FUNGICIDE TIMING
FACT SHEET

GRDC Grains Research & Development Corporation

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Location influences foliar fungal disease control options

When faced with foliar fungal diseases in cereals, control and damage limitation strategies need to be tailored to the rainfall region, variety resistance status and the disease.

KEY POINTS

- Appropriate control strategies need to be selected for the region, crop type and prevalent diseases.
- Understanding key growth stages is critical if returns from inputs including fungicides and water use are to be optimised.
- Variety resistance is the simplest method of disease control but may not always be the most profitable.

Foliar fungal diseases of wheat and barley, such as stripe, leaf and stem rust as well as powdery mildew, can result in substantial losses in all but resistant varieties if left unchecked (Figure 1).

While variety resistance remains an important line of defence against yield loss due to foliar fungal diseases, other strategies also need to be considered.

Research has found:

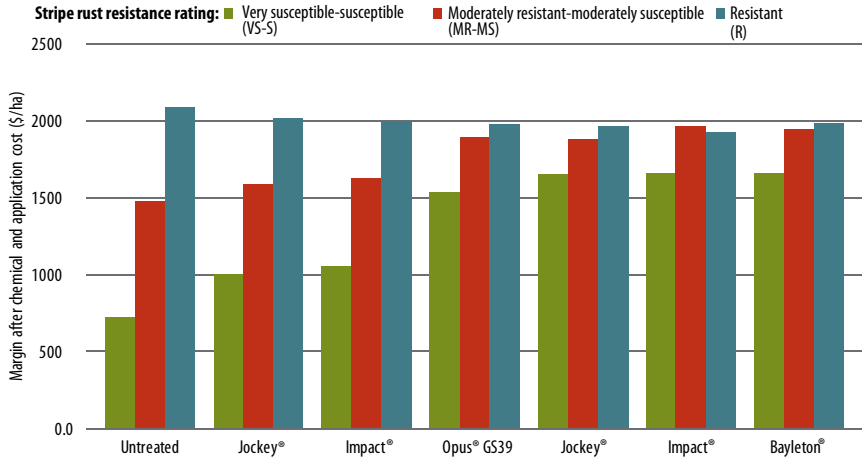
- in the High Rainfall Zones with a longer growing season, the combination of less resistant varieties and appropriately timed fungicide applications can sometimes result in higher yields;
- adult plant disease resistance becomes effective at:
  - different growth stages; and
  - under different environmental conditions in different varieties; and
- fungal diseases can mutate resulting in the breakdown of resistance in an otherwise productive variety.

Fungicides represent the last line of defence against disease after other measures such as stubble management, seed hygiene and crop rotation have been considered.

The aim of foliar disease control is to match the period of disease protection to the period of green-leaf retention determined by water availability and temperature.

Information in this fact sheet is based on work reported in the publication *Disease Management and Crop Canopies* (see Useful Resources). More details on product choice and the interaction between nitrogen timing and disease management can be found in this publication.

FIGURE 1: FLAG LEAF SPRAY VERSUS UPFRONT – MARGINS $/HA, 2005



VS-S	734	1007	1062	1542	1653	1664	1661
MR-MS	1482	1592	1635	1899	1883	1971	1952
R	2094	2025	2002	1978	1974	1935	1993

Jockey® seed treatment based on 450ml/100kg costed at $20/ha; Impact® in furrow 400ml/ha costed at $20/ha Opus® 250ml/ha GS39 costed at $15/ha; Bayleton® 1.0l /ha GS32 costed at $5/ha. Wheeling damage from foliar sprays based on 2.5% yield loss with $7.50/ha application cost for foliar sprays. Grain at $300/tonne.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 2 6166 4500 | f. +61 2 6166 4599 | e. grdc@grdc.com.au | w. www.grdc.com.au

VARIETY RESISTANCE

When a cereal variety is truly resistant to a disease (rated R), there will be no response to a fungicide application, since the fungicide only protects an inherent yield potential that would have been expressed in the absence of disease. Before disease management is dismissed, it is important to make sure that the variety is resistant to all the major diseases prevalent in that region.

For varieties with intermediate resistance to disease (rated MR to MS), the timing of a disease outbreak in the crop's lifecycle and the speed at which it develops will influence choice and timing of disease management (Figure 2).

Earlier infections tend to be associated with greater disease susceptibility and need earlier intervention. Greater disease resistance delays the onset of a disease epidemic.

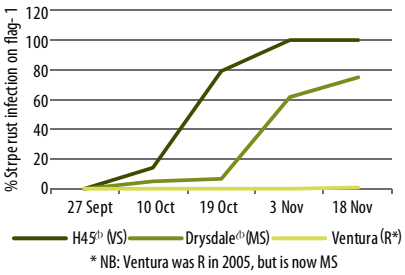
Some varieties will be more susceptible to early disease (seedling susceptibility) and then develop greater resistance at stem elongation: this is termed adult plant resistance (APR). With these varieties it is important to make sure that earlier sowing and/or increased disease early in the season does not destroy green leaf tissue on flag-2 and flag-1 (Figure 5) prior to the expression of APR.

Regional differences

In trials in the High Rainfall Zones (HRZ) for the control of stripe rust, fungicide application for disease control changed the overall ranking and profitability of individual cultivars (Figure 3).

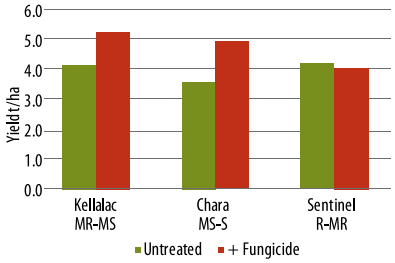
Based on current knowledge, resistant varieties should be selected where they can prove to be more profitable than disease susceptible varieties grown with a disease management package, particularly in regions with higher rainfall and a longer growing season.

FIGURE 2: INFLUENCE OF VARIETY RESISTANCE ON STRIPE RUST DEVELOPMENT – YOUNG, NSW 2005



* NB: Ventura was R in 2005, but is now MS

FIGURE 3: INFLUENCE OF FUNGICIDE ON 3-YEAR MEAN YIELD (T/HA) – SFS INVERLEIGH, SOUTHERN VICTORIA 2005–07



UPFRONT DISEASE CONTROL

Fungicide treatments can be applied upfront, on the seed or applied in furrow, to provide protection to the emerging cereal crop.

For varieties with poor resistance to stripe rust, upfront measures can delay the epidemic but are likely to need a follow up in-crop fungicide to protect the upper leaves of the canopy.

However, for varieties with poor seedling resistance and good APR it may be appropriate to protect the crop upfront, or with a foliar fungicide at GS31–32 (Figure 5), and rely on APR activity for later disease protection.

These upfront measures are also particularly useful where early sowing is carried out or where protection against root disease, such as Take-all is required.

Stripe rust and barley mildew.

Trials found that upfront treatments can give good disease control of stripe rust until stem elongation (GS30) – in some environments through until flag leaf emergence (GS39). Similar results have been found with mildew in barley.

In untreated crops where there is an early infection of stripe rust, older leaves generally show higher infection than younger leaves exposed to the disease for less time. With upfront treatments the newer leaves, with less active ingredient to protect them, show higher infection.

Stem and leaf rust

Though there will be some effect of upfront treatments on leaf rust, the mostly later onset of this disease means the active ingredient may have dissipated in the upper leaves of the canopy. Currently, upfront treatments are not registered for stem rust.

Regional differences

In some short season scenarios where crops become infected early and the subsequent grain fill period is curtailed by hot dry conditions, upfront treatments can be the most cost effective option.

However in longer season scenarios with higher rainfall, upfront options such as seed and in-furrow treatments do not give sufficient protection to the three upper-most leaves of the crop canopy (flag, flag-1 and flag-2). This is due to the lack of the active ingredient moving into the largest leaves of the crop (Figure 4a and b).

With high stripe rust pressure in the HRZ, a single foliar fungicide applied at flag leaf emergence (GS37–39) was more cost effective than the best upfront sowing options (Jockey® and Impact® in furrow) applied alone.

FOLIAR FUNGICIDES

When it comes to using foliar fungicides, the difference in strategy between high and low-rainfall zones becomes increasingly important as does the type of disease that is prevalent.

In principle, the period between growth stages GS30–39 (the start of stem elongation through to flag leaf emergence) is important for applications of nitrogen and fungicides to protect key leaves, such as the flag leaf in wheat and flag-1 in barley (the leaf below the flag leaf) (Figure 5).

Regional differences

In the HRZ the contribution of the top three leaves to yield is much greater than the same leaves of a cereal crop grown in the drier Mallee regions. This is because in the HRZ there is much greater contribution to yield from post flowering leaf photosynthesis (in effect a longer grain fill period).

In the Mallee crops there is less contribution from the leaves and relatively more from the stem. As a general rule disease infection of these leaves has less impact in the Mallee than in the HRZ.

However, stem rust is equally destructive in both environments if warm, humid conditions that favour the disease prevail, since the greatest impact of this disease is on the stem. Stem rust infection will prevent carbohydrate reaching the ear.

Stripe Rust – High Rainfall Zone

With a susceptible variety, a two-spray program with foliar fungicides applied at GS32 and GS39, has proved to provide economic control of stripe rust in the HRZ.

However in trials with a susceptible and moderately susceptible variety, there was little yield difference in performance between controlling stripe rust infection pre-flag leaf (GS39) with an upfront measure (Jockey® and Impact® in furrow) or a stem elongation foliar spray (Figure 1).

Stripe Rust – low-rainfall region

In drier regions with shorter growing seasons, responses to all fungicides are reduced and the relative advantage of foliar fungicides is reduced or nullified in comparison to upfront measures.

In these environments the yield difference between upfront and in-crop options is more evenly balanced, provided disease development is evident in the crop at pre-flag leaf emergence.

In a shorter season scenario (eg the Mallee), the shorter grain fill period gives less opportunity for a single flag leaf fungicide to be suitably effective. To better control disease in this scenario would either require an earlier timed foliar fungicide or the use of a superior upfront measure (Jockey® and Impact® in furrow).

The length of time taken for a leaf to emerge is called the **phyllochron** *and is driven by temperature. It is measured in day degrees (°C days) meaning that the length of time for leaf emergence in calendar days depends on the temperature. Most wheat cultivars have phyllochrons of approximately 100 -120°C days. At a mean daily temperature of 15°C it would take approximately seven to eight days for a new wheat leaf to emerge.*

FIGURE 4A: UPFRONT VERSUS FLAG LEAF FUNGICIDE ON A SUSCEPTIBLE VARIETY – LONG SEASON/HRZ SCENARIO

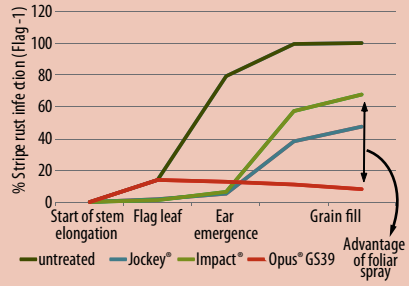


FIGURE 4B: UPFRONT VERSUS FLAG LEAF FUNGICIDE ON A SUSCEPTIBLE VARIETY – SHORTER SEASON/DRIER SCENARIO

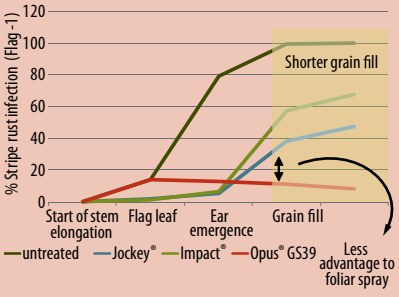
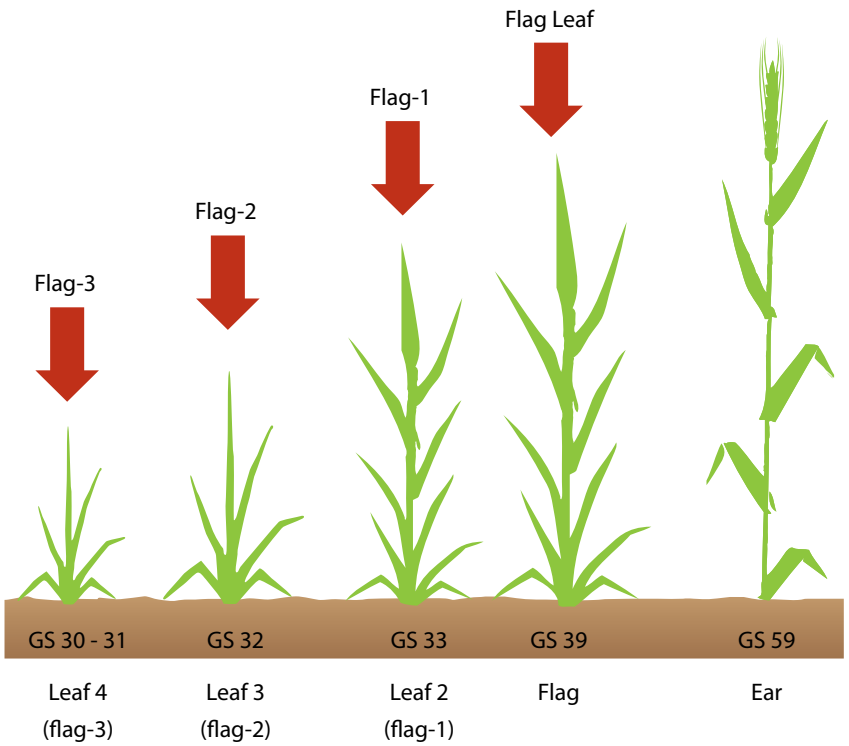


FIGURE 5: AT WHICH STAGE DO THE IMPORTANT LEAVES EMERGE?



Stem rust – all regions

Unlike other rusts the severe impact of stem rust can be expressed in crops with a low yield potential as well as in the high-rainfall areas.

Spraying for stem rust can be economic at a later growth stage than other diseases (for example, stripe rust) since the disease can affect the plant stem and ear late in the season.

Yield increases of 56 per cent have been obtained from GS71 (watery ripe stage) applications in research conducted in WA. Generally fungicide is effective at preventing subsequent infection when stem rust severity is slight on the plant parts to be protected.

Early sprays before head emergence (GS45–51) are more effective for stem rust infection on the flag leaf sheath. After ear emergence up to grain fill (GS55–75), foliar sprays are more effective for stem rust infection on the peduncle (stem to the ear). Optimum single timing appears to be centred around ear emergence GS55–59.

However:

- if infection is building up on leaf sheaths then a flag late-boot spray (GS39–51 spray) may be necessary; or
- if another disease requires application of a flag spray then this will control early stem rust infection, provided the product is suited. If ideal conditions persist for disease development, a GS39–51 spray will not control the disease on the peduncle and ear itself.

Leaf rust and powdery mildew – barley, High Rainfall Zones

Across three years of trials in WA, a single foliar fungicide on barley was more effective than an upfront measure.

If applied at GS33 when the most important leaf is emerging (flag-1) a three-fold increase in yield and margin was achieved compared to the use of an upfront measure (Impact® in furrow).

Better green leaf retention during grain fill was more important than disease control prior to the start of stem elongation (GS30–31). Trials found that applying two foliar fungicides, instead of using an upfront followed by a single foliar spray or upfront treatments only, produced the best economic returns.

In the six years of trial work, leaf rust and powdery mildew were not encountered at sufficient levels to generate positive results from fungicide application.

The aim of foliar disease control is to match the period of disease protection to the period of green-leaf retention determined by water availability and temperature. Crop type, region and prevalence of diseases need to be considered when selecting disease control strategies.

PHOTO: EMMA LEONARD

Useful resources:

Disease management and crop canopies – a new cereal management guide	**Ground Cover Direct, 1800 11 00 44**
Southern Farming Systems (SA, Vic, NSW and Tas – High Rainfall Zones)	**www.sfs.org.au**
South East Premium Wheat Growers Association (WA – High Rainfall Zone)	**www.sepwa.org.au**
Birchip Cropping Group (Vic)	**www.bcg.org.au**
Hart Field site	**www.hartfieldsite.org.au**
Yorke Peninsula Alkaline Soils Group (SA)	**www.alkalinesoils.com.au**
GRDC website, Rustlinks	**www.grdc.com.au/rustlinks**

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