

CEREAL FUNGICIDES FACT SHEET

SOUTHERN REGION

MANAGING CEREAL FUNGICIDE USE

Understanding foliar fungal diseases of cereals and how to manage them is in the interests of both the grower and the grains industry as a whole.

KEY POINTS

- ▶ Fungicides are only one component of a good management strategy.
- ▶ Correct identification of the cause of plant symptoms is essential, and an understanding of the growth and spread of any pathogen will assist in any decision making.
- ▶ Cultivar resistance is the best protection against fungal diseases.
- ▶ Understand the role of the season and have a plan in place, and if growing susceptible varieties have the right chemicals on hand.
- ▶ For cereal rusts and mildew, remove the green bridge between crops.
- ▶ Monitor crops throughout the season.
- ▶ Fungicide resistance is an important issue for powdery mildew control in Western Australia and may develop in other states and other pathogens in the future.

Identifying and understanding fungal disease

Most diseases that affect cereals are caused by fungi. A fungal species that causes disease is called a pathogen.

Fungal pathogens feed off living plants, diverting carbohydrates that are required for grain fill to their own growth and reproduction.

They also reduce the green area of the plant that is required for carbohydrate production and so reduce growth and grain fill of infected plants.

Where fungi infect the stems of plants, further damage is caused by blockage of the transport tissues that feed carbohydrates to the grain. It is this stem damage that often causes the most severe yield losses.

Many plant symptoms are confused with disease, and this may lead to wasteful disease control decisions.

Nitrogen deficiency, for example, may be mistaken for yellow spot, and some

symptoms of herbicide phytotoxicity can be mistaken for fungal lesions.

Barley responds to a range of stresses by developing spots – it may not be disease.

Different fungi have different life cycles and have specific environmental requirements.

To manage these diseases it is important that the correct fungal species is identified so the most effective control strategy can be followed.

Aim of fungicide use

Fungicides reduce the growth of pathogens so the plant tissues that provide carbohydrates to the grain are protected from damage.

They can be applied to seed, in the furrow or directly onto the leaves and stems as foliar sprays.

The most important plant parts for grain fill are the final three leaves, stems and heads.

However, the best way to protect these tissues is often by applying seed or soil treatments or sprays during stem



PHOTO: HUGH WALLWORK

Net form of net blotch in barley is a necrotrophic pathogen that starts with tiny brown lesions that elongate into dark streaks along and across the leaves. Management includes selection of resistant varieties, crop rotation (avoid sowing barley into barley stubble), seed treatment, and crop monitoring with a view to fungicide applications, if required.

elongation. This will reduce the growth and reproduction of the fungus in the weeks leading up to their appearance as:

- ▶ fungicides are better at protecting than eradicating disease;
- ▶ early treatments can reduce the amount of airborne pathogens spreading through a district from one crop to another;

TABLE 1 Growth stage and leaf emergence

Development phase	Zadoks growth stage	Approximate leaf emergence stage
Stem elongation (GS30-39)	GS32 (second node)	Leaf 3 (F-2, the second leaf underneath the flag) emerges on main stem.
	GS33 (third node)	Leaf 2 (F-1, the leaf underneath the flag) emerges on main stem.
	GS37	Flag leaf just visible on main stem.
	GS39	Flag leaf fully emerged on main stem.
Booting (GS40-49)	GS49	First awns emerging, flag leaf sheath extended.

COURTESY: NICK POOLE, FAR AUSTRALIA

- ▶ some pathogens appear very rapidly and can multiply and cause extensive damage before a grower is able to apply a foliar fungicide; and
- ▶ where a pathogen can cause stem or head infection, it is critical that inoculum is kept at a low level in the canopy, as fungicides are far more difficult to use effectively on diseases in later growth stages.

It is important to be able to correctly identify the growth stages of plants so the top three leaves, leaf sheaths or head can be sprayed before they are infected (see Table 1).

Fungicide modes of action

There are two modes of action available in foliar fungicides used in Australian cereals:

- ▶ Group 3 Demethylation inhibitors (DMIs), including triazoles;
- ▶ Group 11 Quinone outside inhibitors (QoI), or strobilurins.

Fungicides work differently on different diseases. Some are more mobile in the leaves than others.

Flutriafol is an active ingredient that is highly mobile in the plant. When applied with fertiliser it enters the root system and moves up the developing plant, providing protection.

Products that combine different active ingredients, particularly if one is a Group 3 and one a Group 11 fungicide, may provide more complete protection for a plant.

Disease management

Measures to employ at sowing include:

- ▶ fungicide seed dressings;
- ▶ fungicide applied on fertiliser; and
- ▶ liquid in-furrow application at sowing.

If a variety is susceptible to **stripe rust**, chemical control at seeding will provide initial protection. A further foliar application is also likely to be required, particularly in higher rainfall regions with longer seasons. Often GS37 to GS39 is a good time for this spray.

Depending on the treatment used at seeding, protection can be effective from eight weeks to early to mid-stem elongation.

Protection against **rust** with a fungicide applied at seeding is less effective on the top two leaves of the crop canopy, as the fungicide is diluted by plant growth during stem elongation.

Seed and in-furrow treatments are also effective on powdery mildew (sensitive strains) and to a lesser degree on scald in barley. They are not effective against yellow

leaf spot or the net blotches.

Foliar fungicide timing

Factors that influence spray timing recommendations include:

- ▶ growth stage;
- ▶ level of disease;
- ▶ length of the grain fill period;
- ▶ crop yield expectations;
- ▶ whether the region/season is high or low rainfall and if an early seasonal cut-off is expected;
- ▶ the resistance rating of the variety; and
- ▶ the likelihood of disease.

With rust-susceptible wheat varieties where in-furrow treatments or fluquinconazole seed treatments have been used, the first foliar fungicide can usually be delayed until the emergence of the flag leaf (GS37 to GS39). This should provide season-long protection.

At this time, apply fungicide directly to the top three leaves of the canopy.

If pre-seeding treatments have not been used, the strategy with susceptible cultivars should assume that two foliar fungicides may be required.

The first spray is applied at the start of stem elongation, first to second node (GS31 to GS32) to protect flag-2 (F-2); the second at flag leaf fully emerged on the main stem (GS39) to protect the flag leaf and flag-1 (F-1).

Where wheat varieties have a useful level of adult plant resistance (APR), there will be less need to apply two foliar fungicides. Only a single fungicide may be required between GS32 and GS39, depending on the variety, seasonal conditions and disease presence on the top three leaves.

Where a longer-lasting fungicide has been applied at seeding to varieties with APR, there may be no need to apply any follow-up fungicide, particularly in drier environments.

In high-rainfall situations more conducive to disease, a follow-up fungicide can achieve greater returns.

Sprays applied with the herbicides during tillering when no rust is evident are often included for logistical reasons: to save an operational pass or as a risk-reduction strategy.

Depending on when **rust** appears in the district, these sprays may provide a critical delay in any epidemic build-up and reduce the need for later sprays. They will not protect the top three leaves

(flag, F-1, F-2), however, as they will not have emerged.

If **stripe rust** infection is observed during tillering, spraying will reduce inoculum pressure, but it will not protect the key top leaves or be as effective as the best seed or in-furrow treatments.

Spraying during tillering may therefore need to be followed by further sprays at both the start of stem elongation (GS31 to GS32) and again at flag leaf emergence (GS39) where cultivars are susceptible.

Stem rust is a disease that does not appear in crops until later in the season when the weather is warmer, but it can move rapidly once established.

Spraying for **stem rust** can be economical at much later growth stages than with other diseases.

Sprays at GS45 to GS51 (booting to early ear emergence) are more effective on stem rust on the flag leaf sheath. Later sprays, GS55 to GS75, are more effective on disease on the ear and the peduncle.

The optimal single spray timing is around GS55 to GS59, with timing dependent on the onset of infection.

Foliar fungicides are more effective in controlling rusts and mildews than they are in controlling necrotrophic diseases such as yellow leaf spot and the net blotches.

Sprays for **net blotch** control are usually only effective for two to three weeks or until a new leaf emerges, as the fungicide does not effectively suppress infection on the lower dying leaves.

Sprays for **yellow leaf spot** control during tillering are usually uneconomical. In the south, the disease rarely progresses up the plant to any damaging degree, and if it does, fungicide will not control the source of inoculum in stubbles or on dead lower leaves.

Control of any disease is highly dependent on the timing of application, with product choice, rate and method of application also important. Higher rates of recommended product will give longer protection and are usually more effective on harder-to-control diseases.

Barley disease management

In barley, the flag leaf contributes less to yield than it does in wheat: F-1 and F-2 leaves are more important. However, the flag leaf sheath in barley is also a major contributor to yield and it is not exposed until awn emergence (GS49).

Protection of these leaves in barley is centred on two principal fungicide timings:



PHOTO: McINTOSH, WELLINGS, PARK



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PHOTO: McINTOSH, WELLINGS, PARK

Leaf rust (left) can be identified by small circular to oval orange-brown pustules, mainly on the upper surface of the leaf. **Stem rust (centre)** is characterised by oval, elongated reddish-chestnut-brown pustules with tattered edges. It will infect both sides of the leaf, the leaf sheaths, the stem, the peduncle and the outside of the head. The distinctive appearance of **stripe rust (right)** is caused by small yellow-orange circular pustules arranged along yellow stripes. It mainly infects the upper surface of the leaf, but can also appear on the leaf sheaths, the awns and inside the glumes.

at the start of stem elongation (GS30 to GS32) and from flag leaf to first awn emergence (GS39 to GS49).

The first spray is particularly effective against the earlier disease infections, such as scald and net blotch, as well as powdery mildew and early leaf rust infection.

The second timing more fully protects the upper crop canopy, particularly F-1 and the flag sheath from the same diseases, particularly leaf rust. The second spray is more important in disease-susceptible cultivars and in seasons with a softer finish.

Fungicide application

Foliar fungicides need to cover a much larger plant area than herbicides. Unlike herbicides, they are translocated in only one direction (from the point of contact towards the leaf tip) so fungicides will protect only the portion of the leaf that is visible at the time of spraying. When applying fungicides, a higher carrier volume (around 70 to 80 litres) is needed.

New emerging leaf material is unprotected, although the earlier spray will mean inoculum levels are lower.

Medium to medium-coarse droplets

provide the best coverage. Fine droplets have poorer penetration of the crop canopy and present a greater risk of spray drift. Coarse droplets are not always retained on a waxy leaf surface as they can bounce off.

Tips for optimal fungicide efficacy

- ▶ Ensure thorough boom decontamination.
- ▶ Understand most fungicides have limited translocation. Hence coverage is required where control or protection is needed.
- ▶ Use a minimum of 70 to 80L carrier volume and medium to medium-coarse droplets. In denser canopies, more volume may be required if the product needs to reach the lower parts of the canopy.
- ▶ Limit speed to less than 20 kilometres per hour. Higher speeds risk spray coverage being concentrated on only one side of the plant.
- ▶ Consider a narrower nozzle spacing (for example, 25 centimetres), with one angled forwards and one backwards, or twin jets. If using this option, limit speed

to 16km/h.

- ▶ Use the correct surfactant, if advised, as per label recommendation.
- ▶ Use minimum controller hold settings to avoid pressure loss and under-dosing at the ends of runs where seed and pressure are normally reduced.

Aerial application (in non-controlled traffic systems) is another option for most foliar fungicides and is generally less damaging to the crop because there are no wheel tracks.

Aerial application works well with much lower carrier volumes (around 30 to 40L) for products designed to protect the flag leaf or upper parts of the foliage. However, higher application volumes may be required where deposition is needed in lower parts of large canopies.

However, barriers to aerial application (trees, power lines, proximity to roads/waterways) can be an issue and may leave parts of a paddock unsprayed that would otherwise have been covered with an application using a ground rig. This can cause issues with more rapid reinfection of a paddock once the fungicide protection wanes.

Economics

The decision to apply a fungicide for disease control is usually based on economics. That is, will the fungicide application give an economic return greater than the cost of application? Factors to consider are:

- ▶ the presence of disease;
- ▶ yield potential;
- ▶ potential loss of yield and quality;
- ▶ commodity prices; and
- ▶ cost of fungicide plus application.

A break-even return suggests that the application is not warranted. Many growers consider a 100 per cent return on

TABLE 2 Modes of action registered for control of foliar diseases in Australian cereals

Group	Active ingredient	Example product name	Foliar (F), seed (S) or in-furrow (IF)
3 – DMI	Triadimefon	Triad®	F and IF
	Propiconazole	Tilt®	F
	Propiconazole + cyproconazole	Tilt® Xtra	F
	Tebuconazole	Folicur®	F and S
	Flutriafol	Impact®	F, S and IF
	Tebuconazole + flutriafol	Impact® Topguard	F
	Tebuconazole + prothioconazole	Prosaro®	F
	Epoxiconazole	Opus®	F
	Difencconazole	Dividend®	S
Triadimenol	Baytan®	S	
3 + 11 (Strobilurins)	Fluquinconazole	Jockey®	S
	Azoxystrobin + cyproconazole	Amistar® Xtra	F
	Pyraclostrobin + epoxiconazole	Opera®	F

COURTESY: RICHARD OLIVER, CURTIN UNIVERSITY

the cost of spraying justifies application of a fungicide.

A decision to spray a crop may also be made on the economic protection that that spray will provide to surrounding crops where spores will travel from one crop to another.

Fungicide resistance

Resistance to several fungicides has recently been confirmed in the barley powdery mildew population in WA. This affects the older triazole fungicides tebuconazole, flutriafol and triadimenol. The only remaining seed treatment effective against barley powdery mildew in WA is fluquinconazole.

The resistance to fungicides has been attributed to the widespread growing of the very susceptible (VS) variety Baudin, low use of seed treatments on barley and conducive environments for infection.

Large amounts of fungal inoculum and the repeated use of similar fungicides has led to the selection of resistant mutants of the fungus.

In the southern region, growers can help reduce the threat of fungicide resistance by avoiding the use of VS varieties, treating all barley seed with seed treatments and, where sprays are required, rotating with the fungicides that remain effective in WA.

These are the triazoles (propiconazole, cyproconazole, prothioconazole and epoxiconazole) and the strobilurins (azoxystrobin and pyraclostrobin). See Table 2, page 3.

Growers should instead consider rotating with fungicides from alternative modes of action (for example Amistar® Xtra, Opera®) and the remaining triazole fungicides (for example Tilt®, Tilt® Xtra, Prosaro®, Opus®). Refer to Table 2 for active ingredients.

GRDC PROJECT CODES

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PHOTO: RICHARD OLIVER

Powdery mildew is identified by the white fungal strands on the leaf or stem surface. These can develop black fruiting bodies later in the season which are the survival structures of the fungus. Infection on the stem requires early control before the canopy closes.



PHOTO: HUGH WALLWORK

Yellow spot is characterised by coloured sections of dead leaf tissue surrounded by a tight yellow margin. It is not well controlled by foliar fungicides, so primary management decisions need to be made prior to or at sowing. Avoid wheat-on-wheat, and select varieties with some level of resistance (noting the resistance levels to other diseases).

The GRDC is investing in research to bring new Australian modes of action to manage these risks.

Stewardship

In the absence of diseases or any threat of diseases, it is uneconomical and unnecessary to apply fungicides.

Good management practices such as controlling the green bridge for cereal rusts, attention to potential risk of stubble-borne leaf disease when deciding on crop rotations, and avoiding susceptible varieties will reduce the reliance on fungicides and disease pressure overall.

MORE INFORMATION

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Advancing the management of crop canopies: A cereal crop management guide

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Free Phone: 1800 11 00 44

E-mail:

ground-cover-direct@canprint.com.au

Adult plant resistance (APR) Fact Sheet

[www.grdc.com.au/GRDC-FS-](http://www.grdc.com.au/GRDC-FS-AdultPlantResistance)

[AdultPlantResistance](http://www.grdc.com.au/GRDC-FS-AdultPlantResistance)

Cereal disease diagnosis

Samples of infected tissue should be in paper packaging – paper bags, envelopes or wrapped in newspaper. Do not send samples in plastic.

Hugh Wallwork

Plant Research Centre

Hartley Grove

Urrbrae SA 5064

Rust samples:

Samples of rust-infected plant tissue should be sent in paper packaging to:

Australian Cereal Rust Survey

Plant Breeding Institute

Private Bag 4011

Narellan NSW 2567

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