

BARLEY POWDERY MILDEW FACT SHEET

WESTERN REGION

CONTROL STRATEGIES FOR POWDERY MILDEW

A combination of resistant varieties, plant health and effective fungicides are required to prevent widespread losses from powdery mildew outbreaks in barley.

KEY POINTS

- ▶ A single gene mutation in populations of the powdery mildew pathogen has caused disease control failure by some triazole fungicides.
- ▶ Use integrated disease management to reduce disease pressure and reliance on fungicides.
- ▶ Avoid VS and S varieties whenever possible in disease-prone areas.
- ▶ Use an effective seed dressing for early crop protection.
- ▶ Apply effective fungicides as soon as the disease becomes apparent; early control is essential to maximise fungicide efficacy.
- ▶ Strobilurin-based products (Group 11) should be used as preventive control rather than curative control; rotate with effective new generation DMI-based products (Group 3).
- ▶ Do not use tebuconazole fungicide to control barley powdery mildew; it is no longer effective in Western Australia.

Powdery mildew is a major issue for growers in the western region, particularly in south-west Western Australia. The selection of susceptible varieties and emergence of fungicide resistance makes it a difficult disease to manage.



PHOTO: KITHSIRI JAYASENA

Protecting barley yields from the effects of barley powdery mildew requires prompt fungicide application as soon as there is evidence of infection (inset).

The declining efficacy of some triazole-based fungicide products is the result of mutations in the barley powdery mildew pathogen.

Losses to barley powdery mildew have previously been estimated at \$30 million annually in WA. The epidemics of the disease in 2010 and 2011 resulted in substantial yield losses. Together with downgrading of malt barley to feed, the economic cost of the outbreaks could total more than \$200/ha.

The two most important strategies in preventing and controlling barley powdery mildew are:

- ▶ selecting varieties with improved resistance; and
- ▶ timely applications of effective fungicides.

What is barley powdery mildew?

Barley powdery mildew is a fungal disease caused by *Blumeria graminis* f. sp. *hordei* (BGH). BGH is an important disease of barley, especially in the western region, and is specific to barley and barley grass. It does not infect wheat or oats (they have their own mildews).

Severe infections can occur in winter during early crop growth, affecting the yield potential through tiller abortion. The disease generally declines later in the season, except in high-yielding situations with high nitrogen, or in humid coastal areas.

A severe infection at later growth stages can affect grain filling. Yields may be reduced by 1t/ha or more depending on the severity and timing of the infection.

Symptoms

Symptoms appear as fluffy white growths on the surface of the leaf. These are colonies of fungal spores. The colonies enlarge and coalesce, producing so many

spores that they appear powdery. The area surrounding the spores turns yellow as the fungus depletes the leaf nutrients. Older infections turn grey and may develop small black fruiting bodies called cleistothecia. When the spores are washed off by heavy rain, symptoms of old infections appear as brown patches on the leaves. Moderate to severe infection leads to premature yellowing and eventually the death of the entire leaf.

Sources of infection

The fungus survives as cleistothecia; 'black bodies' on stubble and plant residues. With autumn rains, spores are released from these bodies and infect volunteer barley and barley grass weeds. Spores produced on these plants can be carried hundreds of kilometres by the wind. Airborne spores are likely to be the main source of infection for barley crops. Spores that land on and infect emerging barley plants form the primary infection in the crop and appear as white powdery spores known as conidia.

Within the crop canopy, the white fluffy conidia are spread as a secondary infection by the wind. In favourable conditions the cycle of spore germination, infection and subsequent spore production can be completed in as little as six days. Rapid asexual reproduction causes the characteristic swift build-up of disease in

the crop. Powdery mildew infections do not tend to appear in 'hot spots' in crops; distribution is more general as infection is spread by wind.

Disease risk factors

- Sowing varieties susceptible to powdery mildew.
- Infection in the previous season, with inoculum over-summering on barley stubble, barley volunteers and barley grass.
- Autumn rainfall, which activates spores. High humidity and moderate temperatures following rain (5°C to 20°C) provide ideal conditions for the disease. The fungus cannot survive high temperatures and tends to die out once temperatures reach more than 25°C.
- Dense crop canopies that foster leaf wetness. This provides the kind of conditions the inoculum needs to germinate and penetrate the leaf.
- Consistently humid conditions. These occur more regularly in areas within 100 kilometres of the WA coast.

Selecting a variety

In powdery-mildew-prone areas, growers are advised to avoid barley varieties that are very susceptible or susceptible to disease (see Table 1). Most malting barleys

Table 1 2012 mildew resistance ratings of barley cultivars for Western Australia

Variety	Resistance to powdery mildew
Malt varieties	
Baudin [Ⓛ]	VS
Buloke [Ⓛ]	MR
Gairdner [Ⓛ]	S
Hamelin [Ⓛ]	S
Stirling	S
Vlamingh [Ⓛ]	S
Food varieties	
Hindmarsh [Ⓛ]	MS
Feed varieties	
Barque*	R
Capstan [Ⓛ]	MS
Commander [Ⓛ]	MS
Dash [Ⓛ]	R
Fleet [Ⓛ]	MR-MS
Hannan [Ⓛ]	S
Lockyer [Ⓛ]	MS
Maritime [Ⓛ]	S
Molloy	MS
Mundah	S
Oxford	R
Roe [Ⓛ]	MS
Scope [Ⓛ]	MR
Yagan	MR-MS
Yarra	S
Awaiting classification	
Henley	R
Bass [Ⓛ]	MS
Westminster [Ⓛ]	R

VS = very susceptible; S = susceptible; MS = moderately susceptible MR = moderately resistant; R = resistant
*under threat from virulent powdery mildew races

Source: WA Barley Variety Guide, Intergrain, Elders and ACNFP.



Barley powdery mildew appears as fluffy white growth on the surface of the leaves. The area surrounding the spores turns yellow as the infection depletes the leaf of nutrients.

are susceptible. Buloke[®], which is rated moderately resistant, has the best level of resistance among malting varieties. Varieties that are ranked MS or better may still require foliar fungicide treatment to be grown successfully.

When selecting a variety, consider market prices and demand, the availability and cost of fungicides and seasonal outlook. The mildew resistance rating of malting and feed barley cultivars are updated annually and are available from variety guides and the NVT website, www.nvtonline.com.au.

Powdery mildew pathogens, like rusts, can readily mutate to overcome specific-resistant genes, which will result in the downgrading of cultivar resistance ratings over time. Mutations can also result in a fungicide becoming ineffective.

Different types of disease resistance

There are several sources of resistance genes used to protect barley from powdery mildew. Non-race-specific resistance genes such as the 'mlo' resistance gene have remained effective for more than 50 years. The mlo gene is known to be carried in the cultivars Dash[®], Henley and Oxford.

Effective fungicides

In WA there have been reports of declining fungicide efficacy since 2005. In 2009, resistance to some triazole fungicides by powdery mildew pathogen populations was confirmed.

The 2010 and 2011 surveys of barley powdery mildew infection across the cereal belt showed that 100 per cent of samples tested carried the genetic mutation that confers resistance to tebuconazole.

As a result of these findings, tebuconazole should not be used for powdery mildew control. Its use may encourage further mutations that would make the pathogen resistant to other triazole fungicides.

Paddock observations indicate reduced efficacy of propiconazole and flutriafol for powdery mildew control in high disease pressure environments.

So far the mutation only affects the efficacy of some triazole fungicides (Table 2). It has no effect on the efficacy of strobilurin fungicides.

Table 2 lists the fungicides registered for use against barley mildew in Western Australia as at 1 January 2012. All products

Table 2 Fungicides registered in Western Australia for use against barley powdery mildew and effectiveness ratings, based on 2011 laboratory efficacy trials.

Group	Active ingredient	Trade name (representative products)	Foliar or seed	Fungicide effectiveness
GROUP 3 (DMI)	Triadimenol	Baytan [®]	S	Not tested
	Fluquinconazole	Jockey [®]	S	Effective
	Triticonazole	Real	S	Not tested
	Tebuconazole	Folicur	S and F	Ineffective
	Flutriafol	Impact	S and F	Ineffective
	Triadimefon	Bayleton [®]	F	Uncertain
	Propiconazole	Tilt [®]	F	Uncertain
	Propiconazole + cyproconazole	Tilt Xtra [®]	F	Uncertain + effective
	Tebuconazole + flutriafol	Impact [®] Topguard	F	Ineffective + ineffective
	Tebuconazole + prothioconazole	Prosaro [®]	F	Ineffective + effective
	Epoxiconazole	Opus [®]	F	Effective
GROUP 3 (DMI) + GROUP 11 (Strobilurins)	Cyproconazole + azoxystrobin	Amistar [®] Xtra	F	Effective + effective
	Epoxiconazole + pyraclostrobin	Opera [®]	F	Effective + effective

Source: Curtin University

contain active ingredients from the DMI mode of action group (Group 3) and some have two active ingredients, a DMI and a strobilurin.

This leads to recommendations for the use of fluquinconazole as a seed dressing and the foliar fungicide products Tilt Xtra[®], Opus[®], Opera[®], Amistar[®] Xtra and Prosaro[®]. If possible, apply fungicides with different active ingredients at each application.

The recommended products should be used according to the label rates.

Effective fungicide application

Always apply an effective seed dressing and use at full rate to ensure the maximum period of protection is provided. This recommendation applies to all varieties grown in mildew prone areas, regardless of their mildew resistance classification. Use of an effective seed dressing will help extend the effective life of both genetic and chemical control measures.

Effective in-furrow or fertiliser-applied fungicides can help prevent the onset of infection and reduce the number of foliar fungicide applications required later in the season.

Untreated crops can provide a breeding ground for the fungus, leading to severe epidemics once the effects of seed treatments have worn off. Widespread use of seed treatments may also reduce the risk

of further fungicide resistance by reducing the need for foliar sprays.

Monitor crops regularly from emergence for the first signs of an outbreak. Also regularly consult with neighbours, agronomists and check with updated information sources (see useful resources).

For greatest efficacy, foliar fungicides should be applied before significant levels of disease establish in the crop. Use the Strobilurin fungicides to protect the crop, rather than attempt to recover the crop. Fungicide applications after the barley powdery mildew has taken hold will rarely be very effective.

Spray early with fungicides such as Tilt Xtra[®], Opus[®], Opera[®], Amistar[®] Xtra and Prosaro[®] to control the disease. In disease-conducive environments it is possible that susceptible varieties may require two or three sprays.

- ▶ DO NOT apply fungicides if no disease is expected.
- ▶ DO NOT use tebuconazole for powdery mildew control in Western Australia (it does have value for rust control).
- ▶ DO apply fungicides before significant levels of disease establish.
- ▶ DO consider seasonal conditions. Are they are conducive to further disease development?
- ▶ DO apply fungicides according to label directions and restrictions.

Other farm management strategies

The GRDC is investing with registrants to bring new modes of action fungicides to Australia in 2012 to manage future resistance risks.

While varietal selection and fungicides are the most effective and widely used control strategies, there are other crop management practices that may help reduce the risk or severity of infection.

These include maintaining good farm hygiene and removing the green bridge, which may carry inoculum into the following season, particularly on volunteers of susceptible barley varieties and barley grass. Removing the green bridge can also reduce levels of leaf rust inoculum.

Avoid sowing back into barley stubble from highly infected crops, as mildew is carried as fruiting bodies on infested stubble.

Research shows that potassium-deficient crops are more susceptible to powdery mildew infection. Providing adequate potassium supplies through fertiliser applications will help crops to withstand infection.

High rates of nitrogen used at or just after seeding may encourage early and dense canopy growth. This could make crops more susceptible by providing conditions ideally suited to the infection. Dense canopies also make it more difficult to effectively apply fungicides in the event of an outbreak.

Trials at Gibson, WA, suggest that grazing barley crops before stem elongation may help to control powdery mildew without affecting yield. While providing feed for stock, this strategy physically removes the inoculum from the crop. It may also reduce dense canopy growth that could otherwise facilitate infection.

FREQUENTLY ASKED QUESTIONS

Why are some fungicides still working and not others?

Powdery mildew has many features that make the evolution of fungicide resistance especially likely. Triazole fungicides work by inhibiting an enzyme called Cyp51. Powdery mildew with a single mutation in this gene is enough to confer resistance to tebuconazole (and some other fungicides). Additional mutations are needed to confer resistance to other newer triazoles such as epoxiconazole and prothioconazole. Reducing reliance on fungicides will help extend the effective life of remaining products.

Last year I sprayed Opus® on my barley and it did not control powdery mildew; why not?

Once a barley crop has been badly infected, any fungicide will struggle to rescue the crop. The message is: keep ahead of the disease, use resistant varieties and be timely with fungicides.

Can I use tebuconazole to control other barley diseases?

Yes. So far no other barley disease has confirmed resistance to any fungicide, including tebuconazole. If there is little or no risk of powdery mildew infection, select the fungicide that is best suited to the management of the disease threat; that includes any older C3-DMI products.

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USEFUL RESOURCES

Bulletin 4826: Barley Variety Guide for WA for 2012

www.agric.wa.gov.au

DAFWA Farmnote 216: Potassium deficient barley is more susceptible to powdery mildew disease

www.agric.wa.gov.au

DAFWA Farmnote 466: Management of barley powdery mildew in the face of fungicide resistance

www.agric.wa.gov.au

GRDC Disease Links

www.grdc.com.au/director/events/linkpages/diseaselinks

National Variety Trials online

www.nvtonline.com.au

Pestfax

www.agric.wa.gov.au/PC_94564.html

Mildew Mania

<http://science.curtin.edu.au/outreach/citizen-science.cfm>

ACNFP

<http://acnfp.curtin.edu.au/>

GRDC RESEARCH CODES

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