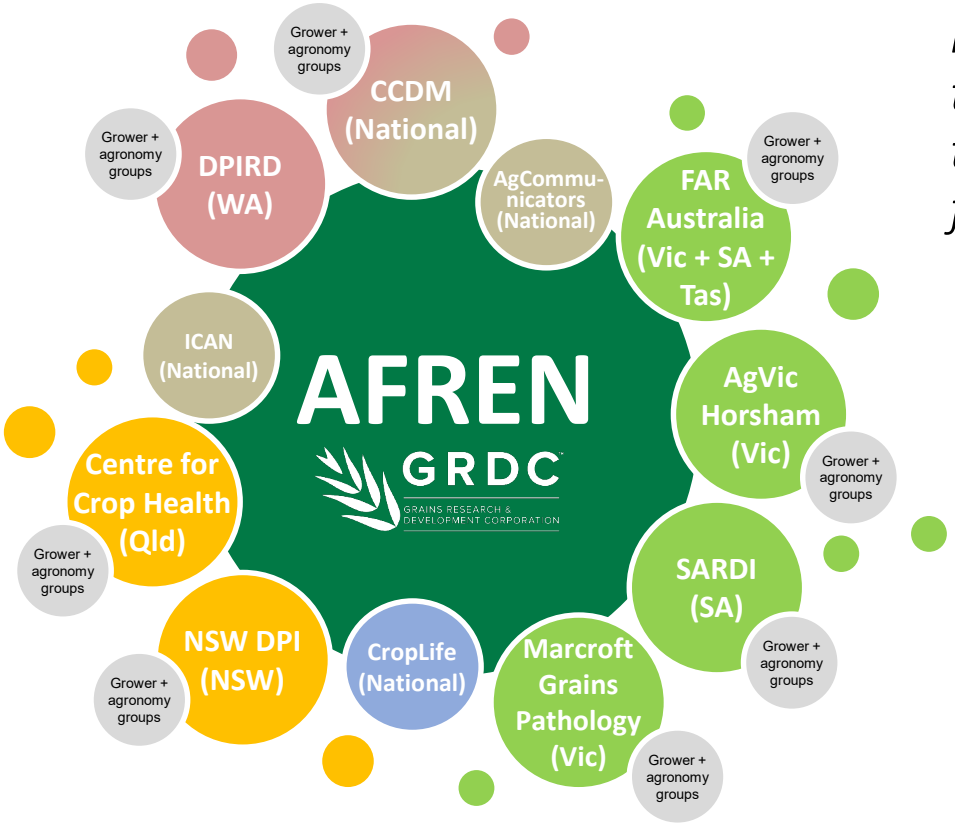
DISEASE CONTROL & FUNGICIDE RESISTANCE MANAGEMENT IN VICTORIA - MRZ

Grant Hollaway, Agriculture Victoria

AGRICULTURE VICTORIA

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Australian Fungicide Resistance Extension Network



Regionally specific resources and training to help growers and advisors understand the status, risks and management of fungicide resistance in Australian grains.

Develop and deliver:

- Fungicide resistance management guide
- Workshops, info sessions & webinars
- Factsheets, updates & email alerts

grdc.com.au/afren

@theGRDC

#AFREN

afren@curtin.edu.au

Cereal Foliar Fungicide Use: A short history

1980s

- Limited range, expensive and not overly effective
- Minimum disease standards for cultivar release

1990s

- Use of triadimefon (cheap) for Leaf Rust control in wheat in HRZ

2000s

- New pathotype of stripe rust overcame resistance in many cultivars
- Increasing range, cheap and more effective fungicides (more triazoles and strobilurins)

2010s

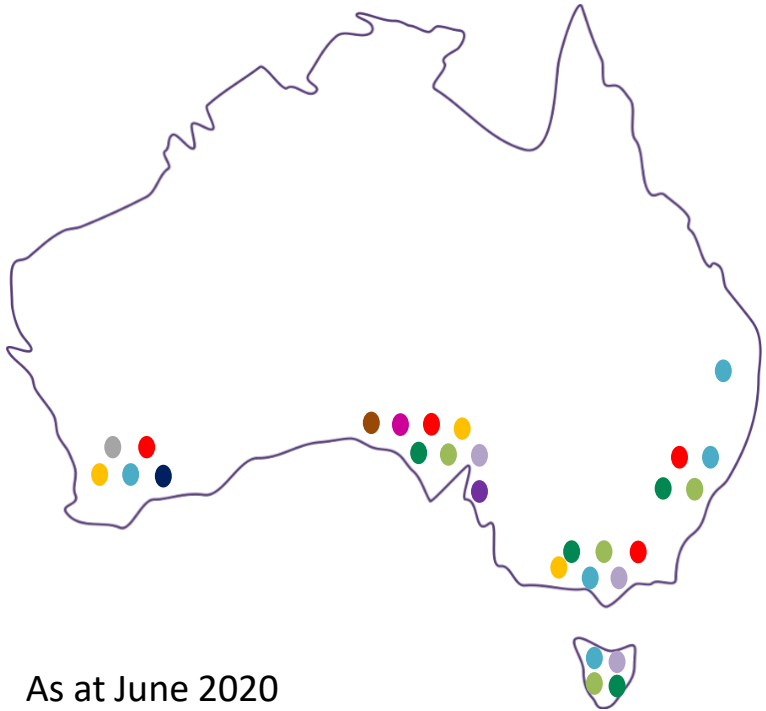
- SDHIs introduced
- Larger range of actives and more mixtures of actives and groups
- Minimum disease standards dropped

The honeymoon is over!

Can you grow cereals without fungicides?

Fungicide resistance in Australian grains crops

Centre for Crop and Disease Management
GRDC | Curtin University



As at June 2020

NB. Dots point to state only, not area where resistance was discovered.

	Disease and fungicide group
L, RS, R	Barley Powdery Mildew – Group 3 (DMI)
L, RS, R	Barley Net Form Net Blotch – Group 3
L, R	Barley Net Form Net Blotch – Group 7 (SDHIs)
RS, R	Barley Spot Form of Net Blotch – Group 3
RS	Wheat Powdery Mildew – Group 3
L, R	Wheat Powdery Mildew – Group 11 (strobilurins)
RS	Wheat Septoria tritici Blotch – Group 3
L	Canola Blackleg – Group 2 (MAP-kinase)
RS	Canola Blackleg – Group 3
L	Ascochyta Blight of Lentil – Group 1 (MBC)
L	Botrytis Grey Mould of Chickpea – Group 1

L = Lab detection RS = Reduced sensitivity R = Resistant

Cereal Fungicides

www.croplife.org.au

Group 7 (SDHI)	Group 3 (DMI / Triazoles)	Group 11 (Qols / Strobs)
Fluxapyroxad (Systiva®, Imbrex®)* Penflufen (EverGol® Prime)*	Triadimefon (e.g. Triad®), Propiconazole (Tilt®, Bumper®), Flutriafol (Impact®), Tebuconazole (e.g. Folicur®), Epoxyconazole (Opus®), Flutriafol (e.g. Impact®) Fluquinconazole (Jockey®)*	
	Tebuconazole + Prothioconazole (Prosaro®)	

Group 7 (SDHI) + Group 3 (Triazole)	Group 3 (Triazole) + Group 11 (Strob)
Bixafen + Prothioconazole (Aviator Xpro®) Benzovindiflupyr + Propiconazole (Elatus® Ace)	Cyproconazole + Azoxystrobin (Amistar® Xtra) Epoxiconazole + Pyraclostrobin (Opera®) Tebuconazole + Azoxystrobin (Veritas®) Epoxiconazole + Azoxystrobin (Radial®, Tazer® Xpert) Propiconazole + Azoxystrobin (Topnotch®)

Group 7 (SDHI) + Group 3 (Triazole) + Group 11 (Strob)

Fungicide resistance terminology

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

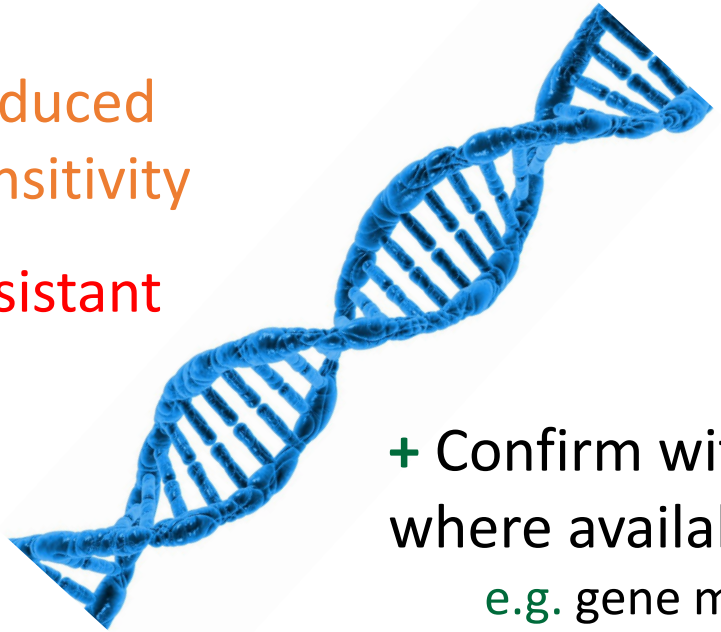
Term	Impact on fungicide use
Sensitive	Still works
Reduced sensitivity	Might still work okay • May need to use higher rates • Higher risk of developing resistance
Resistant	Doesn't work – avoid use • Field failure detected
Lab Confirmation Required	Measurable decrease in sensitivity when fungus cultured in the lab ± mutation detection

Group 3 (DMI) sensitivity in SFNB – Lab detection

Sensitive

Reduced sensitivity

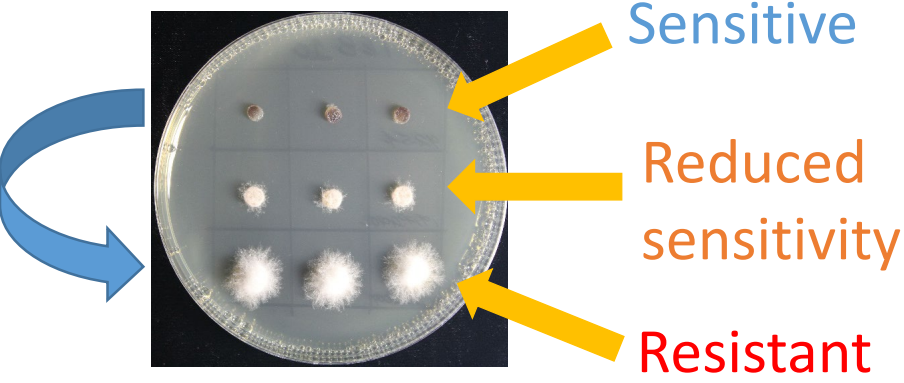
Resistant



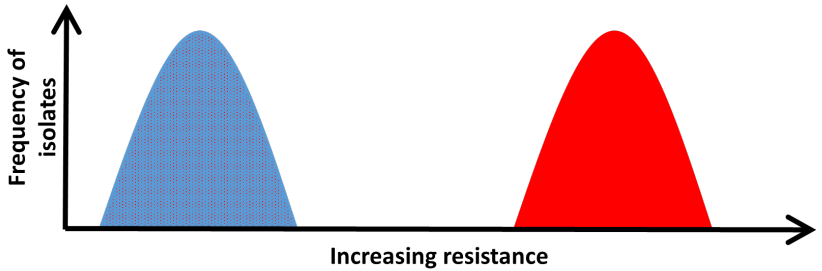
+ Confirm with molecular tests where available

e.g. gene mutations, overexpression

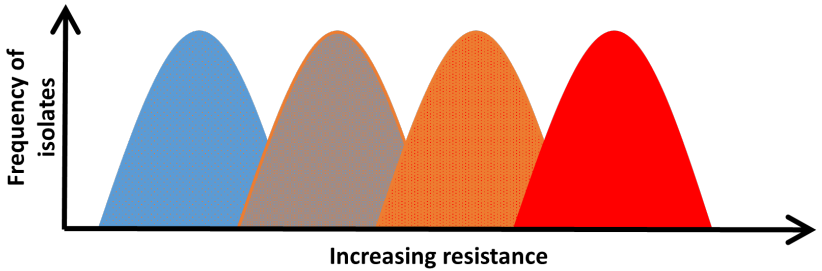
Development of Fungicide Resistance



"Single-step" - e.g. Group 11 fungicides



"Multi-step" - e.g. Group 3 fungicides

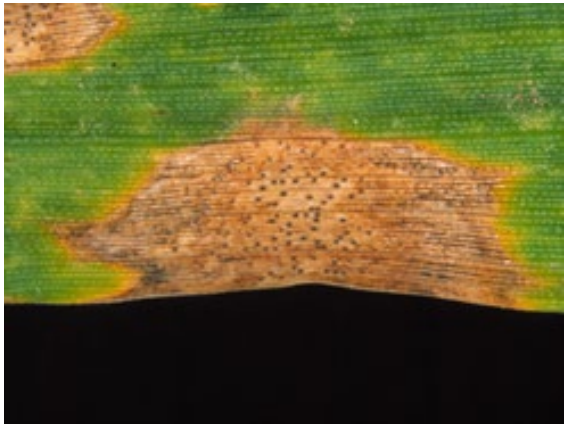


Fungicide resistance in SE Australia

More evidence of fungicide resistance and reduced sensitivity has emerged in these three common diseases over the last 5 years.

Net Form Net Blotch (NFNB)
Yorke Peninsula, SA
SDHI resistance 2019
(Curtin University)

Wheat Powdery Mildew – Vic, SA, Tas
Resistant QoI (strobilurin) WPM mutant now widespread in eastern states
(Curtin University)

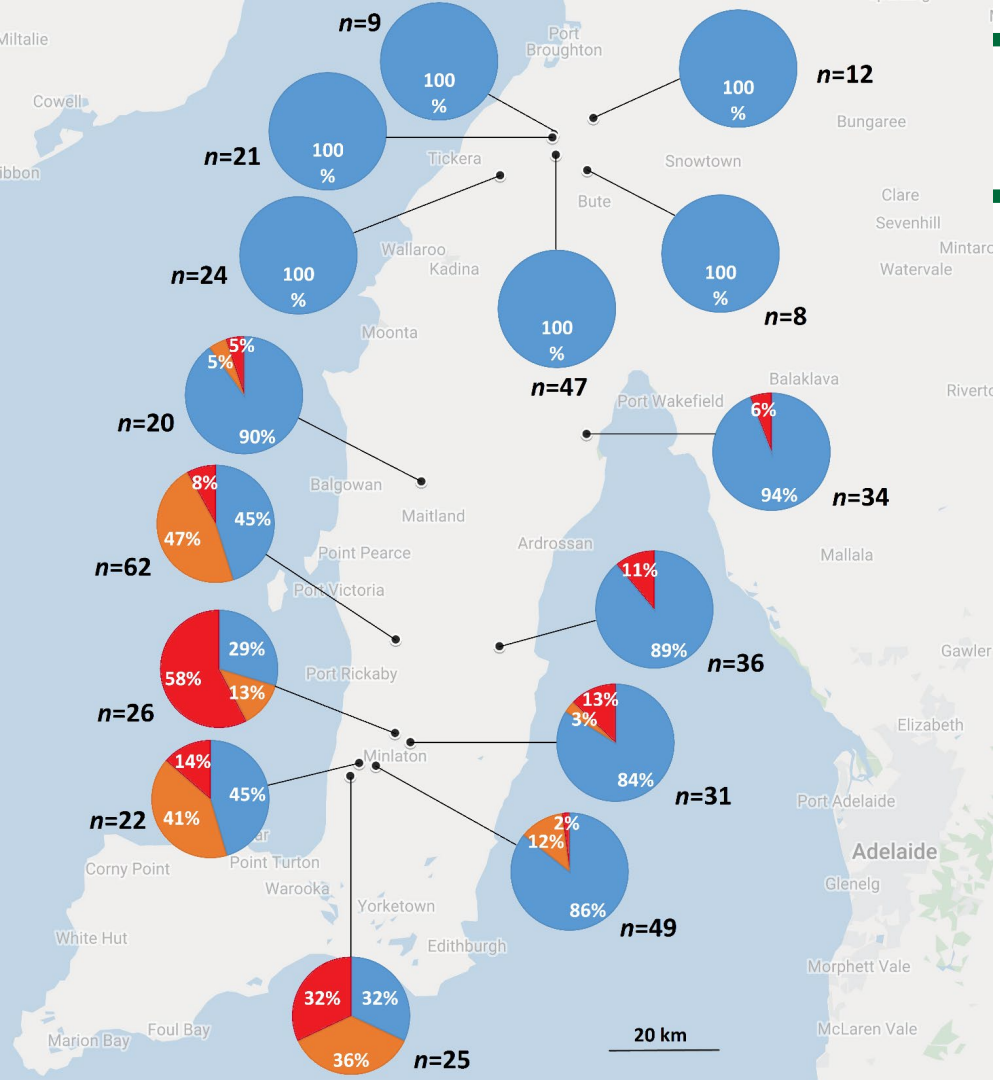


Septoria tritici Blotch (STB)
Reduced sensitivity to DMI triazoles confirmed
(NSW DPI)

Net form net blotch (NFNB) – Minlaton, SA

Variety: Spartacus CL

Fungicide: Systiva (fluxapyroxad)



SDHI - Fluxapyroxad

Sensitive	< 5 µg/mL	78.2 %
Reduced sensitivity †	5 µg/mL	11.7 %
Resistant ‡	10 µg/mL	10.1 %
		n = 427

† Sensitivity level equivalent to *SdhD*-D145G

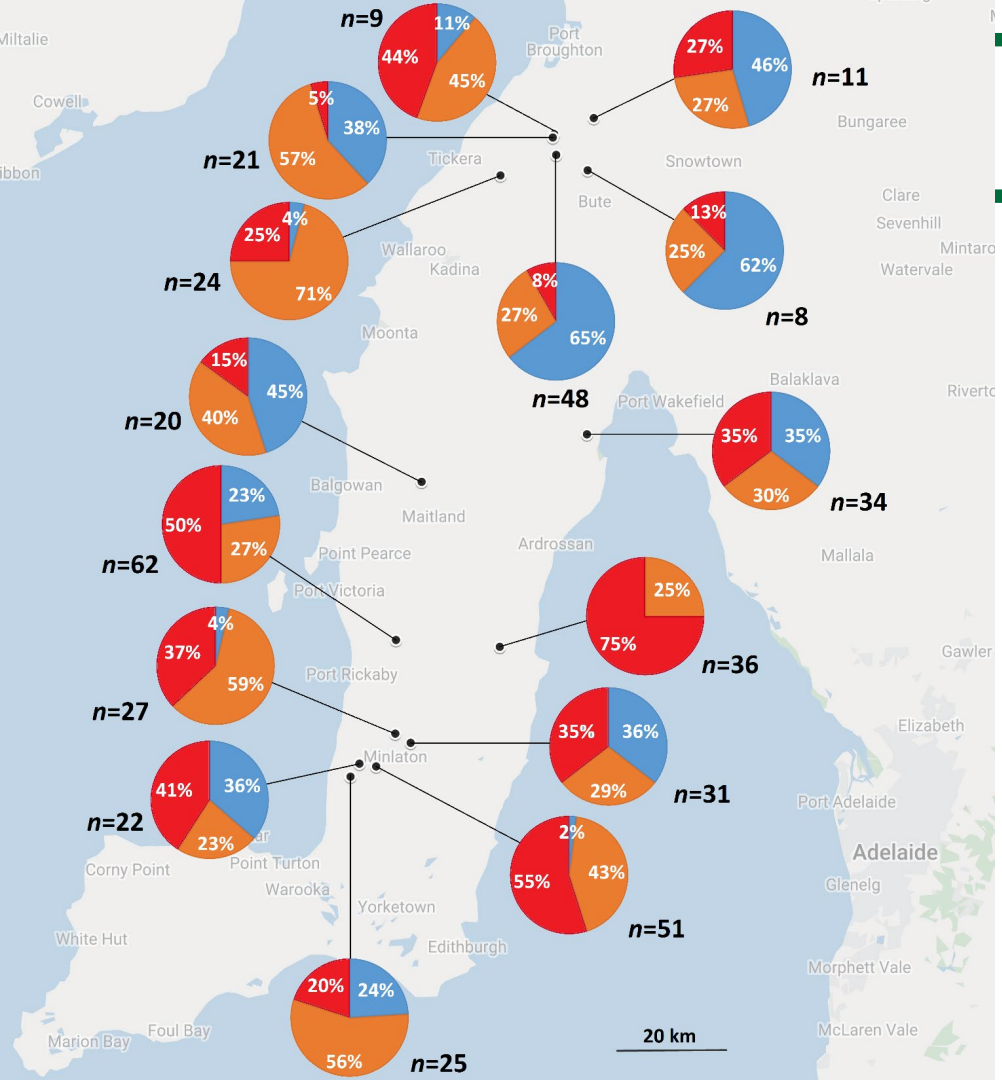
‡ Sensitivity level equivalent to *SdhC*-H134R

As at February 2020

Centre for Crop and Disease Management

GRDC

Curtin University



DMI - Tebuconazole

Sensitive	< 15 µg/mL	26.3 %
Reduced sensitivity †	15 µg/mL	37.6 %
Resistant ‡	50 µg/mL	36.1 %
		n = 429

† Sensitivity level equivalent to F489L (*Ptt* or *Ptm*) or Indel (*Ptm*)

‡ Sensitivity level equivalent to F489L+Indel (*Ptm*) or F489L+CNV (*Ptt*)

As at February 2020

Centre for Crop and Disease Management

GRDC

Curtin University

Dual Resistance to DMIs & SDHIs

- 20% of all ‘isolates’ (*n*=86) show at least reduced sensitivity to both tebuconazole (growth at rates of ≥ 15µg/mL) and fluxapyroxad (growth at rates of ≥ 5µg/mL)

- 4.2% of all ‘isolates’ (*n*=18) are highly resistant to both tebuconazole (growth at 50µg/mL) and fluxapyroxad (growth at 10µg/mL)

Managing fungicide resistance in NFNB

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

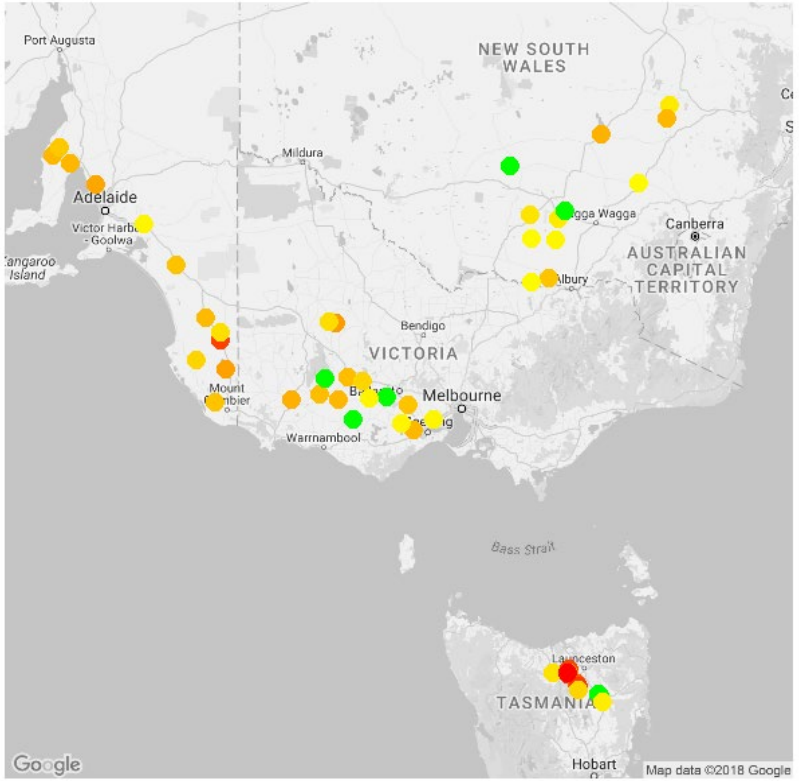
- No suggestion at this stage that NFNB resistance to SDHI fungicides is widespread outside of South Australia.
- However, this is a warning that it may spread or the same mutations can occur elsewhere.
- Reduced sensitivity to Triazole fungicides in Vic

➢ **Please share your experiences & connect with your local state pathologist to send in samples**

Septoria tritici blotch (STB)

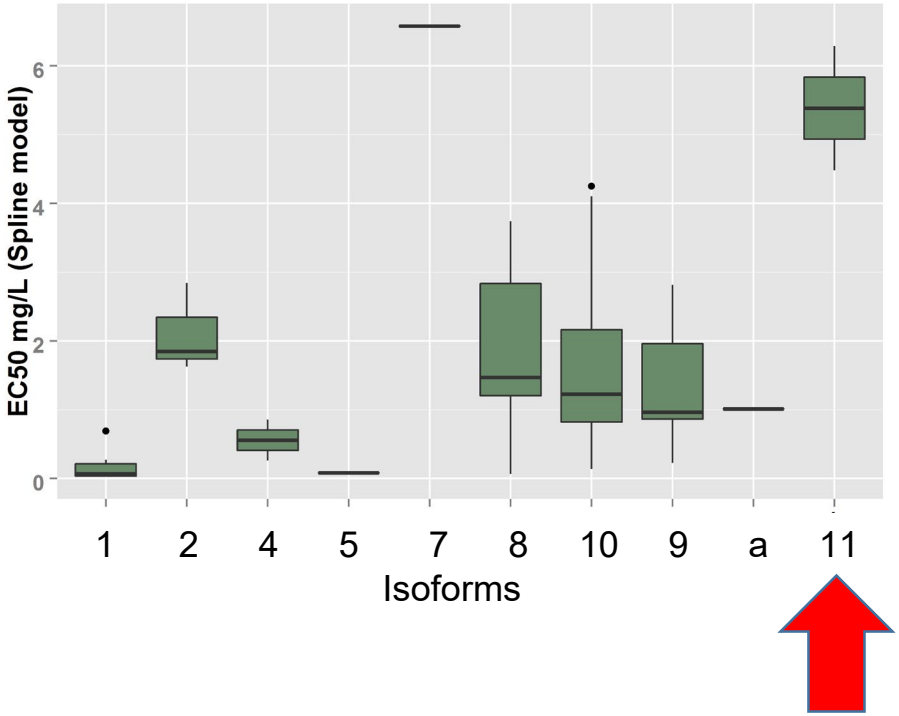
STB – Fungicide Resistance Survey 2017

- Wide distribution of a **Cyp51** mutation (**isoform 11**) has led to a significant loss of sensitivity to some DMIs
- No changes in the sensitivity to strobilurins or SDHIs reported as yet (but high risk of development)



Acknowledgement: Andrew Milgate

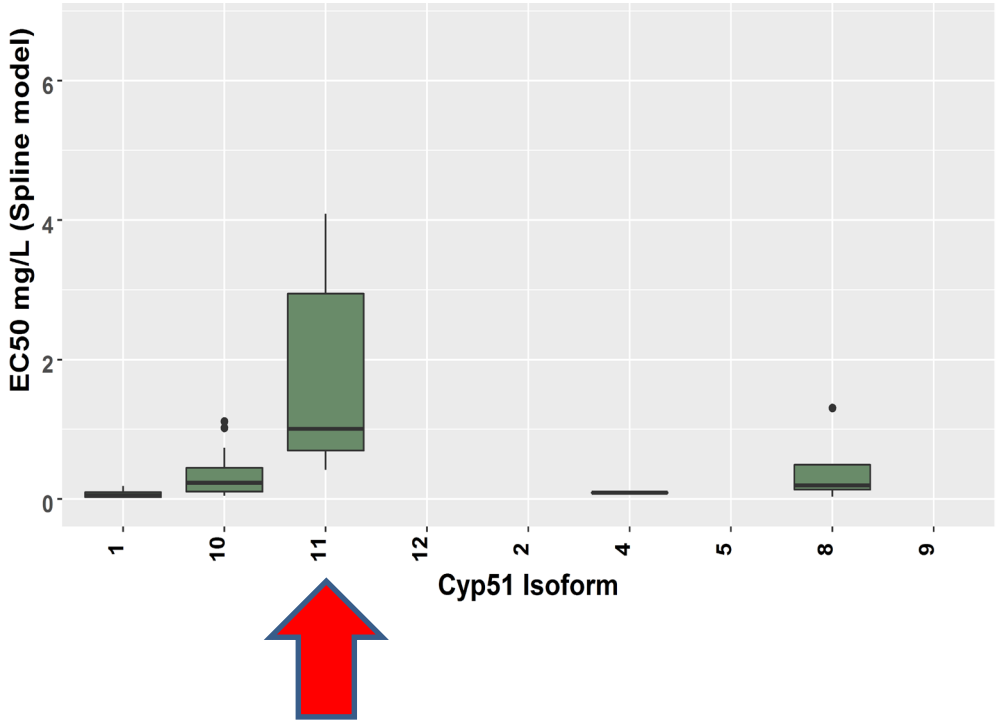
STB Isoform effects – Tebuconazole



Acknowledgement: Andrew Milgate

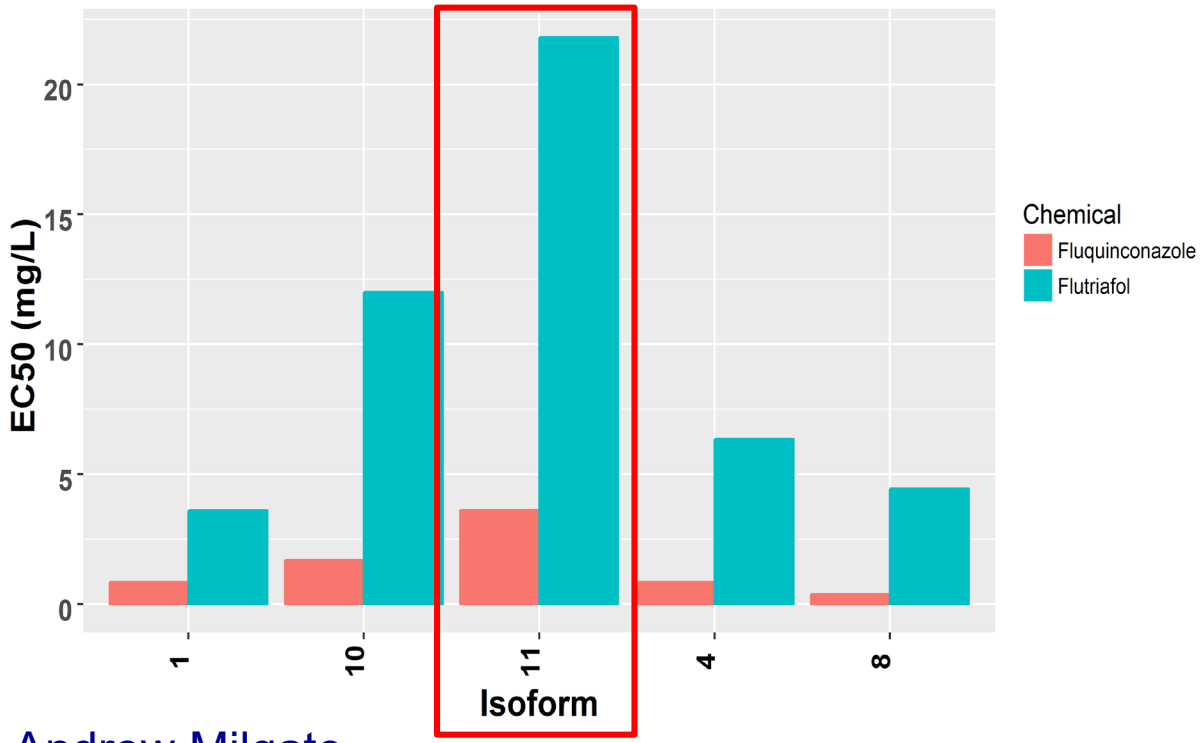
STB Isoform effects – Epoxiconazole

Still effective in the field but some change will be noticed



Acknowledgement: Andrew Milgate

STB Isoform effects – Differences in upfront treatment options



Acknowledgement: Andrew Milgate

STB – Fungicide Resistance Survey 2017

Active ingredient	Resistance status
Strobilurins	Effective
SDHIs (Bixafen)	Effective
Epoxiconazole	Effective
Prothioconazole	Effective
Cyproconazole	Less effective
Flutriafol	Less effective
Tebuconazole	Less effective
Propiconazole	Less effective
Triadimenol	Not effective

Acknowledgement: Andrew Milgate

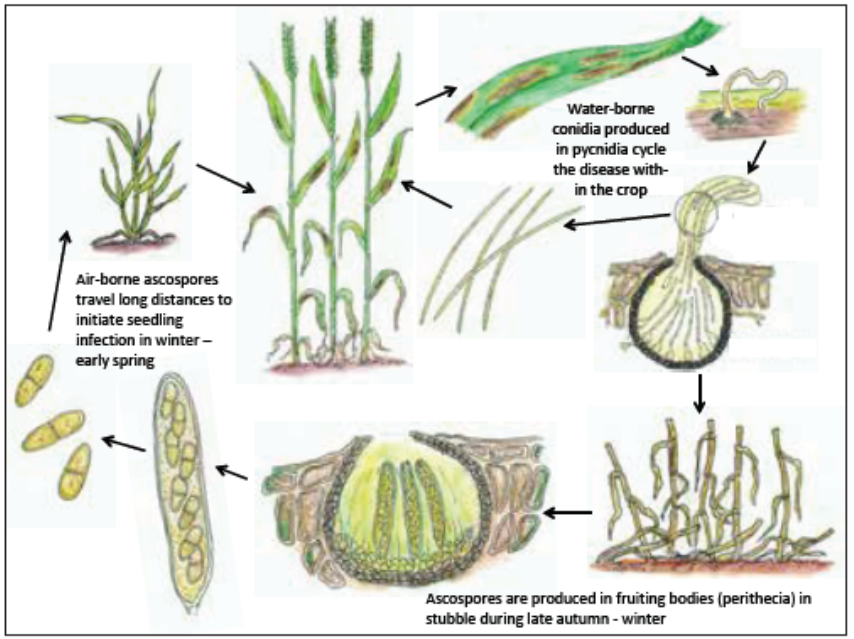
Septoria tritici blotch (STB) – what makes it tick?

1. First phase of infection from stubble is by airborne ascospores (long distance).

2. Second phase of infection is rain splashed conidia up the crop canopy (short distance).

3. After early spring little or no infection from sources outside of the paddock (different to rusts).

The life cycle of *Zymoseptoria tritici* (STB)



©PLANTwise 2014.

Dry weather is the best fungicide for this disease!

BEWARE! Long latent period makes STB difficult to control

- Long latent period (250°C days or 14 – 42 days) **disguises** disease advance. Optimum development temperature 15-20°C
- STB infection in spring the crop appears to grow away from the disease, when clean leaves are already infected.
- During stem elongation (as the top three leaves emerge) if conditions are conducive **–>** STB will be approximately two clean leaves below the newest emerging leaf.

Zymoseptoria tritici (Septoria tritici blotch, STB)

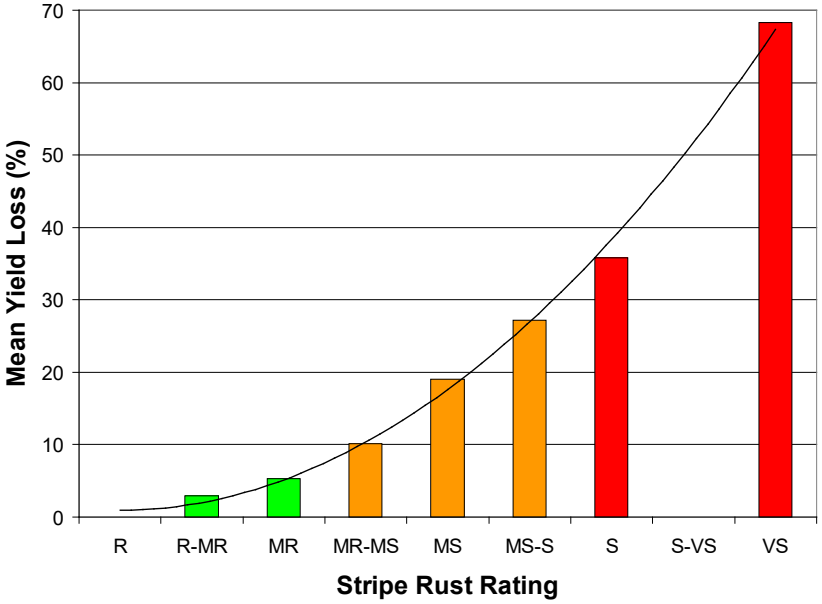
Measures to ~~slow~~ accelerate resistance to fungicides

Year	Crop / SFNB	Fungicides	
		Up Front	In Crop
2017	Barley / SVS	fluxapyroxad	tebuconazole
2018	Lentil / R	-	-
2019	Barley / SVS	fluxapyroxad	tebuconazole
2020	Barley / SVS	fluxapyroxad	tebuconazole

Measures to slow resistance to fungicides

- Reduce reliance on fungicides
  1. Avoid highly susceptible varieties

Avoiding “sucker” varieties shares the load



Cereal Disease Guide 2020

Grant Hollaway and Mark McLean

Cereal Pathologists, February 2020

2019 in Review: A wet start to the season favoured disease early, but drier conditions during spring limited disease development in many areas. Despite this, Agriculture Victoria (AgVic) field trials showed grain yield losses of up to 17% in situations where susceptible varieties were planted into infected stubble and fungicides were not applied. This demonstrated the importance of proactively managing diseases during favourable seasons.

2020 Cereal Disease Management

Cereal diseases will need proactive management during 2020 as there will be high levels of stubble-borne inoculum following limited breakdown over the dry summer. This dry summer will reduce the risk posed by rust and aphid spread viruses due to the limited green bridge. However, this may change if rainfall events continue in the lead up to sowing.

Soil-borne diseases are a risk to cereals and testing prior to sowing (PREDICTA B®) allows at risk paddocks to be identified and avoided.

Wheat: Foliar Diseases

Septoria tritici blotch and stripe rust are the main concern for high rainfall regions, while yellow leaf spot will be important in the medium to high rainfall zones.

Stripe Rust A new strain of stripe rust that caused issues for LRPB Trojan and DS Bennett, was detected during 2019. This strain is a mutation of the WA stripe rust family and has increased virulence on some wheat varieties (e.g DS Bennett and LPB Trojan and to a lesser extent Devil, Illabo, DS Darwin, Emu Rock and Hatchet CL Plus) and more importantly has virulence on many durum wheats (e.g. DBA Spes, DBA Lillaroi, DBA Vittaroi and EGA Bellaroi). The ratings provided in this guide consider this new strain of stripe rust.

A new tablet based app (StripeRustWM) is available to support in-crop fungicide decisions for the management of stripe rust. This app is based on the BlacklegCM and SclerotiniaCM apps that are widely used in canola and provides an easy format to determine the likely returns from fungicide applications. The app is available at no cost for iPads or Android tablets from the Apple App Store or Google Play Store. Search for “StripeRustWM”

Septoria tritici blotch (STB) is important in the high rainfall regions. Many varieties are rated as susceptible or worse, and there are strains with partial resistance to common fungicides. Adopting an integrated management approach, that combines variety (avoid susceptible), paddock selection (avoid infected stubble) and timely use of fungicides will help with its management.

Barley: Foliar Diseases

Stubble-borne diseases, spot form of net blotch (SFNB), net form of net blotch (NFNB) and scald, will need to be managed in susceptible varieties, especially in paddocks where barley stubble is present from the last two seasons.

Economic return from fungicide application is likely where foliar diseases affect more than 10% of leaf area and yield potential is more than 2.5 t/ha.

Oat: Foliar disease

Red leather leaf (RLL) is the most common foliar disease in the medium and high rainfall zones. Field trials during 2019 showed that it caused up to 17% (0.7 t/ha) grain yield loss and 12% (2.1 t/ha) biomass loss in susceptible milling and hay varieties respectively. Losses were significantly less for moderately susceptible (MS) or better rated varieties. RLL is stubble-borne so avoid sowing into oat stubble to reduce disease severity and loss. Where red leather leaf infection develops, foliar fungicide application during mid tillering to stem elongation was found to provide the best suppression. Bacterial blight was also found to be common, at low levels in most oat crops. However, there are no in crop control options available, so avoid sowing into infected oat stubble to reduce its impact.

Fungicide Resistance

There are increasing reports of fungicide resistance occurring in fungal diseases of wheat and barley. Of most significance was the detection of resistance to both fluxapyroxad (an SDHI fungicide in the seed treatment Systiva®) and tebuconazole in South Australia, during 2019. Resistance to fungicides are more likely to develop in situation where growers become over reliant on chemicals for disease control.

An industry approach is needed to protect the longevity of currently effective fungicides.

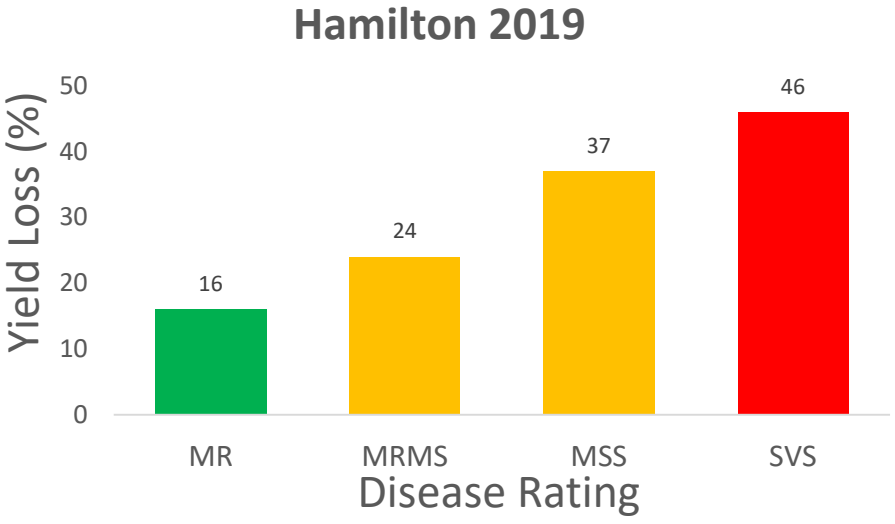
1. Use a range of control strategies to minimise disease development including:
   - avoiding growing highly susceptible cultivars,
   - using crop rotation to avoid planting into paddocks with disease present, and
   - managing the green bridge for diseases such as mildew and rust.
2. Use seed and/or fertiliser treatments, if available, to suppress early disease development.
3. Avoid unnecessary fungicide use.
4. Use fungicide mixtures formulated with more than one mode of action.

AGRICULTURE VICTORIA

National Variety Trials A GRDC INITIATIVE

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Septoria tritici blotch



Poor genetic resistance to Septoria tritici blotch in SA & VIC

VIC Variety Ratings (Source: NVT/Ag VIC)

Beaufort	MSS
Beckom	S
DS Bennett	MSS
Corack	S
Manning	MRMS
RGT Accroc	MS
RGT Calabro	MRMS
Kittyhawk	MRMS
SQP Revenue	S
Scepter	S
Trojan	MS

- MS confers advantages over S, particularly if suitable for early sowing.

Cereal Disease Guide 2020

Grant Hollaway and Mark McLean

Cereal Pathologists, February 2020

2019 in Review
A wet start to the season favoured disease early, but drier conditions during spring limited disease development in many areas. Despite this, Agriculture Victoria (AgVic) field trials showed grain yield losses of up to 16 per cent (0.7 t/ha) in situations where susceptible varieties were planted into infected stubble and fungicides were not applied. This shows the importance of proactively managing diseases.

2020 Cereal Disease Management
Cereal diseases will need proactive management during 2020 as there will be high levels of stubble-borne inoculum following limited breakdown over the summer. The dry conditions during early summer will reduce the risk posed by rust and aphid spread viruses due to the limited green bridge, however, this may change if rainfall events continue in the lead up to sowing.

Soil-borne diseases are a risk to cereals and testing prior to sowing (PREDICTA B®) allows at risk paddocks to be identified and avoided.

Wheat: Foliar Diseases
Septoria tritici blotch and stripe rust are the main concern for high rainfall regions, while yellow leaf spot will be important in the medium and low rainfall zones.

Stripe rust: A new strain of stripe rust (first detected during 2018) caused issues for LRPB Trojan and DS Bennett, last year. This strain, a mutation in the "WA" stripe rust family, has increased virulence on some wheat varieties (e.g DS Bennett and LRPB Trojan and to a lesser extent Devil, Illabo, Emu Rock and Hatchet CL Plus) but more importantly has virulence on many durum wheats (e.g. DBA Spes, DBA Lillaroi, DBA Vittaroi and EGA Bellaroi). The ratings provided in this guide consider this new strain of stripe rust.

A new tablet-based app (StripeRustWM) is available to support in-crop fungicide decisions for the management of stripe rust. This app is based on the BlacklegCM and SclerotiniaCM apps that are widely used in canola. The app is free for iPads and Android tablets from the Apple App or Google Play Stores. Search for "StripeRustWM"

Septoria tritici blotch (STB) is important in the high rainfall regions. Many varieties are rated as susceptible or worse, and there are strains with partial resistance to common fungicides. Adopting an integrated management approach, that combines variety (avoid susceptible varieties), paddock selection (avoid infected stubble) and timely use of fungicides will help with its management.

Barley: Foliar Diseases
Stubble-borne diseases, spot form of net blotch (SFNB), net form of net blotch (NFNB) and scald, will need to be managed in susceptible varieties, especially in paddocks where barley stubble is present from the last two seasons.

Economic return from fungicide application is likely where foliar diseases affect more than 10 per cent of leaf area and yield potential is more than 2.5 t/ha in susceptible varieties.

Oat: Foliar Diseases
Red leather leaf (RLL) is the most common foliar disease of oats in the medium and high rainfall zones. Field trials during 2019 showed up to 16 per cent (0.7 t/ha) grain yield loss and 13 per cent (2.1 t/ha) biomass loss in susceptible milling and hay varieties, respectively. Losses were significantly less for moderately susceptible (MS) or better rated varieties. RLL is stubble-borne so avoid sowing into oat stubbles. Where red leather leaf infection develops, foliar fungicide application during mid tillering to stem elongation provides the best suppression.

Bacterial blight was also common, but at low levels in most oat crops. As there are no in crop control options available, avoid sowing into infected oat stubble to reduce its impact.

Fungicide Resistance
There are increasing reports of resistance to fungicides in fungal diseases of cereals. Most significant was the detection of resistance in barley net form of net blotch to both fluxapyroxad (an SDHI fungicide in the seed treatment Systiva®) and tebuconazole in South Australia, during 2019. Resistance to fungicides are more likely to develop in situation where growers become over reliant on chemicals for disease control. Industry wide adoption of the following strategies can help protect the longevity of currently effective fungicides:

1. Use a range of control strategies to minimise disease development including:
   - avoiding growing highly susceptible cultivars,
   - using crop rotation to avoid planting into paddocks with disease present (i.e. infected stubbles), and
   - managing the green bridge for diseases such as mildew and rust,
2. Use seed and/or fertiliser treatments, if available, to suppress early disease development,
3. Avoid unnecessary fungicide use,
4. Use fungicide mixtures formulated with more than one mode of action,
5. Do not use the same active ingredient more than once within a season, and
6. Adhere to label recommendations.

AGRICULTURE VICTORIA

National Variety Trials – A GRDC INITIATIVE

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

AGRICULTURE VICTORIA

GRDC NATIONAL VARIETY TRIALS™

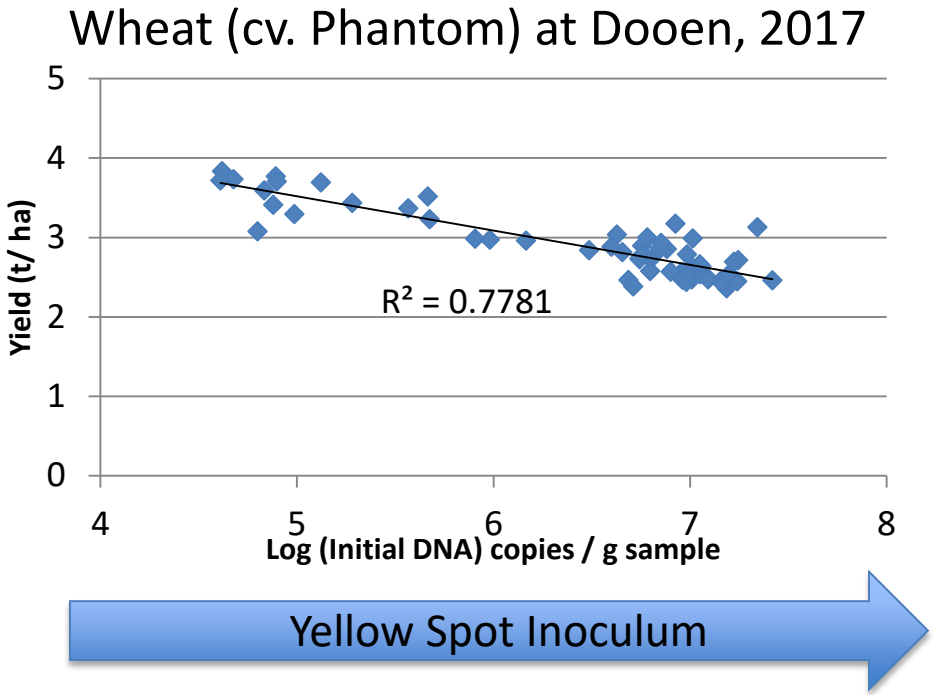
GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Measures to slow resistance to fungicides

- Reduce reliance on fungicides
  1. Avoid “sucker” varieties (variety selection)
  2. Avoid high risk situations (paddock selection)

Paddock selection: understand risk

Yellow Leaf Spot in Wheat



Measures to slow resistance to fungicides

- Reduce reliance on fungicides
  1. Avoid “sucker” varieties (variety selection)
  2. Avoid high risk situations (paddock selection)
  3. Avoid unnecessary use (identification and thresholds)

Avoid unnecessary fungicide use

- **Is it a disease? –** Fungicides don't fix nutritional deficiency or physiological issues

Herbicide damage

Boron

Zinc deficiency

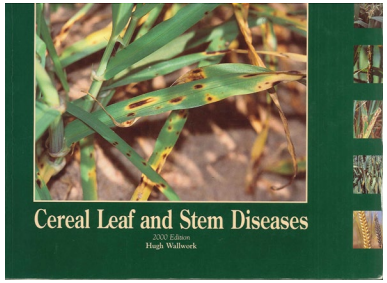
Leaf tip necrosis

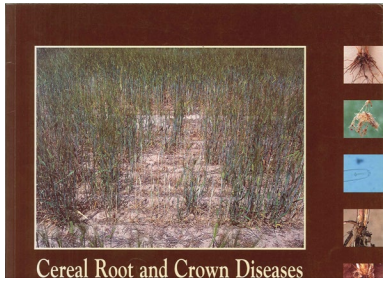
Pseudo black chauf

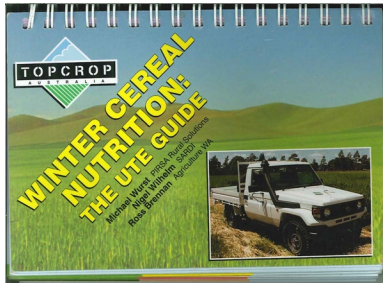
Disease Identification

Rule out chemical and nutritional disorders

- Use ute guides
- Look for patterns in paddock, or areas that have not been sprayed
  e.g. close to fence is often chemical drift
- Understand fertiliser history and soil type







Available on the App Store

GET IT ON Google play

GRDC UTE GUIDES

Available Titles

Avoid unnecessary fungicide use

- Not all disease causes yield loss
- Low disease levels not an issue
- Late epidemics of less concern
- Use decision support tools

Department of Primary Industries and Regional Development

AVAILABLE ON THE App Store

GET IT ON Google play

In-Crop Stripe Rust Control: StripeRustWM

StripeRustWM

Stripe rust management app for wheat. StripeRustWM uses a forecasting model to assist wheat growers with fungicide application decisions, on a paddock by paddock basis, and the likely economic returns from those decisions.

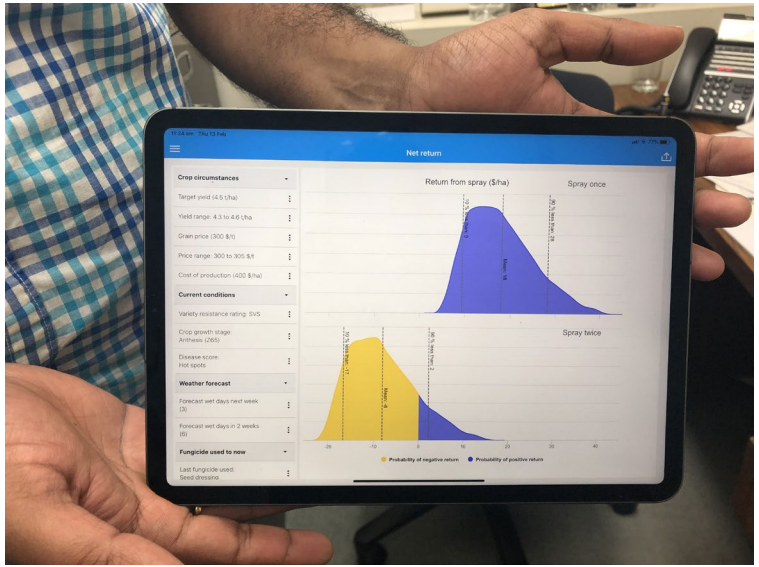
The user can specify individual paddock data as well as expected weather conditions so that the output relates to their own cropping circumstances.

To download the StripeRustWM App, click on the App store link below from your iPad, or the Google play link below from your Android tablet.

AVAILABLE ON THE App Store

GET IT ON Google play

"We want to put a pathologist in your back pocket" – Art Diggle, developer



Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Measures to slow resistance to fungicides

- Reduce reliance on fungicides
  1. Avoid “sucker” varieties (variety selection)
  2. Avoid high risk situations (paddock selection)
  3. Avoid unnecessary use (identification and thresholds)
- When they must be used
  1. Use strategies that support longevity

When we need a fungicide:

- Only spray if necessary – **limit applications**
- Choose mixtures with **different modes of action** (if available)
- Never apply the same Group 3 fungicide twice in a row – **alternate sprays**
- Avoid using Group 7* SDHIs & 11 strobilurin fungicides (seed dressing and foliar) more **than once per season**

  ** SDHI's that are applied as foliar sprays and/or seed treatments with foliar activity e.g. fluxapyroxad seed treatment*
- Use fungicides **before wide infection**
- Do not compromise effective control – **stay within label rates**
- **Monitor** & test your samples

Variety Rotation Strategies: Net Form Net Blotch of Barley

Year	Crop/Variety (NFNB Rating)	Fungicides			Comment
		Planting	GS 31	GS 39	
2020	**Barley / RGT Planet (SVS)**	**Fluxapyroxad**	**-**	**Tebuconazole**	
2021	Barley / RGT Planet (SVS)				**Bad**
2021	Barley / Compass (MRMS)				**Better**
2021	Anything other than barley				**Best**

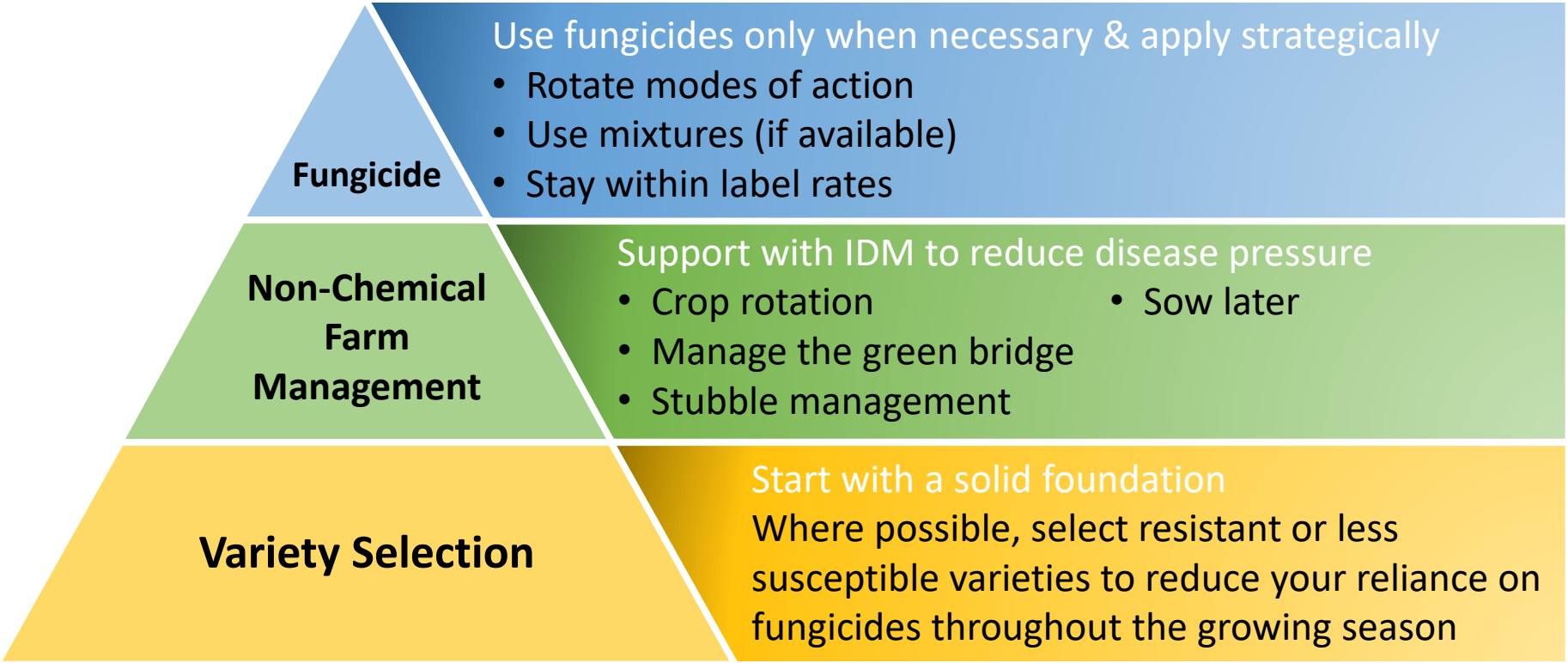
Fungicide Rotation Strategies: Net Form Net Blotch of Barley

Year	Crop/Variety (NFNB Rating)	Fungicides			Comment
		Planting	GS 31	GS 39	
2020	**Barley / RGT Planet (SVS)**	**Fluxapyroxad**	**-**	**Tebuconazole**	
2021	Barley / RGT Planet (SVS)	Fluxapyroxad	-	Tebuconazole	**Bad**
2021	Barley / RGT Planet (SVS)	Fluxapyroxad	-	Bixafen + Prothioconazole	**Bad** (2 x SDHI)
2021	Barley / RGT Planet (SVS)	Baytan	Propiconazole	e.g. Epoxiconazole + Pyraclostrobin	**Better**

Fungicide Resistance Management

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION



Acknowledgements

Fran Lopez & Kylie Ireland – CCDM

Andrew Milgate – NSW DPI

Art Diggle - DPIRD

Grains Research and Development Corporation (GRDC)

A Level 4, East Building, 4 National Circuit, Barton, ACT 2600

Australia

P PO Box 5367 Kingston, ACT 2604 Australia

T +61 2 6166 4500

F +61 2 6166 4599

www.grdc.com.au

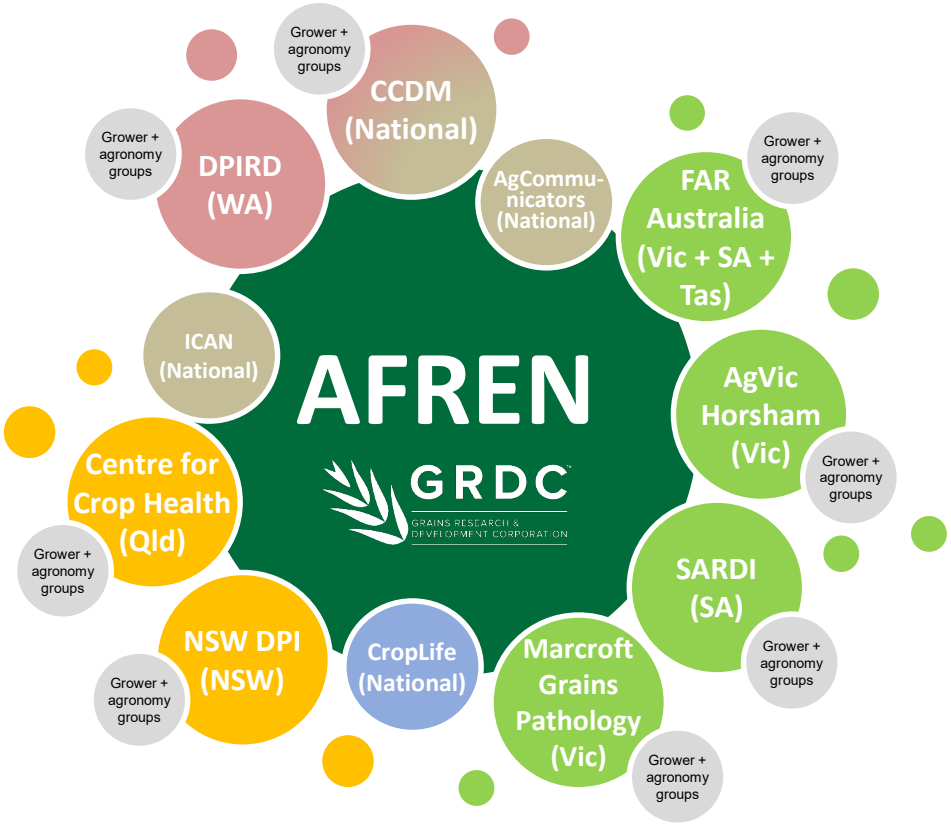
@thegrdc

Centre for Crop and Disease Management

GRDC

Curtin University

Australian Fungicide Resistance Extension Network



Connect with AFREN

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

@theGRDC
#AFREN

grdc.com.au/afren

afren@curtin.edu.au

Fungicide resistance management guide

Workshops, info sessions & webinars

Factsheets, updates & email alerts

Dr Grant Hollaway
03 4344 3111; grant.hollaway@agriculture.vic.gov.au

If you suspect fungicide resistance, let us know what's happening & help us sample!