SUPPORTING LONG-TERM CONTROL OF CEREAL RUSTS

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Investment in cereal rust research saves Australian wheat and barley growers an estimated $34.7 million in lost production annually.

The challenge

Three wheat rust diseases are prevalent in Australia – stripe, stem and leaf rust – and all are highly infective diseases that can spread widely and quickly within and between regions.

In Australian growing conditions, stem rust can cause total crop failure and stripe rust infection can cause up to 50 per cent losses.

By comparison, in-crop losses due to leaf rust tend to be lower with one Australian study documenting 30 per cent yield losses. However, leaf rust is considered to be more damaging than the other rusts because it can develop under a wider range of environmental conditions and is therefore more widespread.

Fortunately, rust epidemics have largely been kept in check over the past 40 years through the selection and cultivation of varieties with adequate rust resistance.

However, the Australian cereal industry cannot afford to rest on its laurels as rust pathogens are highly adaptable and can mutate into new strains which attack previously resistant varieties.

This progression is often rapid, with varieties succumbing to new rust strains within three to five years.

While foliar fungicides can provide some in-crop rust protection, inoculum build up in self-sown volunteer wheat plants and rust susceptible grasses during the non-cropping phase and/or wet spring weather can result in explosive, devastating rust outbreaks. Therefore, on-going genetic advancement offers growers the most effective long-term solution to rust management.

The response

Over the years, the GRDC has invested in collaborative national and international projects which have helped to deliver superior rust resistant wheat and barley varieties to Australian growers. The overarching program is known as the Australian Cereal Rust Control Program (ACRCP), which monitors Australian cereal rust pathogens, finds and understands new sources of rust resistance, assists in the development of rust resistant cultivars, and contributes to the post-release management of cereal varieties.

These investments have provided Australian wheat and barley breeders with improved access to international pools of genetic material and data for use in the breeding of locally-adapted new varieties with improved grain yield performance, stress tolerance and resistance to rusts and other important diseases in Australia.

They include contributing to the Mexico-based global non-profit agricultural research and training institution, the International Maize and Wheat Improvement Centre (CIMMYT) which operates a comprehensive wheat research program.

The ACRCP draws together expertise and resources from the University of Sydney Plant Breeding Institute at Cobbitty (PBIC), the CSIRO Division of Plant Industry in Canberra, and The University of Adelaide and has focussed on:

- monitoring and producing information on cereal rust pathogens throughout Australia
- identifying and characterising new sources of rust resistance in cereals; and
- assisting Australian cereal breeders to incorporate rust resistance into new cultivars.

The current program builds on the enormous body of research undertaken since 1921 when Professor W. L. Waterhouse in the University of Sydney's Faculty of Agriculture initiated studies into cereal rust pathogen variability, host resistance, and resistance breeding.

Much of the national knowledge about rust variability and genetic resistance sat within the University's breeding program until the formation of a nationally coordinated strategy known as the National Wheat Rust Control Program following the 1973 rust epidemic in southern Australia.

Over time, the National Wheat Rust Control Program evolved into today's ACRCP.

The impact

Long term investment in cereal rust research has delivered significant productivity and profitability gains to Australian cereal growers through improved genetic resistance, disease monitoring and management.

Cost benefit analysis figures generated by the GRDC suggest investment across the suite of cereal rust research projects will return $5.70 for every $1 spent over the next 25 years.

GRDC has had investment in rust programs for many years. The research has been working on various solutions including identifying alleles for resistance to historic and existing endemic rust pathotypes as well as known exotic pathotypes. This has resulted in new varieties that are more resistant to endemic rust saving growers an estimated $2.90 per hectare from lost production annually.

Investment in the ACRCP has given growers access to rust resistant varieties with the potential to yield well under local conditions, helped preserve the efficacy of fungicide chemistries by reducing the need for applications and raising industry awareness and adoption of varietal/fungicide management strategies, as well as helped manage the biosecurity risk for new rust pathogens entering Australia.

Research conducted by the University of Sydney and CSIRO through the ACRCP has helped simplify the conventional breeding of rust resistant wheat and barley by providing breeders with genetic markers for more than 25 resistance genes. These markers allow breeders to identify superior lines containing resistance genes that prevent rust infecting the plant or help plants successfully combat a rust attack.

At the same time, the ACRCP is enabling the Australian industry to combat the threat of introduced cereal rust isolates.

Exotic wheat rust isolates are new rust pathogens, or new pathotypes of existing pathogens, and are known to have entered Australia on 13 separate occasions since the University of Sydney's rust pathogen monitoring program began in 1921.

Concerningly, incursion rate of these exotic rusts is on the rise and minimising their impact will rely on continued monitoring, identification and genetic resistance research undertaken through the ACRCP.

GRDC investment enables the ACRCP to test Australian cereal germplasm against exotic rusts at key locations around the world by working closely with colleagues CIMMYT.

Validation

Kym Shepherd grows wheat, barley, field peas and vetch on his property on South Australia's Eyre Peninsula. Since 1981, when he began farming on the property, he has seen minimal rust on a year-on-year basis.

This track-record is testimony to the effectiveness of his preventative rust management approach which integrates genetic resistance with fungicides.

Mr Shepherd selects wheat varieties according to their yield potential and regional agronomic suitability as well as their disease resistance ratings. Mr Shepherd regularly reviews these resistance ratings in consultation with his agronomist and the latest research information from the GRDC, to ensure he remains abreast of any changes to varietal disease risk profiles due to the introduction of new pathotypes.

In terms of in-crop management, Mr Shepherd applies a preventative spray relatively early in the season and then follows up with a second spray if seasonal conditions require it around the time of head emergence. He also avoids using the same fungicides two seasons in a row to minimise the risk of resistance and always evaluates previous fungicide applications with his agronomist to help guide future disease management planning.

As rusts survive on living plants, Mr Shepherd always ensures self-sown out of season cereals are sprayed out, applying a knockdown herbicide at the first sign of emergence.

He believes his grain quality has not been impacted by rust and values a preventative approach as the best outcome for his operation.

The outlook

Current and future research is designed to increase the durability of rust resistance in cereal varieties, and to develop tools that accelerate the process of developing new varieties, delivering greater profitability to growers through reduced production costs and increased yield and quality.

Efforts continue to accelerate diagnostics for rust pathogen characterisation, and tools to allow the efficient development of complex resistances that will reduce and stabilise the threat posed by local and offshore rust strains.

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GRDC codes: CIM1207-001RTX