Tips and Tactics

Leaf rust in wheat

Northern, Southern and Western Regions

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Conditions favouring leaf rust

Humid conditions and warm temperatures between 15°C and 20°C favour leaf rust epidemics in wheat crops.

Leaf rust is one of three wheat rust diseases. The other two wheat rusts are stripe and stem rust. The life cycle of leaf rust is seven to ten days at optimal temperatures. This is the time from a spore infecting a leaf until the formation of spores from the new infection.

Volunteer wheat plants susceptible to leaf rust enable inoculum levels to build up during the non-cropping summer and autumn period.

Wet summers that favour the growth of volunteer wheat can provide a favourable environment for leaf rust to build up, increasing the threat of rust in the following season.

If these conditions are followed by a mild winter and a warm wet spring, the chances of a leaf rust epidemic are high. Therefore, the chances of a leaf rust epidemic are greatest following a wet summer.

NEWS: Wheat leaf rust pathotype found for the first time in Western Australia

An eastern Australian wheat leaf rust (*Puccinia triticina*) pathotype has been identified in Western Australia by researchers at University of Sydney and DAFWA. This may cause the rust resistance ratings of several wheat varieties to change.

Varieties that may become more susceptible to leaf rust include Mace(ᵖᵇʳ), which is the most popular wheat variety in Western Australia (WA).

Wheat leaf rust can significantly reduce wheat yields on susceptible varieties, given appropriate environmental conditions.

Growers are advised to carefully select varieties and to be aware of the resistance ranking of their chosen varieties for 2016.

For more information, see http://rustbust.com.au/news-information/reports/

KEY POINTS

- Growing resistant varieties is the key to minimising yield losses, reducing the build-up of leaf rust inoculum, and reducing the chance of new pathotypes (strains) developing.
- Rust diseases require living plants to grow and reproduce. Therefore, eliminating volunteer/weed wheat plants (the 'green bridge') over summer/autumn can reduce the carry over of leaf rust, and other rust inoculum, between seasons.
- Warm, moist autumn conditions favour the development of leaf rust.
- Foliar fungicides protect against infection but do not cure existing infections.
- Monitor your crop to detect infection at the earliest stage possible.

Figure 1: Warm, humid conditions favour the development of leaf rust. (Image: Robert Park)

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The disease

Wheat leaf rust is caused by the fungus *Puccinia triticina*. While wheat, barley and oats are all infected by a leaf rust disease, each disease is caused by a different fungal species. For example, the leaf (crown) rust in oats does not infect wheat or barley; leaf rust in barley only infects barley.

P. triticina, like all other cereal rusts, produces spores that are wind-blown and can be spread over large areas in a short amount of time.

Epidemics can occur when:

- there is a carry over of the pathogen from the previous season
- susceptible varieties are grown
- there are warm humid conditions in the spring.

Breeders are constantly challenged as new pathotypes of the pathogen continue to emerge throughout Australia.

The Australian Cereal Rust Control Program, Rust Bust Initiative and state and territory government departments are the best sources of information for which pathotypes are emerging.

An example of changes over time in pathotype dominance in WA is shown in Table 1.

The naming of pathotypes of all three wheat rust pathogens is necessarily complex. Pathotypes are named depending upon their abilities to overcome rust resistance genes, and because there are many resistance genes, the names are designed to summarise a great deal of information in the shortest possible way.

Leaf rust infections are usually evident in new pustules erupting, 7–10 days after infection (Table 2). Like all rust pathogens, leaf rust requires a living host to survive from one season to the next. The most important host for rusts in Australia are susceptible volunteer wheat plants growing during the summer/autumn. Rust cannot carry over from one season to the next on seed, stubble or in soil.

Table 1: Known wheat leaf rust pathotypes in WA.
(Source: Robert Park, Australian Cereal Rust Control Program)

Year	Pathotype name	Comments
1990	104–1,(2),3,(6),(7),11	Was common, less so now
1990	104–1,2,3,5,(6),(7),11	Rare
1993	122–1,2,3,(6),(7),11	Rare
1996	104–1,2,3,4,(6),(7),11	Rare
1998	104–1,2,3,(6),(7),11	Was common, less so now
2002	104–1,(2),3,(6),(7),11 +Lr37	Common (less since 2013)
2002	104–1,2,3,5,(6),(7),11	Rare
2013	76–1,3,5,7,9,10,12 +Lr37	New, introduced, becoming widespread
2015	104–1, 3, 4, 6, 7, 8, 10, 12 +Lr37	New, introduced, likely to become dominant eventually

Figure 2: Leaf rust forms small, circular, orange-brown spore masses that are raised above the leaf surface. (Image: DAFWA)

Table 2: Optimal and possible temperatures for stripe, leaf and stem rust infection and disease development. The infection temperature ranges indicate when rust spores can infect the plant. The incubation temperature ranges indicate the conditions required for disease development after infection. The latent period is the number of days between infection and visible pustules forming under optimal incubation temperatures.

Rust	Infection		Incubation		Latent period (days)
	optimal temperature (°C)	possible temperature (°C)	optimal temperature (°C)	possible temperature (°C)	
Stripe	8–12	5–20	17–20	12–23	10–14
Leaf	15–20	5–25	20–23	15–25	7–10
Stem	20–25	15–30	25–30	15–30	7–10

Identifying the disease

Leaf rust is a relatively easy disease to identify as it forms small, circular, orange-brown spore masses, known as pustules, that are raised above the leaf surface. They are found mainly on the upper surface of the leaf (Figures 2, 3).

The spores within pustules can be rubbed off the leaf leaving an orange-brown residue on the finger or a white cloth.

Stem rust and leaf rust are often hard to tell apart. Stem rust spores are much darker in colour than leaf rust spores.

Leaf rust pustules are lighter brown to orange, small, circular to oval and mostly develop only on the upper surfaces of leaves and less frequently on leaf sheaths. Stem rust is the only rust pathogen of wheat that can infect the true stem (Figure 4).

Figure 3: Leaf rust pustules are found mainly on the upper surface of the leaf. (Image: Bob Rees)

Figure 4: Stem rust appears on both the leaves (including the flag leaf sheath) and stems (far right) of the plant running parallel to the long axis of the leaf or stem.

Management strategies

1. Make a strategic variety selection

The best tool growers have to control leaf rust and prevent or reduce yield loss is rust-resistant varieties (Table 3).

If a district-wide approach is undertaken to grow resistant varieties, there will be considerably less inoculum than if the majority of varieties are susceptible or very susceptible.

Growers should use the latest information on each variety's reaction to leaf rust because ratings can change if there are changes in the rust pathogens. For example, the detection of new leaf rust pathotypes in Western Australia in 2013 and South Australia and Victoria in 2014 resulted in changes to wheat leaf rust ratings for many varieties.

Consult the rust resistance ratings tables for your region provided by state departments of agriculture, the Rust Bust initiative, National Variety Trials and in bulletins released by the University of Sydney's Plant Breeding Institute (Useful Resources, page 6). Local knowledge from other growers and agronomists is also useful to understanding the disease status of your district.

It is also important to understand the difference between all-stage resistance and adult plant resistance (APR) as this will impact your crop management (Forms of resistance, page 4).

2. Remove the 'green bridge'

Rust pathogens need a living host to survive. During the non-cropping phase, plants that can harbour rust pathogens (volunteer cereals, some weed species) are referred to as the 'green bridge' (Figure 6).

Heavy grazing, cultivating or spraying with herbicides during autumn to remove the 'green bridge' will reduce the amount of leaf rust in following crops.

The key is to remove summer host plants at least four weeks prior to the beginning of a new cropping season to ensure no cereal volunteers are present when the new crops are emerging.

Particular care should be taken to destroy plants around sheds and silos, as leaf rust often survives on plants in these areas.

It is also important to control host weeds during the growing season to prevent seed set that could contribute to 'green bridge' development in the next fallow period.

Wheat leaf rust does not survive on seed, stubble or soil.

Table 3: Wheat variety resistance ratings and potential maximum yield loss due to leaf rust. (Source: DAFWA)

Resistance rating	Definition	Potential yield loss from leaf rust (%)
Very susceptible (VS)	Early high disease build-up; can promote epidemic development	40
Susceptible (S)	High disease build-up	30
Moderately susceptible (MS)	Develops disease less quickly and so reduces loss risk	20
Moderately resistant to moderately susceptible (MRMS)	Some partial resistance; losses depend on disease pressure	15
Moderately resistant (MR)	High partial resistance; generally few losses	0

3. Foliar fungicides

There are a number of foliar fungicides registered for the control of leaf rust in wheat, but spraying should not be regarded as a substitute for growing resistant varieties.

Crops should be monitored to ensure the appropriate application and timing of fungicides.

Current fungicides are effective as protectants to stop infection rather than as curatives to kill existing infections. Therefore they should be applied prior to the crop displaying high levels of the disease.

Foliar fungicides only protect the leaves they are applied to and do not provide systemic protection or protection to new leaves that emerge after the spray has been applied.

In varieties rated MR to VS in seasons favouring leaf rust, fungicide will be required to reduce the impact of disease which can cause up to 40% yield loss if not controlled.

Varieties with some level of resistance or APR are less likely to require fungicide intervention, depending on the time of disease occurrence.

Care should be taken with thick canopies as fungicides may have trouble penetrating and contacting all the leaves. Correct sprayer set up is imperative. Spraying after crop flowering is normally not economical for stripe or leaf rusts. Late rust infection should be carefully inspected to check it is not stem rust.

Observe maximum residue limits and withholding periods.

Checklist for spray decisions

- Will I get an economic return on my spray investment?
- What is the yield potential of my paddock?
- Am I too early/late to benefit from this spray?
- What is the length of residual of this spray? Will it require a second application?
- If I do not spray this crop will neighbouring crops be at greater risk of infection?
- Am I growing a susceptible variety?
- What is the disease status in the district?
- What was the disease status in adjacent paddocks in the previous season?
- Have the weather conditions favoured the development of the disease?
- Was there a 'green bridge' in this or adjacent paddocks over the summer/ autumn months?

St Patrick's Day

17 March is considered an ideal time to control the 'green bridge' of overwintering cereals and host weeds.

4. Seed and fertiliser treatments

There are seed- or fertiliser-applied fungicide treatments available that will suppress early infections of leaf rust.

Seed treatments are important in susceptible varieties, especially if they are sown early or following a wet summer favouring growth of volunteer plants.

Some seed treatments can control leaf rust for 8–12 weeks after sowing, but be aware of withholding periods if the crop is intended for early grazing.

Although useful against seedling infections, seed dressings have little, if any, efficacy remaining to combat the disease later in the season when it is at its most damaging.

Forms of resistance

There are two forms of resistance:

- All-stage resistance, which operates throughout the life of the plant.
- Adult plant resistance (APR), which develops as the plant matures (usually post node formation growth stage) and provides protection in a crop's post-seedling stages.

What is adult plant resistance?

Adult plant resistance (APR) is resistance to any disease that becomes effective in a variety sometime in the post-seedling stage of crop development.

APR is often expressed as 'slow rusting' as it reduces rather than removes pustule formation.

The genes that control APR are often additive, meaning that the more APR genes present in a variety, the greater the cumulative effect on reducing rust infection. Depending on the APR genes present in a variety, the resistance can be activated from early in the crop's development, at tillering (GS20), through to full head emergence (GS59).

The expression of APR can vary with environmental conditions, and hence can vary from season to season. APR expression is normally lower in cooler conditions and when plants have high nitrogen content.

In the absence of all-stage resistance, varieties with APR will still be susceptible to rust at the seedling stage.

5. Crop monitoring

Careful monitoring of crops is crucial. Identification of rust infections in the previous year can help determine the threat of rust and other diseases in the following year of planting.

If rusts were found in adjacent paddocks in the previous season, strict management guidelines involving the planting of resistant varieties and other control measures should be employed.

Growers should closely monitor crops during the growing season to detect infection as early as possible.

Biosecurity measures to minimise rust becoming established or spreading on your farm

Rust spores are small, light and may survive for several days without a host, or indeed for more than two weeks on on clothing at ambient temperature. Rust spores can spread long distances by wind, on machinery/vehicles, on tools, on clothing and on footwear. Remember that if you walk through an infected crop, follow biosecurity protocols and thoroughly clean your boots, hands and trousers before entering another paddock or travelling, as rust spores can be unknowingly transferred via people locally and also from overseas. Also check biosecurity measures taken by your visitors and agronomists.

Be particularly vigilant when returning from interstate or overseas as rust pathotypes with different virulences exist in different areas.

If entering a paddock suspected to be infected with rust, biosecurity suggestions include:

- Wear protective overalls and rubber boots.
- After crop inspection clean any material off boots with a brush. Prepare footbath of bleach (10% household bleach, 90% water), and spray bottles of methylated spirits brew (95% metho, 5% water) for use to disinfect footwear, pants and hands.
- Decontaminate vehicles, tools and machinery.
- Walk rather than drive through crops.
- Ask visitors/agronomists to leave their vehicle at the gate and only travel on your property in your vehicle.

Source: DAFWA, http://www.agric.wa.gov.au/grains-research-development/implications-known-wheat-leaf-rust-pathotypes-wa?page=0%2C1

Take action

Communicate

Growers need to work collaboratively, rather than as individuals, to ensure regional control of the 'green bridge' and management of the disease.

If you have a rust outbreak, inform your neighbours, agronomist and state plant pathologist.

Submit a sample

The Plant Breeding Institute (PBI) at the University of Sydney surveys Australia for pathotype variation in all the cereal rusts. The diagnostic survey relies primarily on growers sending rust samples for pathotype identification. It provides the whole industry with a valuable snapshot of where rusts are tracking in a season. The survey is paid for by grower levy and is a free service.

If rust is suspected in your crop, send a sample. You can get free reply paid envelopes from PBI or you can send samples in paper envelopes (not plastic bags).

How to send a sample:

1. Fold leaves infected with rust in half from top to bottom so the rust is on the inside.
2. Place straight stems and/or folded leaves into paper envelopes.
3. If you are sending multiple types of rust samples at once, or you are sampling off multiple varieties of wheat, place each in a separate paper envelope.
4. Complete a dispatch form (available from PBI website) for each sample with geo-referencing for mapping and epidemiological modelling. Or you can include this information yourself:
   - » Collector's contact details (name, organisation, address, phone number).
   - » Material: What do you suspect it is (e.g. leaf rust, stripe rust)?
   - » Host (e.g. wheat, barley).
   - » Location: GPS and whether crop, trial, road etc.
   - » Cultivar.
   - » Date collected.

Post your paper envelope to:
University of Sydney
Australian Rust Survey
Reply Paid 88076
Narellan NSW 2567

Disease cycle

Figure 5 outlines the leaf rust disease cycle. Leaf rust fungus is dispersed as wind-blown spores, which produce new infections.

The fungus requires temperatures of less than 25°C (optimal 15°C to 20°C) with a minimum of three hours of leaf wetness (e.g. dew) for new infections to occur.

Build up of inoculum levels on volunteers can occur during the summer and autumn. This can be a problem in seasons following wet summers that favour the growth of volunteer wheat. The plants that become heavily infected with rust in the autumn provide a source of rust for the new season's wheat crop.

If these conditions are followed by a mild winter and a warm wet spring, then the chances of a leaf rust epidemic are high. Therefore, the chances of a rust epidemic are greatest following a wet summer.

FAQs

I have leaf rust in my barley crop. Should I be worried about it infecting my neighbouring wheat crop?
No, leaf rust is crop-specific with different species of *Puccinia* infecting wheat, barley or oats. Hence, leaf rust infection in one winter cereal crop type cannot spread to another type of cereal crop.

Is there any early indication that my crop may be infected with leaf rust?
Yes. The appearance of light green spots in yellowing or senescent leaf tissue is a good indication that leaf rust is present.

My resistant variety has leaf rust, what should I do?
This could potentially be a new rust pathotype or the APR could be slow to kick in. Collect a sample and submit it to the University of Sydney for pathotype testing. Monitor the level of rust in the crop and if it continues to multiply consider intervening with fungicide.

Figure 6: Conditions during the summer can influence rust development because rust diseases can only survive on living plants. Wet summers favour the development of volunteer cereals (volunteers; the green bridge) that can allow rust pathogens to carry over from one season to the next.

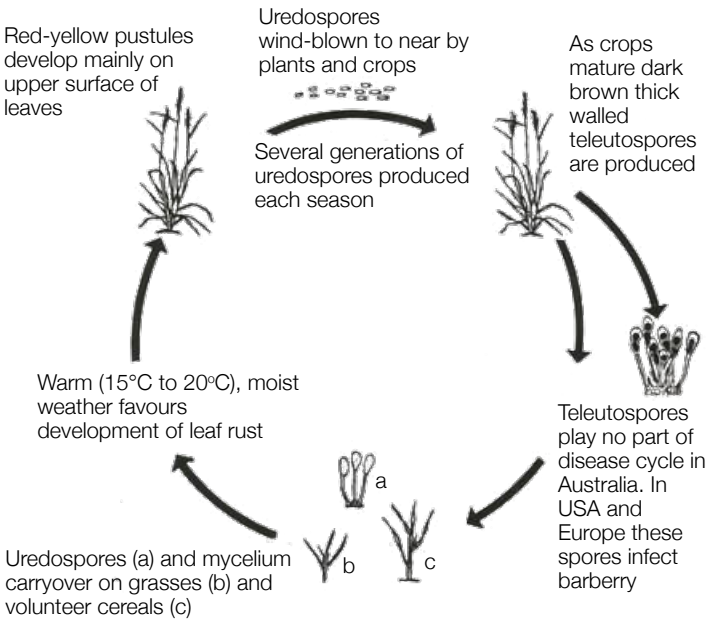

Figure 5: The typical disease cycle for leaf rust. Adapted from: Crop Pro (http://www.croppro.com.au/crop_disease_manual/ch02s02.php)

The Rust Bust

The Australian Cereal Rust Control Program Consultative Committee (ACRCP CC) launched the Rust Bust campaign in March 2011 to encourage growers to be proactive in response to the worst disease risk in nearly 40 years.

A rust outbreak in Australia has the potential to slash farm incomes, which is why it is so vital that growers and advisers implement a plan to manage rust at the beginning of the season, rather than waiting for a rust outbreak to occur and then planning a control approach.

The entire wheat industry, from grain growers through to breeders and the seed industry, must be on the front foot. With variances from season to season, prevention of a devastating outbreak requires proactive decisions throughout the year.

The Rust Bust's charter is to support growers and advisers by providing information and tools on how to proactively manage rust.

The campaign commenced with and continues to promote the following key messages for effective rust control:

- Remove the green bridge by mid-March.
- Grow varieties with adequate resistance to the stem, stripe and leaf rusts.
- Apply fungicides on seed or fertilisers for rust suppression.
- Monitor crops for rust and if needed, apply foliar fungicide for disease control.

The campaign website (www.rustbust.com.au) is an information hub on rust prevention and management strategies.

The Rust Bust is an initiative of the Australian Cereal Rust Control Program Consultative Committee, supported by the Grains Research and Development Corporation.

Further reading

The Rust Bust fact sheets www.rustbust.com.au/news-information/fact-sheets

GRDC Adult plant resistance fact sheet www.grdc.com.au/FS-AdultPlantResistance

GRDC Green bridge fact sheet www.grdc.com.au/Resources/Factsheets/2010/01/Green-Bridge-Fact-Sheet-National-Jan-2010

GRDC Foliar application of fungicides fact sheet www.grdc.com.au/Resources/Factsheets/2014/08/Foliar-applications-of-spray

GRDC Fungicide timing fact sheet www.grdc.com.au/GRDC-FS-FungicideTiming

GRDC GrowNotes www.grdc.com.au/Resources/GrowNotes

GRDC Wheat Rust: The Back Pocket Guide www.grdc.com.au/Resources/Publications/2011/03/Wheat-Rust-The-Back-Pocket-Guide

Useful resources

University of Sydney Plant Breeding Institute www.sydney.edu.au/agriculture/plant_breeding_institute/cereal_rust

The Rust Bust initiative www.rustbust.com.au

NSW DPI winter crop variety sowing guide www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

NVT Queensland Wheat Variety Guide www.nvtonline.com.au

Victorian Cereal Disease Guide www.agriculture.vic.gov.au

South Australian Cereal Variety Disease Guide www.pir.sa.gov.au

DAFWA Wheat variety guide for Western Australia www.agric.wa.gov.au

DAFWA PestFax newsletter for Western Australia www.agric.wa.gov.au/crop-diseases/about-pestfax-newsletter

Plant Health Australia www.planthealthaustralia.com.au/nationalprograms/grains-farm-biosecurity-program

National Variety Trials www.nvtonline.com.au

APVMA registered fungicides www.apvma.gov.au

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