FUNGICIDE RESISTANCE IN WHEAT

FACT SHEET

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Fungicide Resistance in Wheat Crops: Causes, Management and Mitigation Strategies

KEY POINTS

- Fungicide resistance is the loss of fungicide effectiveness against a specific pathogen.
- Wheat powdery mildew has exhibited resistance to all Group 11 fungicides and some Group 3 fungicides in Australia.
- Septoria tritici blotch has exhibited resistance to Group 11 fungicides in South Australia and reduced sensitivity to several Group 3 fungicides in New South Wales, Tasmania, SA, and Victoria.
- Rotate crops, plant resistant cultivars, and manage stubble loads to minimise disease pressure.
- Avoid repeated use of any single fungicide active or fungicide Mode of Action (MoA) group in the same season.

Photo: CCDM.

Powdery mildew and Septoria tritici blotch are important fungal diseases of wheat that have exhibited some degree of fungicide resistance in Australia. Other fungal diseases of wheat, such as eyespot, Septoria nodorum blotch and yellow leaf spot could also develop resistance if fungicide applications are not managed carefully. Adopting good integrated disease management and fungicide usage practices now will help preserve the effectiveness of these useful chemicals.

Introduction

Numerous cases of reduced sensitivity and resistance to fungicides have been identified in Australia's wheat growing regions. More cases are expected to arise as survey and detection methods improve, and if current fungicide use patterns continue.

Fungicide resistance occurs when a previously effective fungicide fails to control a fungal disease.

It is a preventable issue, caused by repeatedly exposing a pathogen to a single fungicide active or to the chemical actives of a single Mode of Action (MoA) group.

It can become a major constraint to good disease control, especially where no alternative fungicide actives or host-plant resistance is available.

Fungicide resistance can be a regional problem. Spores released by some fungicide resistant fungi such as wheat powdery mildew can spread over a large area in a short time. Stubble-borne diseases, such as Septoria tritici blotch (STB), can also be spread over large distances if infected straw is moved. Misuse of fungicides and poor disease management practices on a single farm can affect everybody in the district.

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Fungicide resistance result	Impact on fungicide use
Sensitive	Still works
Reduced sensitivity	Might still work okay • May need to use maximum label rates • Higher risk of developing resistance
Resistant	Doesn't work – avoid use
Lab detection	None – but indicates a potential risk to field effectiveness.

Photo: CCDM.

Wheat powdery mildew.

Fungicide resistance in wheat

Reduced sensitivity to Group 3 (DMI) fungicides is an internationally recognised issue with Septoria tritici blotch (*Zymoseptoria tritici*), including in Australia. Several other countries have experienced reduced sensitivity with Group 7 (SDHI) fungicides for treating STB, along with losing the use of the Group 11 (QoI) fungicides because of fungicide resistance.

Group 3 (DMI) and Group 11 (QoI) actives have also proved vulnerable to the development of resistance and reduced sensitivity in wheat powdery mildew, both in Australia and overseas.

The loss of effectiveness of any major fungicide group would compromise other MoA groups through increased selection pressure. It is therefore essential that wheat growers use all available agronomic and usage precautions to avoid increasing pressure on at-risk fungicides.

This includes planting wheat varieties with improved levels of genetic resistance to critical fungal diseases in your region. Rotating and mixing fungicide actives and MoA groups is also required to avoid consecutive applications of the same chemistry, including between seasons if only one application is needed within a season.

For example, although rust pathogens do not appear prone to developing fungicide resistance, growing rust-susceptible wheat varieties still leads to a reliance on fungicides for disease management. This may inadvertently select for fungicide resistance in other pathogen populations (e.g. wheat powdery mildew) which co-infect crops along with the rusts.

Reduced sensitivity or resistance to a specific chemical active in a particular region should be treated as an indication of risk for other chemicals in the same MoA group within that region, as well as in other regions that share similar environments and/or employ similar agronomic practices.

Known fungicide resistance issues – wheat

The following information is correct at the time of publication and is subject to change. For the latest data on fungicide resistance in wheat, please consult an agronomist or refer to the AFREN website.

Wheat powdery mildew

(Pathogen: *Blumeria graminis* f. sp. *tritici*)

Wheat powdery mildew is typically favoured by growing susceptible wheat varieties, early sowing, mild and humid weather (15-22°C, relative humidity > 70 per cent), higher nitrogen status, dense crop canopies, good soil moisture profiles, and extended periods of humid and damp canopies.

It survives on wheat stubble and volunteer wheat plants, from which spores can be spread by the wind.

FUNGICIDE RESISTANCE PROFILE

- **Resistance** to all Group 11 (QoI) fungicides in NSW, SA, Tasmania, and Victoria.
- **Resistance** to the Group 3 fungicide propiconazole (e.g. Tilt®, etc.) in NSW and Victoria.
- **Lab detection:** Gateway mutation associated with reduced sensitivity to Group 3 (DMI) fungicides detected in NSW, SA, Tasmania, and Victoria.

For many years, Group 3 and Group 11 fungicides were the only registered protection against wheat powdery mildew, which led to their repeated use in areas of high disease pressure.

Group 11-resistant wheat powdery mildew was first detected in samples collected from both Tasmania and Victoria in 2015, following reports of field failures. It has since been reported in SA and NSW.

In 2020 resistance to some Group 3 fungicides was detected across multiple paddocks in NSW and Victoria. The widely detected resistant genotypes also put Group 3 actives at higher risk in all other growing regions.

Septoria Tritici Blotch

(Pathogen: *Zymoseptoria tritici*)

Septoria tritici blotch (STB) is a concern in Australia's high and medium rainfall zones, especially in early sown crops and during wet springs. It survives on wheat stubble and is favoured by stubble retention, susceptible cultivars, cool, wet weather (15-20°C, relative humidity > 70 per cent), dense crop canopies and extended periods of leaf wetness or dew.

STB can cause yield losses of up to 20 per cent in typical seasons, and around 40 per cent under conducive conditions.

FUNGICIDE RESISTANCE PROFILE

- **Resistance** to Group 11 (QoI) strobilurin fungicides (e.g. Radial®, Veritas®, Topnotch®, etc), in Millicent, SA.

  The gene mutation G143A, which is associated with resistance to all Group 11 fungicides, was discovered in STB samples at Millicent, SA, in 2021. The G143A mutation is also a well-known cause of Group 11 resistance in wheat powdery mildew and may be more widespread in STB.

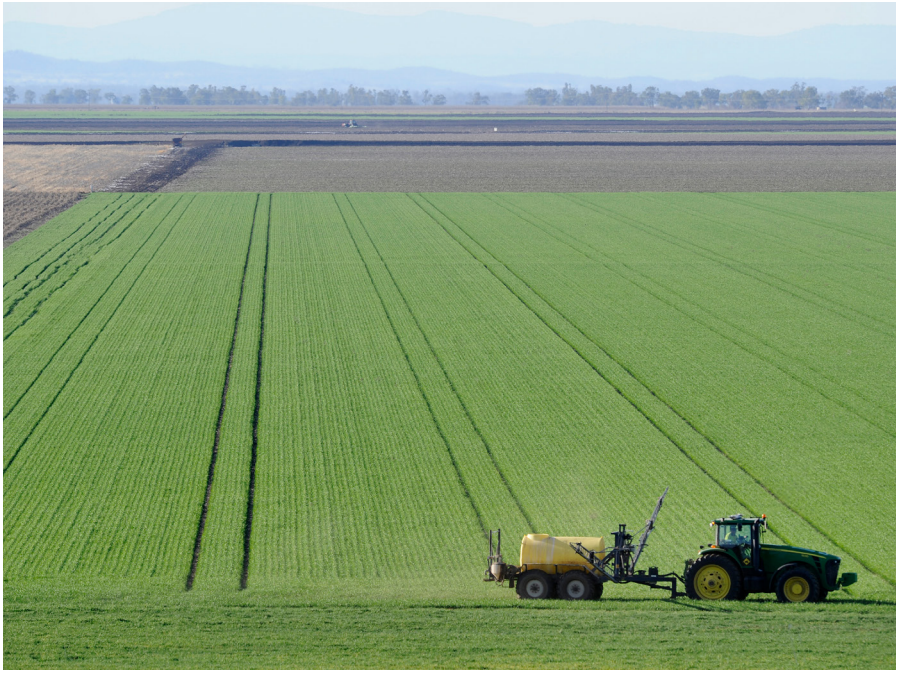
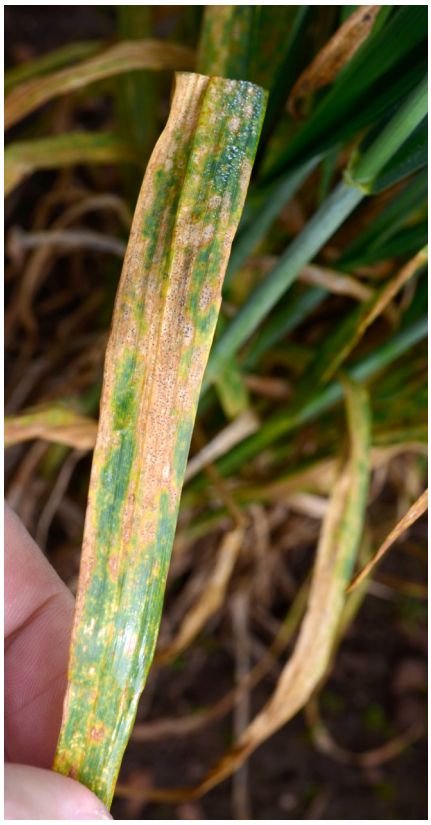


Photo: GRDC.

Photo: CCDM.



Septoria tritici blotch.

- **Reduced sensitivity** to the Group 3 (DMI) fungicides cyproconazole, epoxiconazole (Soprano®, etc.), flutriafol (Bayonet®, Impact®, Pollux®, etc.), propiconazole (Propimax®, Fitness®, etc.), tebuconazole (Laguna®, Orius®, Rebuke®, Folicur® etc.), and triadimenol (Baytan®, etc.) has been detected in New South Wales, SA, Tasmania and Victoria.

  The haplotype with the greatest impact on Group 3 efficacy, the G1 mutant, has been widely detected in STB populations across NSW, Victoria, SA and Tasmania. It was most frequently found in Tasmania.

  While epoxiconazole, propiconazole and fluquinconazole have all been linked to examples of reduced sensitivity, they will still control the disease in the field. However there have been detectable changes in the field performance of flutriafol, cyproconazole and tebuconazole.

Eyespot

(*Oculimacula yallundae*)

No known resistance issues detected in Australia.

There is a moderate risk of fungicide resistance development. Resistance to Group 1 fungicides has been reported in New Zealand. Reduced sensitivity to the Group 3 fungicide prochloraz has been reported in France.

Leaf rust

(*Puccinia triticina*)

Stripe rust

(*Puccinia striiformis*)

Stem rust

(*Puccinia graminis* f.sp. *tritici*)

No known resistance issues.

The risk of fungicide resistance development is low. Despite prolonged and continued fungicide use to manage cereal rusts on a global scale, resistance has not been reported to date.

Septoria nodorum blotch

(*Parastagonospora nodorum*)

No known resistance issues detected in Australia.

There is a moderate risk of fungicide resistance development. Reduced sensitivity to Group 3 fungicides has been reported in China and Europe. Resistance to Group 11 fungicides has also been reported in Sweden and, more recently, in the USA during 2020.

Tan spot / yellow spot

(Pyrenophora tritici-repentis)

No known resistance issues detected in Australia.

There is a moderate risk of fungicide resistance development. Reduced sensitivity to Group 3 and resistance to Group 11 fungicides has been reported in Europe.

Integrated disease management

Good integrated disease management, backed up with strategic use of fungicides only when they are necessary, underpins good fungicide resistance management.

Agronomic strategies

- Plant wheat varieties that are less susceptible to diseases of concern - avoid the most susceptible varieties in disease-prone areas.
- Rotate crops and do not sow wheat into wheat stubble.
- Adjust sowing time to manage risk – early sowing can favour the development and impact of a number of diseases, including wheat powdery mildew and Septoria leaf blotches.
- Graze early sown dual-purpose wheat crops to reduce disease pressure in at-risk crops, particularly during early spring.

When managing for wheat powdery mildew, also:

- Avoid using excess nitrogen and provide adequate potassium.
- Control volunteer wheat plants and weeds to deny the pathogen a 'green bridge'.

Fungicide use and rotation

- Rotate and mix fungicide actives and MoA groups, while minimising the use of fungicides known to have compromised efficacy due to resistance:
  - Avoid using the same fungicide active or MoA consecutively, both within and across seasons.
  - Use mixtures containing different MoA groups whenever possible, especially if disease pressure is high.

The Fungicide Resistance Five!

1. **Avoid susceptible crop varieties**
2. **Rotate crops – use time & distance to reduce disease carry-over**
3. **Use non-chemical control methods to reduce disease pressure**
4. **Spray only if necessary & apply strategically**
5. **Rotate & mix fungicides / MoA groups**

GROUP 3 (DMI) FUNGICIDES

- Minimise the use of Group 3 fungicides that are known to be compromised.
- Limit applications containing Group 3 fungicides to a maximum of three per growing season. In regions where resistance to Group 3 products has already been reported, reduce this to as few applications as possible.
- Rotate Group 3 fungicide actives within and across seasons as they are not equally affected by fungicide resistance.

GROUP 7 (SDHI) AND GROUP 11 (QOI) FUNGICIDES

- Avoid using more than one application of Group 7 or Group 11 actives (solo or in mixture) per season and do not apply them more than twice in any growing season. This includes foliar sprays and in-furrow or seed treatments that affect foliar diseases. In-furrow and seed treatments count as one application.
- Avoid use of Group 11 fungicides in areas where resistance has been reported.
- Use Group 11 fungicides to prevent, rather than treat, diseases of wheat.
- Rotate Group 11 products with an effective Group 3 or Group 3 + 7 product – making sure the product chosen does not share any active constituent with the Group 11 product that was used previously.

Photo: GRDC.

FREQUENTLY ASKED QUESTIONS

How does fungicide resistance develop?

Fungicide resistance occurs when fungicide resistant strains of a pathogen dominate the whole pathogen population. Fungicide resistant strains are 'selected for' by applications of the fungicide. That is, the non-resistant strains are controlled by the fungicide allowing the resistant strains to proliferate. For more on the causes and effects of fungicide resistance, read the GRDC/AFREN Fact Sheet 'How Fungicide Resistance Develops'.

How do I know if I have a fungicide resistant disease in my crop?

If a fungicide application fails to provide adequate control of the disease, or if the lower range of application rates on the label for a fungicide must be steadily increased from application to application, there is cause for concern.

You should keep an accurate record of every fungicide application – including dates, times, weather conditions, application rates, crop growth stage and notes of any evidence of a disease being present.

What should I look for?

It is important to inspect the crop after every fungicide application to confirm whether the expected level of control has been achieved.

If the disease is still present or increasing, review records of the application for reasons why it may have failed. If there is no obvious cause, consult an expert and consider having samples of the infected crop tested for fungicide resistance.

Who do I contact?

Contact your agronomist or adviser and have them review the crop and your fungicide application records. If they suspect fungicide resistance, they will be able to arrange further investigation, sample collection and lab analysis..

Alternatively, you can visit the AFREN website 'About' page for details of fungicide resistance experts in your region.

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MORE INFORMATION

Australian Fungicide Resistance Extension Network afren.com.au

USEFUL RESOURCES

Australian Fungicide Resistance Extension Network (AFREN)
Dedicated website for the latest Fungicide Resistance information, reference materials, case studies, grower survey and news.
afren.com.au

AFREN Guide - Fungicide Resistance Management in Australian Grain Crops
Comprehensive guide to fungicide resistance issues, instances and management – including details of fungicide Mode of Action groups, chemical actives and diseases by crop. Prepared by AFREN and published by the GRDC.
afren.com.au/resources/#management-guide

GRDC Fungicides In Australia Fact Sheet

GRDC How Fungicide Resistance Develops Fact Sheet
afren.com.au/resources/#fact-sheets

GRDC Septoria Tritici Blotch In Wheat Fact Sheet
grdc.com.au/septoria-tritici-blotch-in-wheat

GRDC Powdery Mildew in Barley and Wheat Fact Sheet (Southern Region) grdc.com.au/GRDC-FS-PowderyMildewBarleyWheat

GRDC Wheat Rust Fact Sheets
grdc.com.au/resources-and-publications/all-publications/factsheets/2016/02/wheat-rust-northern-southern-and-western-regions

State Crop Guides - GRDC National Variety Trials
nvtonline.com.au

Currently available wheat varieties with disease susceptibility ratings, by growing region, from the GRDC National Variety Trials website. (Choose: Resources > Crops Guides)

REFERENCES

The content in this Fact Sheet is based on the content and sources included in the AFREN Guide **Fungicide Resistance Management in Australian Grain Crops.** See 'Useful Resources' above.

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