Grains Convo

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Contents

Research aims to boost oat resistance against Septoria blotch in Western Australia

Project name

Mapping of Septoria isolates and oat genetic response to improve genetic solutions to Septoria management in oats in WA

Understanding Septoria blotch

Septoria blotch caused by Parastagonospora avenae (P. avenae) is a significant oat disease especially in Western Australia (WA) where almost all oat crops have some level of Septoria infection.

It can cause oat yields to drop by around 15 per cent, causing significant financial loss for farmers, especially in high rainfall areas.

The Septoria pathogen population is diverse, making breeding for durable resistance difficult.

To date, little work has been undertaken to identify and characterise genetic sources of resistance to Septoria.

With help from the Processed Oat Industry Growth Partnership, the Department of Primary Industries and Regional Development (DPIRD) is aiming to investigate variation in virulence of P. avenae isolates across regional sites of WA in response to key breeding lines and commercial varieties.

As well as to identify novel sources of Septoria blotch resistance and provide breeders with resistant germplasm and selection tools to breed varieties with durable resistance.

Unlocking the enemy

It's hoped by 2025, researchers will have a better grasp of Septoria blotch in WA, studying how it varies in different oat-growing areas and in response to various oat types.

Oat breeders will get access to new sources and tools for Septoria blotch resistance.

This will help them create oat varieties that match specific environments and resist the disease.

By 2035, it's hoped WA growers to have oats with increased resistance to Septoria blotch.

These oats will be tailored for different oat production regions, minimising the damage caused by the disease.

Pathway to the WA oat industry

WA oat breeders will stand to benefit immediately from the project outputs, leveraging them to develop new commercial oat varieties fortified with enhanced resistance against Septoria.

The aligned products cater to breeder needs, ensuring high adoption and utilisation probability, thereby aiding in the creation of oat varieties with heightened Septoria resistance for specific cropping environments.

The key products include:

Pathogen Virulence: Furnishing information on the variation in virulence of P. avenae isolates across diverse sites in regional Western Australia, in response to essential breeding lines and commercial varieties.

Germplasm: Providing germplasm from both national and international sources with novel Septoria blotch resistance, facilitating the development of pre-breeding and breeding strategies for the simultaneous integration of resistance in inbred lines and cultivar development.

New resistant sources will be distributed to oat breeders over the project's 3-year duration.

Screening Methods: Developing rapid, efficient, and cost-effective field and controlled environment disease screening techniques.

These techniques will employ the most recent fungal isolates to evaluate the expression of resistance in breeding lines within relevant environments.

Genetic Resources: The mapping of QTL/genes and understanding gene-environment interactions will enhance comprehension of the genetic architecture of disease resistance.

Genes and QTL discovered may be valuable in genomic selection for resistance.

In addition, the sequence and structural information of oat resistance genes will aid in understanding gene function and support the deployment of resistance genes in oat breeding programs.

As part of the project, a selection of 500 oat accessions will be made based on their response to Septoria blotch at both the seedling and adult plant stages in field sites at Manjimup and Dale.

This aims to identify germplasm with consistent Septoria blotch resistance across various growth stages, environments, and years, potentially serving as resistance donor parents in germplasm development and breeding.

Additionally, the project seeks to establish a panel of oat accessions, showcasing diversity in Septoria blotch resistance expression for genomic modelling and new QTL discovery.

This genomic work will be conducted on a platform directly linked to or the same as that used by the breeding program, ensuring a seamless translation of research outcomes to the market.

Funding partners/project collaborators

Processed Oat Partnership (POP)
InterGrain's Oat Breeding Program
Western Crop Genetic Alliance

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In-field sampling of wheat tissue for metabolites to uncover reduced susceptibility in wheat to frost damage (Source Brenton Leske, DPIRD)

In-field sampling of wheat tissue for metabolites to uncover reduced susceptibility in wheat to frost damage (Source Brenton Leske, DPIRD)

Strengthening wheat crops against frost

Project name

Developing metabolite and lipid biomarkers to select for reduced frost sensitivity in wheat

GRDC code

CSP2310-008RTX

Boosting wheat profits

In Australia, frost is a major threat to wheat crops, especially during spring.

Frost can harm the formation and development of grains, leading to lower yields and lower profits for farmers.
Reducing sensitivity to frost is crucial to ensuring the viability of growing grain crops in regions that experience frost damage.

Even a small improvement, such as making wheat less sensitive to frost during flowering by one-degree Celsius, could bring an extra 360 million to wheat farmers every year.

This project, with support from the Grains Research and Development Corporation (GRDC) seeks to validate whether certain plant protective mechanisms or compounds can help it withstand frost better.

The results will establish whether the manipulation of these traits represents a feasible route that wheat breeders could take to improve crop yields in frost-prone cropping environments.

Australian breeders set to benefit

By 2027, researchers are set to get an understanding of how wheat traits impact frost sensitivity in both controlled environments and real fields.

This information will be shared with Australian wheat breeding companies.
The main outcome, by 2028, is for wheat breeders in Australia to have tools to create wheat varieties that can better withstand frost.

Field experiments

The project involves several modules and activities over multiple years.

Module 1: Germplasm Selection

Over the first year of the project, the team will assemble a panel of around 400 wheat lines with known or potential variations in frost tolerance and include lines from past studies and diversity panels.

Then, wheat spikes from field grown plants will be assessed for non-invasive digital phenotyping of spikelet and grain mapping using the APPF CT scanner.

Module 2: Identification of Lines with Reduced Frost Sensitivity
Field experiments in different locations will be conducted over the next 3-years, to observe performance of selected lines.

These will occur in conjunction with controlled environments testing.

Module 3: Metabolite and Lipid Analysis
Researchers will analyse metabolites and lipids in wheat leaves to understand how they respond to frost and use advanced methods such as mass spectrometry for detailed analysis.

Module 4: Selection Tool Development
From there, tools will be developed for selecting frost-resistant wheat based on hyperspectral technology and genetic markers.

Leaf reflectance measurements will be used to predict genetic variations in metabolites and lipids associated with frost tolerance.

Module 5: Data Infrastructure
The research team will establish a data storage system for handling large amounts of genetic and phenotypic data and make use of high-performance computing for data processing.

DPIRD Research Scientist Dr Brenton Leske will manage the site at Dale in WA.
The other locations selected for field experiments include Mintaro in South Australia and Wagga Wagga in New South Wales.

Partners/Collaborators

GRDC
CSIRO
Charles Sturt University
South Australian Research and Development Institute (SARDI)
Agriculture Victoria
LaTrobe University
University of Western Australia Australian Grain Technologies (AGT)
Analytics for the Australian Grains Industry (AAGI)

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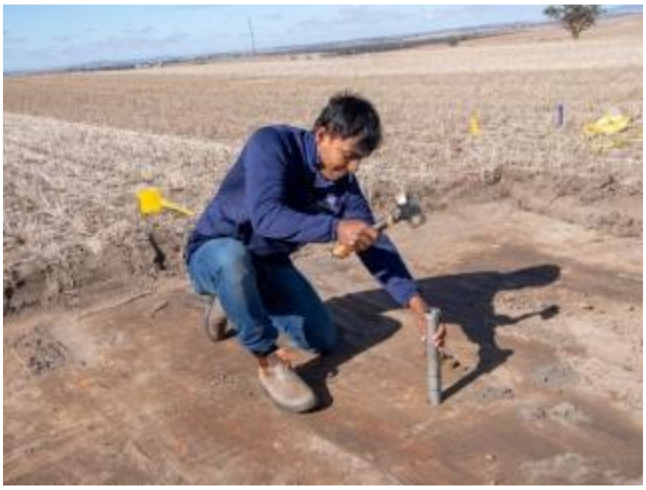

Dr Gaus Azam

Transforming soil for enhanced crop vitality

Project name

Re-engineering soils to improve the access of crop root systems to water and nutrients stored in the subsoil

GRDC code

DAW1902-003RTX

Crop yield breakthroughs at the forefront

The Department of Primary Industries (DPIRD) with support from the Grains Research and Development Corporation (GRDC), is currently entering the concluding phase of a comprehensive 5-year project.

The overarching goal is to re-define the water-limited upper limit for crop grain yield in rain-fed dryland agricultural environments.

This is being accomplished through a strategic approach, addressing multiple soil constraints, and ultimately leading to a substantial boost in grain yields.

Commencing in 2019, DPIRD researchers have been actively engaged in reengineering soil profiles on a considerable scale.

The focus extends to 80cm depth, encompassing diverse constraints, such as compaction, water repellence, acidity, alkalinity, sodicity and water holding capacity associated with both sandy and clay soils.

The central objective is to establish new benchmarks in yield for various crops, especially wheat, barley and canola.

This is achieved through the enhancement of crop root access to deeper soil, ensuring improved availability of moisture and essential nutrients.

Revitalising WA's arable land

Spanning over 12 million hectares of arable land in the south-west of Western Australia, the project targets a range of soil types, including deep sand, texture-contrast soil (duplex), and heavy sodic and boron-toxic soil.

This region often grapples with subsoil compaction, subsoil acidity, sodicity, elemental toxicity (e.g. aluminium and boron) and water repellence.

Experiments at a glance

Researchers have established a total of 11 soil profile re-engineering experimental sites at Bonnie Rock, Salmon Gums, Holt Rock, Carnamah, Toolbrunup, Bolgart, Northampton, Meckering, York, Tarin Rock, and Kojaneerup.

In this project, the team has also conducted a series of 80-centimetre-deep soil column experiments in a controlled environment to determine optimum soil packing density, rates of soil amelioration and inorganic nutrients to improve the learnings from the field experiments.

These sites are equipped with advanced soil moisture probes allowing real-time tracking of soil water, and root architecture monitoring devices to observe crop root development.

Significant outcomes have been achieved at specific trial sites, showcasing notable improvements in wheat, barley and canola yields compared to the average paddock yields. Incorporating clay, lime, and nutrient additions have proven successful in these cases.

Sandy soil

For example, sites prepared on sandplain country at Bolgart and Northampton were excavated to a depth of 80-centimetres, and clay was incorporated to improve water holding capacity. Lime, compost, and inorganic nutrients were also applied.

At the Northampton site in 2021, the wheat yield in the best treatment was 3.3 tonnes per hectare, well above the paddock average of 0.97t/ha. In 2022, the wheat crop yielded 3.8t/ha which is more than double the paddock average of 1.5t/ha.

In 2021 at the Bolgart site, the wheat crop had poor establishment and did not respond well. While in the 2022 season, the canola crop yielded 2.8t/ha compared to the paddock average of only 0.6t/ha.

Texture contrast soil

Loamy duplex soils were examined in four field experiments conducted near Meckering, York, Tarin Rock, and Kojaneerup.

These sites, excavated to a depth of 80cm, underwent various amelioration treatments. At the Meckering location during the 2021 season, the canola crop exhibited a remarkable yield of 3.1t/ha, compared to the paddock average of 1.4t/ha.

Subsequently, in the 2022 season, the barley crop yielded 6.3t/ha, compared to the paddock average of 3.5t/ha.

Moving east of York, the wheat crop at the trial site yielded 5.1t/ha in 2021, outperforming the paddock average of 3.5t/ha.

In the following year, the canola crop at the same site achieved a yield of 3.7t/ha, significantly exceeding the paddock average of 3.0t/ha, even in a record-setting season. At the Tarin Rock trial site in 2021, the barley crop yielded 4.1t/ha, a notable increase from the paddock average of 1.4t/ha.

However, in 2022, the canola crop experienced severe hail damage just before harvest.

Looking to the future

The project team is currently working on the data from the 2023 season, which was extremely dry, especially the latter half of the season.

Beyond immediate yield gains, the project will redefine the upper limits of crop yield potential in water-limited, dryland agricultural environments in Western Australia.

The overarching objective for researchers, is to develop enduring and profitable strategies for growers to be able to effectively manage soil constraints.

Funding partners / project collaborators

Grains Research and Development Cooperation

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DPIRD technical officer Simon Rogers (left) and Murdoch University researcher Dr Sanjiv Gupta compare the performance of two barley lines with different disease resistance gene combinations

Defeating BYDV: Innovating barley varieties for crop resilience

Project name

BYDV screening of NVT lines at Manjimup

GRDC Code

WAA1905-001SAX

Advancing barley varieties for resilience

Every year Barley Yellow Dwarf Virus (BYDV) causes significant losses in cereal crops in the south coastal region of Western Australia (WA), mainly barley, wheat, rye, oat and maize.

Symptoms mainly appear as yellowing/reddening of leaves and cause many agronomical, biochemical, physiological, and ultrastructural changes.

These losses have been known to occur in high rainfall wheatbelt areas of WA.

Although field management practices, such as modifying the sowing date to avoid diseases and applying insecticides to control aphid populations are effective in limiting the spread of these issues, breeding and growing resistant varieties remain the most promising environment-friendly and economic approach to address the challenge.

The project develops information to determine the response of lines in the National Variety Trial (NVT) program to BYDV in high-risk zone and identify resistance genes effective against this disease.

This knowledge for immediate use by growers is the ranking of current barley varieties for resistance (tolerance) to BYDV.
This data is routinely presented in variety sowing guides, to help farmers to make informed choices for the varieties they grow.

Assessing BYDV tolerance in different locations

This trial began in May 2023, comprising of test lines and buffers.
Entries were randomised with a row-column design using 2 plots per row and there were 160 plots in total.

The trial has been hand planted, while a cone seeder run of Dalyup oats is to act as an infection source.

Each plot has a strip of oats along one of its sides.

Replicates will be split into 2 "blocks" (with runs of oats) in between the blocks.
Both plot lengths and pathway include space for an oat buffer on either side.

In this study, two locations were looked at, each differing in field climate and aphid prevalence to achieve a more reliable assessment of BYDV tolerance.

Although the plants in Tasmanian trials were artificially inoculated, higher degree of disease severity and disease incidence was observed in Western Australia.

An increased number of aphids was associated with higher rate of infection.

Additional experiments

Apart from BYDV screening in the NVT program, a research study was undertaken in collaboration with Tasmanian Institute of Agriculture Research.

Australian varieties have been classified into intermediate to susceptible categories to BYDV in the NVT program. No variety is classified as resistant.

In a separate study, the parental varieties showed moderate levels of resistance to BYDV.
The frequency distribution of BYDV symptoms scored based on leaf yellowing showed that the phenotype in the WA trials basically followed nearly normal distribution.

The population sown in WA developed more severe symptoms overall than other national trials, including in Tasmania.

Both genotype and environment (sowing time and location) showed significant effects on symptom scores for the Double Haploid lines with the effect of genotype being more significant than environment.

The major pre-breeding outputs include mapping of resistance genes (3H, 5H and 7H), these are currently being utilised in breeding programs across Australia.

Funding partners / project collaborators

Grains Research and Development Corporation (GRDC) NVT trials

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Sue Broughton, Dr Marieclaire Castello, Julie Killen, Li Li, Chris McMullan and Salzar RahmanBelow: Dr Diem Ly, Kim Tanlamai and Simone Wells

Meet the Double Haploid team

Meet the Genetic Resources team in the Genetic Improvement Portfolio

Headed by Senior Research Scientist, Sue Broughton, this group of dedicated Genetic Resources staff support the Germplasm Repository and the Department of Primary Industries and Regional Development (DPIRD) Cereal Doubled Haploid Program.

Newest team member is Salzar Rahman, who joined the Germplasm Repository project as a Research Scientist in June 2023, with support from casual Technical Officer Kim Tanlamai.

The Germplasm Repository project was developed in response to the 2020-25 Strategic Plan of the Genetic Improvement portfolio where the team identified there were significant genetic resources (seed lines) in the portfolio that were not centrally documented or stored in ideal conditions.

Plant genetic resources are the foundation of crop improvement and vital for pre-breeding research, plant breeding and food security.
DPIRD's Genetic Improvement Portfolio has developed and acquired important germplasm of crops such as wheat, barley, oats, and lupins, comprising thousands of lines.

These genetic resources are a vital resource for current and future projects.

The project also has the capacity to develop new high priority research populations that will address future research targets and gain leverage in funding applications.

Some highlights of the project to date include the purchase of cloud-based plant breeding/germplasm software called BMS-Pro, the installation of environmental monitoring (temperature and humidity) via a LoWaRAN system in five cool rooms used by the Genetic Improvement Portfolio, crossing and the development of new crossbreds and doubled haploid populations for several DPIRD projects, and the development of a protocol for germplasm storage (with thanks to Daniel Taylor, DPIRD intellectual property officer and their team).

The Cereal Doubled Haploid Program has a longer history, originally supporting the department's barley and wheat breeding efforts, when breeding programs were part of the department.

Following the privatization of Australian cereal breeding programs (~ 2010-2011), the program continued to provide doubled haploid (DH) lines to plant breeding companies and researchers across Australia.

Doubled haploid production is an important tool for rapidly generating fixed lines and can save time in variety development.

At DPIRD, researchers have developed culture protocols where immature pollen cells (haploid microspores) are diverted from their normal developmental pathway to one of embryogenesis and haploid plant development.

Following a chromosome-doubling step, the resulting doubled haploid or 'DH' plants are fully fertile and 100% homozygous (fixed or true breeding) at all loci and are valuable tools for breeding, genetic research, and gene mapping.

As with many plant tissue culture protocols, success rates vary widely between different genotypes.

It is an ongoing challenge to produce the required number of DH lines from the wide variety of genotypes we handle.

Currently, there are four permanent staff working on the program including Research Scientist Dr Marieclaire Castello, Senior Technical Officers Li Liu and Julie Killen, and Technical Officer Chris McMullan.

Additional staff are recruited for the peak production period between January and June each year with assistance from short term/casual Technical Officers Simone Wells (2022-2024), Dr Diem Ly and Christine Munday (2023).

The program currently produces ~ 15,000 wheat and barley DH lines annually.

Breeding companies are the team’s largest clients and provide the foundation of support that allows the program to develop important populations for researchers at DPIRD, Murdoch University (including the Western Crop Genetics Alliance or WCGA), Curtin University and other Australian institutions.

For example, the DH team have developed over 47,000 barley DH lines (over 300 populations) which have been extensively utilised by researchers at DPIRD and the WCGA in genetic and gene mapping studies.

The DH team have also developed over 3,200 wheat DH lines (14 populations) for DPIRD researcher, Dr Manisha Shankar, and her team, which have been used to study the genetic control of important wheat diseases in WA including yellow spot, nodorum blotch and powdery mildew.

In addition to wheat and barley DH production, we have also been able to support DPIRD researchers with some specialist DH production.

In 2021/22 we produced over 400 canola DH lines for Dr Ben Congdon.

Ben required DH populations of Brassica napus to fast track the development of pure-breeding lines with resistance to Turnip Yellows Virus (TuYV) for prebreeding and genetic mapping.

He made crosses between disease resistance and susceptible Brassica napus varieties/lines and we developed a series of DH populations from these crosses. Resistant lines have been identified in glasshouse trials and Ben is planning to confirm this data with field experiments.

2023 also saw the release of several cereal varieties that were developed through the DH Program.

In June 2023, the barley variety ‘Neo’ was released by InterGrain.
In September 2023, two wheat varieties, ‘LongReach Tracer’ and LongReach Major’, were released by LongReach Plant Breeders.

Genetic resources – underpinning grains research and development.

Industry News from the Australian Export Grains Innovation Centre

No one does it alone

Strengthening equality, diversity and inclusion within the grains industry and in particular encouraging women into the fields of science and R&D not only enables organisations to reach their full potential, but will help deliver the innovation the world needs to meet the most significant challenges we face today.

In recognition and celebration of the United Nations International Day of Women and Girls in Science (11 February) AEGIC's Executive General Manager Courtney Draper will host a panel of highly respected industry leaders to discuss the topic of equality, diversity and inclusion within the grains industry. With Heather Brayford, DPIRD Director General being a featured panellist.

7.15am, Tuesday 27 February 2024, Perth Convention Centre

https://events.humanitix.com/2024-giwa-breakfast
