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# Disease Management in wheat (2023)

## National overview for the High Rainfall Zone (HRZ)

Currently the spectrum of foliar wheat disease varies enormously across the HRZ of Australia, and, as a consequence requires different management approaches. For a number of regions, the expected change to drier conditions forecast back in the autumn has yet to happen, but could well be a consideration for those growers in longer season HRZ scenarios in Victoria, SA and Tasmania where fungicide decisions will be made later in the spring. It's by no means an exhaustive list but there are a number of factors to consider as we think about our foliar fungicide management plan for wheat crops this spring.

- *2022 was a year of extreme disease pressure in the eastern states, so let's not farm this year's crop on the rebound, 2023 won't be like 2022, even though it may feel like it in some regions currently!*
- *Stripe rust pressure and Septoria tritici blotch (STB) pressure was enormous in 2022 and needed to be controlled in early stem elongation (GS30-32 – pseudo stem erect – second node), and depending on the cultivar, is likely to remain problematic, particularly in susceptible varieties.*
- *However, it's noteworthy that these two diseases are not currently widespread in the WA HRZ landscape. Consequently, responses to fungicide in wheat are not as great in the WA HRZ as they are in the eastern states currently.*
- *The lack of diversity in germplasm is currently a major problem, and inevitably puts pressure on our fungicide armoury in terms of fungicide resistance.*
- *An example of this has been seen with the popular cultivar Scepter, which in some states, in particular SA, has created a wheat powdery mildew (WPM) epidemic, along with susceptibility to stripe rust and Septoria tritici blotch (STB).*
- *With credit to several industry bodies and manufacturers, growers now have access to three mildewicides with new modes of action for use in wheat based APVMA permits.*
- *Fitting these fungicides into strategies will need careful considerations, as is the case with mildewcides globally; as the name suggests they control WPM but are generally not broad spectrum against other fungicides.*
- *Although in its infancy here in Australia compared to herbicide resistance, fungicide resistance is now a factor influencing our fungicide management strategies, particularly the mildew, net blotch and Septoria tritici pathogens.*
- *Fungicide resistance is complicated by the fact that some regions may be more affected than others, and that the effect on some modes of action is full resistance, whilst in other regions the effects may reduce the level of fungicide control but do not confer complete resistance to the fungicide (reduced sensitivity).*
- *Check out the Australian Fungicide Resistance Extension Network (AFREN) Fungicide Resistance Management guide at grdc.com.au/AFREN or bring yourself up to date at the up-and-coming AFREN2 workshops being held around the country.*

The strategy approaches outlined below are pointers to assist with decision making, and due to the nature of the HRZ must not be taken as a recommendation, since individual paddock scenarios have to be determined by visual inspection of the crop and knowledge of the pathogen in that region. In addition, it is important to note that climate variability across seasons and regions makes it important to use your own crops as the principal "barometer" of your fungicide strategy.

Strategy Summary

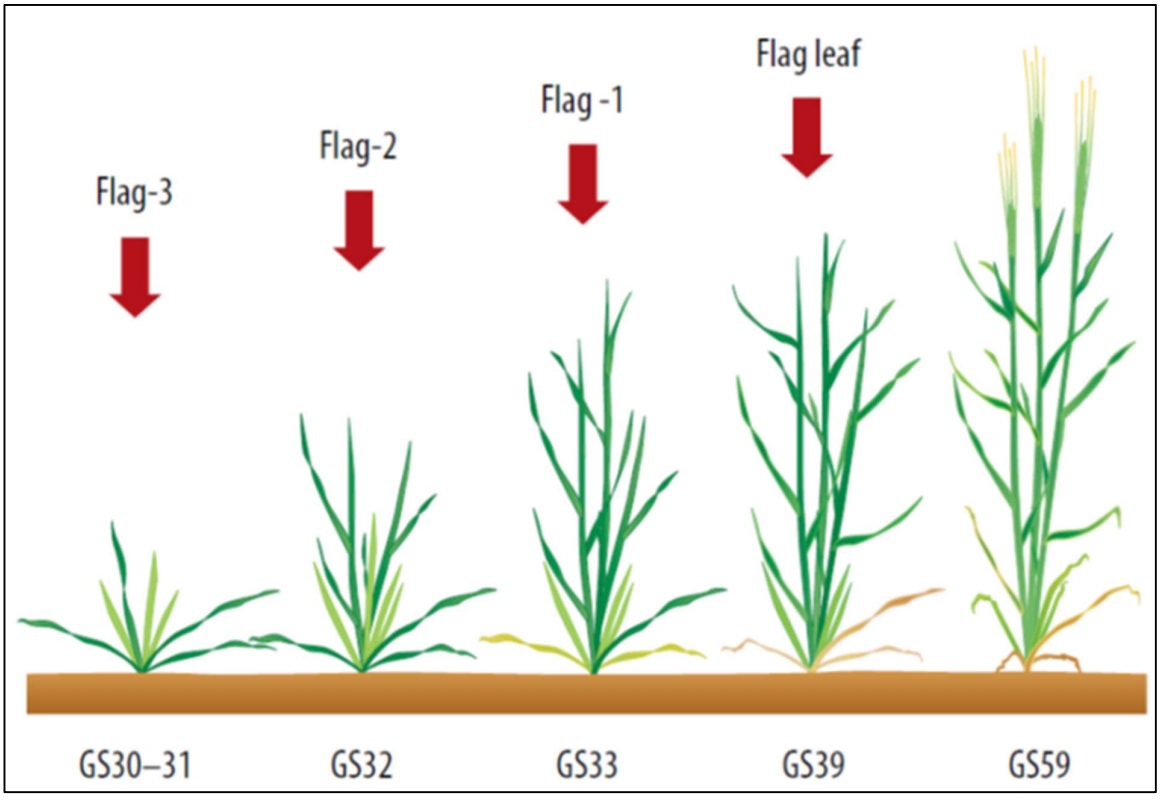
Start with some fundamental questions about your crop and its disease levels and/or expected disease levels. Always start with the visual inspection of the crop at specific development stages as the primary prerequisite to determining fungicide application.

## A checklist for fungicide strategy in wheat

- ***Step 1 – When setting out a foliar fungicide strategy for disease susceptible varieties ensure you protect the "money leaves".*** *These are the last top three to four leaves of the canopy that are associated with producing the carbohydrate to fill the grain. These leaves emerge during stem elongation (GS31 – GS39) and are crucial to protect with fungicide if yield potential is to be maintained.*
- ***Step 2 – What diseases are prevalent in the crop****? If there is no disease in your crop, what are you spraying for? Is the disease problematic in your region? E.g. Septoria tritici blotch (STB) & Stripe rust are not prevalent diseases in WA.*
- ***Step 3 – Is your cultivar susceptible (know your potential weaknesses) or is your farming system predisposed to key diseases?*** *E.g. Stated many times but a MS rating for disease resistance gives much greater protection against disease than S or SVS rating. Stubble retention, e.g wheat on wheat increases prevalence of disease, particularly stubble borne diseases such as STB. Following 2022 there will be high stubble inoculum of diseases such as STB. Did you have a pronounced green bridge to aid the multiplication of rusts in the green bridge? Can my farming system be improved to reduce disease risk & maintain profit?*
- ***Step 4 - Are you in a region where fungicide performance has been impaired by reduced sensitivity or fungicide resistance?*** *E.g. Wheat Powdery mildew (WPM) control has never been a strength of our approved fungicides, but we now have QoI (Group 11) resistance in the WPM pathogen populations in SA, VIC, TAS and NSW, meaning our levels of control are likely to be even poorer.*
- ***Step 5 – Challenge your system for a more Integrated Disease Management (IDM) approach.*** *E.g. Earlier sowing often increases disease pressure (particularly for necrotrophic stubble borne diseases such as STB). Therefore, with later sowing your strategy may not have to be as intensive (e.g. lower label rates or less expensive chemistry) as required in earlier sown crops. Remember that the variety's phenology still needs to be adapted for later sowing. Is grazing something that can be used to reduce your fungicide usage in mixed farming systems?*
- ***Step 6 – Plan a fungicide strategy – based on key intervention periods to maximise profit and minimise fungicide resistance risk.*** *Set out below are the key timings to be considering when putting together your fungicide strategy. These development stages take into consideration the emergence of the "money leaves" and the level of disease infection at that time.*

## What are the "money leaves", why are they important, and at what growth stages do they emerge?

The "***money leaves***" is a term used in cereal disease control to describe the most important leaves in cereal crops to protect from disease. The money leaves are the last four leaves that the cereal plant produces prior to the emergence of the head (ear), the activity of which is most associated with filling the developing grain of the crop. Of these four leaves it is the top two that are the most important in wheat, whilst with barley, it is the flag leaf sheath rather than the flag leaf that is the most important, since the flag leaf is relatively small in barley compared to the size of the other top four leaves. These important leaves are described by their position relative to the flag leaf (the last leaf to emerge and highest up the stem). The leaves underneath the flag form the next leaf layer down from the flag leaf, these are referred to as flag minus 1 (F-1) for the leaf immediately under the flag, then F-2 for the next leaf layer down and so on F-3, F-4 etc. The money leaves emerge during stem elongation when the crop starts to increase in crop canopy size and height. As a result, this period is considered critical for protecting the crop if disease is building up in the base of the crop canopy. So, at what growth stages do the important leaves emerge from the wheat plant? (See diagram).



## Strategies for control of foliar disease in wheat

**1 spray approach (GS39)** – most appropriate in better seasons with low disease pressure as result of resistant cultivar, later sowings or flutriafol at sowing.

**1 spray approach (GS31/32)** – most appropriate in seasons where disease is present in the crop requiring action but in the following 3-4 weeks a spring drought occurs and dry weather acts as the second fungicide. Most likely in lower rainfall regions rather than HRZ.

**2 spray strategy (GS31/32 & GS39)** – Typical for many scenarios where disease is present in the crop during stem elongation and variety susceptibility increases disease risks. Don't stretch the gap between sprays (Mind the Gap! – details below).

**2 spray "straddle programme" (GS33 & GS55/59)** – This is where the timing of two fungicides either side of flag leaf replace the application of three. It requires better disease resistance to allow a delay in the first spray, or the use of flutriafol at seeding (which has been effective on disease).

**3 spray strategy (GS31/32, GS39 & GS59/61)** – "Belt and braces" approach in a season with better yield potential and high disease pressure due to region, variety, and earlier sowing date.

**4-unit strategy (Sowing, GS31/32, GS39 & GS59/61**) – "Belt and braces" approach with additional stripe rust protection in the period leading up to stem elongation provided by flutriafol. Where no flutriafol applied consider a fourth foliar spray at GS30 but only if stripe rust or severe WPM is present. 4-unit approaches should only be required in the HRZ in very good seasons.

## Fungicide timing considerations for the different strategies

### GS30 (start of stem elongation)

This spray timing should not be necessary if flutriafol in furrow has been used on the basal fertiliser.

If no flutriafol or broad-spectrum foliar acting seed treatment has been applied at sowing, then consider this very early spray timing where stripe rust or severe wheat powdery mildew (WPM) is noted in the crop canopy.

Overall, this is generally a less important timing for fungicides in wheat as the primary "money leaves' have not yet started to emerge.

Remember, GS30 is typically at least 6-8 weeks before the flag leaf emerges so it won't protect the key leaves below the flag F-1 and F-2.

So, "Mind the Gap" between the first and second spray.

In 2022 many crops were sprayed at this growth stage (or before during tillering) and then did not receive a second or further spray until flag leaf. This led to the principal money leaves of F-1 and F-2 being badly infected since they were not directly protected with fungicide. So "Mind the Gap" is the key message if you start your fungicide programme very early (end of tillering – GS30) and aim to follow up at flag leaf. Only consider spraying very early when you have clear evidence of severe disease, and/or if your cultivar is susceptible. Spraying at this stage is likely to require a further fungicide application before the crop reaches flag leaf since the ideal timing intervals between fungicide sprays is 3 – 4 weeks. In the extreme infection conditions of 2022, it was probably less than 3-week intervals between fungicides that was needed in order to control infection!

### GS31-32 (1st – 2nd node) – approximately Flag -2 (F-2) emergence & F-3 coverage

The GS31/32 fungicide in the HRZ is typically the second most important spray timing in the strategy and is essential for susceptible varieties where that disease is present in the crop.

The timing traditionally coincides with the emergence of the first of the important "money leaves", F-2 and F-3, with F-2 being the most important.

Ideally this should be sprayed no more than 4 weeks earlier than the flag spray application (GS39), particularly when conditions are conducive for disease.

In a wet disease conducive HRZ season it is the flag leaf spray that will be the most important fungicide application, not GS31-32 since the upper two leaves are more important than F-2 and F-3.

In a dry and less disease prone season, the relative importance of the GS31/32 spray is elevated compared to the flag leaf, but the overall response to fungicide application is reduced.

Dry weather following the GS31/32 application will reduce the expenditure required for the flag spray (in effect drier weather following the GS31/32 now forms part of a more tactical approach).

In regions where STB and stripe rust are not present in the crop or region (e.g. many regions of WA) consider whether there is sufficient disease to warrant spraying, and if possible delay application to the next leaf emergence F-1 and F-2 at GS32-33 (second – third node) and then reassess. If by virtue of better resistance ratings and lack of the disease this is achievable, then it may be possible to reduce the number of fungicide applications, particularly if the second half of the growing season (flag leaf onwards) turns dry. Where disease pressure is very high in susceptible varieties, and evident in the crop at GS31/32, consider expenditure on mixtures of DMI (Group 3 triazoles) with strobilurins (QoI Group 11) or SDHIs (group 7). Where that is not the case, then straight DMIs or DMI mixtures could be considered for more disease resistant scenarios. If no disease is present, consider what you are spraying for, particularly if you applied flutriafol or used a broad-spectrum seed treatment?

### GS33 – (third node) approximately flag-1 emergence & F-2 coverage

Do not adopt delayed applications of the first fungicide to GS33 where the cultivar is susceptible to STB or stripe rust and the disease is present in the crop. A scenario currently most likely to be prevalent in the eastern states.

For more resistant cultivars, or in scenarios in WA where there may be no disease at GS31-32, it may be possible to delay the first fungicide until the emergence of F-1 which typically emerges in the late second node/early third node stage of development.

Delaying the first foliar application will be more successful where upfront applications of flutriafol have been used, or where wheat has been sown much later (late May onwards).

A delayed first spray with a follow up at early head emergence is referred to as a "Straddle Spray Programme", since two fungicides are applied either side of flag leaf emergence.

This potentially results in two sprays replacing three based on lower disease pressure at the start of stem elongation. If after a delayed first fungicide, disease pressure is reduced by drier weather post flag leaf, potentially one application with drier weather acting as the second fungicide will suffice. FAR Australia continues to research the key thresholds and disease resistance ratings to refine this approach. It is also worth stating that if conditions dry up in the period of stem elongation (GS30-39), and the cultivar is resistant to the dominant disease in the region, it may assist the first fungicide

being delayed further until flag leaf emergence itself. Again, this is particularly pertinent in shorter season HRZ scenarios where flutriafol was adopted at sowing with little or no disease development evident in the crop (a scenario more likely in WA this season).

### GS39 – flag leaf emergence on the main stem

In a typical HRZ season with good yield potential, this will be the most important spray application for a wheat crop as it protects the two most important leaves.

In a HRZ season where the spring turns dry between GS31 and GS39, dry weather will be a key part of the strategy as it will be very effective at preventing upper canopy infection.

If this occurs, either the rate could be reduced (ability to use lower label rates) or the need for more expensive chemistry is removed.

Wet conditions susceptible varieties

Where disease pressure is very high in susceptible varieties, and conditions between GS31-39 have been conducive to disease, then better chemistry based on mixtures of DMI (Group 3 triazoles e.g. prothioconazole, epoxiconazole, cyproconazole) with strobilurins (QoI Group 11 – e.g.azoxystrobin or pyraclostrobin) or SDHIs (group 7 – bixafen, benzoviniflupyr) will be warranted, remembering that the protection conferred will lead to good green leaf retention during grain fill.

Dry conditions - more resistant varieties

Where the season turns dry leading up to flag leaf, with a similar outlook for the rest of the season, then higher label rates will not be warranted and lower label rates of mixtures or straight DMIs or DMI mixtures (tebuconazole & prothioconazole e.g Prosaro) could be considered. With more resistant cultivars, always take a reference observation from the crop itself to justify what and why you are spraying.

### GS59-61 – head emergence – first flower on the main stem

This is frequently referred to as the “head spray”.

This description probably overlooks its primary purpose, which is to top up the fungicide activity in the flag leaf when a better season for yield potential leads to greater upper crop canopy duration.

In many scenarios outside the HRZ, this approach is not warranted as drier conditions reduce the yield response of this final spray in most LRZ and MRZ regions.

Key diseases that warrant this input are the three rusts (stripe, leaf and stem), fusarium, and in severe infections WPM.

Of course, 2022 saw the widespread use of these head emergence timed sprays due to continued disease pressure and stripe rust infection of the head. However, for 2023 we must be mindful that the conditions won’t be the same and may not warrant the use of fungicide after flag leaf. However, in the HRZ there is more justification for this application provided that conditions post flag leaf remain conducive for disease, if they don’t then the application may not be warranted, even in the HRZ. With product choice be mindful of harvest withholding periods and label growth stage cut offs.

## Fungicide resistance considerations

It is not illegal to apply two SDHIs in wheat crops or two QoI's, but since these fungicides are at generally higher risk of resistance development, it is preferable to consider only using one per season. It's also important to note that where two applications are applied there are restrictions on applying SDHIs back-to-back in wheat crops.

It's important to remember that one of the primary drivers of fungicide resistance in the pathogen is the number of fungicide applications it is subjected to (i.e. increased number of fungicides increases the selection pressure, or the period the pathogen population is exposed to the fungicide).

Note that the earlier you start spraying foliar fungicides, particularly before the start of stem elongation, the more fungicides you are likely to apply in a season with good yield potential with conducive conditions for disease. So, if you are spraying foliar fungicides during the tillering stage, ensure to go through the justification of what you are spraying for and the value of the leaves you are protecting, since in such scenarios you will commit yourself to more fungicide applications when they may not be necessary. If key diseases are present in susceptible crops, then consider GS30 applications, but remember to "Mind the Gap" and consider the timing interval to the next spray.

## Cultivar susceptibility and response to fungicide management

Although 2022 was subject to extreme disease pressure, and is unlikely to be repeated in 2023, it did allow the disease resistance and response to fungicide to be evaluated in a number of different varieties, particularly against STB and stripe rust in the eastern states. The pressure of these two diseases varied with region, with leaf rust and wheat powdery mildew being of secondary level importance at the principal FAR Australia Crop Technology Centres at Wallendbeen, NSW, Gnarwarre, Victoria and Millicent, SA. Few of the trials in the WA HRZ suffered from severe disease infection, and as a result, the differences in response to disease control were small or negligible relative to trials in the eastern states.

Wallendbeen, southern NSW (high altitude) – Stripe rust and STB were both equally dominant.

Gnarwarre, Victoria (HRZ) – STB was more aggressive than stripe rust.

Millicent, SA (HRZ) – both diseases were aggressive with leaf rust more noticeable than at other sites.

**Wallendbeen, NSW**

In NSW the fungicide management responses reflected the different disease susceptibilities (Figure 1) and indicated that whilst both diseases were very severe, susceptibility to stripe rust was relatively more damaging. At the higher altitude at Wallendbeen where infection tends to occur later in stem elongation, the genetic resistance of Anapurna, Big Red and RGT Cesario to STB was very clear, although it's important to note that stripe rust affected RGT Cesario for the first time in 2022 FAR trials and was particularly aggressive in some states such as Tasmania. Of the milling wheats at Wallendbeen, it was the winter wheat Illabo that was the standout in terms of better disease resistance to stripe rust and a much smaller yield response to fungicide. However other varieties were badly infected with stripe rust which was the dominant disease (Figure 2).

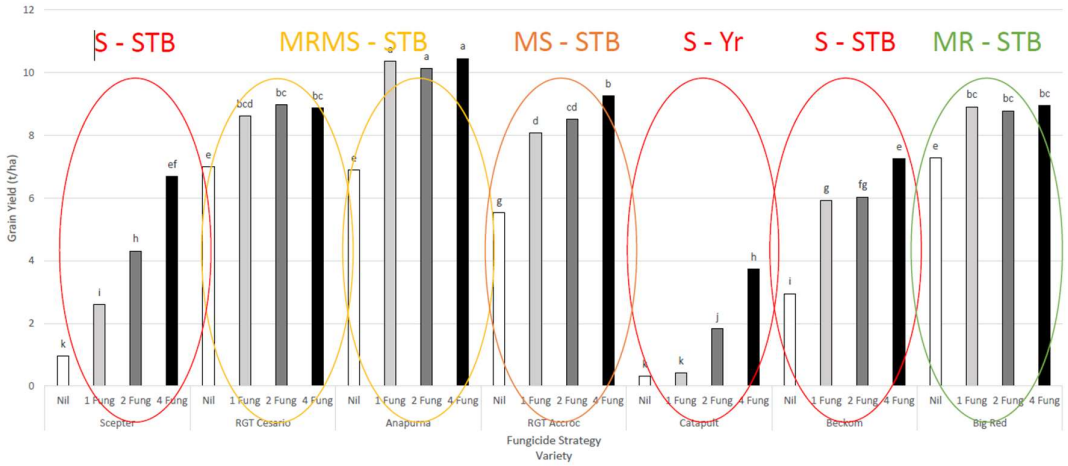



**Figure 1.** STB & Stripe rust rating and the response to fungicide (Fung) (Nil, 1, 2 or 4 fungicide units) – Wallendbeen, NSW 2022 (GRDC Hyper Yielding Crops Project). STB = Septoria Tritici Blotch, Yr = Stripe Rust.

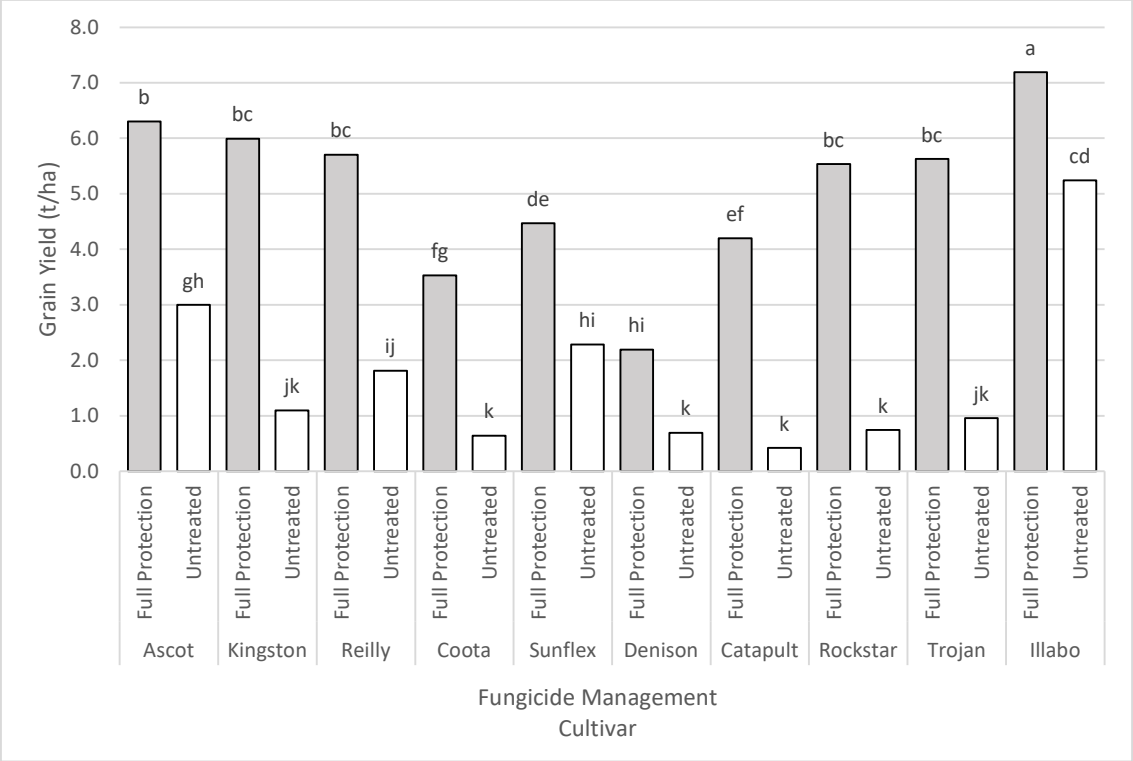



**Figure 2.** Yield response (t/ha) to fungicide (3 fungicide units vs. untreated) in milling wheats– Wallendbeen, NSW 2022 (FAR GEN Industry Innovations (II) 2025).

**Millicent, SA**

Stripe rust for the first time was more aggressive than STB in RGT Accroc, particularly at the SA site. In the SA HRZ at Millicent, where the feed wheat is popular amongst growers, it gave a 5t/ha response to fungicide management (1t/ha untreated and 6t/ha treated with three fungicide units), further indicating the deterioration of its genetic resistance as the variety has become more

widespread across the HRZ. Beaufort at the SA site showed no stripe rust or leaf rust infection but had its yield halved with STB infection, a cultivar very susceptible to this disease. In 2022 it was extremely difficult to control with fungicide, although later sowings in May were less affected than late April sowings. The newer red grained feed wheats AGTW0005 (French in origin for release in 2024) and AGFWH0004818 (to be released in 2024) had impressive genetic resistance in comparison to RGT Accroc, with the white wheats Stockade and RGT Waugh giving intermediate responses to fungicide (2-2.5t/ha).

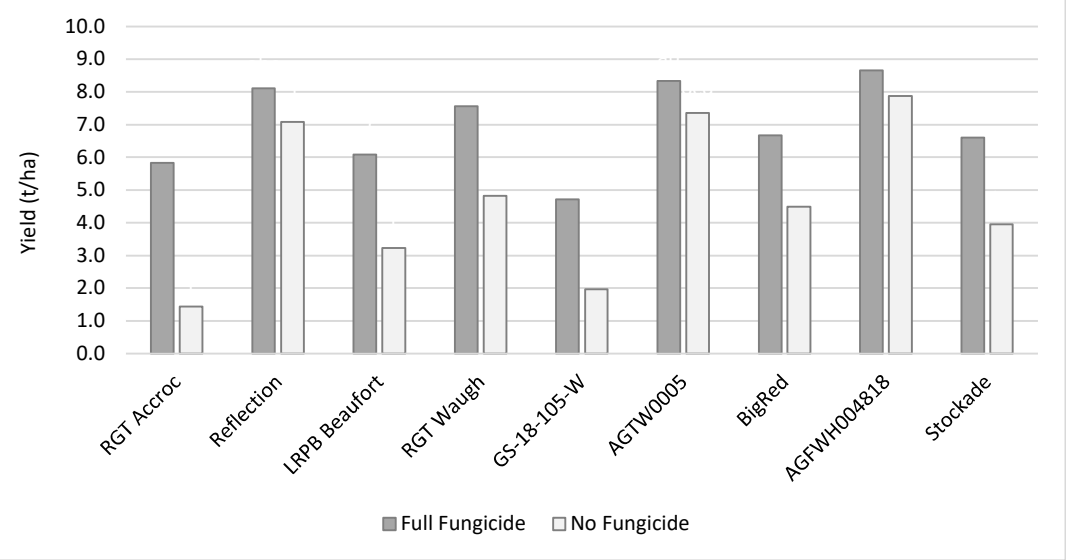



**Figure 3.** Yield response (t/ha) to fungicide (three units) vs. untreated – Millicent, SA 2022 (GRDC Hyper Yielding Crops Project).

**Gnarwarre, VIC**

In the southern Victoria region, although stripe rust and leaf rust were present, it was STB that was the more dominant disease, and the yield response to fungicide application in RGT Accroc was moderated to 3t/ha. Beaufort is worthy of comment in that the data appears to show little response to fungicide, however infection was so severe with this late April sowing that even the treated plots succumbed to STB. RGT Waugh and Stockade showed similar intermediate response to fungicide, similar to that experienced at other sites. The newer red grained feed wheats AGTW005 and AGFWH0004818 gave impressive resistance to the STB pathogen when the extreme severity of the 2022 season was considered.

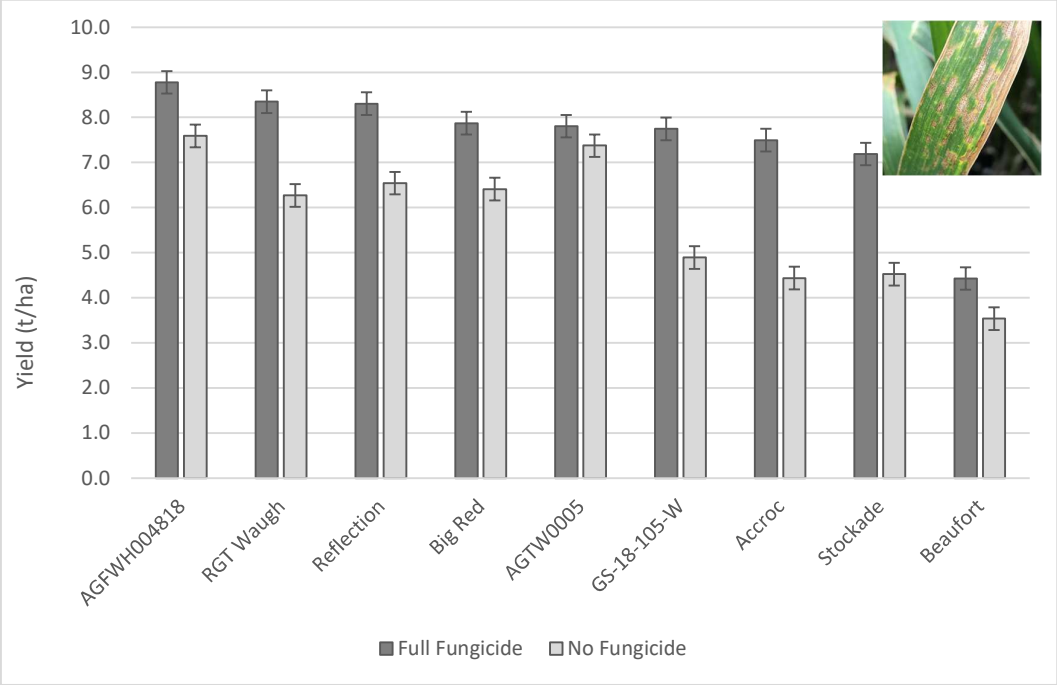



**Figure 4.** Yield response (t/ha) to fungicide (three units) vs. untreated – Gnarwarre, VIC (HRZ) 2022 (GRDC Hyper Yielding Crops Project).

Overall, the trials gave an indication of the most and least fungicide responsive varieties in a season of very high disease pressure where the stripe rust and STB pathogens were the dominant diseases. The trials continue to show that in the HRZ, along with regions of higher productivity, we must have varieties with high yields, the right phenology, stiff straw, and good genetic resistance (particularly to the STB and rust pathogens) if we are to farm more profitably and sustainably. Currently, we have good resistance in feed wheat candidates coming through but seemingly less options in the milling wheat space.

Greater genetic resistance in our varieties reduces the number of fungicides we use which in turn helps reduce the speed and development of fungicide resistance in the pathogen. This is vitally important if we are to maintain the activity of these critical inputs into the future.



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