MANAGING FUNGICIDE RESISTANCE: WHEAT POWDERY MILDEW

FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Wheat powdery mildew

KEY POINTS

- The pathogen responsible for wheat powdery mildew has a very high fungicide resistance risk.
- Resistance to Group 11 (QoI) fungicides is found across most of the southern and northern growing regions.
- Resistance and reduced sensitivity to Group 3 (DMI) fungicides is also widespread across the southern and northern growing regions.
- A gateway mutation, indicating a high probability of further mutations developing to impact Group 3 (DMI) fungicide efficacy, has been detected in the laboratory from isolates in the south west of Western Australia.
- Widespread resistance or reduced sensitivity to Group 3 DMI and Group11 (QoI) fungicides is considered an extremely high risk.
- Careful use and rotation of available fungicide actives will help control the spread of resistance in wheat powdery mildew.
- Agronomic practices that minimise disease pressure reduce the need to apply fungicides.
- Good management will help protect the long-term efficacy of current fungicides.

Wheat powdery mildew is a significant disease of wheat caused by the fungal pathogen *Blumeria graminis*. In Australia, the pathogen has exhibited resistance to major fungicides and these resistances are spreading to areas with historically low fungicide use.

Photo: Nola D'Souza, AFREN Coordinator.

Wheat powdery mildew screenings at the Centre for Crop Disease Management, Curtin University.

Introduction

Fungicide control of wheat powdery mildew is becoming increasingly difficult in Australia. *Blumeria graminis* has a remarkable ability to adapt to fungicide treatments, which makes this pathogen a high risk for the development of fungicide resistance.

Fungicide resistance traits are now being detected in areas where the compromised fungicides have not been widely used, indicating the airborne spread of resistance genes.

Fungicide resistance in wheat powdery mildew

Group 11 (QoI) fungicides

Resistance to Group 11 (QoI) fungicides such as Amistar® has been reported in *B. graminis* populations across New South Wales, Queensland, South Australia, Tasmania and Victoria.

When conditions are conducive to disease and frequency of the resistant isolates is high, Group 11 QoIs will fail to control disease in paddocks sown to susceptible varieties.

This resistance was first detected in samples collected from Tasmania and Victoria in 2015, following reports of paddock fungicide failures. Similar resistance has also been reported in South Australia (since 2019), New South Wales (since 2020) and Queensland (since 2022).

From field observations, the resistance gene for Group 11 fungicides is easily selected for, and can become the dominant pathotype in a paddock within just a few seasons.

Group 3 (DMI) fungicides

Group 3 (DMI) fungicides have long been considered a high resistance risk in wheat powdery mildew. A gateway mutation, known to indicate potential reduced sensitivity to triazoles, was detected in pathogen samples from paddocks in New South Wales, South Australia, Tasmania and Victoria during testing in 2015. Resistance is now widespread in these states and has been confirmed in paddocks of southern Queensland.

A gateway mutation conferring resistance to Group 3 (DMI) fungicides has also been detected in isolates from the south west of Western Australia. Currently this is a laboratory detection only and no impact on paddock fungicide efficacy has been linked to the detection.

There are a range of mutations that can confer reduced sensitivity to DMIs in wheat powdery mildew. These can take many seasons to dominate a paddock

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population, although the effective control provided by fungicide applications will decline noticeably over this time as the mutations accumulate.

Additional fungicide options

Three 2023 emergency permits from the APVMA, in effect until 31 May 2027, allow growers to use the following fungicides for control of wheat powdery mildew.

- Quinoxyfen (Group 13) as Legend™ under PER93197.
- Proquinazid (Group 13) as Talendo® under PER93216.
- Metrafenone (Group 50) as Vivando® under PER93198.

It is important to note that these chemistries all specifically target mildews, have limited effect against other diseases and are best used at the first sign of infection. That means they will need to be used in addition to the current fungicide program (for control of rusts, septoria tritici blotch, etc) and are unlikely to provide a benefit once wheat powdery mildew becomes established.

As with all fungicides, responsible use within an integrated disease management strategy is important to protect the long-term efficacy of these products. AFREN recommends preventative sprays only when seasonal conditions are expected to be conducive to the pathogen.

Managing fungicide resistance

Fungicides are best applied curatively if the first signs of infection coincide with weather that is conducive for disease development and the crop is in its key growth stages.

Group 11 QoI actives work best as a preventative fungicide, given their contact nature. However, environmental conditions should be taken into consideration when applying mixtures containing QoI fungicides and spraying should coincide with conducive weather conditions for disease development, to minimise unnecessary prophylactic applications.

Fungicide management is largely a numbers game: Very high levels of disease can overwhelm an otherwise-effective fungicide and, as the pathogen population (disease pressure) increases, so does the likelihood and frequency of resistant individuals being present.

It is therefore better to use fungicide against a small pathogen population. That way, only a small number of resistant individuals will be present to survive the treatment and they will remain vulnerable to other competitive pressures in the agri-ecosystem.

Keeping the pathogen population low can be achieved by taking all possible agronomic steps to minimise disease pressure (see *Non-chemical controls* on page 3).

It is worth noting that wheat powdery mildew pustules will usually first appear on the lower leaves and lower leaf sheath, so careful inspection and good canopy penetration are both essential for effective fungicide use.

Fungicide resistance terminology

When a pathogen is effectively controlled by a fungicide, it is defined as sensitive to that fungicide. As fungicide resistance develops, that sensitive status can change to:

REDUCED SENSITIVITY

When a fungicide application does not work optimally but does not completely fail. This may not be noticeable at a paddock level, or the grower may find previously experienced levels of control require higher chemical concentrations up to the maximum label rate. Reduced sensitivity must be confirmed through specialised laboratory testing.

RESISTANCE

When a fungicide fails to provide disease control in the paddock at the maximum label rate. Resistance must be confirmed by laboratory testing and be clearly linked to a loss of control when using the fungicide correctly in the paddock.

LABORATORY DETECTION

A measurable loss of sensitivity can often be detected in laboratory in-vitro tests before or independent of any loss of fungicide efficacy in the paddock. Laboratory testing can indicate a high risk of resistance or reduced sensitivity developing in the paddock.

Fungicide usage recommendations

Fungicide rotation plans need to consider all fungal pathogens that may be present in a wheat crop. Otherwise, the fungicide treatment for one pathogen may select resistance in another.

When treating fungal diseases in wheat:

- **Avoid using Group 11** fungicides where resistance has been detected in wheat powdery mildew. Group 11 QoI resistance is easily selected for. It can escalate rapidly and spread widely.
- **Minimise** use of the **Group 3** fungicides in areas known to have resistance and monitor performance in regions where resistance and reduced sensitivity have been reported.
- **Avoid** applying more than three applications containing **Group 3** fungicides per growing season. Control of wheat powdery mildew with these products will be poor compared to other foliar diseases. Where reduced sensitivity has been confirmed, an average of 40-60 per cent control is typically achieved with Group 3 DMIs.
- **Always rotate Group 3** fungicides within and across seasons to avoid using the same Group 3 product twice in succession.
- **Group 11** fungicides should be mixed with a Group 3 product and applied at the first sign of disease. This will provide a curative and preventative control while minimising the likelihood of a purely prophylactic application.
- **Avoid** applying **Group 7** and **Group 11** products more than once per growing season, either alone (in the case of the Group 7 SDHIs) or in mixtures. This includes in-furrow or seed treatments with foliar activity, as well as subsequent foliar sprays. (Combined seed and in-furrow treatments count as one application.)
- **Monitor fungicide performance closely**, ensure good canopy penetration and report any clear decline or failure in fungicide effectiveness.

Non-chemical controls

Follow the AFREN 'Fungicide Resistance Five' recommendations for fungicide use. These guidelines can be applied to all crops and pathogens, regardless of their formal fungicide resistance status, to reduce the chances of resistance developing.

Wheat powdery mildew is favoured by susceptible wheat varieties growing in mild and humid weather (15° to 22° Celsius, relative humidity > 70%), with a dense crop canopy, high nitrogen levels, good soil moisture profiles and extended periods of damp, humid conditions under the canopy.

B. graminis survives on wheat stubble and volunteer plants. Spores can be spread to crops by the wind. The pathogen is crop specific and only infects wheat, not barley or other grain crops.

Recommendations for reducing disease pressure and spread include:

- **Planting less susceptible wheat varieties**
  Avoid growing S and VS wheat varieties in disease-prone areas. Any improvement in wheat powdery mildew resistance rating can help slow the rate of pathogen and disease development within a crop. This, in turn, reduces the reliance on fungicides for managing the disease.

  Research in the Upper Yorke district of South Australia by Trengove Consulting indicates that wheat powdery mildew can cause yield losses of 0.7 to 1.0 tonnes per hectare. (See 'Useful resources'.) As a result, planting varieties with an improved disease resistance rating over top-yielding S and VS rated varieties can provide a greater economic benefit than applying fungicides where the yield potential remains in this band.

  In top-yielding S and VS varieties, fungicides may not always protect the yield potential, and fungicide resistance risks must be considered when using fungicides to manage the disease.
- **Inoculum management**
  Eliminating volunteer wheat plants during fallow periods and reducing infected stubble loads through grazing, rolling, etc, will reduce the volume of spores spreading into an adjacent or subsequent wheat crop.
- **Practicing good crop rotation**
  A program of crop rotation creates a dynamic host environment that helps reduce inoculum levels from year to year. Wheat and barley powdery mildew are caused by different forms of *B. graminis* and are specific to their host crops. Barley powdery mildew will never infect wheat and vice versa. This means wheat and barley rotation is effective for reducing inoculum.
- **Avoiding early sowing**
  Later planting can delay plant growth until after the initial warm and damp period of early winter that favours wheat powdery mildew. This is important as infection of young plants can lead to increased losses at maturity. However, delayed sowing can have an associated yield penalty and growers need to consider their risks.

Photo: © GRDC

Wheat powdery mildew infection of wheat spikelets.

- **Careful nitrogen management**
  Excess nitrogen can favour disease development by promoting a dense, closed crop canopy. Nitrogen applications should be budgeted to measured soil N levels and target yield.
- **Encouraging air circulation**
  Actions that help increase airflow into the crop canopy can help lower relative humidity. This can include wider row spacing, reduced plant populations (without compromising yield potential) and, in mixed farming systems, grazing by livestock to reduce and open up the crop canopy.
- **Taking region-wide action**
  Resistant powdery mildew spores can spread easily. It is worth talking with neighbours and working together for integrated, area-wide fungicide resistance management practices.

AFREN PRINCIPLES

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

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The Fungicide Resistance Five provides a creed to follow.

The Fungicide Resistance Five
1 Avoid susceptible crop varieties
2 Rotate crops – use time and distance to reduce disease carryover
3 Use non-chemical control methods to reduce disease pressure
4 Spray only if necessary and apply strategically
5 Rotate and mix fungicides/MOA groups

Growers should seek to provide a strong and reliable foundation of resistant or less susceptible crop varieties, supported by non-chemical integrated disease management (IDM) that can be complemented by strategic and responsible use of fungicides.

Fungicide
Use fungicides only as necessary and apply strategically
- Rotate modes of action (MOA)
- Use mixtures (if available)
- Stay within label rates

Non-chemical farm management
Support with IDM to reduce disease pressure
- Stubble management
- Crop rotation
- Good hygiene
- Sow at the best time to avoid or tolerate disease
- Manage the green bridge

Variety selection
Start with a solid foundation
Where possible, select resistant or less susceptible varieties to reduce your reliance on fungicides throughout the growing season

FREQUENTLY ASKED QUESTIONS

How does fungicide resistance develop?

Fungicide resistance occurs when naturally resistant strains of a pathogen come to dominate the pathogen population in a paddock or region. These naturally occurring strains are 'selected for' by applications of the fungicide. That is, the non-resistant population is controlled by the fungicide while the resistant population is not. With repeated applications, the resistant individuals come to dominate the overall population and benefit from reduced competition.
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 pathogen in my crop?

If a fungicide application at the registered rate fails to exhibit full control of the disease, or if the application rate 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 and water rates, crop growth stage and notes on any evidence of a disease being present.

What should I look for?

It is important to inspect the crop within a two to three week window 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 resistant experts in your region.

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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USEFUL RESOURCES

Australian Fungicide Resistance Extension Network (AFREN)
Dedicated site for the latest fungicide resistance information, reference materials, case studies, grower surveys and news. grdc.com.au/afren

GRDC Video:
What to do about Wheat Powdery Mildew
https://youtu.be/SkSP8v5PywE

GRDC Podcast: *What to do about wheat powdery mildew*
grdc.com.au/news-and-media/audio/podcast/what-to-do-about-wheat-powdery-mildew

GRDC Update (August 2023): *Fungicide resistant wheat powdery mildew – update on management and resistance testing*
grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2023/08/fungicide-resistant-wheat-powdery-mildew-update-on-management-and-resistance-testing

GRDC Factsheet
***Fungicide-resistant wheat powdery mildew* (Oct 2024)**
Trengove Consulting
grdc.com.au/resources-and-publications/all-publications/factsheets/2024/10/fungicide-resistant-wheat-powdery-mildew

AFREN Fungicide Resistance Information Guide
Comprehensive guide to fungicide resistance issues, instances and management – including details of fungicide Mode of Action groups, chemical actives and diseases.
grdc.com.au/resources-and-publications/all-publications/publications/2021/fungicide-resistance-management-in-australian-grain-crops

AFREN Fact Sheet - Wheat
afren.com.au/resources#factsheets

MORE INFORMATION

Australian Fungicide Resistance Extension Network afren.com.au

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