Tips and Tactics

Stripe rust in wheat

Northern, Southern and Western Regions

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Stripe rust: the first rust to appear in the cropping cycle

Wheat stripe rust is a fungal disease of wheat, barley, triticale and some grass weeds. It can cause losses of 60–80% in susceptible to very susceptible wheat varieties.

Thrives in cool, moist conditions

Of the three wheat rust diseases—stripe, stem and leaf—stripe rust is best suited to cooler temperatures that occur during late autumn and early spring. It is therefore usually the first rust disease to appear in a cropping cycle.

Stripe rust has been the main rust farmers have had to manage in recent times.

It reproduces and spreads by spores, which are wind-blown and can travel hundreds of kilometres.

The severity of stripe rust within a crop depends on varietal susceptibility, the nitrogen status of the crop, moisture and temperature.

Figure 1: Stripe rust can cause severe losses in susceptible to very susceptible wheat varieties.

KEY POINTS

- The most powerful tool available to growers to minimise the impact of the disease is resistant varieties.
- Rust diseases grow and reproduce only on living plants. Eliminating volunteer plants (the 'green bridge') over summer/autumn reduces the carryover of rust inoculum between seasons.
- Fungicides for controlling stripe rust should be regarded as a support and not a substitute for growing resistant varieties.
- Monitor your crop to detect infection at the earliest stage possible.
- Cool, moist and humid conditions favour the development of stripe rust.
- Where very susceptible varieties of wheat are infected with stripe rust, resulting losses can be as high as 80%.

Management strategies

1. Make a strategic variety selection

The best tool growers have to control stripe rust and prevent or reduce yield loss is to grow rust-resistant varieties (Table 1).

Taking a district-wide approach to growing resistant varieties will considerably reduce the amount of inoculum, and in turn reduce the threat of epidemics.

On the other hand, a high inoculum load significantly increases the need for, and the cost of, rust control. It also increases the risk of pathogen mutation, putting existing, effective rust-resistance genes at risk.

It's important to understand the different rust ratings and the difference between all-stage resistance and adult plant resistance (APR) as this will impact on your crop management (Forms of resistance, page 5).

Growers should use the latest information on each variety's reaction to stripe rust because ratings can change if there are changes in the rust pathogens.

Consult the rust resistance ratings tables for your region provided by state departments of agriculture, the Rust Bust initiative and in Cereal Rust Reports released by Sydney University's Plant

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Breeding Institute (see Useful Resources). The Australian Cereal Rust Control Program (ACRCP) Consultative Committee recommends the following minimum resistance standards for different regions:

- Northern (Qld and northern NSW): MR-MS
- Southern (southern NSW, Vic and SA):
  - » Conventional spring wheats: MR-MS
  - » Long season and early sown (before mid-April) wheats: MR-MS
- Western (WA): MS.

Varieties rated as Moderately Resistant to Moderately Susceptible (MRMS) or Moderately Susceptible (MS) generally have adult plant resistance (APR). These varieties are unlikely to lose all their flag leaf area to disease, but may need a fungicide spray if rust is detected early (before flag emergence).

Varieties rated Moderately Resistant (MR) show only limited rust symptoms on their flag leaves under climatic conditions favouring stripe rust development. Varieties rated as Resistant (R) are those with resistance that persists for the duration of the plant's life. Even varieties rated as MR and R should be monitored with a view to fungicide application as mutations in rust populations may occur.

2. Remove the 'green bridge'

Stripe rust can survive from one season to the next on living plants (mostly wheat, triticale and barley grass, and to a lesser extent rye, barley, brome grass and phalaris). This growth of volunteer/weed cereal plants over summer/autumn is called the 'green bridge'.

In long season areas the gap between crops is much shorter, increasing the likelihood of over-summering and making 'green bridge' management more important.

It is critical that all volunteer plants are removed either by spraying, cultivating or heavy grazing, at least four weeks before the next crop is sown.

Particular care should be taken to destroy plants around sheds and silos, as stripe rust will also survive on plants in these locations. This approach will also ensure the control of leaf rust and stem rust.

Stripe rust does not carry over on seed, stubble or soil.

St Patrick's Day

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

Table 1: Rust disease rating classifications and average yield losses in south-eastern Australia in the presence of stripe rust. These figures are indicative only. (Source: Rust Bust and DPI Victoria).

Resistance rating	Definition	Average Victorian yield loss %
Resistant (R)	The disease will not multiply or cause any damage on this variety. This rating is usually only used where the variety also has seedling resistance.	0
Moderately resistant (MR)	The disease may be visible and multiply but no significant economic losses will occur.	3
Moderately resistant to moderately susceptible (MR-MS)	Rust can establish early and an epidemic can develop from these infections. The level of resistance may improve as the crop develops, although losses up to 20% can be expected if fungicides are delayed or not used.	17
Moderately susceptible (MS)	Disease may develop at any stage of crop growth and leaf area damage can be high, leading to serious crop losses if left unchecked.	20
Moderately susceptible to susceptible (MS-S)	Disease can develop rapidly at any growth stage with high crop loss potential.	26
Susceptible (S)	The disease can be severe at any growth stage on these varieties. Losses over 50% are likely if the disease is not controlled and losses of 15-50% can occur.	65
Very susceptible (VS)	Where a disease is a problem this variety should not be grown. Losses ranging from 50-80% can be expected and the variety will create significant problems for other growers.	70

3a. Seed or fertiliser-applied fungicides

Treating seed or fertiliser, or applying fungicide in-furrow, can reduce the autumn build-up of stripe rust on early-sown winter or grazing wheats, and triticales. This can lower inoculum levels in the system for spring when the disease is at its most damaging.

Although useful against seedling infections, seed dressings have little, if any, efficacy remaining to combat the disease when it is at its most damaging later in the season. Therefore, seed- or fertiliser-applied fungicides should be used in conjunction with a foliar fungicide strategy in at-risk crops (see section 3b).

Be aware of the maximum residue limits of chemicals, as well as withholding periods required before stock can be safely introduced for grazing.

Consult your agronomist/adviser for recommendations for your specific situation.

3b. Foliar fungicides

Effective fungicides for controlling stripe rust are available, but should be regarded as a support and not a substitute for growing resistant varieties.

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

When stripe rust is first detected at ear emergence, only the most susceptible (S and VS) or longer season crops may need spraying. After a fungicide application, crop monitoring should continue as fungicides provide only 3 to 4 weeks protection.

There is often an apparent increase in stripe rust for a few days after spraying. This is caused by the development of symptoms of infections that occurred just before spraying. Control becomes apparent within a week of spraying. Growers' fungicide strategies should reflect what is happening in the paddock and district for that year.

Some fungicides, such as DMI fungicides, can cure infection for up to 4–7 days after infection. This is before any symptoms of disease can be seen. These fungicides are acting in a curative manner.

4. Crop monitoring

Careful monitoring of crops on an ongoing basis is important, regardless of how severe the previous epidemic was. 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 (see Identifying stripe rust, page 3).

When scouting crops for the disease, go to the part of the crop with the thickest growth and check leaves throughout the canopy.

- Untreated crops: older leaves generally show higher infection than younger leaves exposed to the disease for less time.
- Treated crops: the newer leaves, with less active ingredient to protect them, show higher infection.

The disease

Wheat stripe rust is caused by the fungus *Puccinia striiformis* f. sp. *tritici*.

While wheat and triticale are the main hosts, wheat stripe rust can develop on barley, rye, barley grass, rough wheat grass, brome grasses and some other grasses.

The infectious spore state is called an urediniospore. These spores are spread by wind and can travel long distances. Once a spore has landed on a leaf and successfully infected it, the fungus grows inside the leaf and then produces pustules containing new spores that erupt out of the leaf and repeat the cycle, causing epidemics to develop.

Like all rust diseases of wheat, stripe rust causes yield losses by reducing the sugar supply to the developing seed.

In-head infections can also develop if plants become infected during flowering, causing floret abortion and/or pinched grain.

The net result of infection is lower yield with higher screenings and, if in-head infections occur, florets can abort and grain can be stained. These effects could lead to quality downgrading at receival.

Identifying stripe rust

The first indication of stripe rust is likely to be hotspots in a wheat crop, usually 1 to 10 metres in diameter in winter or early spring.

In seedlings, stripe rust pustules form small, circular, densely packed shapes (Figure 2) on the leaves that can spread both along and sideways in the leaf such that the characteristic stripes do not develop.

In older plants, stripe rust forms long yellow/orange stripes of small pustules on the leaf (Figure 3). They mainly infect the upper surface of the leaf, but can also appear on the leaf sheaths, awns and inside the glumes surrounding the seed. The pustules run parallel to the long axis of the leaf, are raised above the leaf surface and contain masses of spores. They can be easily wiped off onto a white cloth or tissue leaving a yellow/orange residue (Figure 4).

As the wheat plant nears maturity, the stripes can turn black and a different spore is formed, the teliospore. The teliospores are not easily dislodged and in Australia are non-functional in the disease cycle (Disease cycle, page 5).

Checklist: Should I spray my wheat crop?

- What is the yield potential of my paddock?
- Will I get an economic return on my spray investment?
- 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?

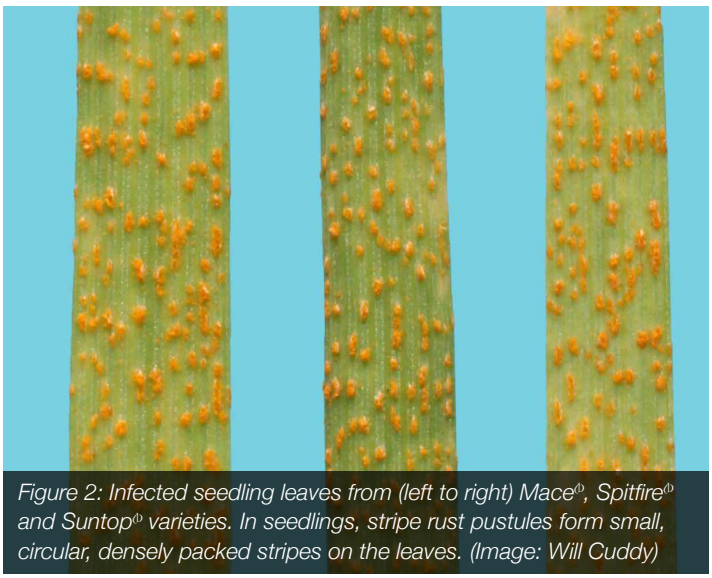


Figure 2: Infected seedling leaves from (left to right) Mace®, Spitfire® and Suntop® varieties. In seedlings, stripe rust pustules form small, circular, densely packed stripes on the leaves. (Image: Will Cuddy)

Figure 3: In older plants, long yellow/orange stripes of small pustules develop on the leaf. (Image: Hugh Wallwork)

Figure 4: Stripe rust pustules leave a yellow/orange residue when wiped with the fingers or a cloth. (Image: Hugh Wallwork)

Conditions favouring stripe rust

Stripe rust develops in cooler temperatures that occur during late autumn and early spring. It is therefore usually the first rust disease to appear in a cropping cycle.

Wind is the main means of spreading the spores. Under high humidity conditions, airborne spores will clump together and fall out of the air quickly, reducing the distance they spread and often resulting in hot spots of infection in the crop. As humidity declines, the spores disperse separately and can travel greater distances, resulting in rust infection being more uniform across the crop.

The life cycle of the disease is temperature-dependent (Table 2, page 5). At optimal temperatures it takes 10–14 days from the spore infecting the plant to when pustules erupt and new spores are released.

Stripe rust is favoured by cool, moist conditions with day temperatures below 20°C and night temperatures of 8°C and 12°C. The highest likelihood of infection occurs when the incubation temperature is between 8°C and 12°C (optimal) but rust infection is possible between 5°C and 20°C.

It is important to note that even late in the season when daytime temperatures might be getting above 30°C, infections can occur so long as nighttime temperatures are below 20°C. Temperatures below the optimal range will slow down fungal growth and extend the latent period.

Once an infection is established, the fungus can survive short periods of temperatures as high as 40°C.

The more susceptible the variety the wider the range of conditions under which infection can occur.

Stripe rust patches are commonly found in the nitrogen-rich parts of the paddock and higher rates of N increase the severity of the disease during grain filling.

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

Rust spores are small, light and may survive for more than two weeks without a host. 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

Submit a sample

The Plant Breeding Institute (PBI) at the University of Sydney surveys Australia for pathotype (strain) 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, place each in a separate paper envelope.
4. Complete a dispatch form (available on 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

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.

More information

Keep up to date with rust incursions throughout the growing season by keeping an eye on the University of Sydney Plant Breeding Institute Cereal Rust Alerts at:
http://sydney.edu.au/agriculture/plant_breeding_institute/rust_alert.shtml

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 and can provide very good protection during later crop growth.

What is adult plant resistance?

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

APR is often expressed as 'slow rusting'; 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), from stem elongation (GS30) and ear growth or later in crop development at full head emergence (GS59).

As a general rule APR expression can be trusted to be active in MS to MR varieties from full head emergence onwards.

In the absence of all-stage resistance, varieties with APR will still be susceptible to rust at the seedling stage. The box 'Managing stripe rust in APR varieties: a case study' is just one example of managing stripe rust. Lessons can be applied more widely to all varieties where growers are relying on APR.

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

Can APR expression vary?

Yes. 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.

Managing stripe rust in APR varieties: a case study

Since the release in 2013 of the wheat variety, Suntop$^{\Phi}$, there have been reports of higher than expected stripe rust severity in Suntop$^{\Phi}$ crops.

Crops of Suntop$^{\Phi}$ infected with the 'WA pathotype' of stripe rust with combined virulence for *Yr17* and *Yr27* (pathotype 134 E16 A+ 17+ 27+) are only protected by the adult plant resistance (APR) gene *Yr31*. Although the level of APR is excellent in both Suntop$^{\Phi}$ and LongReach Spitfire$^{\Phi}$, it is important to remember that crop management and environmental conditions can have a significant impact on the effectiveness of APR in protecting crops from rust diseases. For varieties that rely largely on APR, high nitrogen inputs, as well as cooler and wetter conditions, can increase the severity of infection and reduce the effectiveness of APR.

In a year when the threat of stripe rust is high, anyone planning to grow varieties such as Suntop$^{\Phi}$ or LongReach Spitfire$^{\Phi}$ should have a stripe rust management plan well ahead of planting.

- In southern regions with high rainfall, and northern regions where growers are chasing higher yield and grain protein, appropriate fungicides should be applied at planting, whether on the seed or in-furrow, to provide control early in the season. A potential follow-up spray around late stem elongation to flag leaf emergence may be necessary depending on the incidence of stripe rust in the region. The monitoring of stripe rust during stem elongation will be critical in safeguarding leaf area from stripe rust in these situations.
- Other growers should closely monitor their crops and manage the disease as it occurs in consultation with their local advisers.

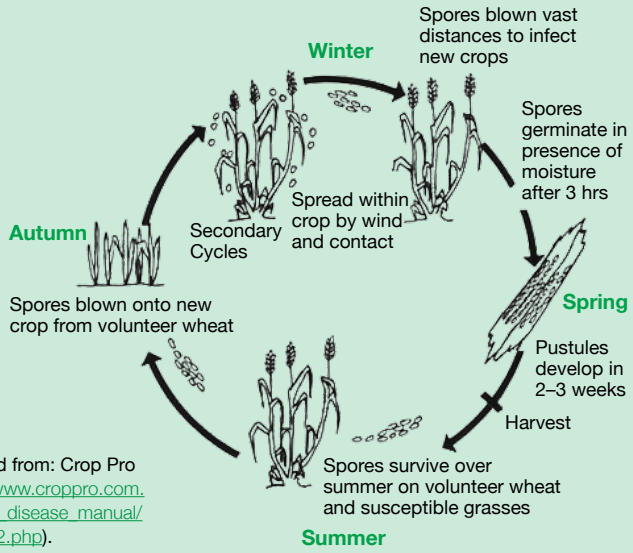
Source: http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-115-MarApr-2015/Stripe-rust-management-in-Suntop-and-LongReach-Spitfire-in-2015

Disease cycle

Stripe rust fungus is dispersed as wind-blown spores, which produce new infections. This cycle is repeated many times during the cropping season causing epidemics to develop.

Conditions suitable for epidemic development occur from April to November in most states, and stripe rust can be expected in crops by late August or early September in most years. Epidemics can develop as early as May. The earlier the start of the epidemic, the more severe the epidemic is likely to be. To infect the plant, the fungus requires temperatures of less than 20°C (optimal temperature between 8°C and 12°C) with a minimum of three hours of leaf wetness (e.g. dew).

Sufficient rust survives the summer on volunteer plants to allow a new epidemic to develop in the following season. Only one infected leaf per 30 ha of regrowth needs to survive the summer to produce severe epidemics. Stripe rust can also infect the developing head during flowering, reducing grain number and size.



Adapted from: Crop Pro (http://www.croppro.com.au/crop_disease_manual/ch02s02.php).

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 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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