successful GRDC, RIRDC (now AgriFutures Australia) and DAFF-funded projects in collaboration with CSIRO, DPIRD, AHRI and UA, both as a project leader and team member. Currently she is a Research Fellow within the CCDM project 'Agronomy and management solutions to sclerotinia stem rot (SSR) of canola and pulses' which uses field, glasshouse and laboratory-based research to improve knowledge of the disease, understand triggers for infection and its ecological adaptation in Australia. This project has delivered several notable research outcomes to date such as understanding the germination and conditioning requirements of sclerotia populations in WA and screening canola varieties for SSR susceptibility.

Summary

Key points include:

- SSR is a damaging and increasingly prevalent disease in lupins, with disease risk higher in high density crops grown in paddocks with a previous history of SSR and a loamy soil type, that achieve early canopy closure and have good yield potential.
- During 2021, SSR was widespread in northern and central WA lupin crops, both in the canopy and at ground level (basal), thought to be promoted by wetter than average conditions and wet soil profiles in early winter combined with mild temperatures. In field trials, several foliar fungicide treatments applied during or at end of crop flowering, reduced canopy infection but did not significantly reduce basal infection. Yield responses were variable but more likely if fungicide application preceded or coincided with weather conditions that promoted canopy infection.
- Lupin varieties Jurien, Barlock and Amira differ in their susceptibility to diverse WA sclerotinia isolates as measured by yield, lesion length and sclerotia production.

(Continued on following page...)

A four-year GRDC funded project investigating SSR (caused by Sclerotinia sclerotiorum) in broadacre lupin crops (narrowleaf and albus) commenced during 2021, a collaboration between DPIRD, CCDM and MIG with support from the WA lupin industry. It aims to understand the SSR disease infection process, yield/grain quality impacts and effective management strategies, and includes research focussing on basal (sclerotia myceliogenically germinate directly infecting plants at ground level) and canopy infection (sclerotia carpogenically germinate, releasing ascospores that infect petals and crop canopy).

This presentation will cover field trials, large-scale grower trials, glasshouse experiments and surveys of commercial lupin crops conducted in 2021 in order to understand: how SSR development is affected by weather conditions, SSR paddock history, time of sowing, lupin variety and fungicide timing; aggressiveness of WA sclerotinia isolates on commercial varieties; environmental triggers for myceliogenic germination of sclerotia leading to basal stem infection; distribution, incidence and yield/ quality impacts of sclerotinia in lupin crops surveyed in the Geraldton and Albany port zones. Surveys of 22 lupin crops in the Geraldton port zone (GPZ) found 21 had canopy SSR infection and 20 had basal infection. Yield increases of 4–23% were found in five out of seven trials from a single fungicide application. The disease has been observed to predominantly cause yield loss by affecting pod production on the main spike. Development of SSR was too slow or late in cooler southern regions to significantly respond to fungicide application or to impact yield in 2021.

The project found that SSR in lupins is dependent on favourable rainfall and temperature conditions for disease development, persistence and spread. Incidence of both basal and canopy infection in lupins was very high in the GPZ and parts of Kwinana north port zone in 2021, where dense crops with early canopy cover combined with on-going rainfall and mild temperatures (15–25°C) through winter favoured disease development and spread. Damaging disease levels of SSR in lupin are hard to predict, making decisions on value of management in each cropping situation challenging. Instead of disease management aiming solely for a yield response, there may be other benefits such as for grain quality and reducing sclerotia production, which could reduce both need to grade seed and future infection risk of canola and pulse crops. Thank you to DPIRD Geraldton research support unit, the significant contributions of growers through both trial cooperation and GRDC investment (DAW2104-002RTX).

Reference

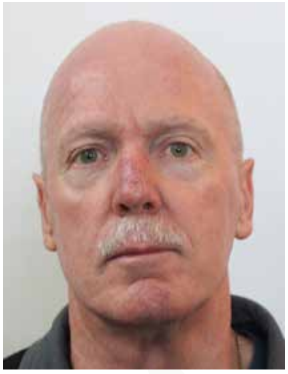
Understanding and managing sclerotinia in lupins

Ciara Beard[1], Geoff Thomas[1], Anne Smith[1], Laurie Wahlsten[1], Michelle Sampson[1], Pippa Michael[2], Rachel Crockett[2], Sarita Bennett[2], Ashmita Rijal Lamichhane[2], Lars Kamphuis[2] , Tiarna Kanny[3]

[1]DPIRD; [2]CCDM; [3]Mingenew Irwin Group

Recent and impending changes to chemical MRL's in markets

Gerard McMullen, National Working Party on Grain Protection



Gerard is the Director of McMullen Consulting, which began operations during 2005. Gerard has worked in the grain industry for 37 years. He initially worked for the Australia Wheat Board for 20 years and held a number of roles including field operations and as Manager of the Quality Assurance and Food Safety Division.

He is currently the Project Manager for Grain Quality in Grain Trade Australia responsible for providing advice and training on grain trading standards and on market quarantine and food safety requirements.

Gerard is Chair of the National Working Party on Grain Protection, responsible for providing information to industry in the areas of post-harvest grain storage and hygiene, chemical use, outturn tolerances, international and domestic market requirements and chemical regulations. His business also offers consultancy services to the grain industry on aspects relating to grain quality, food safety, market requirements and identity preservation.

Summary

It is a legal requirement to follow all label directions when applying any crop protection chemical.

There is a need for all in the industry to understand the risks of residues arising from chemical use and the impact on market acceptance.

Each export and the Australian domestic market have their own chemical legislation and corresponding maximum residue limits (MRLs). These MRLs apply to each chemical and to a specific grain commodity. Markets continually review and where necessary change these MRLs on varying occasions. The result is that different MRLs for the same chemical and commodity may exist in key markets for Western Australian grain.

Chemicals may give rise to residues on the harvested commodity. Chemicals that can legally be used in WA may not be permitted in some markets or because of those residues, exceed those market MRLs placing the marketing of that grain into that country at risk.

To understand the market access implications when using chemicals, various recent and impending changes to MRLs will be provided in key WA markets. This information will assist growers and their advisors to be better prepared when developing systems to managing a range of pests such as insects and weeds when growing the 2022/23 crop.

Further information

https://www.graintrade.org.au/nwpgp

Papers submitted and not presented for the Perth Update

For the 2022 Grains Research Updates events, not all papers could be accommodated to present at the Perth Update. All papers provided will be uploaded to the GRDC website at https://grdc.com.au/resources-and-publications/grdc-update-papers when they are supplied and approved for public access.

Sessions are being recorded and will be made available on the GRDC website following the event. You will receive a link by email to access these.

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