2023: A TESTING year for cereal disease management!

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GRDC codes

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Take home message

- The 2022 season was very conducive to a range of cereal leaf diseases and Fusarium head blight (FHB) during flowering and grain fill
- However, this exceptional season for cereal diseases needs to be kept in perspective
- Leaf disease pressure, especially stripe rust, will likely be high again in 2023 requiring management early in the season, but plans need to be responsive to spring conditions
- Seed retained from any crop where FHB or white grains were evident in 2022 must be tested for Fusarium infection levels as it negatively impacts on germination and vigour
- Widespread FHB in 2022 is the Fusarium crown rot (FCR) fungus letting you know that it has not gone away with wetter and milder spring conditions the last few seasons
- Do you know your FCR risk in paddocks planned for cereals in 2023, especially if sowing durum?
- Help is available with testing and stay abreast of cereal disease management communications throughout the season, as 2023 is likely to be another dynamic year.

Introduction

Cereal disease management has become complicated over the past three consecutive wet seasons with multiple stripe rust pathotypes blowing around and an increase in diseases not frequently seen in central and northern areas (e.g., Septoria tritici blotch, wheat powdery mildew and Fusarium head blight). This has all occurred in combination with the added stress of increased input costs, with many growers stating that '2022 was the most expensive wheat crop they have ever grown'. This certainly created an elevated level of anxiety for growers and their agronomists. Deep breathe……

So, if 2022 taught us nothing else, it is that we cannot control the weather. However, nothing has changed and in 2023 growers need to have extra focus on 'controlling the controllable'. The 2022 season needs to be kept in perspective, as it was the year for leaf diseases and by default returns from multiple fungicide applications in susceptible varieties. However, what are the chances of still lighting the inside wood fire in November 2023?

2022 – What a season!

2022 was wet! Records were broken and flooding was widespread in some areas. Frequent rainfall is very conducive to the development of leaf diseases such as stripe rust, as causal pathogens require periods of leaf wetness or high humidity for spore germination and initial infection. However, just as a significant contributing factor to the prevalence of cereal leaf diseases was the spring (Sep-Nov) temperatures in 2022, even compared with 2020, which remained mild (Figure 1).

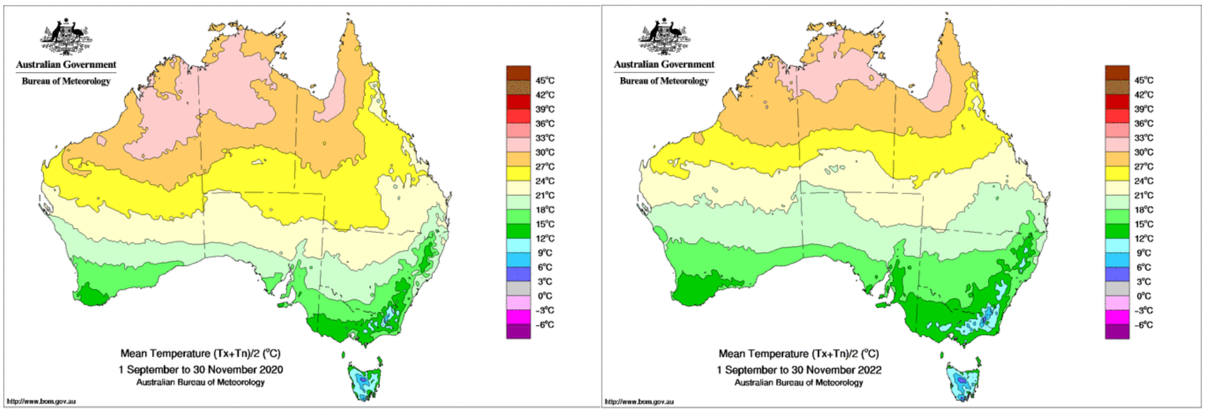

Figure 1. Mean daily temperature for spring (Sep-Nov) in 2020 (left) compared with 2022 (right).

Temperature interacts with cereal diseases in two ways. Each pathogen has an optimal temperature range for infection and disease development (Table 1). Time spent within these temperatures dictates the latent period (time from spore germination to appearance of visible symptoms) of each disease which is also often referred to as the cycle time. Disease can still develop outside the optimum temperature range of a pathogen, but this extends the latent period. Hence, prolonged milder temperatures in 2022 were favourable to extended more rapid cycling of leaf diseases such as stripe rust, Septoria tritici blotch and wheat powdery mildew (Table 1).

Table 1. Optimum temperature range and latent period of common leaf and head diseases of wheat

Disease	Optimum temperature range	Latent period (opt. temp)
Stripe rust	12-20°C	10-14 days
Septoria tritici blotch	15-20°C	21-28 days
Wheat powdery mildew	15-22°C	7 days
Leaf rust	15-25°C	7-10 days
Yellow leaf spot	15-28°C	4-7 days
Fusarium head blight	20-30°C	4-10 days

The second effect that temperature can have on disease is more indirect on the plants themselves. The expression of adult plant resistance (APR) genes to stripe rust can be delayed under lower temperatures. However, cooler temperatures also delay development (phenology) of wheat plants, extending the gap between critical growth stages for fungicide application in susceptible wheat varieties. The slower phenology under cooler spring temperatures therefore increases the time of exposure to leaf diseases in between fungicide applications, which is the case for stripe rust which was also on a rapid cycle time under these temperatures. Hence, underlying infections can be in their latent period and also beyond the curative activity (~1/2 of cycle time with stripe rust) when foliar fungicides are applied. This can result in pustules appearing on leaves 5 or more days after fungicide application. The fungicide has not failed, rather the infection was already present but hidden within leaves and was too advanced at the time of application to be taken out by the limited curative activity of fungicides. At optimum temperatures, stripe rust has a 10-day cycle time in an S rated variety, whereas it is a 14-day cycle in a MRMS variety. Disease cycles quicker in more susceptible varieties! Reliance on fungicides for management made susceptible (S) wheat varieties critically reliant on correct timing of fungicide application. Frequent rainfall in 2022 caused plenty of logistical issues with timely foliar fungicide applications related to paddock accessibility by ground rig and/or delay in aerial applications. The associated yield penalty was significantly higher in more stripe rust susceptible varieties due to the shorter disease cycle time. There were plenty of reports of 10-day delays in fungicide applications around flag leaf emergence (GS39) due to uncontrollable logistics that saw considerable development of stripe rust, particularly in S varieties. Yield loss at harvest has been estimated at around 30-50% due to this 10-day delay. This simply does not happen in more resistant varieties, where there is more flexibility in in-crop management, because the disease is not on speed dial when climatic conditions are optimal. The 2022 season has certainly challenged the risk vs reward of growing susceptible varieties – the management of which does not fit logistically within all growers' systems.

The prolonged cool conditions in spring 2022 also extended the flowering period in wheat and durum varieties, which in combination with extended high humidity, was very conducive to Fusarium head blight (FHB). The prevalence of FHB and white grain disorder (*Eutiarosporella* spp.) across large areas of eastern Australia in 2022 is unprecedented. However, what is the likelihood of these specific conditions occurring at a time critical growth stage (early flowering) again in 2023?

Can we really grow susceptible varieties in the longer term?

Always a solid topic for debate. From a plant pathologist viewpoint, the following are simply fact.

- Pathogens with longer distance wind dispersal (e.g., stripe rust and powdery mildew) are 'social diseases'. What you do impacts on your neighbours and the rest of industry. Yes, 'it blows'
- Stripe rust has a shorter cycle time in more susceptible varieties which equals increased disease pressure
- More susceptible varieties can place increased disease pressure on surrounding MS, MRMS and MR varieties
- The more susceptible the variety, the greater 'green bridge' risk volunteer plants present to survival of biotrophic pathogens such as stripe rust and wheat powdery mildew during fallow periods
- Mutations within the pathogen population which lead to 'break down' of resistance genes or development of fungicide resistance is all a numbers game. More susceptible varieties produce more fungal spores = increased risk of mutations
- Susceptible varieties have less flexibility with in-crop fungicide timings. The yield penalty is much larger if application is delayed (i.e., increased production risk)
- Susceptible varieties are reliant on fungicides, often multiple within conducive seasons, to control leaf diseases. This increases selection for fungicide resistance or reduced sensitivity within the pathogen population either directly (e.g., with rust) or indirectly on other fungal pathogens also present at the time of application (e.g., powdery mildew)
- Rust pathogens CAN develop fungicide resistance!! (see Rob Park paper).

Keep the 2022 season in perspective

The 2022 season was the year for fungicides, especially in more susceptible varieties and with the mix of various diseases that occurred. The prolonged mild conditions also extended the length of grain filling so there was a benefit of retaining green leaf area through this period in 2022. Remember, fungicides do NOT increase yield, they simply protect yield potential (i.e., stops disease from killing green leaf area). As highlighted above, disease is very dependent on individual seasonal conditions, so the same returns are not guaranteed from fungicide use in 2023. What's your disease management plan if spring returns to closer to normal temperatures and rainfall? There is no talk of La Niña again in 2023 and seasonal outlook must be part of disease management planning. Early leaf disease pressure is likely to be high again in 2023, given elevated inoculum levels from 2022 and decent levels of stored soil moisture. Manage early leaf disease pressure in 2023 then adapt management to spring conditions. The most effective fungicide can often be 2-3 weeks of warmer and dry weather in spring.

Where has Fusarium crown rot gone?

Fusarium crown rot (FCR) has NOT disappeared with the last few seasons of wetter and milder spring conditions. FCR risk was particularly elevated in more northern areas leading into planting in 2022.

Increased frequency of cereal crops within rotations following drought conditions from 2017-2019, along with reduced sowing of chickpea crops being underlying causes. However, FCR requires moisture for infection, so inoculum levels have progressively been building up within paddocks (Figure 2). The wetter and milder spring conditions have limited the expression of FCR infection as whiteheads.

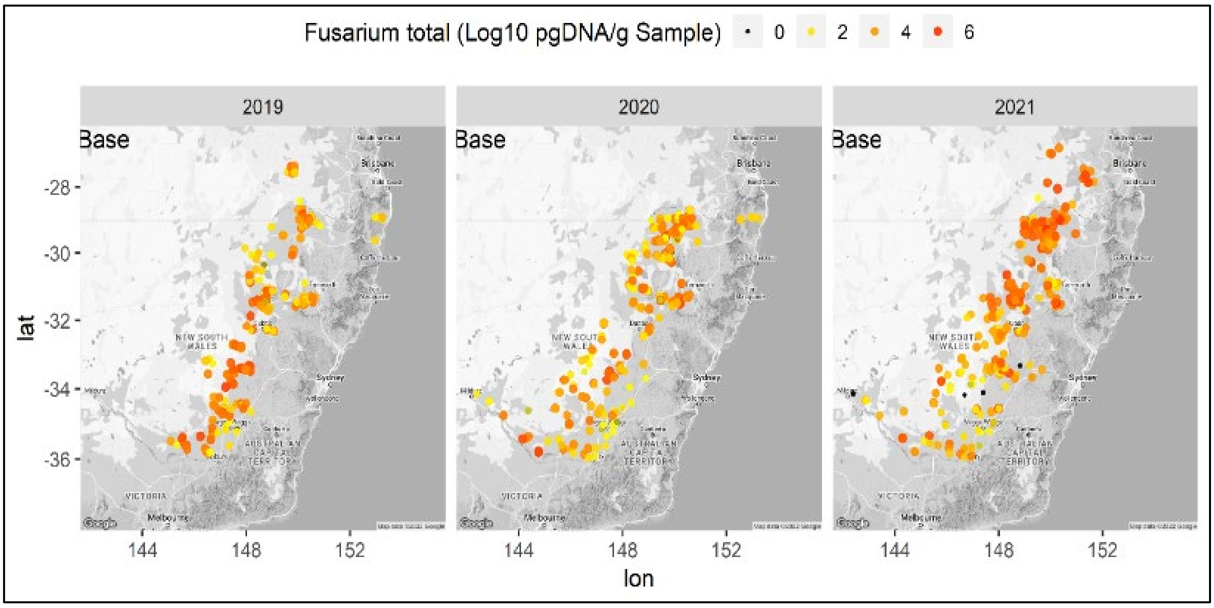

Figure 2. Levels of Fusarium crown rot within base of randomly surveyed winter cereal crops (2019 to 2021) as assessed using quantitative PCR of pathogen DNA levels – BLG208 and BLG207. Map from collaborative surveys conducted with Dr Andrew Milgate and Brad Baxter, NSW DPI Wagga Wagga.

Fusarium head blight (FHB) which caused premature partial bleaching of heads and white or pink grains was very widespread at varying levels across eastern Australia in 2022 along with white grain disorder in some regions (see separate FHB/white grain paper). Current testing of 218 head or grain samples indicates that ~79% of the FHB which occurred across NSW and southern Qld in 2022 was related to tiller bases infected with FCR. That is, Fusarium infection of wheat and durum crops in 2022 expressed as FHB due to the wetter/milder conditions during flowering and grain fill. This basal Fusarium infection would have expressed as whiteheads if crops had been temperature and/or moisture stressed during this period in 2022. This was a massive warning sign. Do not ignore it. TEST, TEST, TEST!

Why is testing so important in 2023?

FHB was widespread in 2022 with implications for seed retained from infected crops. Fusarium grain infection reduces germination and causes seedling blight (death) in plants arising from infected grain. The fungus replaces the contents of infected seed with its own mycelium, so while seed treatments can help reduce the level of seedling blight, they cannot restore the quality of heavily infected seed sources. Sowing Fusarium infected seed also introduces FCR into paddocks. The level of pink or white grains in grain is likely an underrepresentation of the true level of Fusarium grain infection, as later infections (i.e. high humidity) during grain fill, can allow some fungal spread into formed grains which appear normal. Sourcing quality seed for sowing in 2023 is potentially a big issue. Do not assume, even if you have never tested seed before or thought things were fine with seed after 2021 which was also wet. The difference was the widespread levels of FHB in 2022. If you had any level of FHB in crops retained for sowing seed or noticed white or pink grain at harvest, then get a commercial germination and vigour test or send a sample to NSW DPI for 'free' Fusarium testing (see FHB paper) well in advance of sowing. Do not let 2023 be 'the year of the re-sow'.

Testing of any paddock planned for a cereal-on-cereal rotation needs to be assessed for FCR risk using either PreDicta® B Sampling_protocol_PreDicta_B_Northern_regions.pdf (pir.sa.gov.au) or NSW DPI/LLS stubble plating (sampling bags available from LLS offices across NSW or contact author) prior to sowing in 2023. This is imperative in any paddock where FHB was noticed in 2022, as there is a high (79%) probability that the infection came from FCR in the base of plants. Yes, testing is painful and no doubt that some will just play the numbers from current testing of 2022 cereal crop infection levels across central/northern NSW. Of the 158 cereal stubbles assessed from the 2022 harvest so far, 34% had low (<10%), 27% moderate (11-25%), 20% high (26-50%) and 19% very high (>50%) FCR infection. However, FCR risk is very much dependent on the individual paddock, so is more like sending your neighbour for a prostate test to see if you will be okay! Trust me, testing cereal stubble and seed is less painful.

FCR integrated disease management options are all prior to sowing so knowing risk level within paddocks is important.

If medium to high FCR risk then:

1. Sow a non-host break crop (e.g., faba bean, chickpea, canola).

If still considering a winter cereal;

1. Consider stubble management options
2. Sow more tolerant bread wheat or barley variety (durum is out)
3. Sow at start of recommended window for each variety in your area
4. If previous cereal rows are intact – consider inter-row sowing (cultivation is bad as it spreads inoculum)
5. Be conservative on N application at sowing (urea exacerbates FCR and 'hyper yielding' is potentially 'hyper risk' when FCR is present)
6. Zinc application at sowing – ensure that crops are not deficient
7. Current fungicide seed treatment is suppression only – useful but limited control
8. Determine infection levels around GS39 to guide other in-crop management decisions.

Summary

Cereal disease management is heavily dependent on climatic conditions between and within seasons. Therefore, the situation can be quite dynamic, including the unpredictable distribution of different stripe rust pathotypes across regions. Arm yourself with the best information available including the latest varietal disease resistance ratings. Ensure you are sowing the best seed available based on testing. Do your own if you do not want to send samples away, simply count three lots of 100 random seeds and sow in separate spaced rows in the garden and see what comes up. Seed quality cannot be assured after the exceptional conditions in 2022, potentially seed retained from 2021 may be of better quality for planting in 2023. You don't know if you don't test. Do not do a whole paddock experiment to find out.

FCR risk is at record highs across much of the northern grain region. Widespread FHB in 2022 was predominantly the FCR fungus letting you know that it has not gone away with wetter and milder spring conditions the last few seasons. Do not ignore the signs. Do you know your FCR risk in paddocks planned for cereals in 2023, especially if sowing durum? We cannot keep banking on wet and mild spring conditions as our main FCR management strategy.

Keep abreast of in-season GRDC and NSW DPI communications which address the dynamics of cereal disease management throughout the 2023 season.

Further resources

PreDicta®B sampling procedure -
https://www.pir.sa.gov.au/__data/assets/pdf_file/0007/291247/Sampling_protocol_PreDicta_B_Northern_regions.pdf

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