QUEENSLAND: Mung bean powdery mildew, wheat powdery mildew, barley net blotches

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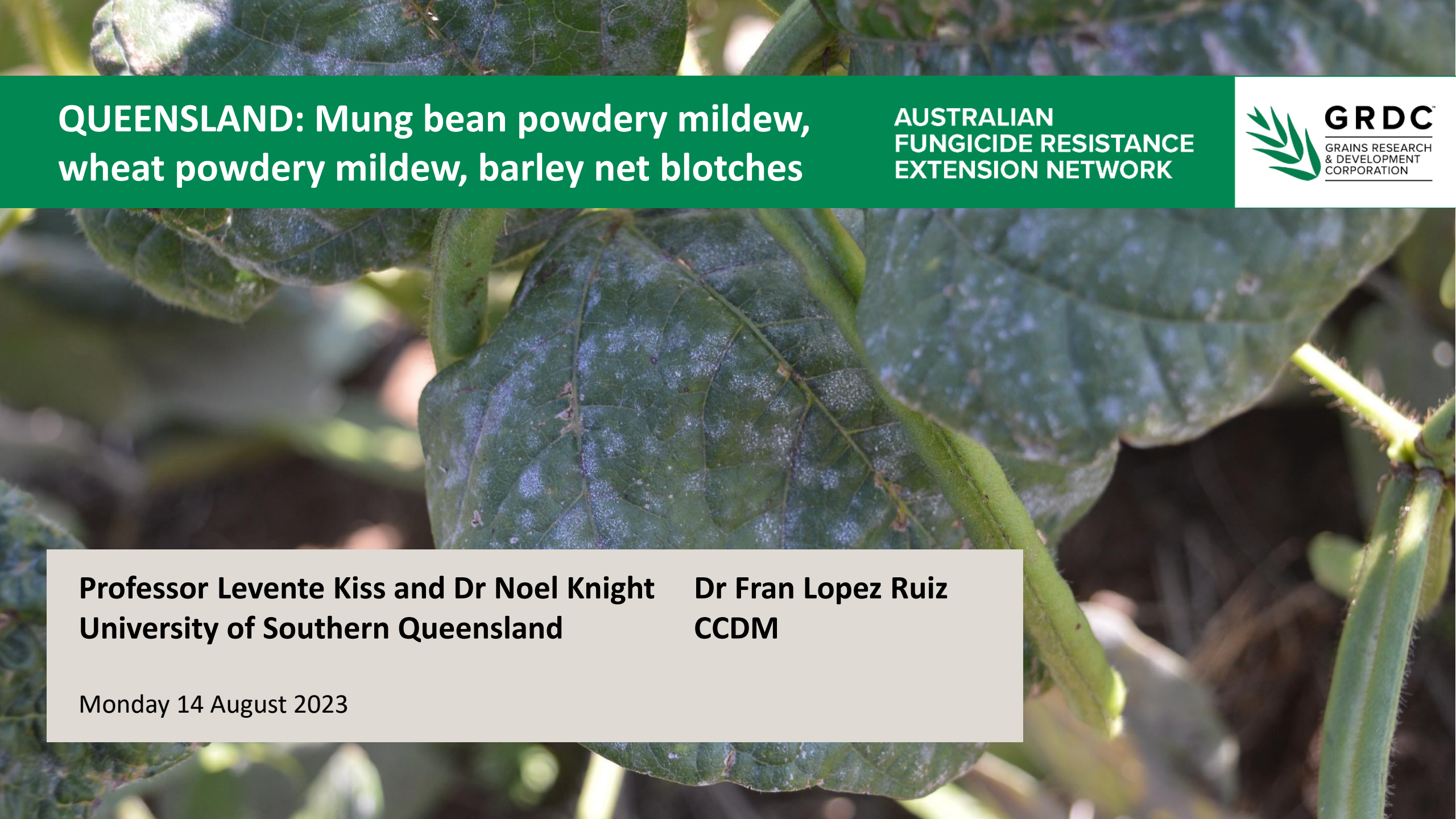

Professor Levente Kiss and Dr Noel Knight
University of Southern Queensland

Dr Fran Lopez Ruiz
CCDM

Monday 14 August 2023

Australian Fungicide Resistance Extension Network

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

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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

afren.com.au

afren@curtin.edu.au

@theGRDC

#AFREN

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Fungicide resistance in Queensland grains crops: Introduction and a case study

Prof Levente Kiss

University of Southern Queensland

Fungicide resistance terminology

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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
Lab confirmation required	
Resistant	Doesn't work – avoid use • Field failure detected

Lab detection	Measurable decrease in sensitivity when fungus cultured in the lab ± mutation detection

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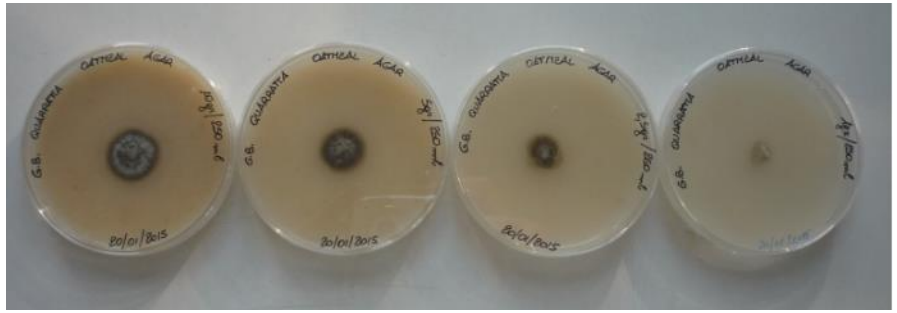

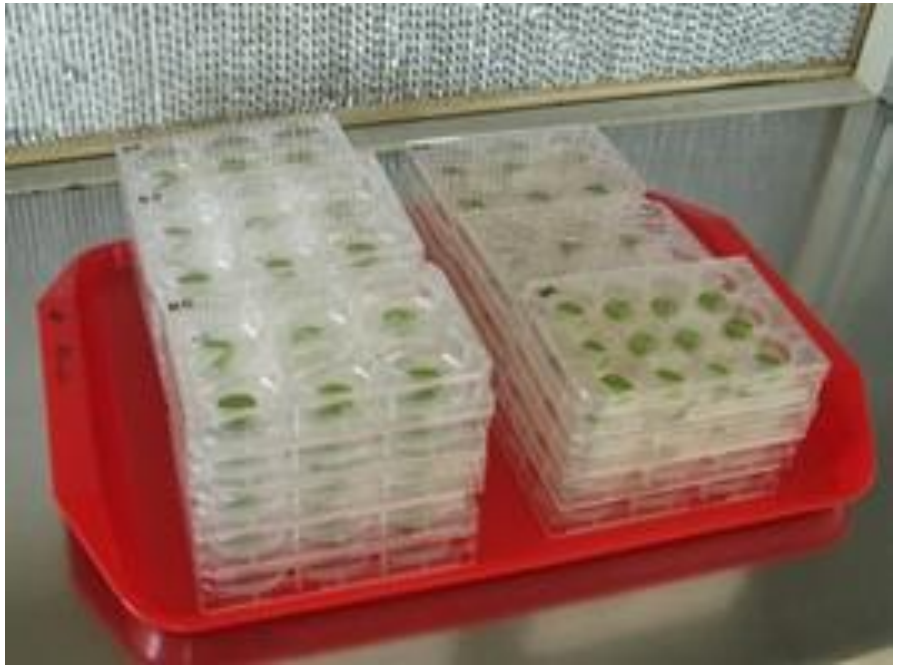

To detect reduced sensitivity or resistance to a fungicide:

1. **Field failure**

2. **Lab detection of reduced sensitivity of pathogenic strains isolated from the field – baseline sensitivity!**

3. **DNA-level detection of one or more mutations in the pathogen's gene(s) associated with the mode of action of the fungicide**

How does fungicide resistance evolve?

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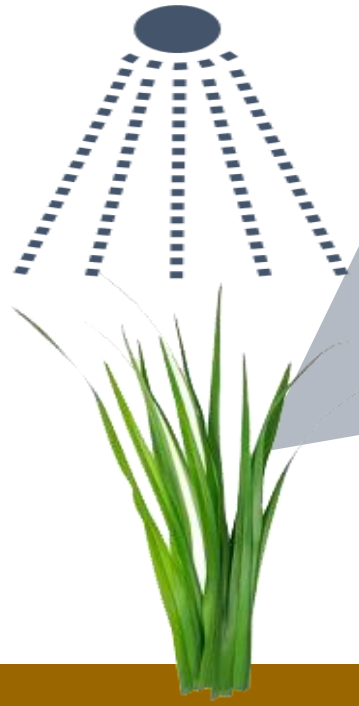
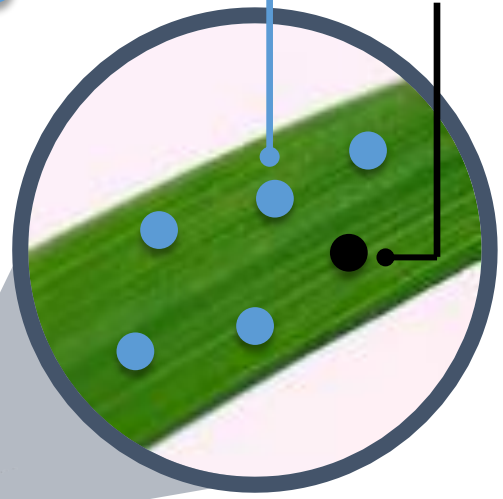
Fungicide applied

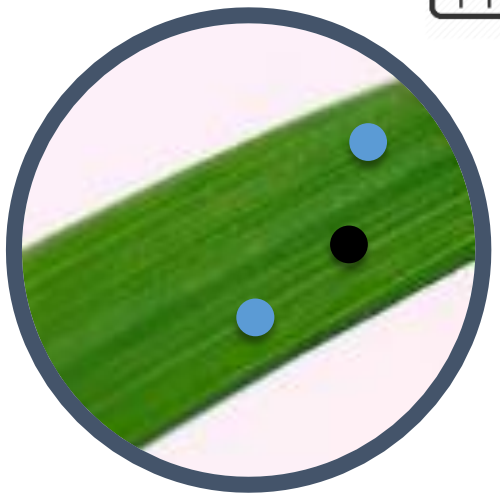


Sensitive fungus

Resistant fungus

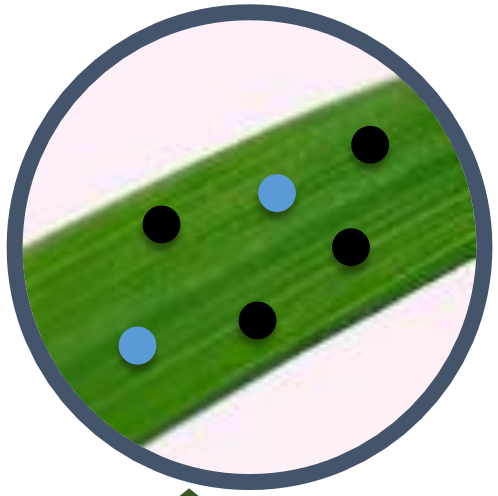


A few individuals in the fungal population are resistant to certain fungicide actives.



When the fungicide is used, it controls almost all of the fungal population.

Survivors reproduce over time



Survivors are naturally resistant to the action of the fungicide and can increase in frequency in the fungal population.

Applying the same fungicide with the same mode of action repeatedly enables the resistant population to multiply.

Modified from CropLife Australia Fungicide Resistance Management Fact Sheet - https://www.croplife.org.au/resources/programs/resistance-management/fact-sheet-fungicide-resistance/

Fungicide resistance in Australian crops

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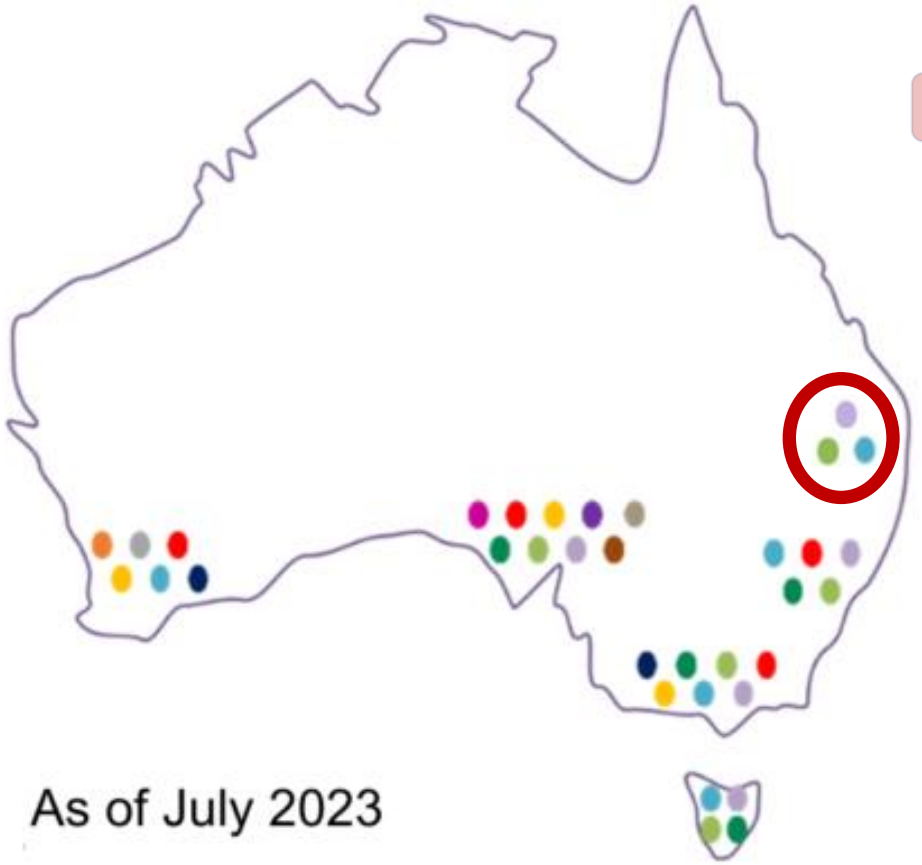

As of July 2023

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
RS, R	Barley Net Form Net Blotch – Group 7 (SDHIs)
RS, R	Barley Spot Form of Net Blotch – Group 3
L, RS, R	Barley Spot Form of Net Blotch – Group 7
L, R	Wheat Powdery Mildew – Group 3
L, R	Wheat Powdery Mildew – Group 11 (strobilurins)
RS	Wheat Septoria tritici blotch – Group 3
L, R	Wheat Septoria tritici blotch – Group 11
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

Case study #1:
FR in mungbean powdery mildew (PM) in Queensland

Research on mungbean PM was supported by:

BACI
Broadacre Cropping Initiative

QUEENSLAND GOVERNMENT
Department of Agriculture and Fisheries

University of Southern Queensland

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Improving Powdery Mildew Management in Mungbean (USQ2202-001RTX)
2022-2024


Photo: Lisa Kelly, QDAF

Mungbean PM

- Common disease
- Serious yield losses if appears before flowering and the environmental conditions are conducive afterwards.
- May have an impact on desiccation efficacy.

- Available fungicides:
  - Tebuconazole (Group 3)
  - Veritas Opti (Teb & azoxystrobin, Groups 3 & 11)
- Current recommendation: spray at first sign of disease and 2 weeks later, if needed.
- And when is it needed? → use an app!

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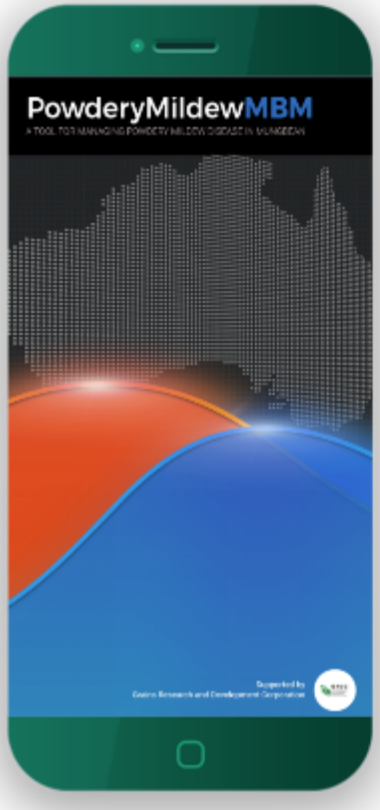
- Industry practice: a “preventive” spray with insecticide applications, followed by one (or two) more fungicide sprays
- How many sprays are economical?
- App (Decision Support Tool): free, easy to use, always reliable



PowderyMildew MBM - Powdery Mildew management app for mungbean

PowderyMildewMBM uses a forecasting model to assist mungbean 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 PowderyMildewMBM 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

GOVERNMENT OF WESTERN AUSTRALIA

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2022 & 2023: a number of field trials to validate and demonstrate the value of the app – conclusions:

- “Preventive” sprays are not needed.
- App recommendations have always resulted in the most economic disease management.
- Some of the trials were the first experiments that compared the efficacy of the two available fungicide products, Tebuconazole and Veritas Opti®, against mungbean PM.

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Improving Powdery Mildew Management in Mungbean (USQ2202-001RTX)

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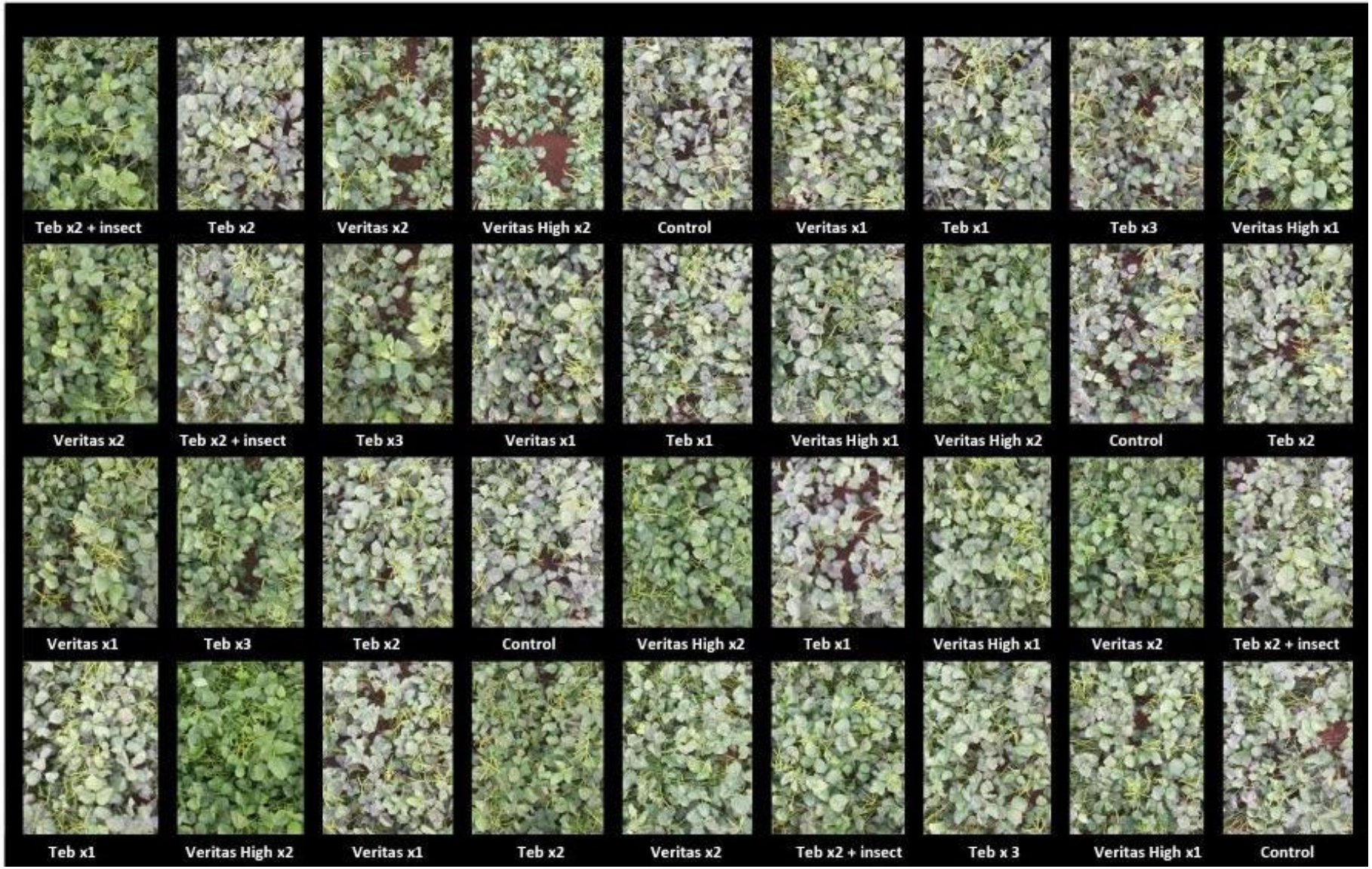

An aerial image of a mungbean PM fungicide trial in 2023.
(Courtesy Neil Robinson)

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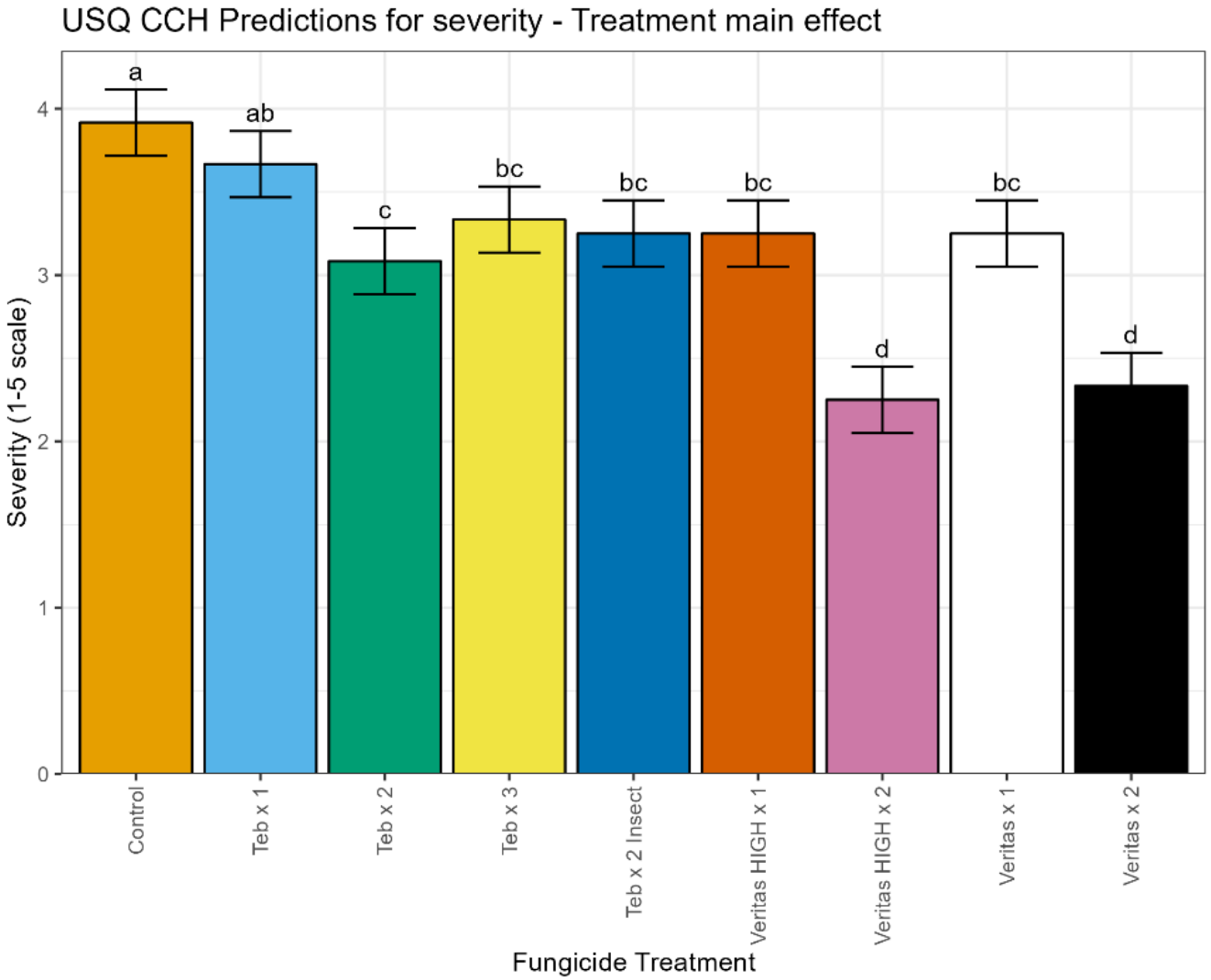

Note: The error bars represent the standard errors of the predictions.
The LSD letters denote treatment differences between Treatments, averaged over Time (days after sowing).

The severity of PM infection was significantly reduced by all fungicide treatments except Tebuconazole applied once, compared to the control ($P<0.001$).

No significant effect of fungicide treatments on yield ($P=0.453$) – PM appeared late in the season, at late flowering/green pod stages.

→ The app did NOT recommend any sprays!

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100% PM control is never achieved with foliar sprays – why?

We sequenced the DNA markers for resistance to Group 3 (tebuconazole) and Group 11 (azoxystrobin) fungicides in mungbean PM samples collected from diverse paddocks & experiments since 2019 – results:

* DNA marker for Group 3 resistance (G461S) detected in a single sample from a glasshouse.
* DNA marker for Group 11 resistance (G143A) detected in three paddocks.

BACI Broadacre Cropping Initiative

Conclusions:

- The app supports spray decisions against mungbean PM in a reliable way. **The app's recommendations are useful for FR management**, in addition to calculating the immediate monetary value returns on sprays – if any.

- DNA mutations conferring resistance to both MoA groups that are available for mungbean PM control were **detected in the lab** in Qld samples, but their incidence appears to be low (monitoring needed).

- Mungbean PM control can be achieved in the field in an economic way with both MoA group fungicides.

The Fungicide Resistance Five – for Mungbean PM

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1. Avoid susceptible crop varieties

   All mungbean varieties are susceptible to PM to some extent

2. Rotate crops – use time and distance to reduce disease carry-over

   Inoculum is airborne, difficult to control by rotation

3. Use non-chemical control methods to reduce disease pressure

   Plant early in the summer season!

4. Spray only if necessary and apply strategically

   Use the app!

5. Rotate & mix fungicides / MoA groups

   Only two MoA groups are available

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Neil Robinson, UniSQ CCH
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Noel Knight, UniSQ CCH
Sadegh Balotf, UniSQ CCH

Fungicide resistance frequencies in Queensland net blotch

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University of Southern Queensland

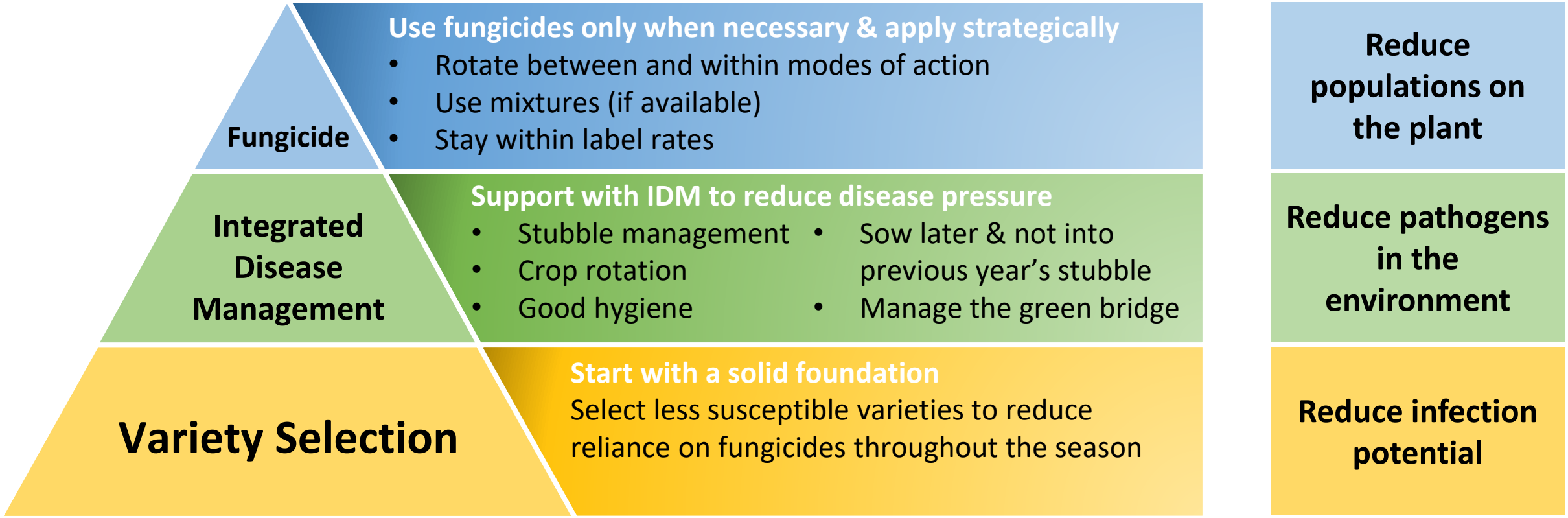
Fungicide resistance in net blotch

Pathogen: *Pyrenophora teres* f. *teres* (net form net blotch)
Pyrenophora teres f. *maculata* (spot form net blotch)

Host: Barley

- Fungicides important disease control option
- Reduced sensitivity and resistance reported for:
  - Demethylation inhibitors (DMI) - **Group 3**
  - Succinate dehydrogenase inhibitors (SDHI) - **Group 7**
- Significant implications for disease management

Fungicide resistance management



Know Your Field!

Fungicide resistance terminology

Sensitive

- Recommended label rate controls disease

Reduced sensitivity

- Fungi can persist at low fungicide rates
  - Reduction in product performance
  - May not be obvious in the field

Resistant

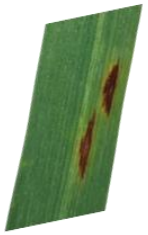
- Fungi survive at maximum fungicide rates
  - Fungicide fails to provide acceptable disease control

Lab detection

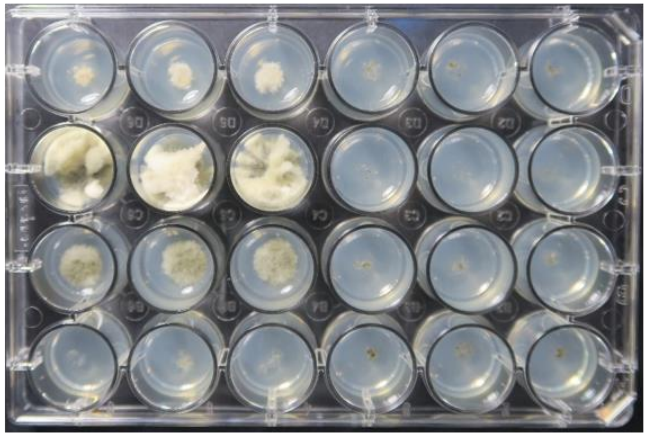
- Phenotype – fungal growth on media
- Genotype – fungal DNA sequence associated with resistance

Steps of characterising fungicide resistance

- First detection – the ground work



Harvest and fragment mycelia



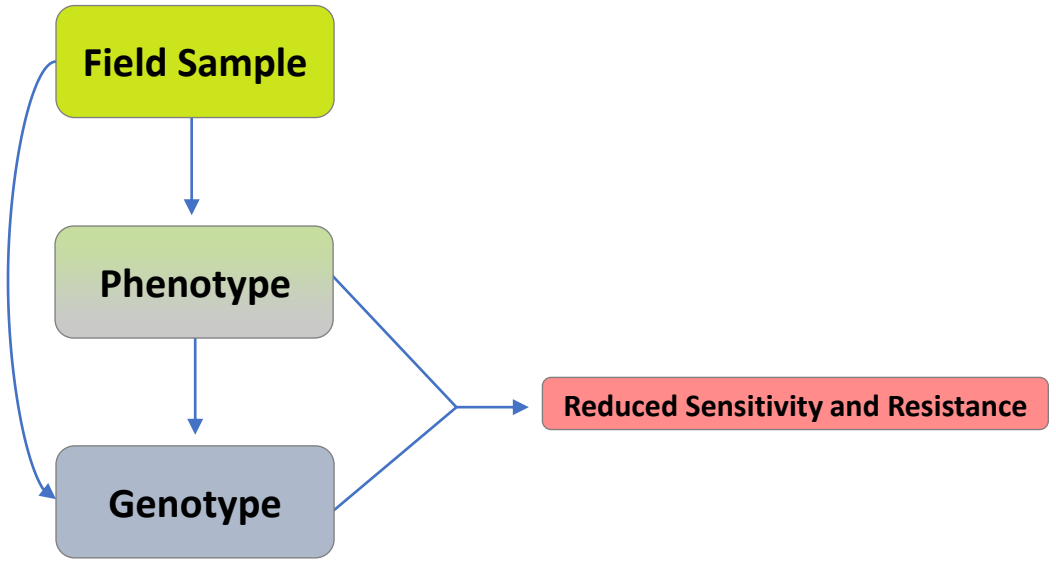
Tebuconazole: 50µg/mL

- Record growth
  - Sensitive
  - Reduced sensitive
  - Resistant
- Harvest hyphae
- Extract DNA

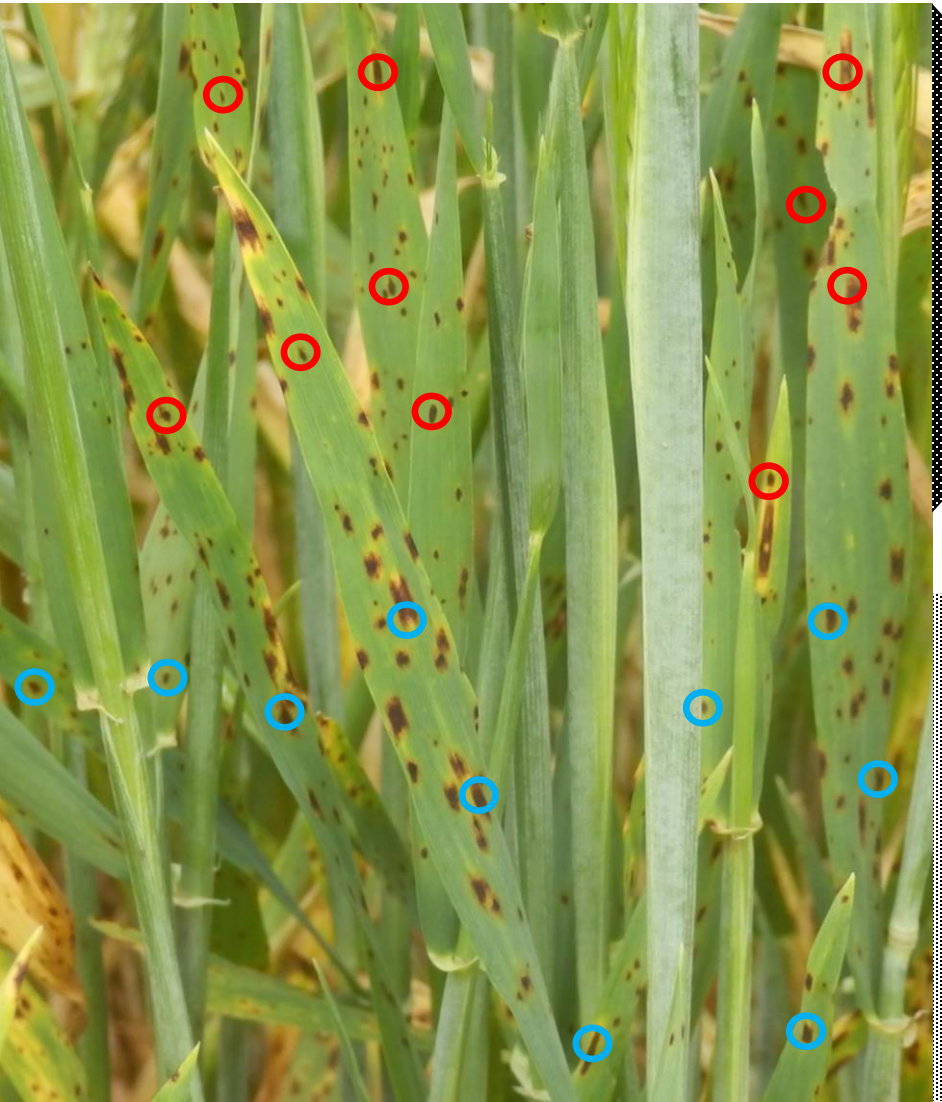
PCR tests

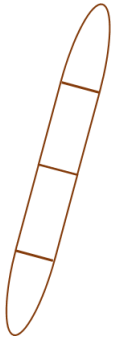
Steps of characterising fungicide resistance

- Characterisation
  - Phenotype
    - Growth with fungicides
  - Genotype
    - Link DNA changes to phenotype
- Informed Detection
  - Monitor DNA changes in field samples
    - Fungal isolates - pure
    - Leaf lesions - mixtures



It’s all about sampling





Fungal isolation

- 10 lesions total
- 1 conidia from 1 lesion
- That ‘represents’ the field

- Requires sporulation
- One type from one lesion
- Living fungi

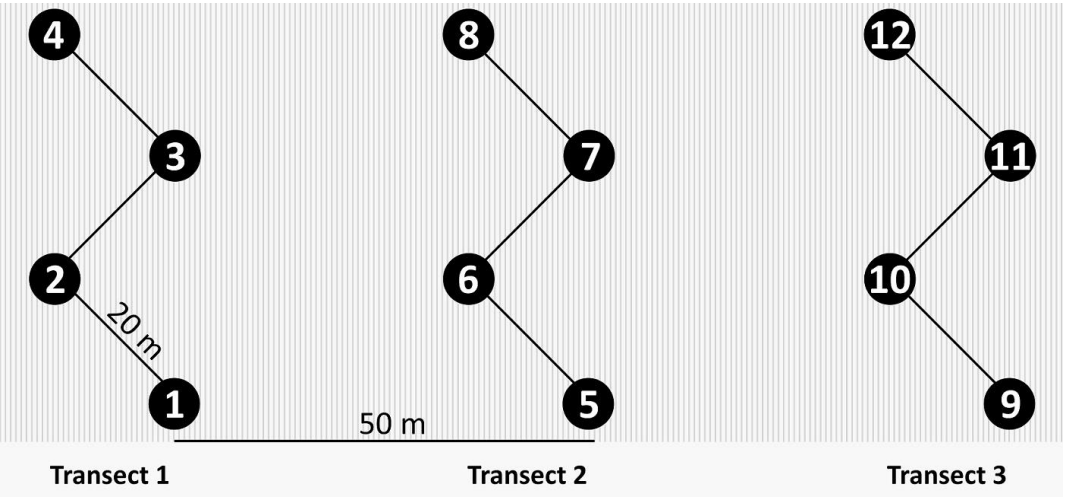
DNA isolation

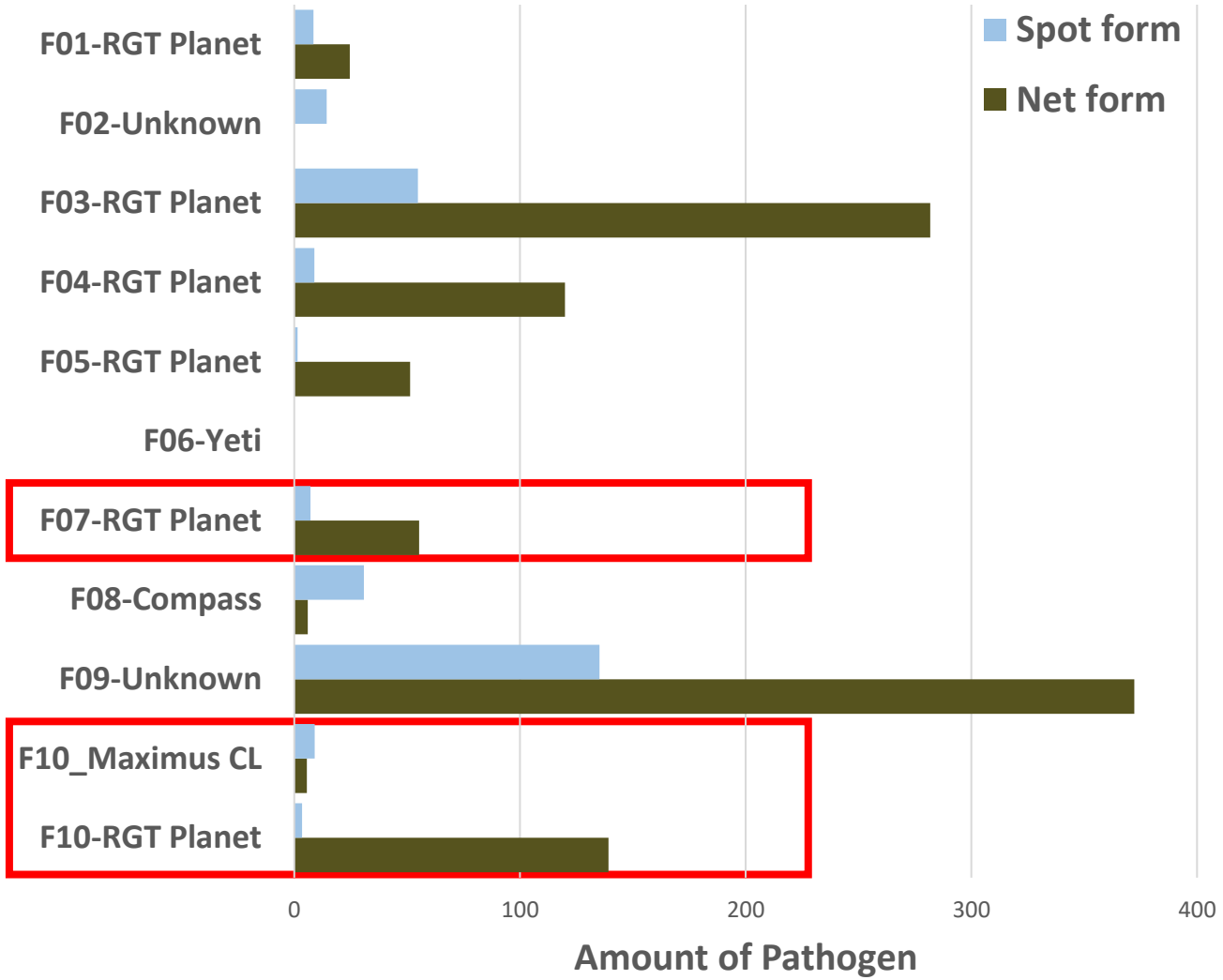
- 10 lesions total
- Mixed DNA from lesions
- That ‘represents’ the field

- Variation within lesion kept
- Amount of each type
- DNA only
- Frequencies

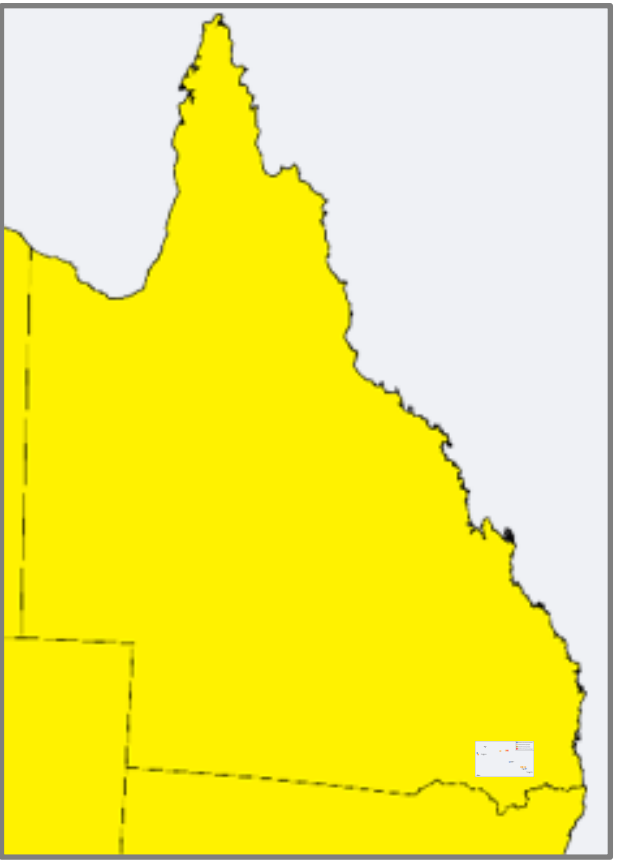
Net blotch sampling and severity - 2022

- 10 barley fields sampled
- Leaves collected at 12 points in each field
  - targeting upper 3 leaves
- Combined 60 lesions
- Genotype monitoring

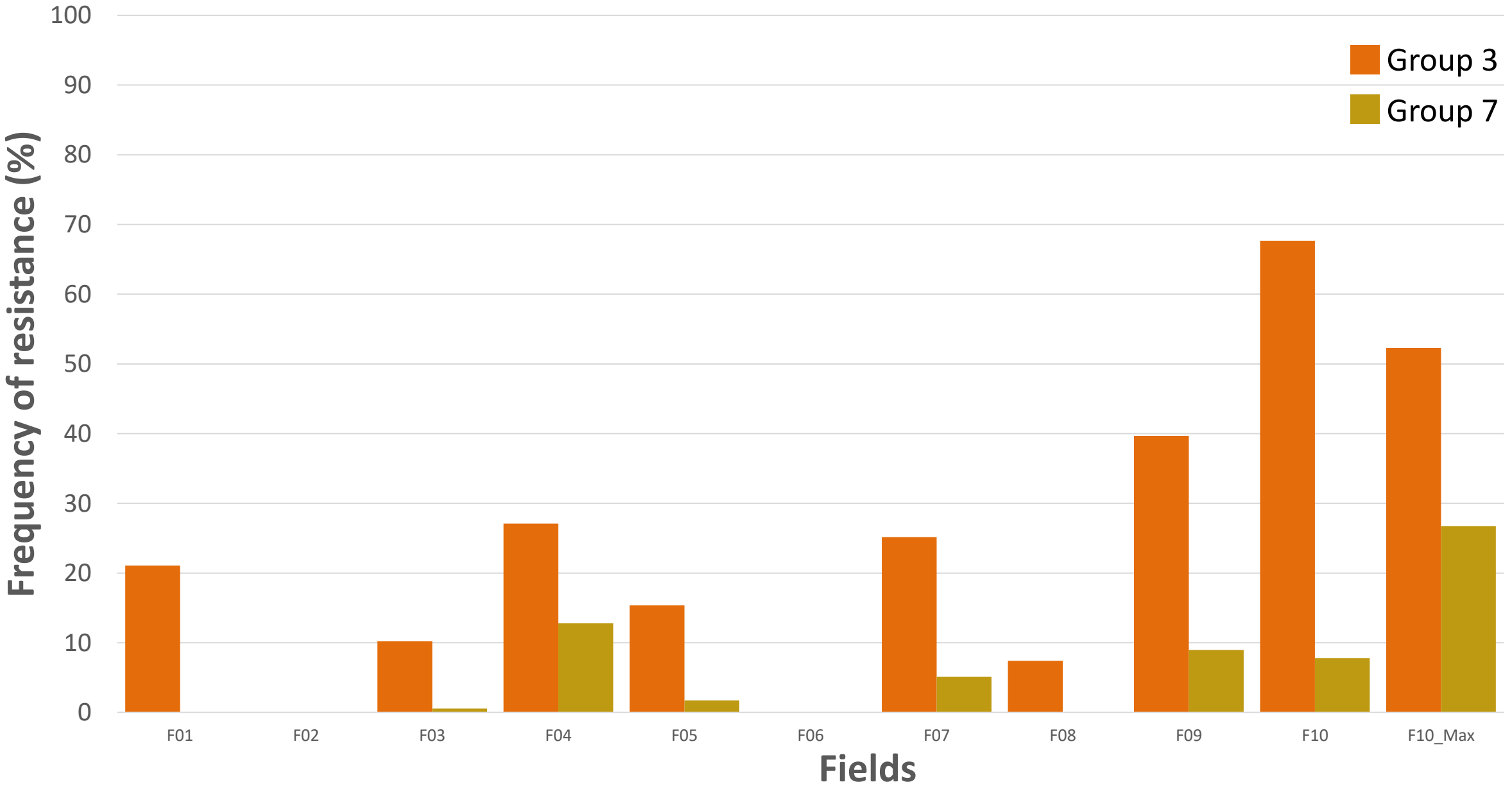




Locations and genotype frequencies



Genotype frequencies



Group 3 - Demethylation Inhibitors (DMI)

- **Genotype results**
  - **80%** of fields had reduced sensitivity and/or resistance genes
  - Across all fields, **34%** of the population had reduced sensitivity or resistance genes
    - Within fields ranged from 0 to 68%

Group 7 - Succinate Dehydrogenase Inhibitors (SDHI)

- **Genotype results**
  - **60%** of fields had reduced sensitivity and/or resistance genes
  - Across all fields, **6%** of the population had reduced sensitivity or resistance genes
    - Within fields ranged from 0 to 13%

Distribution

- Reduced sensitivity and resistance to Group 3 fungicides widespread across sampled region
- Reduced sensitivity and resistance to Group 7 fungicides less frequent
- However …
  - Detection of Group 7 reduced sensitivity genotypes unexpected

Effects of paddock management

- Complex and diverse systems
  - No clear ‘simple’ impact due to fungicide history
  - Multiple seasons of any single mode of action may increase frequency of resistance

- Need to manage inoculum
  - Variety
  - Stubble
    - Crop rotations, tillage, height
  - Seed

Questions to consider

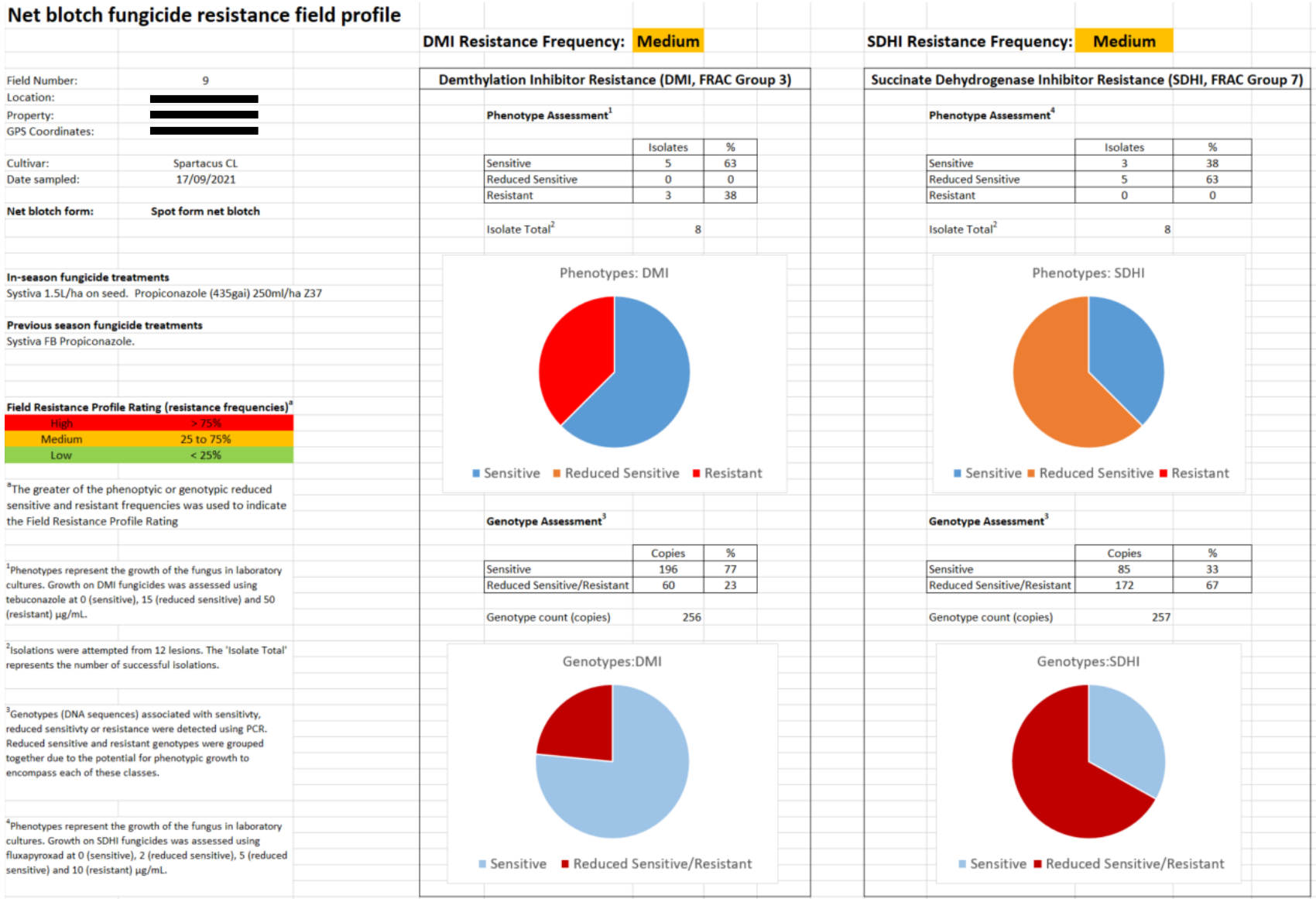
- What is the perceived risk to disease control?
  - Does a greater frequency of resistance mean more disease/loss?
  - Impact of fungicide treatments or rotations?
  - Are fungicide applications effective?

- If you have concerns, contact your local expert
  - AFREN Guide

- **I am interested in sampling 2023 net blotch in Qld fields**

Benefits

- Aim to provide a summary to growers
  - Frequencies
  - General overview
- Can these values be used to guide management now?
  - Is more information on effect of frequency required?



Net blotch fungicide resistance field profile

Field Number:	9
Location:	[redacted]
Property:	[redacted]
GPS Coordinates:	[redacted]
Cultivar:	Spartacus CL
Date sampled:	17/09/2021
Net blotch form:	**Spot form net blotch**

In-season fungicide treatments
Systiva 1.5L/ha on seed. Propiconazole (435gai) 250ml/ha Z37

Previous season fungicide treatments
Systiva FB Propiconazole.

Field Resistance Profile Rating (resistance frequencies)[a]

High	> 75%
Medium	25 to 75%
Low	< 25%

[a]The greater of the phenoptyic or genotypic reduced sensitive and resistant frequencies was used to indicate the Field Resistance Profile Rating

[1]Phenotypes represent the growth of the fungus in laboratory cultures. Growth on DMI fungicides was assessed using tebuconazole at 0 (sensitive), 15 (reduced sensitive) and 50 (resistant) µg/mL.

[2]Isolations were attempted from 12 lesions. The 'Isolate Total' represents the number of successful isolations.

[3]Genotypes (DNA sequences) associated with sensitivty, reduced sensitivty or resistance were detected using PCR. Reduced sensitive and resistant genotypes were grouped together due to the potential for phenotypic growth to encompass each of these classes.

[4]Phenotypes represent the growth of the fungus in laboratory cultures. Growth on SDHI fungicides was assessed using fluxapyroxad at 0 (sensitive), 2 (reduced sensitive), 5 (reduced sensitive) and 10 (resistant) µg/mL.

DMI Resistance Frequency: Medium

Demthylation Inhibitor Resistance (DMI, FRAC Group 3)

Phenotype Assessment[1]

	Isolates	%
Sensitive	5	63
Reduced Sensitive	0	0
Resistant	3	38

Isolate Total[2] 8

Genotype Assessment[3]

	Copies	%
Sensitive	196	77
Reduced Sensitive/Resistant	60	23

Genotype count (copies) 256

SDHI Resistance Frequency: Medium

Succinate Dehydrogenase Inhibitor Resistance (SDHI, FRAC Group 7)

Phenotype Assessment[4]

	Isolates	%
Sensitive	3	38
Reduced Sensitive	5	63
Resistant	0	0

Isolate Total[2] 8

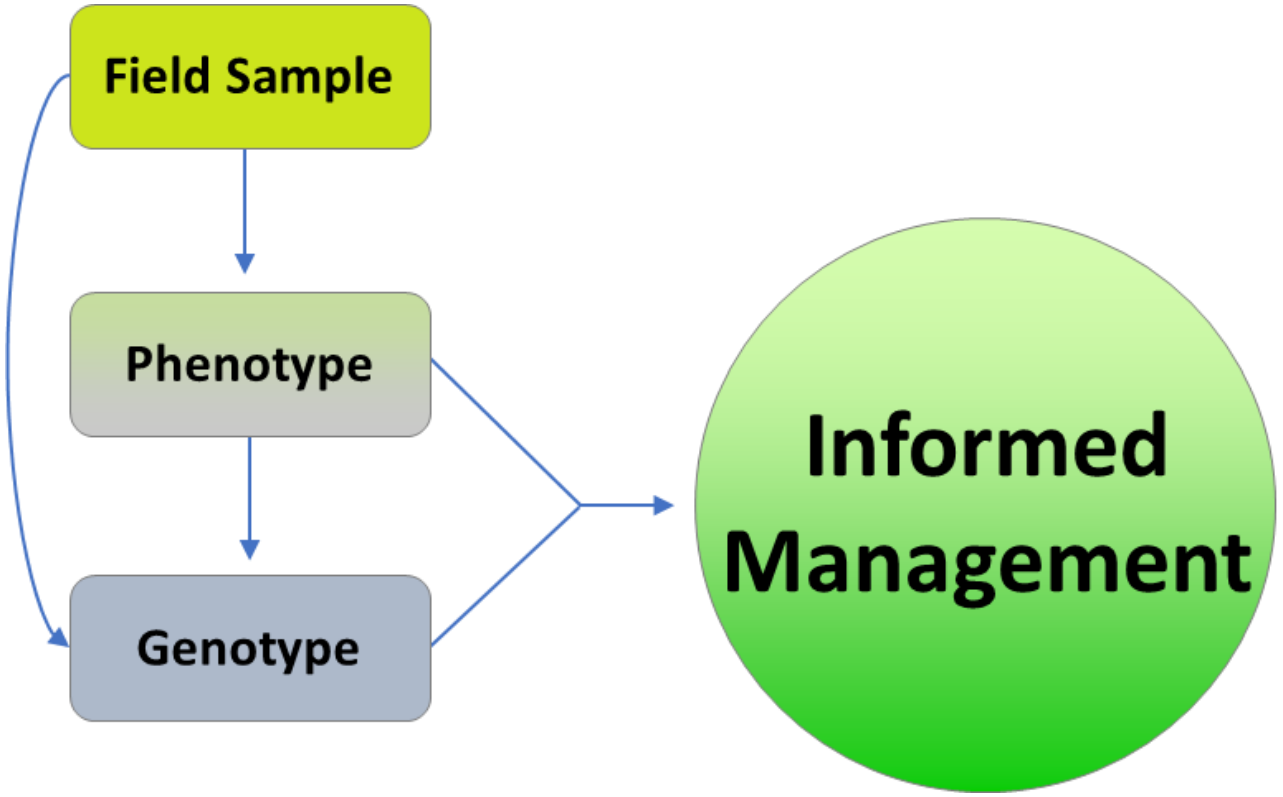
Genotype Assessment[3]

	Copies	%
Sensitive	85	33
Reduced Sensitive/Resistant	172	67

Genotype count (copies) 257

Key messages

- Fungicide resistance present in Queensland
  - Fungicide application strategies should include mixed modes of action and can be informed by testing field samples



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Matthew Skerman (Nutrien Ag Solutions)

Centre for Crop and Disease Management

GRDC Grains Research & Development Corporation

Curtin University

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BACI Broadacre Cropping Initiative

University of Southern Queensland

Questions

Wheat powdery mildew: DMI & QoI resistance

Field resistance to DMIs?

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

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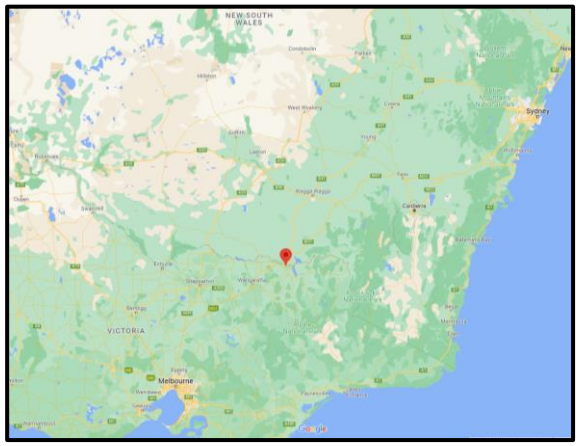
Courtesy of Steven Simpfendorfer, NSW DPI

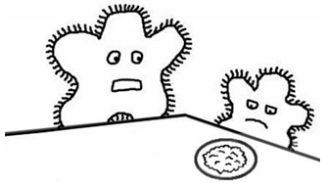


Albury, NSW

Bindaroi S-VS

Wheat on wheat

- Tebuconazole 145mL/ha @ 4 August
- Propiconazole 250 mL/ha @ 6 October



"See Timmy what happens when you finish all your fungicides?"

What happens under controlled conditions?

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Wild type

Propiconazole (1x)

Resistant

Propiconazole (1x)

Propiconazole (2x)

Field rates do not control the resistant genotype

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

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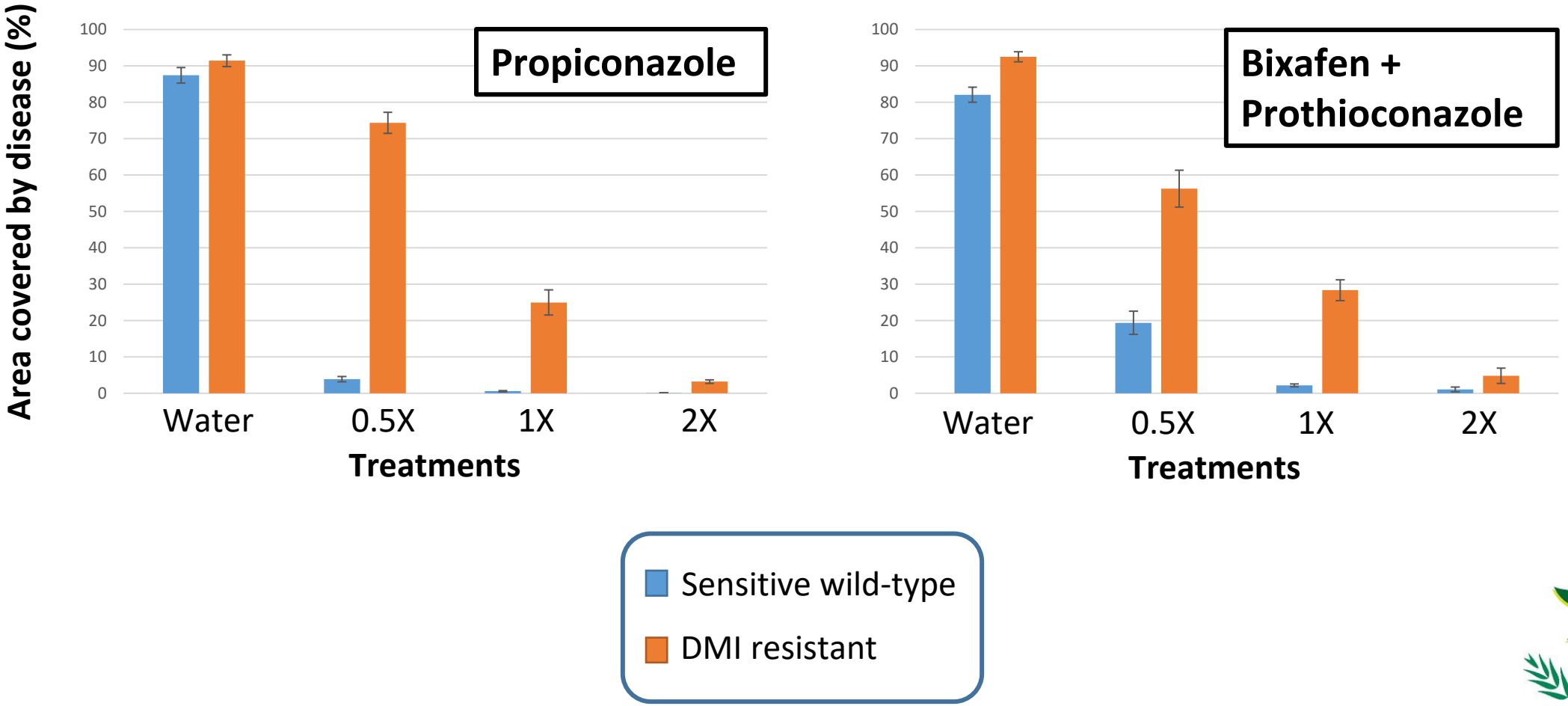

Centre for Crop and Disease Management

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Curtin University

QoI and DMI resistance detected in Qld

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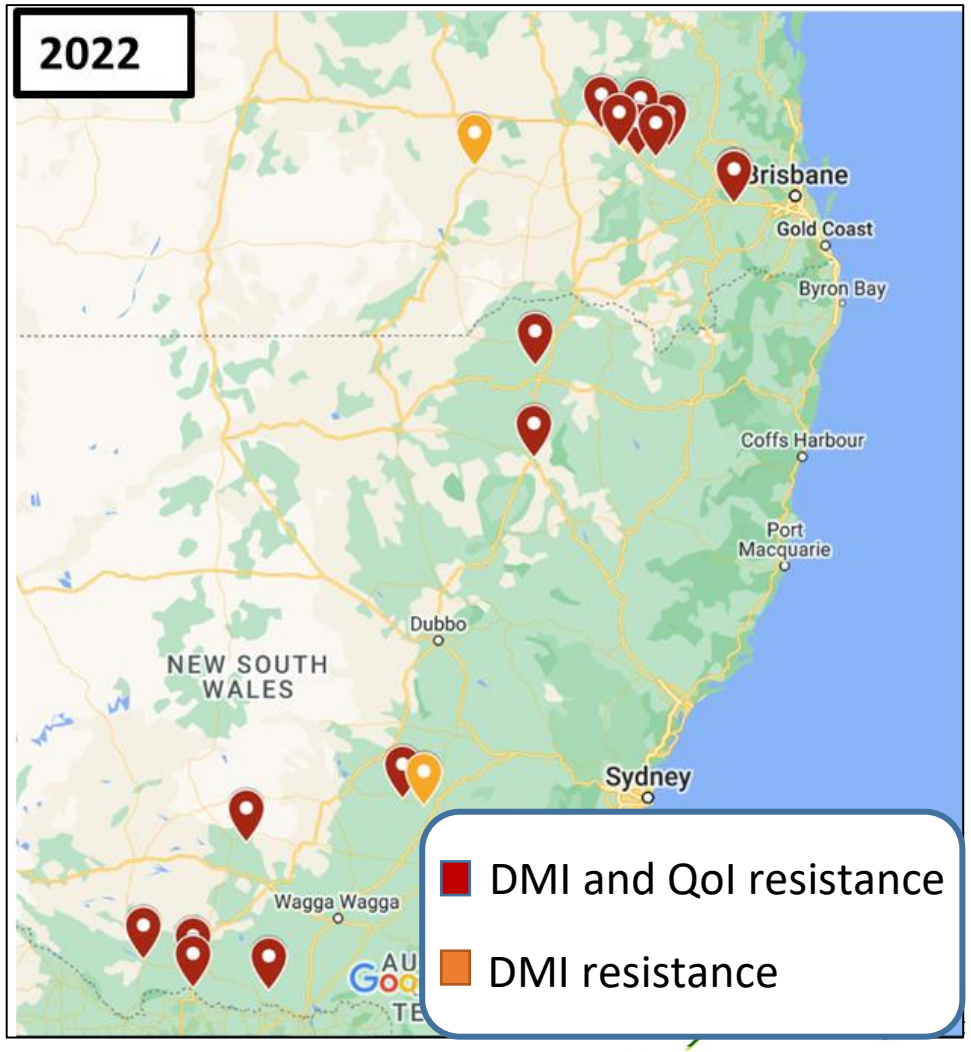
- Emergency permits for:
  - **Quinoxyfen** (Group 13, medium resistance risk)
  - **Proquinazid** (Group 13)
  - **Metrafenone** (Group 50, medium resistance risk)



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Management information
Feedback
Advice

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Steven Simpfendorfer

Trengove Consulting
Sam Trengrove

Connect with AFREN

AUSTRALIAN FUNGICIDE RESISTANCE EXTENSION NETWORK

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

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