WA CROP TECHNOLOGY CENTRE (ALBANY)

FIELD DAY

INCREASING PRODUCTIVITY IN THE ALBANY PORT ZONE

Tuesday 19th September 2023

Photo credit: Evan Collis

Thanks to the following event sponsors:

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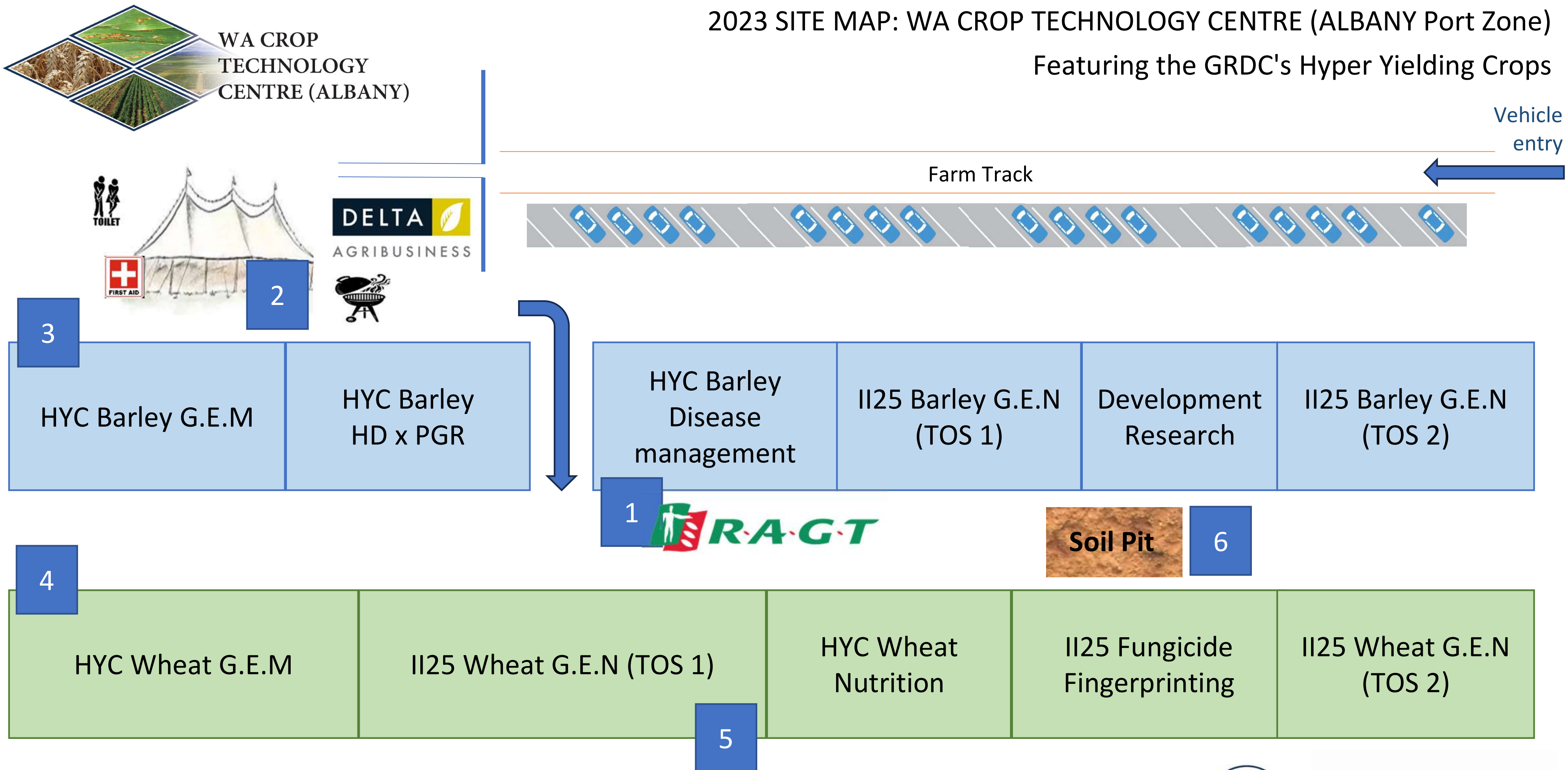
The GRDC Hyper Yielding Crops project is led by FAR Australia in collaboration with:

SOWING THE SEED FOR A BRIGHTER FUTURE

Albany CTC trial site courtesy of: Kellie Shields & Terry Scott

2023 SITE MAP: WA CROP TECHNOLOGY CENTRE (ALBANY Port Zone)

Featuring the GRDC's Hyper Yielding Crops



Key:

HD: Harvest Date

HYC: Hyper Yielding Crops

G.E.N: FAR Australia Germplasm Evaluation Network

II25: FAR Australia Industry Innovation 2025

G.E.M: Genotype x Environment x Management

FAR AUSTRALIA

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

WA CROP TECHNOLOGY CENTRE (ALBANY)

TIMETABLE

WA CROP TECHNOLOGY CENTRE FIELD DAY (ALBANY PORT ZONE): TUESDAY 19 SEPTEMBER 2023

Featuring the GRDC's Hyper Yielding Crops

Thanks to our keynote speaker sponsor: RAGT

In-field presentations	Station No.	10:00am-11.30am	12:30	1:15	1:30	2:00	2:30	3:00	3:30	4:00	4:30
Heping Zhang (Canola Researcher), Nick Poole and Darcy Warren (FAR Australia). *Hyper yielding canola - what have we learnt so far? Key research findings, successes in HRZ canola cropping across WA, and where future gains might come from.*	Canola research site	ALL	Lunch kindly sponsored by DELTA AGRIBUSINESS	**Opening address by Juliet McDonald, GRDC's Western Panel Deputy Chair, followed by Nick Poole FAR Australia's Managing Director for an introduction to the cereal research programme.**							Closing address followed by refreshments kindly sponsored by DELTA AGRIBUSINESS
Dr Frank van den Bosch, CCDM *An experts view on fungicide resistance and the practical implications.*	1				1					2	
Dr Ben Jones, FAR Australia *Spring sun and heat as limits to high yields in SW WA.*	2				2	1					
Darcy Warren, Daniel Bosveld, FAR Australia and Dan Fay, Stirlings to Coast Farmers *Research through to adoption in the paddock: what are we learning about high yielding cereals?*	3					2	1				
Tim Trezise, Frankland Rural *With knowledge comes wisdom: regional agronomist looks at steps forward in cropping development in the Frankland River region.*	4						2	1			
Nick Poole, FAR Australia *Insights from three years of cereal trials in WA's HRZ: what does it tell us, and what are the implications for future crop management?*	5							2	1		
Glenn McDonald, DPIRD *W hat soil amelioration techniques are viable for forest gravels?*	6								2	1	
In-field presentations	Station No.	10:00am-11.30am	12:30	1:15	1:30	2:00	2:30	3:00	3:30	4:00	4:30

For the afternoon's presentations, we would be obliged if you could remain within your designated group number.

Thank you for your cooperation.

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VISITOR INFORMATION

We trust that you will enjoy your day with us at the WA Crop Technology Centre (Albany) Field Day. Your health and safety is paramount, therefore whilst on the property we ask that you both read and follow this information notice.

HEALTH & SAFETY

- All visitors are requested to follow instructions from FAR Australia staff at all times.
- All visitors to the site are requested to stay within the public areas and not to cross into any roped off areas.
- All visitors are requested to report any hazards noted directly to a member of FAR Australia staff.

FARM BIOSECURITY

- Please be considerate of farm biosecurity. Please do not walk into farm crops without permission. Please consider whether footwear and/or clothing have previously been worn in crops suffering from soil borne or foliar diseases.

FIRST AID

- We have a number of First Aiders on site. Should you require any assistance, please ask a member of FAR Australia staff.

LITTER

- Litter bins are located around the site for your use; we ask that you dispose of all litter considerately.

VEHICLES

- Vehicles will not be permitted outside of the designated car parking areas. Please ensure that your vehicle is parked within the designated area(s).

SMOKING

- There is No Smoking permitted inside any marquee or gazebo.

Thank you for your cooperation, enjoy your day.

INCREASING PRODUCTIVITY IN THE SOUTH-WEST HRZ

FEATURING THE GRDC'S NATIONAL HYPER YIELDING CROPS (HYC) PROJECT

On behalf of our investor, the **Grains Research & Development Corporation** along with the HYC project collaborators, I am delighted to welcome you to our 2023 Albany Crop Technology Centre Field Day featuring Hyper Yielding Crops (HYC).

Hyper Yielding Crops is a national project led by Field Applied Research (FAR) Australia. Over the past three years, the HYC project has aimed to push the economically attainable yield boundaries of wheat, barley and canola. As well as the five research centres across the HRZ's of Australia, the project has been successful in engaging with growers to scale up the results and create a community network with the aim of lifting productivity.

To make the programme as diverse as possible I would like to thank all our speakers who have helped to put today's programme together; in particular our keynote speaker Dr Frank van den Bosch who has made the trip from Thailand to join us today. Frank is one of the industry's most influential biologists/plant pathologists and modeller who will be sharing some key tips on how we can achieve hyper yielding crops across the HRZ of Australia.

Finally I would like to thank the GRDC for investing in this research programme. Also a big thanks to Kellie Shields and Terry Scott our host farmers for their tremendous practical support given to the team, and to today's Keynote speaker sponsor RAGT and our lunch sponsor Delta Agribusiness.

Should you require any assistance today, please don't hesitate to contact a FAR Australia staff member. We hope you find the day informative, and as a result, take away new ideas which can be implemented into your own farming business.

Nick Poole
Managing Director
FAR Australia

Hyper Yielding Crops

Hyper Yielding Crops (HYC) has been built on the success of the GRDC's four-year Hyper Yielding Cereals Project in Tasmania which attracted a great deal of interest from mainland HRZ regions. The project demonstrated that increases in productivity could be achieved through sowing the right cultivars, at the right time and with effective implementation of appropriately tailored management strategies. The popularity of this project highlighted the need to advance a similar initiative nationally which would strive to push crop yield boundaries in high yield potential grain growing environments.

With input from national and international cereal breeders, growers, advisers and the wider industry, this project is working towards setting record yield targets as aspirational goals for growers of wheat, barley and canola.

In addition to the research centres, the project also includes a series of focus farms and innovative grower networks, which are geared to road-test the findings of experimental plot trials in paddock-scale trials. This is where in the extension phase of the project we are hoping to get you, the grower and adviser involved.

HYC project officers in each state (Dan Fay from Stirlings to Coast farming group here in the West) are working with innovative grower networks to set up paddock strip trials on growers' properties with assistance from the national extension lead Jon Midwood.

Another component of the research project is the HYC awards program. The awards aim to benchmark the yield performance of growers' wheat paddocks and, ultimately, identify the agronomic management practices that help achieve high yields in variable on-farm conditions across the country. This season, HYC project officers are seeking nominations for 50 wheat paddocks nationwide (about 10 paddocks per state) as part of the awards program.

For more details on the project contact:

Rachel Hamilton – HYC Communications and Events, FAR Australia
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Darcy Warren – HYC barley research lead
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Rohan Brill – HYC canola research lead
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Jon Midwood - HYC extension coordinator, TechCrop
Email: techcrop@bigpond.com

Dan Fay, WA HYC Project Officer, Stirling to Coast Farmers
Email: dan.fay@scfarmers.org.au

Scan the QR code for 2022 HYC project results

Hyper Yielding Canola – canola variety selection and nutrient management

Heping Zhang, Canola Researcher and Rohan Brill, Brill Ag

Key Points:

- In Hyper Yielding Canola sites across four states in 2021 and 2022, applying animal manure (chicken or pig) improved canola yields.
- In Kojonup, chicken manure (applied pre-sowing) increased yields by 0.8 t/ha in 2021 and 0.3 t/ha in 2022 when applied with a high rate of nitrogen (N) compared to N application without manure.
- The 2022 trial confirmed that a similar response to manure could be achieved using slow-released inorganic nitrogen.
- Variety selection played a crucial role, with Clearfield canola (Hy45Y95CL) yielding the highest (4.3 t/ha) in the GEM trial series in 2022, especially in a season with a soft finish.
- Fungicide did not show a response in disease management trials for the two varieties 45Y28 RR and HyTTec Trifecta at Kojonup. In fact, a fungicide response was observed in only two out of seven trials conducted across four states in the HYC canola program in 2021 and 2022.

Importance of Nutrition for Hyper-Yielding Canola

The Hyper-Yielding Crops project aims to achieve a 5 t/ha canola grain yield in high-yield potential environments. In Kojonup in 2021, the highest yield reached nearly 4.7 t/ha for 45Y28 RR, fertilized with 225 kg/ha N + Chicken Manure. The nitrogen response plateaued at 75 kg/ha N, possibly due to increased mineralization of N from the organic pool (3.4% Organic Carbon) driven by favourable spring conditions. Given the potential unavailability or cost-prohibitive nature of animal manure, trials in 2022 and again in 2023 are investigating the reasons for the manure response. These trials aim to determine if a similar response can be achieved by matching the nutrition supplied by manure with inorganic inputs. The positive response to manure was consistent across all four HYC Canola sites in 2021 and 2022, including Gnarwarre, Victoria (pig manure), Millicent, SA (pig manure), and Wallendbeen, NSW (chicken manure).

Variety Choice

Spring GEM (Genotype * Environment * Management) trials were conducted at each HYC canola research site in WA, NSW, Victoria, and SA in 2021 and 2022. All sites exhibited similar responses to genotype, nutrition, and disease management. Clearfield consistently produced the highest yields across all sites in 2022, followed by RR/TF canola. TT canola yielded lower than Clearfield and RR/TF canola. At Kojonup, hybrid Clearfield canola emerged as the best-performing variety, producing over 4 t/ha. The high yield of Clearfield canola was attributed to its greater biomass, despite its slightly lower harvest index than TT canola, emphasizing the importance of biomass in achieving high yields. Increasing nitrogen application from 150 kg N/ha to 225 kg N/ha did not significantly increase yield across the sites due to the relatively fertile soil with organic carbon levels around 3.6%.

Fungicide Response

Fungicide did not show a response in disease management trials for the two varieties, 45Y28 RR and HyTTec Trifecta, at Kojonup. In fact, a fungicide response was observed in only two out of seven trials conducted across four states in the HYC canola program in 2021 and 2022.

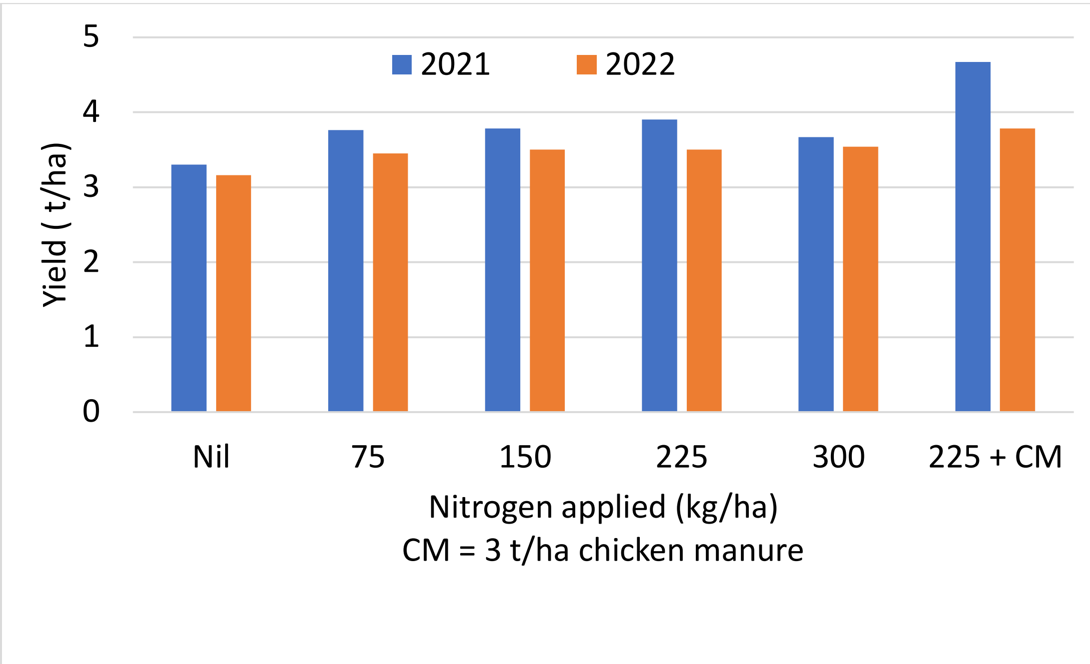


Figure 1. *Response of 45Y28 RR canola to nutrition treatments at Kojonup in 2021 and 2022. Chicken manure was 3.0% N and 0.9% P. LSD = 0.31 t/ha in 2021 and LSD=0.43 t/ha in 2022.*

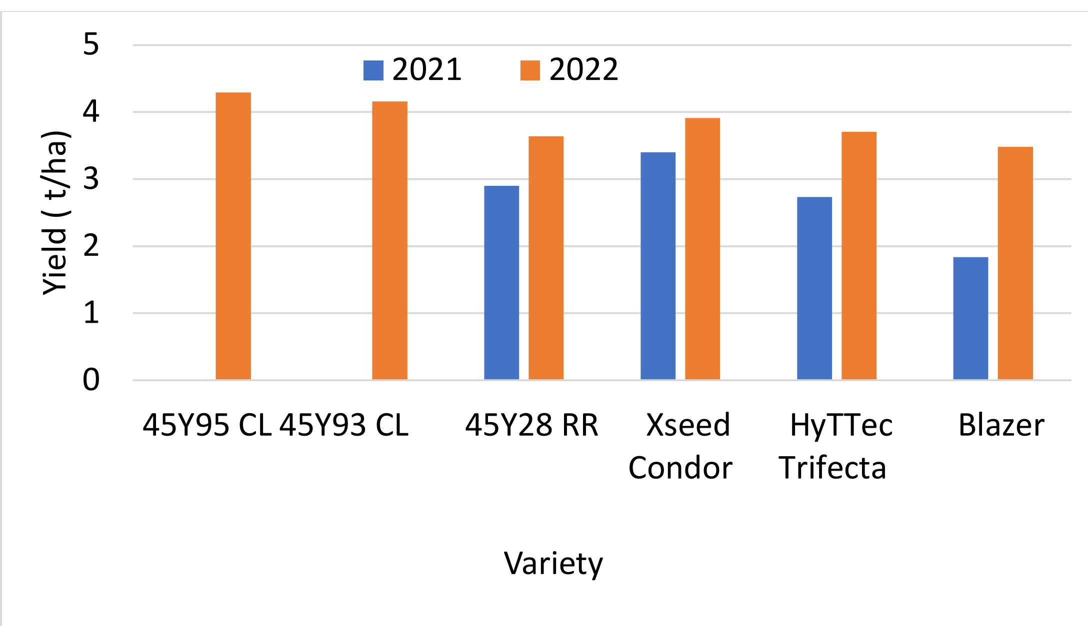


Figure 2. *Yield difference among canola varieties at Kojonup in 2021 and 2022. LSD = 0.13 t/ha in 2021 and LSD=0.50 t/ha in 2022.*

Azole and SDHI resistance in net blotch in Western Australia, adjusting fungicide treatment programs when resistance is developing

Frank van den Bosch[1]; Wesley Mair[1]; Ayalsew Zerihun[1]; Nick Poole[2]; Fran Lopez Ruiz[1]
[1] Centre for Crop and Disease Management, School of Molecular and Life Sciences, Curtin University, Bentley 6102, Perth, Australia.
[2] Field Applied Research (FAR) Australia, 2/63 Holder Road, Bannockburn 3331, Australia.

Aim

To describe the current status of azole (group 3) and SDHI (Group 7) resistance in Western Australia. To answer the question 'what adjustments to the fungicide treatment programme can be made when azole and SDHI resistance further develops in the pathogen population over the coming years?'

Key Points

- **CCDM survey data shows that net blotch pathogen resistance to azole (group 3 – e.g. propiconazole (Tilt), tebuconazole (Folicur)) and SDHI (group 7 – e.g. fluxapyroxad (Systiva)) is spreading in WA.**
- **Modelling the optimum strategy for net blotch control depends on the yield potential, barley price and the resistance status of the net blotch population.**

Sensitive net blotch populations

- **Dose rate response curves modelled for sensitive strains of spot form net blotch (SFNB) suggest that one full rate application of propiconazole (Tilt) is generally cost effective for low yielding areas of WA.**
- **In higher yielding areas such as the high rainfall zone (HRZ) two full rate applications of fungicides are required, preferably using different fungicide active ingredients.**
- **Equally, in many scenarios if the net blotch pathogen is sensitive to SDHI chemistry, the SDHI gives good control and economic returns except when yield potential and barley price are low.**

Resistant net blotch populations

- **When resistant strains to azoles e.g. Tilt (Group 3) dominate the net blotch population studies suggest that propiconazole will not give economic returns to application.**
- **When SDHI resistance dominates the pathogen population, the fluxapyroxad seed treatment does not have a positive economic return, independent of the potential yield and the barley price.**
- **In these studies, there was evidence that where these resistant biotypes dominant prothioconazole (Group 3 – e.g. Proviso) was still effective and able to deliver positive economic returns.**

- **The model was used to determine when growers should shift from using propiconazole to using prothioconazole (or any other effective fungicide).**
- **The switch point depends on the potential yield in the area, the barley price, whether a seed treatment is used, and whether a grower aims at maximising mean economic return or is risk averse.**
- **Reduce the spread of fungicide resistance by adopting the AFREN fungicide resistance five.**

Methods

The survey data gathered by CCDM were translated into maps showing absence and presence of the various strains. A model was developed and analysed to study the economic return of azole and SDHI fungicide treatment programmes for spot-form net-blotch.

Results

CCDM survey data show that both azole and SDHI resistance is spreading in Western Australia. The data also show that net-form net-blotch increased in prevalence over the last year.

Dose response curves are developed for propiconazole, prothioconazole and fluxapyroxad. Response curves are developed for both sensitive, reduced sensitive and resistant strains.

The model outputs suggest that when no azole resistance developed yet, the optimal treatment programme consists of one application of propiconazole at full dose in the lower yield areas, and two full dose applications in the higher yield areas.

The model output suggests that when no resistance to SDHI has developed yet, seed treatments give a positive economic return for a wide range of potential yield and barley prices. Only in areas with low potential yield and when barley price is low an SDHI seed treatment does not give a positive economic return.

The optimal fungicide treatment programme depends on the potential yield and on the barley grain price. We explore the effect of these two quantities on the optimal fungicide SDHI and azole treatment programme.

The situation changes drastically when the resistant strains starts to dominate the population. In all treatment programmes modelled, propiconazole does not give a positive economic return when azole resistance dominates the pathogen population. The same holds for the SDHI seed treatment when SDHI resistance dominates the pathogen population.

Prothioconazole does however still give a positive economic return because it controls the resistant strain moderately well.

When SDHI resistance dominates the pathogen population, the fluxapyroxad seed treatment does not have a positive economic return. This result is independent of the potential yield and the barley price.

The model was used to determine when growers should shift from using propiconazole to using prothioconazole (or any other effective fungicide). The switch point depends on the potential yield in the area, the barley price, whether a seed treatment is used, and whether a grower aims at maximising mean economic return or is risk-averse.

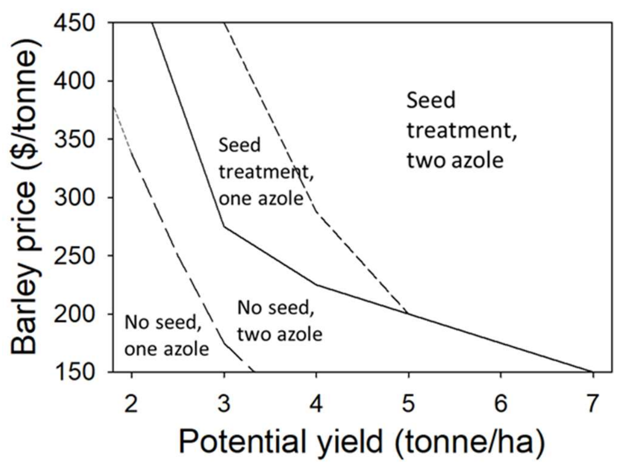


Figure 1. Modelled relationship between yield potential and grain price and their combined effects on fungicide strategy in net blotch scenarios (sensitive scenario).

Discussion

Our work shows that azole and SDHI resistance threatens the sustainability of spot-from net-blotch control. For the azole resistance that is developing shifting from the use of propiconazole to the use of prothioconazole is a possible solution. However, with the increased use of prothioconazole the pressure on the pathogen to develop increased resistance to prothioconazole will increase. In the UK resistance to prothioconazole in net-blotch has already developed. When the resistance to SDHIs is widespread the seed treatment with fluxapyroxad is no longer useful.

Australian Fungicide Resistance Extension Network (AFREN)

Since fungicides are the last line of defence against disease it is important to recognise that there are a number of important measures that growers and advisers can take in order to slow the spread of fungicide resistance. AFREN have summarised these as the AFREN Fungicide Resistance Five (see below).

Acknowledgements.

This study was supported by the Centre for Crop and Disease Management, a joint initiative of Curtin University and the Grains Research and Development Corporation – research grant CUR00023.

WHAT CAN WE DO TO SENSIBLY REDUCE THE RISKS OF FUNGICIDE RESISTANCE?

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

The Fungicide Resistance Five!

1. **Avoid susceptible crop varieties**
2. **Rotate crops – use time & distance to reduce disease carry-over**
3. **Use non-chemical control methods to reduce disease pressure**
4. **Spray only if necessary & apply strategically**
5. **Rotate & mix fungicides / MoA groups**

Spring sun and heat as limits to high wheat yields in SW WA

Dr Ben Jones, Field Applied Research (Australia)

Key points

- Light and heat set potential grain number (and hence yield) for a particular flowering date.
- Closer to the coast, more frequent cloudy days mean the optimal flowering window is wider, and similar whether July-September is wet or dry. Cultivar and sowing decisions can be made around other management priorities.
- Inland, there more clear days, and a high potential yield penalty for flowering before mid-September (in addition to frost): ~100 kg/ha/day.
- Further inland (eg. Kojonup), the optimal flowering window is up to 20 days later in wet seasons. Target later flowering on high yield potential paddocks, where soil can still support grain-filling in drier seasons.
- Crops that have flowered in early-mid September 2023 will have lower than usual light and heat-related yield potential, especially in the east of WA.

The choices that will determine crop flowering time are all made before sowing: which variety, which paddock, when you start, the order you sow in, how hard you go. Traditionally in dryland Australia the choice is a balance between the risk of frost (too early), and terminal drought (too late).

In better seasons in medium and high rainfall zones, sunlight and temperatures through the critical grain set period (about 30 days before flowering) set an upper limit on grain number, and hence potential yield. Understanding how these limits work together with rainfall in particular locations helps guide what needs to be done to capture the upsides of wetter seasons, without creating more risk if they turn out dry.

In this paper 'wet' seasons are those where July-September rainfall is higher than the 2010-2022 average.

PTQ: high light and low temperature = more grains, more yield

The PhotoThermal Quotient (PTQ) is light received per day, divided by average temperature, during the period grains are being set (about 30 days before flowering). Higher PTQ is given by more light, and/or less temperature (above freezing). More grains are set if the crop grows more during this period. Assuming the crop has enough nutrition and water, growth is determined by whether the leaves intercept all the light, and how much light there is. If it's cooler, this period takes longer, and so the crop has longer to photosynthesise and grow.

The PTQ can be directly converted into a PTQ-limited yield potential, which is how it has been presented here.

In SW WA several general trends influence the trend of PTQ on average:

- The SW corner has cooler daytime maxima.
- Coastal areas have warmer overnight minima.
- Coastal areas tend to be cloudy: less light.
- Northern areas have more light in general.

Inland, the cloud associated with rainfall events decreases light and temperature more in wet years. In coastal locations it's cloudy more often, and the uncertainty is whether (and how much) it rains.

Esperance and Kojonup provide two contrasting examples (Figure 1) of how PTQ-limited yield changes depending on whether it's wetter or drier-than-average during late winter/early spring (July through September).

Esperance (173 mm Jul-Sep Av) Kojonup (213 mm Jul-Sep Av)

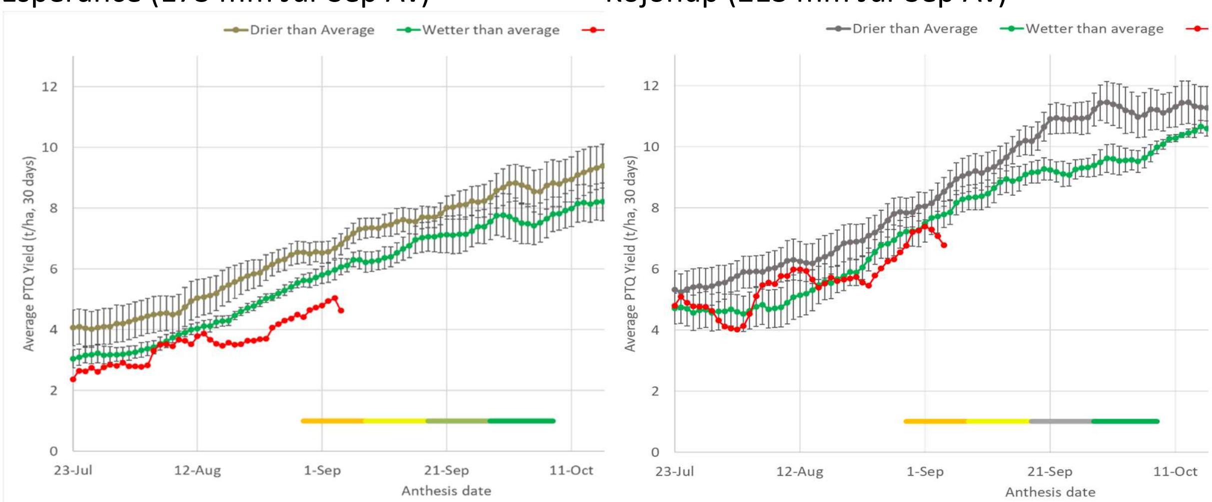


***Figure 1**. Potential yield for a particular anthesis (flowering) date, limited by average photothermal quotient (PTQ) in the 30 days beforehand. The calculations are an average between 2010 and 2022, split into drier and wetter than average rainfall July-September. Estimates for the 2023 season are shown in red. Optimum flowering date ranges from a recent study are given in coloured bars below; the optimum for both locations is 18 to 27 Sept.*

There is a light-related PTQ yield penalty for flowering earlier than optimum, but it's less at Esperance than Kojonup (around 50 vs 100 kg/ha/day, Figure 1). After the optimum, the PTQ yield benefit to later sowing is close to flat at Esperance, and at Kojonup in drier years. In wetter years at Kojonup, the optimum flowering time (assuming grains can be filled), is up to 20 days later.

At Esperance wetter years are just a bit more cloudy than normal, and cooler (which offsets the reduced light). At Kojonup, drier years are less cloudy from September on, but also hotter. Before September, there is little difference in light, but drier years are cooler.

At the time of writing, early flowering crops in 2023 will be experiencing a PTQ yield penalty at Esperance due to warmer temperatures and less light. At Kojonup the year so far has been about normal for a wetter-than-average year.

Frankland River

The impact of rain at Frankland River is more like Esperance than Kojonup (Figure 2): wet years having slightly lower PTQ yield potential for most flowering dates is characteristic of coastal locations in SW WA. Differences in PTQ yield potential between wet and dry years with late September flowering are only seen further inland.

There is a broad optimum flowering window between late September and October, after which there is quite a strong radiation-related PTQ yield penalty to late flowering in dry years (recalling that 'dry' only relates to July-September). Frankland is more like Kojonup in having a 100 kg/ha/day PTQ yield penalty to flowering earlier than late September (apart from any frost risk).

Frankland River (224 mm Jul-Sep Av)

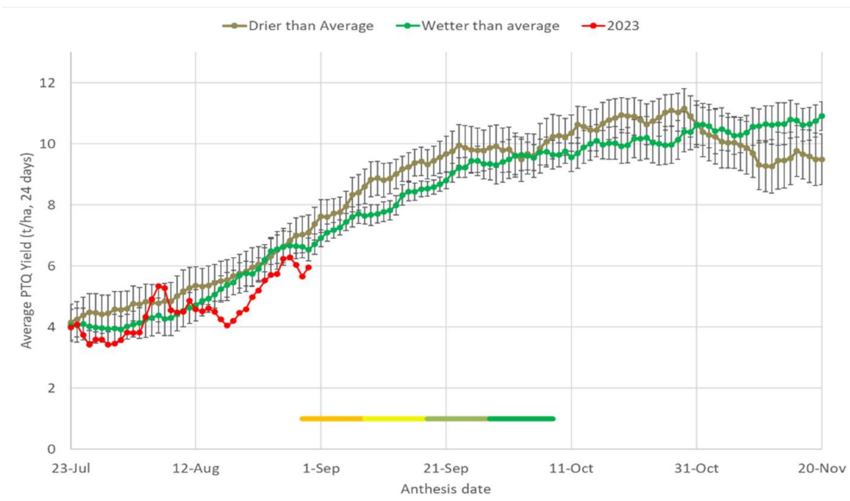


Figure 2. *Potential yield for a particular anthesis (flowering) date, calculated and presented as per Figure 1.*

Managing for high yield opportunities

The Esperance environment has quite a forgiving optimum flowering window for PTQ-limited potential yield. The penalties to being earlier or later are relatively small, so other management priorities can be used to guide cultivar and sowing time decisions. Later flowering suits wetter seasons better, but the differences are minor (and likely non-existent in some years).

At Kojonup (and other inland high rainfall environments), there is a much higher penalty for earlier flowering (in addition to any frost risk). Later flowering is favoured in wet years. For a proportion of paddocks that have high yield potential, it may be worth targeting later flowering, to maximise the opportunity in wet seasons. The penalty for later flowering in dry seasons is minimal, provided sufficient water remains for grain-fill. There is no benefit regardless of rainfall to flowering later than the end of October (from a radiation or temperature point of view).

Frankland River has a forgiving optimum flowering window, provided that flowering is after mid-late September and finishes in October. Similar to Kojonup, it may be worth targeting later flowering in high yield potential paddocks, and using the flexibility of the flowering window to spread risk and work, and manage other priorities.

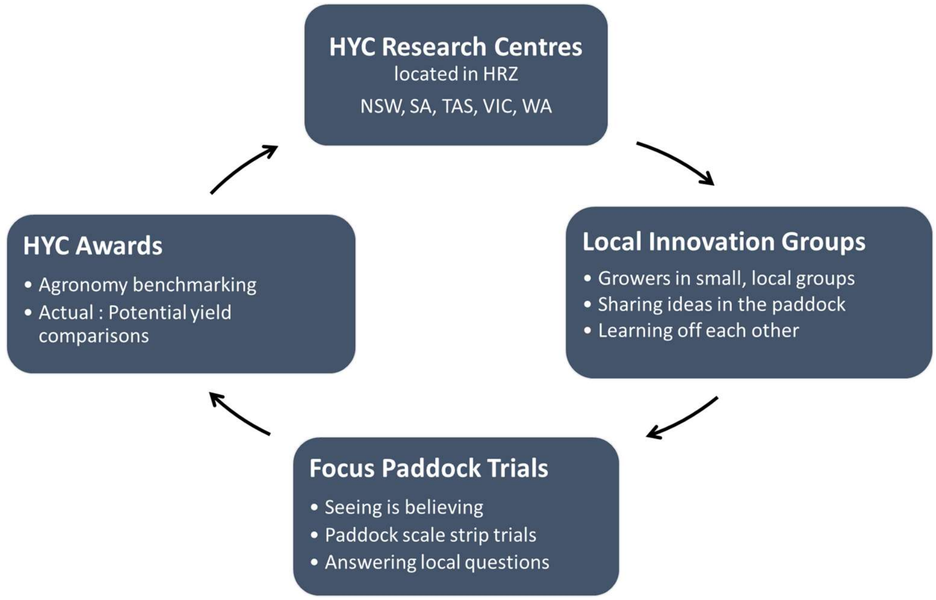
Hyper Yielding Crops Award and innovation Groups

Dan Fay (Stirlings to Coast Farmers)

Key Takeaways:

- Winter wheats in 2022 significantly outyielded spring wheats, with a yield average of 7.49 t/ha compared to 5.69 t/ha for spring wheats.
- The top 20% of wheat growers applied 60 more units of nitrogen (N) compared to the remaining 80% of farmers. However, crop rotation played a significant role in the individual farmers approach to N management.
- Head count and average grains per head where the key yield components that drove the top yielding paddocks.
- In Barley, fungicide management was a key driver of productivity. With the top performing paddocks having spent $10 more a hectare on fungicide then the remaining 80%. Despite higher expenditure on fungicides cost per tonne of production in these crops was lower, illustrating that fungicide input was a key driver of profitability.
- The top 20% of barley growers applied on average 80 more units of N than the remaining 80%, however they applied similar levels of phosphorus, potassium and sulphur.
- The highest yields in both wheat and barley came from the western region, whilst the highest percentage of yield potential was achieved in the northern region.

In 2020, the GRDC Hyper Yielding Crops (HYC) project started. The project is being conducted in Victoria, Tasmania, South Australia, New South Wales, and Western Australia, with each state hosting a GRDC Centre of Excellence. These sites have been selected to run research trials to help determine some of the major factors growers and advisors can use, in their specific environment, to achieve optimum yields through variety and agronomic management of wheat, barley and canola. The following graphic shows the various outputs from the project and how they are inter-related with each other:



In combination with the research centres, there is a large emphasis on local grower involvement in the project. In the HRZ of WA, Stirlings to Coast Farmers runs the local innovation groups, the focus farm paddock trials and the facilitation and data collection for the HYC awards program. Together these four elements of the Hyper Yielding crops Project, aim to deliver grower focused and regionally relevant data that can lead to increased cropping productivity across the high rainfall zones of Australia.

Innovation groups:
The innovation groups are a key component of the HYC project, where groups of likeminded farmers meet in the paddock during the season to discuss relevant issues, opportunities, interventions, and outlooks. These sessions provide an opportunity for peer-to-peer learning, where farmers can learn from their neighbours, with an emphasis on improving crop productivity across the whole district.
Current innovation groups within WA:

(1) Albany HYC- East (East of Albany encompassing an area to Green Range, and as far north as the Stirling Ranges)
(2) Albany HYC- West (West of Albany encompassing an area to Frankland River and as far north as Mobrup)
(3) Northern HYC Group – New in 2022 (Based around the Kojonup area)

The Innovation meetings have allowed farmers to tackle key issues as they have popped up in season, and as a result have grown over the four years of the project to become a valuable resource for the farmers to draw from. In 2021, waterlogging was the key issue that needed to be addressed, in 2022 it was disease pressure in barley, crop rotation and wheat cultivar selection, and this year the focus has been on wheat cultivar selection, crop nutrition, and risk management.

2022 HYC Awards

In 2022, the HYC awards program expanded to include barley. The awards program saw at total of 25 paddocks being entered for benchmarking, 10 wheat paddocks and 15 barley paddocks. The 2022 season in WA delivered excellent yields across the board, despite the protracted harvest period. Many farmers across the district (particularly to the east of Albany) recorded record yields in wheat, barley and canola. The disease burden in barley was particularly high, with net type-net blotch in RGT Planet barley causing issues across the district. Farmers fungicide applications were up from an average of two in-season plus a seed dressing, to three to four in-season fungicides plus a seed dressing. This increased input expenditure, coupled with market uncertainty has driven farmers to reconsider their barley options going into 2023.

Within the awards program the average wheat yields continued their increase year-on-year. Although this has largely been driven by the top 50% of wheat yields achieved each year of the HYC project. In 2022, the wheat averages ranged from 4.96 t/ha to 7.78 t/ha, and there were six different wheat cultivars entered into the awards, highlighting the diversity of high yielding wheat options suitable for the WA HRZ.

Growing Season	Top 20%	Remaining 80%
2020	5.8 t/ha	4.2 t/ha
2021	6.7 t/ha	5.5 t/ha
2022	8.35 t/ha	5.5 t/ha

The 2022 season saw a confluence of events that led to high cereal yielding conditions. The cool temperatures coupled with higher-than-average levels of solar radiation in

September and October, meant that there were ideal conditions in the critical period for grain set and yield accumulation (2 weeks prior to flowering). This coupled with the ample PAW were the key drivers of the fantastic yields that made up the award paddocks. These conditions meant that the wheat varieties that flowered later were able to maximise their yield potential, which drove the high yields observed in the longer season wheat varieties.

In 2022, Barley yields in the HYC award crops for WA?? ranged from 8.92t/ha to 3.92t/ha. The vast majority of the paddocks were planted to RGT Planet barley, with Maximus CL being the only other cultivar to feature in the awards. The higher yielding paddocks were from the western and northern districts. The lower yielding paddocks tended to be impacted by a combination of severe disease pressure (net blotch) and lodging/brackling. The grain quality across the awards paddocks was low, with all but three paddocks failing to make malting grade.

2023 Season

The 2023 season is off to a very promising start with great yield potential shown across all three districts. Waterlogging has been a concern in areas where seeding was delayed, particularly in canola and spring wheat. The enthusiasm for the HYC awards program has continued to grow with the maximum number of paddocks being registered early in the year. The 2023 HYC award paddocks illustrate wide cultivar diversity in both wheat and barley this year, as farmers search for wheat cultivars that suit the unique environment that is the WA HRZ. In the quest is for barley cultivars that can replicate Planet barley's productivity, whilst displaying stronger disease resistance. Nutrient management has been a key focus of the awards entrants and the innovation groups, as they adopt different strategies to maximise productivity, following two particularly wet and high yielding seasons.

With knowledge comes wisdom: regional agronomist looks at steps forward in cropping development in the Frankland River region.

Tim Trezise, Frankland Rural

Over the past 5 years crop yields achieved by growers in the HRZ have increased at an exciting pace. The reasons for this have been a combination of improvements in plant genetics, sound agronomy and research, as well as the ability through technology and improvements in machinery to implement a plan in a timely manner.

We see glimpses of crops reaching their water limited potential in the high rainfall zone. There are always paddocks and parts of paddocks that go close to water limited potential, however the challenge is to replicate this over a larger portion of the program whilst recognizing some areas/soil types will never have the same potential as others.

Water Limited Potential

Yield (tonnes/ha) = WUE* (stored soil water + growing season rainfall - evaporation)

Table 1. *Potential Yield for* ***Canola****- Frankland River*

Potential Yield	WUE	GSR	Effective Rainfall
2445	6	(22.5+550-165)	407.5
2852.5	7	(22.5+550-165)	407.5
3260	8	(22.5+550-165)	407.5
3667.5	9	(22.5+550-165)	407.5
4075	10	(22.5+550-165)	407.5

Table 2. *Potential Yield for* ***Cereals****- Frankland River*

Potential Yield	WUE	GSR	Effective Rainfall
5705	14	(22.5+550-165)	407.5
6520	16	(22.5+550-165)	407.5
7335	18	(22.5+550-165)	407.5
8150	20	(22.5+550-165)	407.5
8965	22	(22.5+550-165)	407.5

Table 3. *Yields Achieved in HRZ*

	Top District Average	Realistic average to aim for
Barley	6.5	7
Canola	3.4	4
Oats	5	5.5
Wheat	6	6.5
Faba Beans	3.2	4

Is protein a good indicator of how well you have performed?

Rotation

- It doesn't seem to matter what crop you grow, more how well you grow it
- The longer the rotation the better
- Legumes are currently not common/ a high % of a traditional rotation however they will potentially be more widely adapted for root disease, sustainability and soil health

Time of Sowing (TOS)

- Pick a TOS and design your program/ varieties around that, not the other way around
- Early sowing has been successfully done in HRZ
- Leading growers currently looking to finish sowing 10th May
- Weed control over program is important.

For successful early TOS

- You need a low weed seed bank and good post emergent options
- Good seeding equipment for seed placement and seed soil contact
- Soil wetters/ on row sowing
- Stubble management
- Moisture conservation (summer weeds)
- BE ORGANISED

Establishment

- The best crops are usually the ones that look the best from the start
- You need to be fanatic about establishment
- Be aware of target plants m^2

Establishment issues

- Depth
- Fert toxicity
- Chemical safety

Nutrition

- pH
- Phosphorus is still king in high PBI soils
- Potassium is important but confusing
- Nitrogen- play the game
- It's great to have a plan- but keep one eye on crop health

Waterlogging

- Drainage
- Early crops handle water better
- Crop choice
- Genetics

Weeds

- In good operations we spend a small amount of time on weeds
- Paraquat and Glyphosate resistance changes things - be disciplined.
- Plenty of tools to kill weeds

Fungicides

- Early crops = high biomass + high fungal disease
- Rotation is key- even within cultivar
- Resistance
- Prevention is better than cure

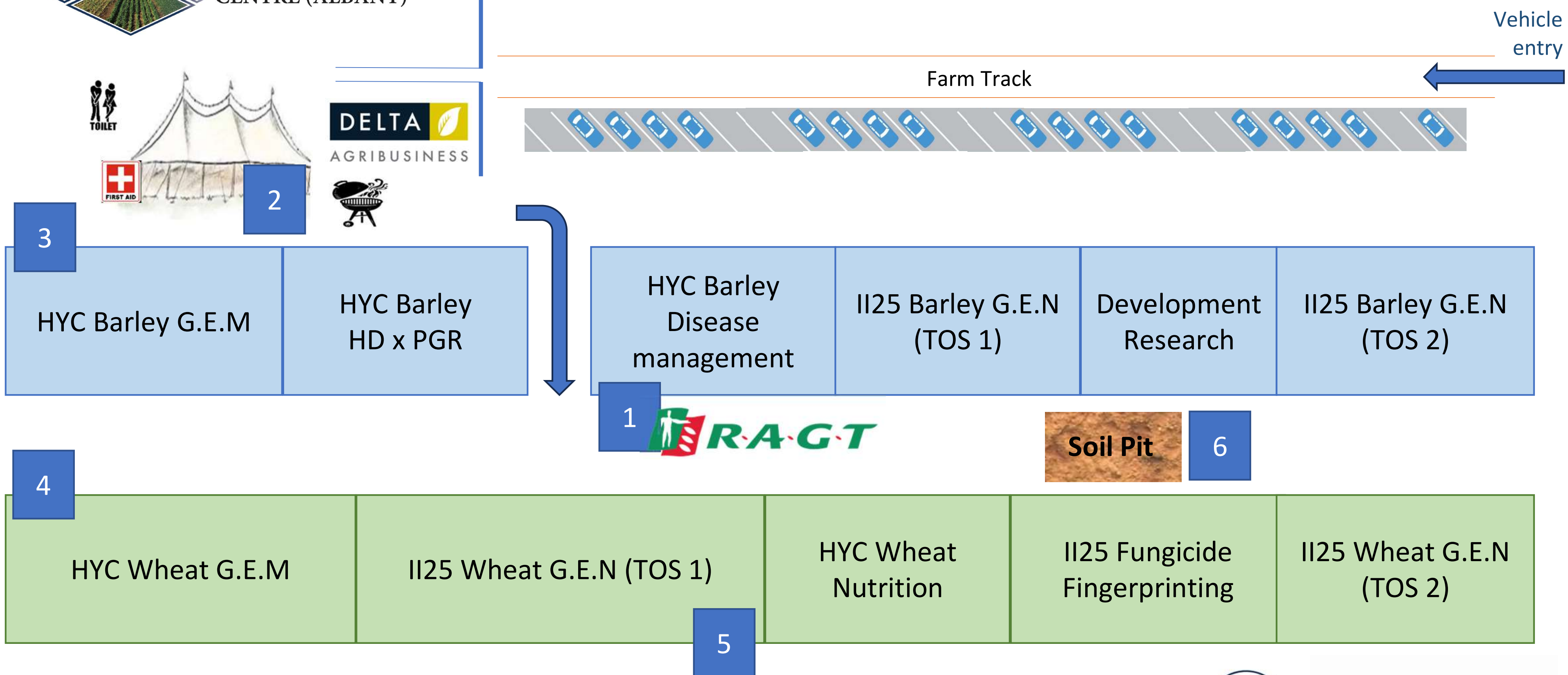
Generally

- Have confidence in your environment
- High effort = high yields
- Good crops grow good crops
- "Hyper yielding" crops aren't for everyone- farm within your personality/ ethics, implement a clear plan and get good at it.

WA CROP TECHNOLOGY CENTRE (ALBANY)

2023 SITE MAP: WA CROP TECHNOLOGY CENTRE (ALBANY Port Zone)

Featuring the GRDC's Hyper Yielding Crops



Key:
HD: Harvest Date
HYC: Hyper Yielding Crops
G.E.N: FAR Australia Germplasm Evaluation Network
II25: FAR Australia Industry Innovation 2025
G.E.M: Genotype x Environment x Management

FAR AUSTRALIA

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

WA CROP TECHNOLOGY CENTRE (ALBANY)

TIMETABLE

WA CROP TECHNOLOGY CENTRE FIELD DAY (ALBANY PORT ZONE): TUESDAY 19 SEPTEMBER 2023

Featuring the GRDC's Hyper Yielding Crops

Thanks to our keynote speaker sponsor: RAGT

In-field presentations	Station No.	10:00am-11.30am	12:30	1:15	1:30	2:00	2:30	3:00	3:30	4:00	4:30
Heping Zhang (Canola Researcher), Nick Poole and Darcy Warren (FAR Australia). *Hyper yielding canola - what have we learnt so far?* *Key research findings, successes in HRZ canola cropping across WA, and where future gains might come from.*	Canola research site	ALL	Lunch kindly sponsored by DELTA AGRIBUSINESS	Opening address by Juliet McDonald, GRDC's Western Panel Deputy Chair, followed by Nick Poole FAR Australia's Managing Director for an introduction to the cereal research programme.							Closing address followed by refreshments kindly sponsored by DELTA AGRIBUSINESS
Dr Frank van den Bosch, CCDM *An experts view on fungicide resistance and the practical implications.*	1				1					2	
Dr Ben Jones, FAR Australia *Spring sun and heat as limits to high yields in SW WA.*	2				2	1					
Darcy Warren, Daniel Bosveld, FAR Australia and Dan Fay, Stirlings to Coast Farmers *Research through to adoption in the paddock: what are we learning about high yielding cereals?*	3					2	1				
Tim Trezise, Frankland Rural *With knowledge comes wisdom: regional agronomist looks at steps forward in cropping development in the Frankland River region.*	4						2	1			
Nick Poole, FAR Australia *Insights from three years of cereal trials in WA's HRZ: what does it tell us, and what are the implications for future crop management?*	5							2	1		
Glenn McDonald, DPIRD *W hat soil amelioration techniques are viable for forest gravels?*	6								2	1	
In-field presentations	Station No.	10:00am-11.30am	12:30	1:15	1:30	2:00	2:30	3:00	3:30	4:00	4:30

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FAR AUSTRALIA

For the afternoon's presentations, we would be obliged if you could remain within your designated group number.

Thank you for your cooperation.

Group
1
2

The primary role of Field Applied Research (FAR) Australia is to apply science innovations to profitable outcomes for Australian grain growers. Located across three hubs nationally, FAR Australia staff have the skills and expertise to provide 'concept to delivery' applied science innovations through excellence in applied field research, and interpretation of this research for adoption on farm.

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SOWING THE SEED FOR A BRIGHTER FUTURE

Key Learnings - Albany Crop Technology Centre – Frankland River, WA

Nick Poole[1], Jayme Burkett[1], James Rollason[1], Tracey Wylie[1], Daniel Bosveld[1], Nicky Tesoriero[2]
[1] Field Applied Research (FAR) Australia, [2] Ceres Agronomy

Insights from three years of cereal trials in WA's HRZ: what have we learnt so far and what implications have we experienced along the way?

Spring versus winter wheat germplasm sown mid-April

The activity in the Albany Port Zone has been much smaller in focus but has mirrored the Esperance work on winter versus spring germplasm with late April sowings. In 2020 this took place on a Sandplain soil at Green Range northeast of Albany with below average growing season rainfall (and then 50% falling in August causing waterlogging), and then at Frankland River on a forest gravel with above average rainfall in 2021 and slightly above average rainfall in 2022, although September rainfall was 50% down on average rainfall.

Key point summary

- Despite slightly later April sowing dates (ranging from 21st April to 1st May) winter wheat germplasm has been more consistent in the southern western WA environment than was the case at Esperance.
- Even the longer season red wheat RGT Accroc performed well in relation to Scepter, despite having a flowering date in mid-October that was later than was regarded as optimal.
- There may be several specific reasons for this in terms of overall rainfall (which was very high in 2021 compared to average) and milder spring temperatures.
- In addition, the rainfall distribution pattern in 2022 delivered a dry September which may have been more deleterious for the shorter season wheats that were at a more advanced development stage in this period.
- Over the three years 2020 – 2022 Mowhawk (winter wheat) had the edge over the more established variety Illabo (winter wheat).
- Unlike Esperance where higher harvest dry matter has not been as advantageous in winter wheat germplasm (due to lower harvest indices), lower than average maximum temperatures in October and November at Frankland River resulted in generally better yields from winter wheats, even with varieties flowering later than optimum window.
- Increased inputs, particularly nutrition have been the key to cost effective yield increases in wheat trials over the final two of the three seasons of the project.
- An additional 25 or 90kg N/ha on top of a standard N dose provided profitable increases in productivity in 2021 and 2022 based on yield increases of 0.71 and 0.66t/ha (urea at $600/t & grain price at $375/t) and associated protein lifts

(mean of seven cultivars).

- RGT Accroc was the least responsive variety to higher input management, despite generally producing higher harvest dry matters, although grain proteins have been lower.
- In contrast, the spring milling wheats have shown good responses to a higher input management strategy (additional N, PGRs and greater fungicide input), which from observations of disease, lodging and crop structure is most associated with additional N fertiliser input.
- As was the case at the Esperance site, increasing fungicide input in wheat has not given rise to better crops with little evidence of disease to warrant spending more than a standard two spray strategy based on DMI chemistry.
- Defoliation simulating grazing had variable effects on grain yields and margins but was most negative in the highest yielding season, depending on the value attributed to grazing.

Grain Yields 2020 – 2022

At the Albany Crop Technology Centre, the grain yields have been more variable in comparison to Esperance, in part due to a change of site and soil type between 2020 and 2021 (Figure 1). Over the three project years the notable difference between Esperance and Frankland River has been better performance of winter germplasm relative to spring germplasm. This was not only apparent with the shorter season winter wheats Mowhawk and Illabo, but also the long season red wheat RGT Accroc, which has been much more consistent than expected over the three varying seasons.

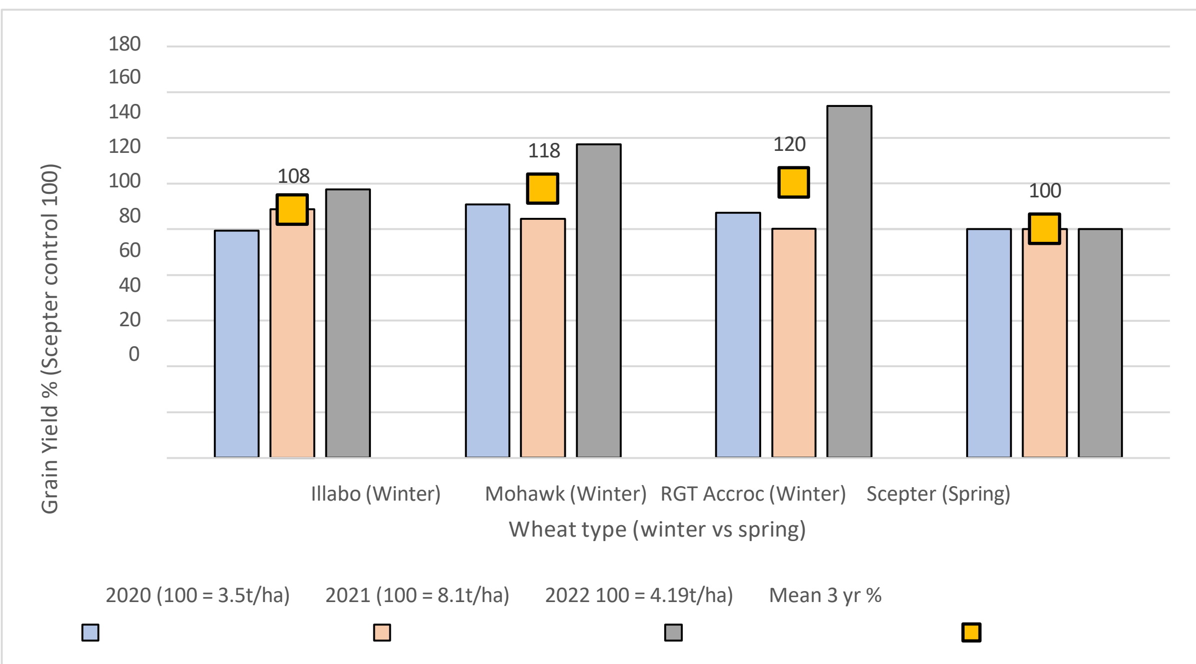


Figure 1. *Winter vs. spring germplasm grain yield (%) under high input management over three seasons.*

When did crops flower at the Frankland River trial?

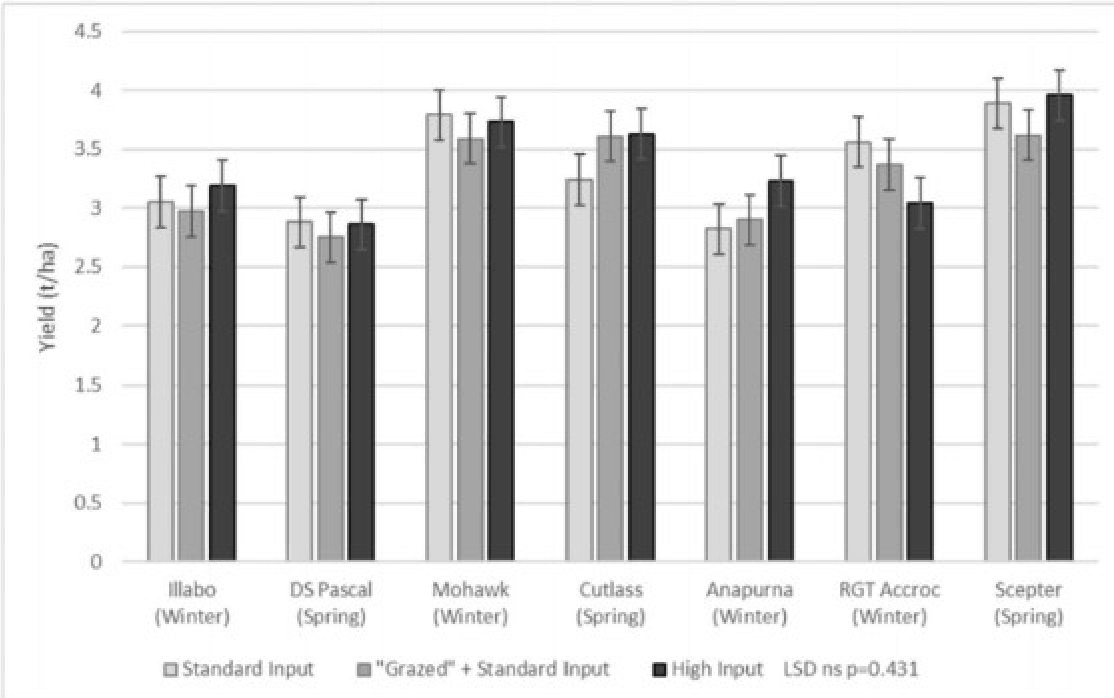
Following a 21st April sowing date in 2022, Table 10 shows the diversity in flowering dates of the winter and spring cultivars established at the Frankland River site, with almost 2 months difference between Scepter and RGT Accroc. From modelling studies, the optimum flowering period for the region is regarded as late September, slightly later than mid-September for Esperance. As might be expected, those spring wheats that flowered first had significantly lower harvest dry matters than the winter wheats. However, the surprise has been the good grain yield performance of winter wheats despite them flowering much later than the optimum period. Further assessment in future seasons is necessary to determine whether this is an artefact of two mild springs or a lift in productivity from European germplasm not previously tested in southwest WA.

Table 1. *Approximate calendar date that each cultivar reached stem elongation (GS30) and the beginning of flowering (GS61) – 21 April sown.*

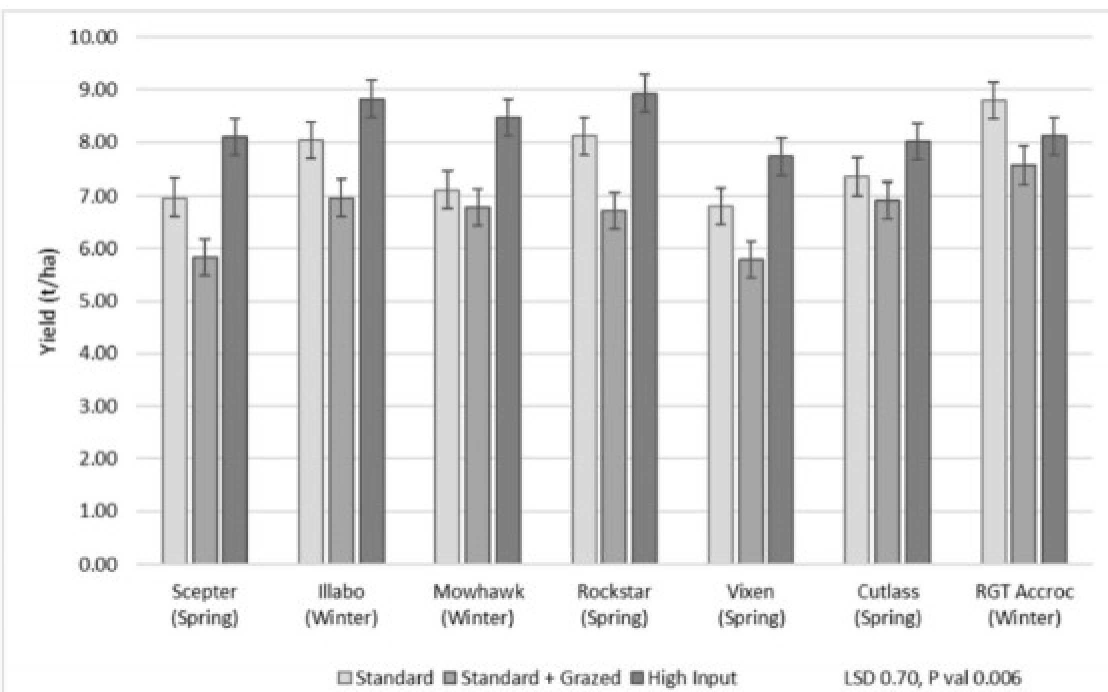
Cultivar (type)	Date GS30	Date GS61
Illabo (Winter)	1 July	26 September
Rockstar (Spring)	16 June	30 August
Mowhak (Winter)	1 July	12 September
Kinsei (Spring)	16 June	30 August
RGT Accroc (Winter)	16 June	14 October
Scepter (Spring)	2 Aug	19 August

As figure 8 indicates, the differential between spring and winter germplasm performance could be reduced by introducing spring wheat cultivars such as Rockstar and Denison that were higher yielding than Scepter. However, the generally cooler environment of Frankland River compared to Esperance has favoured the winter wheat germplasm.

2020 Green Range, WA - Standard Input N – total 86.5kg N/ha, High Input N – total 136.5kg N/ha



2021 Frankland River, WA Standard Input N – total 116kg N/ha, High Input N – total 209kg N/ha



2022 Frankland River, WA Standard Input N – total 100kg N/ha, High Input N – total 125kg N/ha

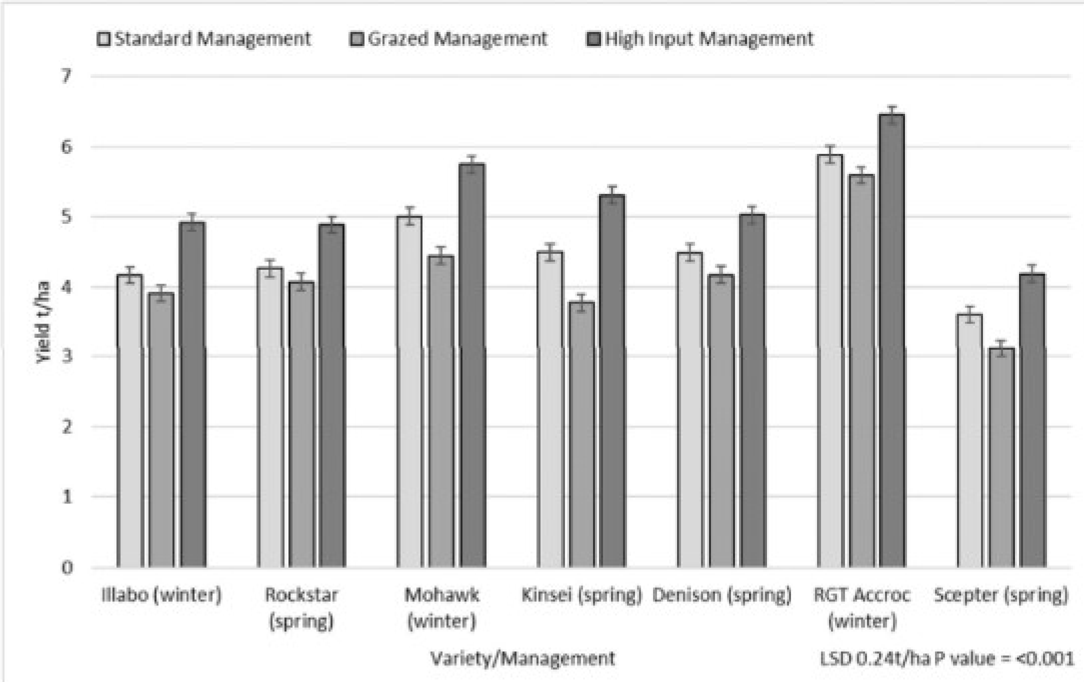


Figure 2. *Influence of management approach on wheat variety performance 2020 – 2022 Frankland River, WA*.

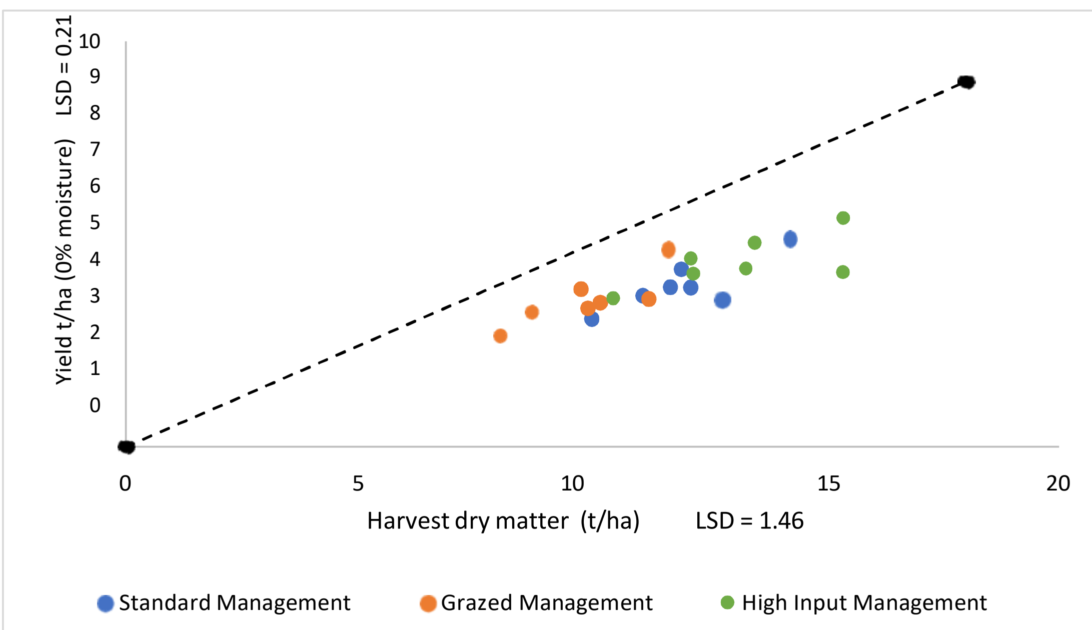


Figure 3. *Influence of management approach on wheat harvest dry matter and grain yield (recorded at 0% grain moisture) under three management approaches - Frankland River, WA 2022.*

Further reading – Please refer to the Cereal Results documents for *Optimising high rainfall zone cropping for profit in the Western and Southern Regions (DAW1903-008RMX)*

This key learning document features a small sample of the information collected in the project over the last three years. If you would like to follow up on any of the results, background details or assessments please refer to the individual results documents issued for 2020, 2021 and 2022 which have the following links.

210316-HRZ-2020-Cereal-Results-FINAL.pdf (faraustralia.com.au)
220222-HRZ-2021-Cereal-Results-FINAL-PROVISIONAL.pdf (faraustralia.com.au)
HRZ-2022-Esperance-Cereal-Results_FINAL.pdf (faraustralia.com.au)

Acknowledgements

We would like to thank the GRDC for investing in this research programme and CSIRO and DPIRD for collaborating in this project. Also, a big thanks to our host farmers, the Whiting family in Esperance, Scott Smith in Green Range and Kellie Shields and Terry Scott in Frankland River for their tremendous practical support given to the team over the course of the project.

We would also like to acknowledge our field day sponsors who helped make the six field days over the course of the project a success, Rabobank, AgLink David Grays and AFGRI.

Finally we would like to thank Nicky Tesoriero of Ceres Agronomy who assisted with the research leading to the 2022 results and reviewed the final results summary.

Planning to Ameliorate Gravel Duplex Soils (Forest Gravels)
FEATURES OF FOREST GRAVELS

Glenn McDonald, DPIRD

The forest gravels are typically described as a gravelly sand to loam over a dense clay subsoil. Gravel content in the soil can be as high as 80% or more of the soil. The texture change to the clay subsoil can range in depth from 10-20cm to more than 100cm. The clay subsoil can vary significantly in sand proportion and chemistry but generally these forest gravel clay subsoils do not have the chemical constraints found in other soil types.

Given the amount of gravel that can be found in the forest gravel soils, the proportion of soil volume that is easily accessible by plant roots can be substantially reduced. Therefore, it is important to consider the nutrient and water holding capacity of the soil volume when planning fertilizer or other activities.

Forest gravels have the same soil constraints as most other WA Wheatbelt soils including soil acidity and compaction. However, there are some particular soil constraints that are a feature of the forest gravel soils; primarily transient waterlogging and soil water repellence (SWR). It is important to understand that rarely does only one constraint occur in a soil type and often multiple constraints should be addressed concurrently if possible.

WATERLOGGING

Waterlogging in these soils can occur rapidly and, depending on slope, can disappear equally fast in the absence of continuing rainfall. It is not uncommon for the more coarse and gravelly layers of the soil to be waterlogged while the clay subsoil is almost dry. To complicate the waterlogging story, often the root zone can be waterlogged while the topsoil appears well drained and this is referred to as a perched water-table. When this occurs root growth in the profile is restricted to the shallower drained parts of the profile and crop growth may appear normal. Then in spring when the waterlogging dissipates, the weather warms and crop growth rates increase resulting in the crop quickly exhausting the limited stored soil water in the upper layers of the duplex soil. As a result of the waterlogging and the dense subsoil clay, few crop roots are able to penetrate into the clay and the crop senesces prematurely (Figure 1). This effect is often referred to as the “Boom-Bust” of crops… A “Boom” in vegetative growth followed by a “Bust” in expected grain yield.

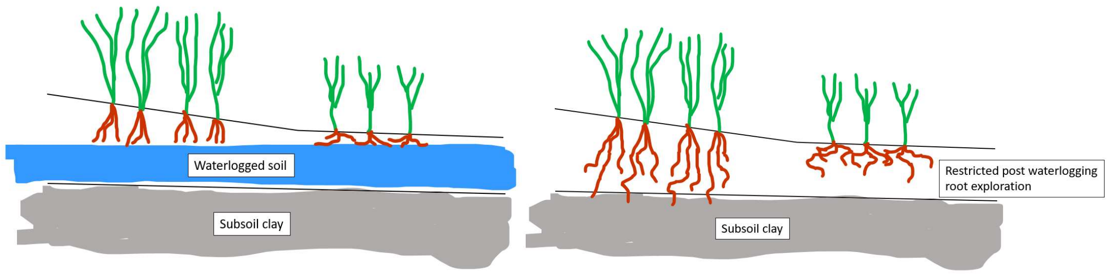


Figure 1. *Diagrammatic representation of restricted root growth from subsurface waterlogging.*

SOIL WATER REPELLENCE

Soil Water Repellence, or non-wetting soils, are a widespread problem for most growers with forest gravel soils. It is caused by the deposition of organic oils and waxes from decaying organic material from a range of mechanisms and develops over the warmer summer months. For repellent soils to naturally become wettable requires water to stimulate microbial activity to break down these organic compounds. And since this can be a slow process, many growers utilise soil wetting agents to help the soil absorb water and improve crop establishment. The mechanical movement of dry soil can increase the repellence of the soil.

AMELIORATION STRATEGIES

As with any change in a farming business, soil amelioration should involve collecting information and developing a plan. It is important to understand the characteristics of the soil profile including the physical, chemical and biological soil qualities. Once a good understanding of the soil characteristics throughout the profile has been achieved, a key part of the soil amelioration planning process is to determine for the relevant soil layers how the soil is to be modified, improved and mechanically relocated. Many growers have damaged the productivity of their soil by not adequately assessing the soil characteristics and not determining a desired soil profile end state. Additionally, not all amelioration options used on other soil types are suitable for gravel soils. For example, spaders tend to be unsuitable due to the high rate of wear from gravel soils and unpredictable soil obstacles such as rocks and tree roots.

Mechanical amelioration with mouldboard plough or modified one-way plough (e.g. plozza) has been shown to be the most effective, long lasting, and profitable amelioration strategy for addressing soil water repellence on forest gravel soils (Figure 2). Soil water repellence is rarely the only soil constraint that will need to be overcome to maximise grain production so other soil amelioration strategies should be considered in combination or alternative to inversion tillage.

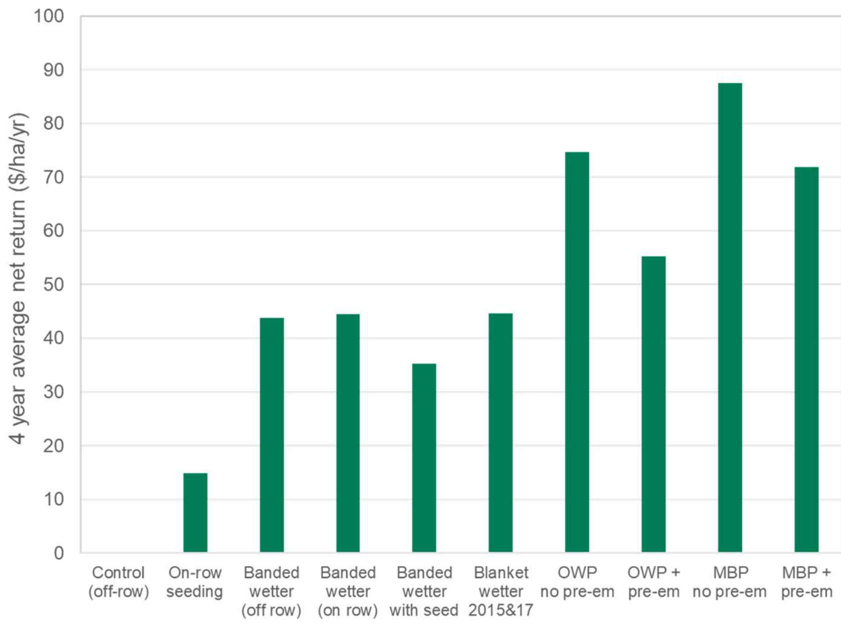


Figure 2. *Average net returns from soil water repellence amelioration options – Boscabel 2015-2018 (taken from 2019 Australian Agronomy Conference paper).*

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

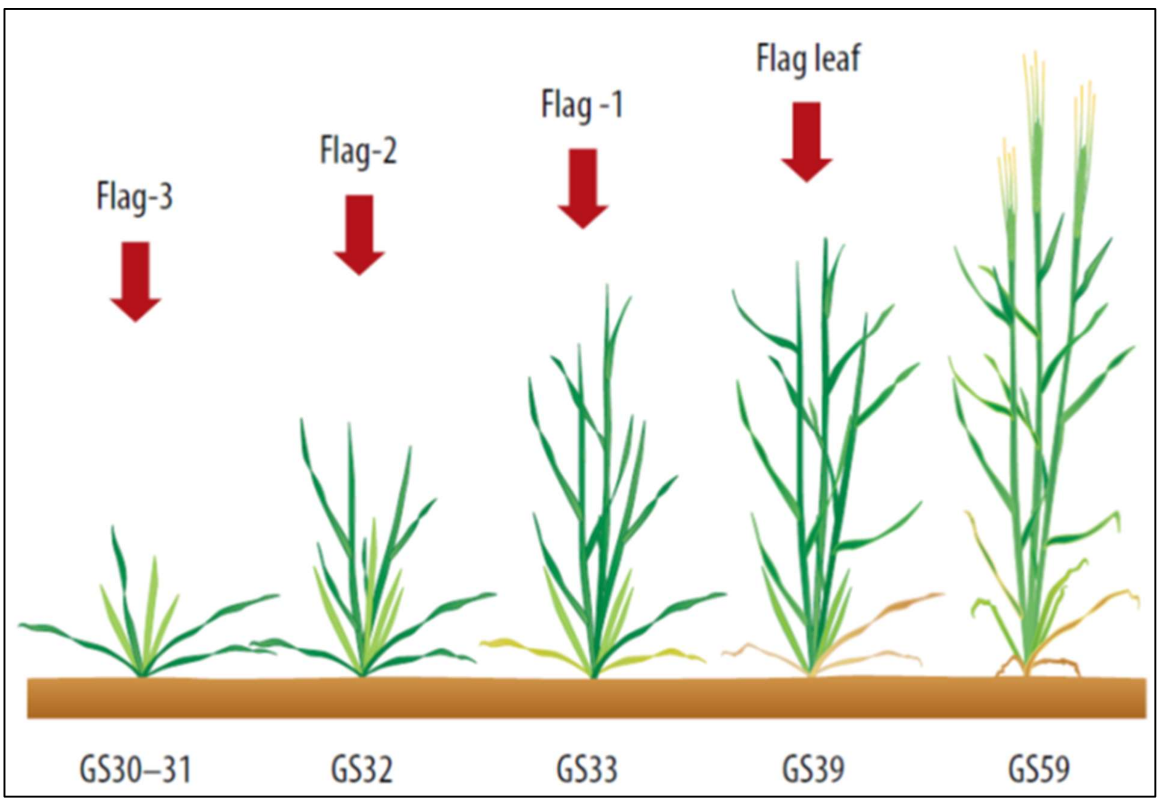
Start with some fundamental questions about your crop and its disease levels and/or expected disease levels. Always start with the visual inspection of the crop at specific development stages as the primary prerequisite to determining fungicide application.

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).

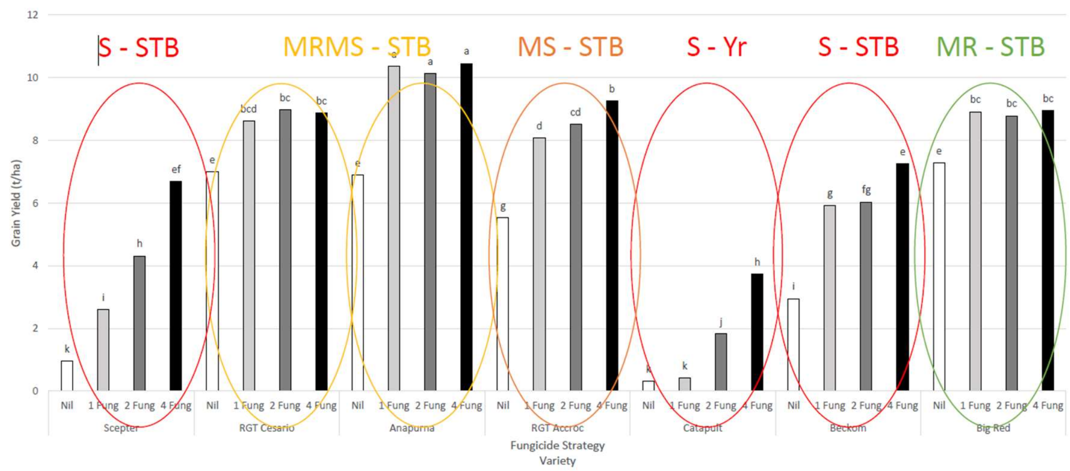


Figure 1. STB & Stripe rust rating and the response to fungicide (Fung) (Nil, 1, 2 or 4 fungicide units) – Wallendbeen, NSW 2022 (GRDC Hyper Yielding Crops Project). STB = Septoria Tritici Blotch, Yr = Stripe Rust.

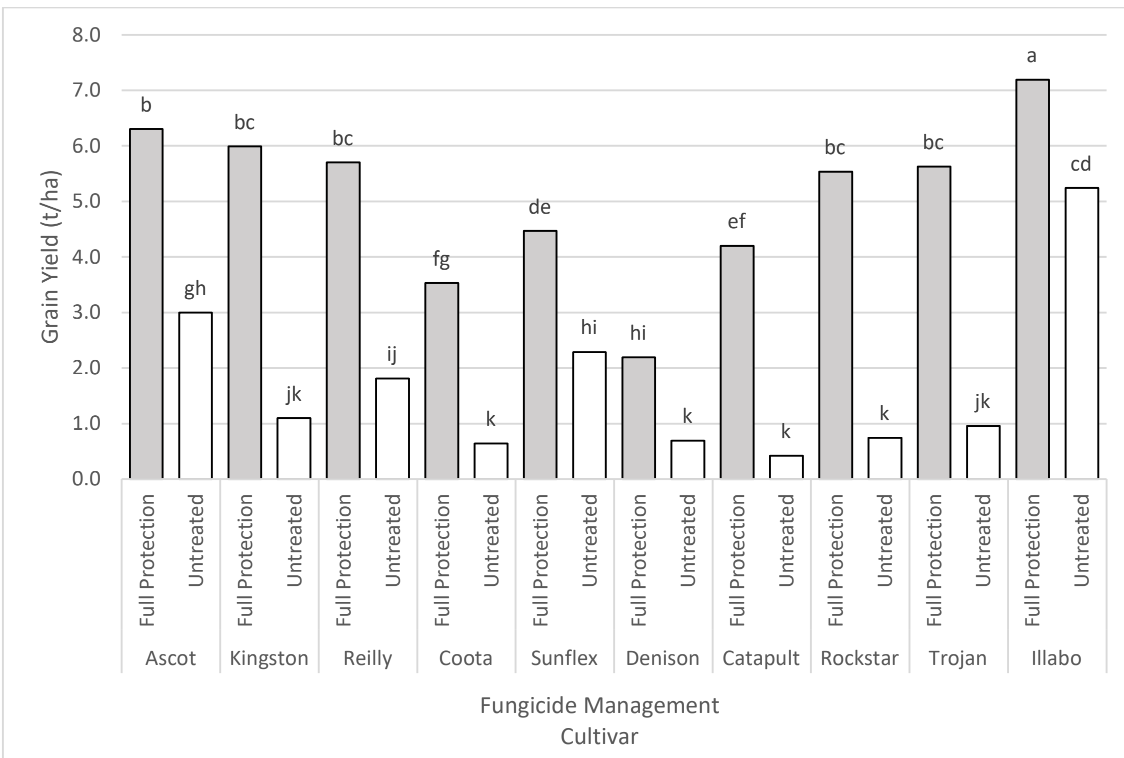


Figure 2. Yield response (t/ha) to fungicide (3 fungicide units vs. untreated) in milling wheats– Wallendbeen, NSW 2022 (FAR GEN Industry Innovations (II) 2025).

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).

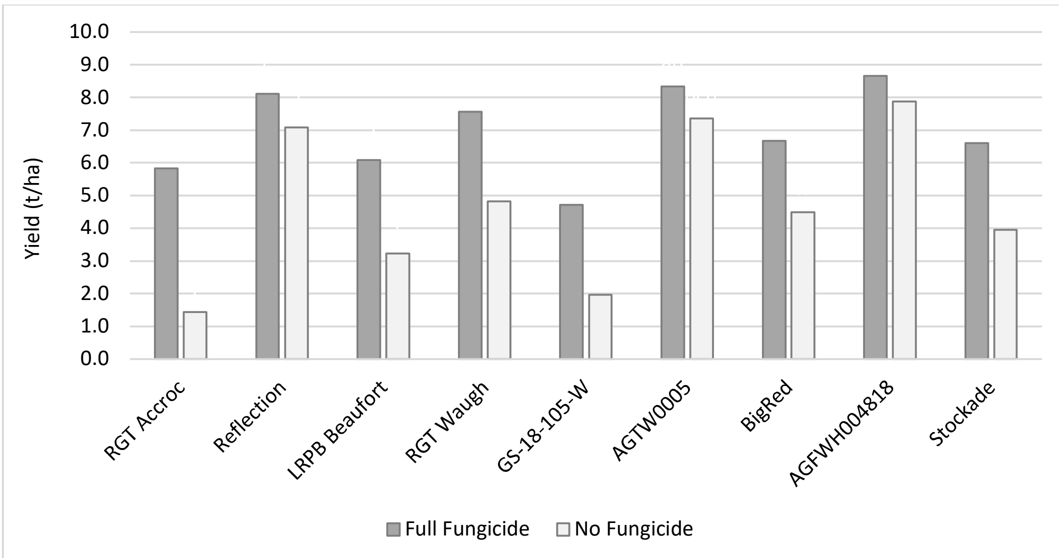


Figure 3. Yield response (t/ha) to fungicide (three units) vs. untreated – Millicent, SA 2022 (GRDC Hyper Yielding Crops Project).

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.

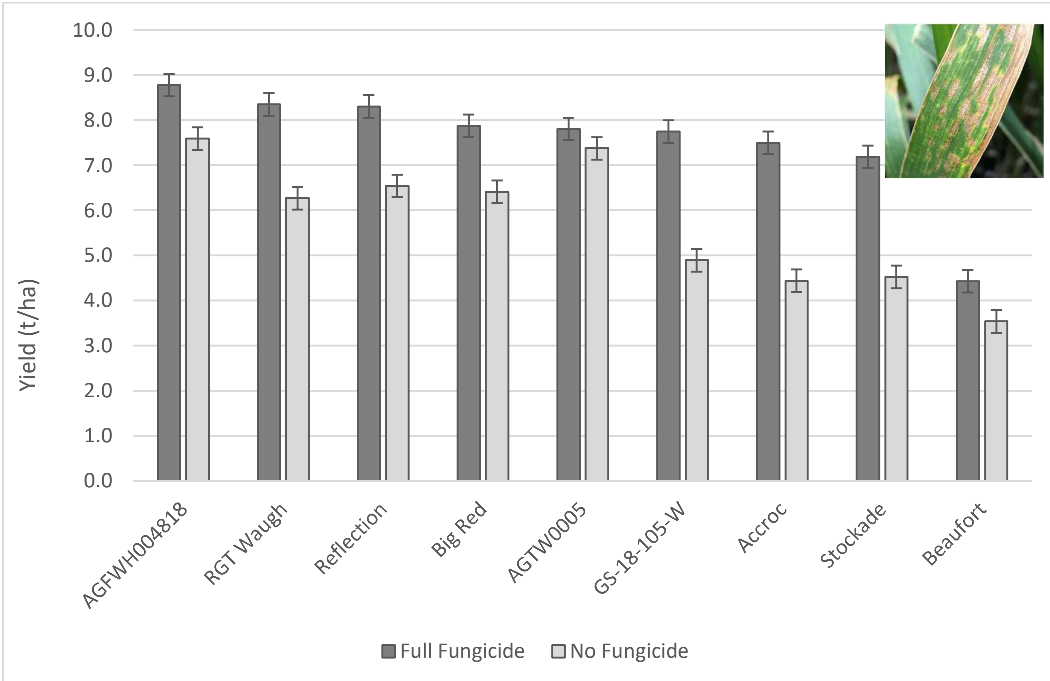


Figure 4. Yield response (t/ha) to fungicide (three units) vs. untreated – Gnarwarre, VIC (HRZ) 2022 (GRDC Hyper Yielding Crops Project).

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.

Field Applied Research (FAR) Australia gratefully acknowledge GRDC investment for the Hyper Yielding Crops project some of the data for which is presented above.

To access this document noline, visit https://faraustralia.com.au/wp-content/uploads/2023/08/230803_Issue-1_Disease-Managemen-in-Wheat.pdf

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