FUNGICIDE-RESISTANT WHEAT POWDERY MILDEW

FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN
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Regional resistance surveys and management options

Photo: Trengove Consulting

KEY POINTS

- Wheat powdery mildew is now widespread across the southern region
- Growers should use varieties less susceptible to the disease and employ management options that reduce the risk of resistance to fungicides developing
- Wheat varieties with moderately susceptible to susceptible (MSS) and moderately susceptible (MS) levels of resistance reduce mildew development significantly compared with susceptible to very susceptible (SVS) varieties.
- Group 11 (QoI) fungicide resistance has increased two to three times over five seasons. Resistance is generally low in the west of the southern region and increases in the east
- Fungicides are key to managing the disease, but their effectiveness is decreasing with wheat powdery mildew becoming increasingly resistant
- Permitted fungicides (expiry May 2027) Legend®, Talendo® and Vivando® provide high levels of wheat powdery mildew control when applied prior to or at the first sign of infection

Choose varieties less susceptible to wheat powdery mildew and employ management options that reduce the risk of resistance to fungicides developing.

Background

Wheat powdery mildew has become widespread across the southern region in recent years. This is due to a range of factors, including the predominance of susceptible to very susceptible (SVS) varieties grown in most regions and early crop establishment. A favourable season resulting in large crop canopies provides optimal conditions for the carryover of disease inoculum.

In the absence of moderate varietal resistance, and with current farming systems, the control of wheat powdery mildew relies heavily on fungicides to ensure crops achieve their yield potential. This reliance has led to reduced sensitivity and resistance.

Fungicide resistance is caused by repeatedly exposing a pathogen to the same fungicide or fungicide

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actives from the same chemical mode of action (MOA) group.

It can become a major constraint to effective disease control, especially if there is no alternative fungicide or host plant resistance available.

Fungicide resistance terminology

When a pathogen is effectively controlled by a fungicide, it is defined as sensitive to that fungicide. As fungicide resistance develops, that sensitive status can change to:

REDUCED SENSITIVITY

This is when a fungicide application does not work optimally but does not completely fail. This may not be noticeable at field level, or a grower may find previous levels of control require higher chemical concentrations up to the maximum label rate. Reduced sensitivity must be confirmed by laboratory testing.

RESISTANCE

Resistance is when a fungicide fails to provide disease control at the maximum label rate and when it is known to have been used correctly. Resistance must be confirmed by laboratory testing.

Table 1: G143A mutation frequency (%) and expected strobilurin fungicide efficacy.

G143A frequency	Expected strobilurin fungicide efficacy
>20% High mutation frequency	Does not work – avoid use for wheat powdery mildew.
10–20% Moderate mutation frequency	In field trials, poor wheat powdery mildew control has been observed.
<5% Low mutation frequency	In the short-term, growers may still obtain some useful efficacy on wheat powdery mildew from the strobilurins. Use of fungicides containing a strobilurin will further select for populations with this mutation and rapidly increase its frequency.

Source: Trengove Consulting

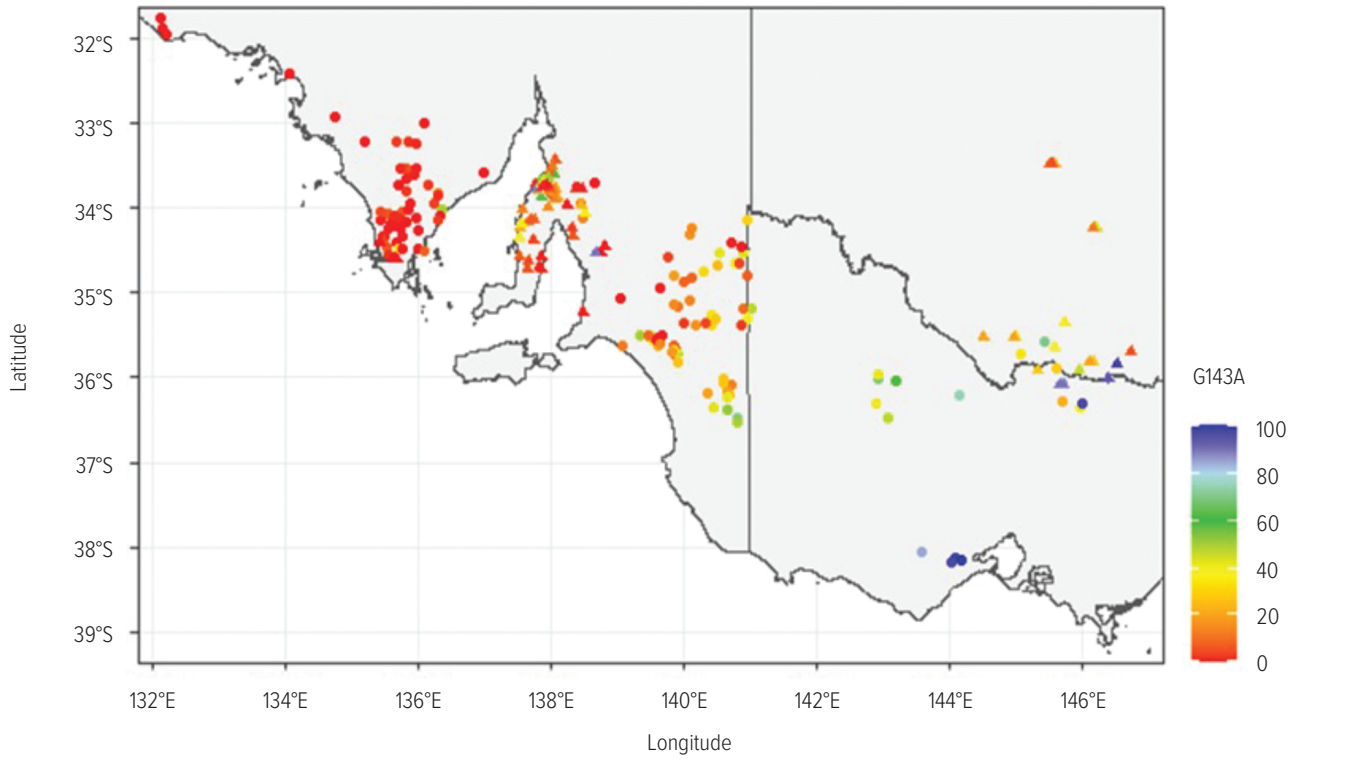
Table 2: Frequency (%) of G143A mutation in six fungicide trials during 2021–23. Letters denote significant differences within a column (P≤0.05).

Treatment	Bute 2021	Bute 2022	Bute 2023	Katamatite 2022	Malinong 2022	Port Neill 2022
Control	19 def	1 c	16 c	24 c	4	2 b
Epoxiconazole (3)	8 gh	5 b	30 b	38 bc	7	2 b
Prothioconazole (3)	30 bcde	2 bc				
Tebuconazole* (3)	17 efg			53 ab		
Azoxystrobin** (11)	36 abcd	9 a	55 a	45 bc	11	4 a
Tazer Xpert® (3+11)	63 a	6 ab	24 bc	70 ab	12	2 b
Veritas® (3+11)	34 abcd			79 a		
Maxentis® (3+11)	51 ab	5 b				

*Tebuconazole and **azoxystrobin have been applied standalone for the control of wheat powdery mildew for research purposes only.

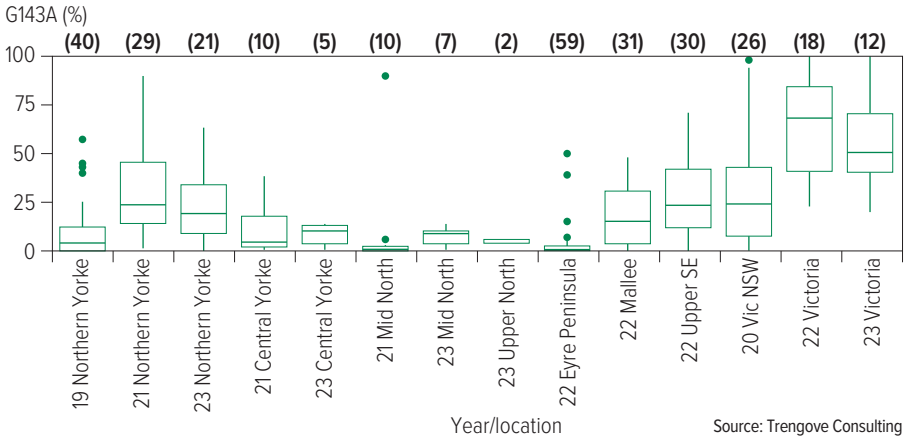
Source: Trengove Consulting

Figure 1: Frequency (%) of the G143A mutation. Triangles show 2020-21 samples and circles show 2022 samples.



Source: Trengove Consulting and Steven Simpfendorfer, NSW DPIRD

Figure 2: Frequency (%) of the G143A mutation from areas in the southern region sampled during 2019 to 2023. Numbers in brackets represent the number of samples per region.



Source: Trengove Consulting

Photo: Trengove Consulting

Wheat powdery mildew head infection.

LAB DETECTION

A measurable loss of sensitivity can often be detected through in vitro tests in the laboratory before, or independent of, any loss of fungicide efficacy in the field. Laboratory testing can indicate a high risk of resistance or reduced sensitivity developing in the field.

Detection of fungicide resistance

GROUP 3 (DMI) FUNGICIDE RESISTANCE

Paddock surveys collected wheat powdery mildew samples from the southern region from 2019 to 2023. The DMI reduced sensitivity in wheat powdery mildew was found to be linked to mutations associated with increased production of the DMI fungicide target and, specifically, the genetic mutation, Y136F. For this reason, the molecular assessment of these samples was based on testing for Y136F as a marker for reduced sensitivity.

The results from wheat samples showed there was a high level of reduced sensitivity and resistance to DMI fungicides in all samples collected from across the southern region. All samples reported a mutation frequency of more than 90 per cent, with a mean of more than 99 per cent.

GROUP 11 (QOL) FUNGICIDE RESISTANCE

Another mutation, G143A, is associated with Group 11 (Qol) resistance. Group 11 resistance was first detected in samples collected from Tasmania and Victoria in 2015, following reports of fungicide failures. Similar resistance has since been reported in South Australia in 2019 and New South Wales in 2020.

In contrast to the DMI Y136F mutations that are required to be at very high levels to cause reduced sensitivity, if the G143A mutation is present at 20 per cent, then 20 per cent of the sampled wheat powdery mildew population is completely resistant to Qol fungicides applied at the maximum label rate.

Currently, the frequency of the G143A mutation increases from west to east (Figure 1). Only three paddocks from the 136 sampled in 2022 had no detected mutation. This indicates that the mutation is present in nearly all paddocks across the region.

It is expected that the use of fungicides containing a strobilurin will further select for populations with this mutation.

Mutation frequency (%) and expected fungicide efficacy

There is a large range in the G143A mutation frequency across the southern region. While it is challenging to infer a fungicide efficacy for a given mutation frequency, there are some general observations from field research.

HOW QUICKLY DOES RESISTANCE MOVE AND INCREASE?

Regional surveys have shown there is a geographic difference in the frequency of the G143A mutation, with the frequency increasing from west to east (Figure 1).

The South Australian Mallee – where wheat powdery mildew has rarely been an issue and the use of strobilurin fungicides has historically been low – had moderate mutation frequencies (mean 18 per cent).

This suggests the resistance has not developed locally but spores move over time from an area that does have the resistance mutation.

The frequency of the G143A mutation is also changing over time within regions (Figure 2).

The highest values in mutation frequency have been observed in high-rainfall areas of Victoria. Samples in 2020 showed a 32 per cent mutation frequency that increased to 64 per cent in two seasons.

Interestingly, the G143A mutation frequency data from 2023 is lower than the 56 per cent seen in 2022. This slight reduction can be attributed to general paddock variation and sampling time in relation to fungicide application/s in a given season.

Overall, the key message remains: there has been an observed increase in the G143A mutation over time.

Similarly, samples from the northern Yorke Peninsula have shown both increases and decreases in mutation frequency over time. Paddock surveys showed moderate levels in 2019 and in 2021 increased to 32 per cent.

Sampling in 2023 showed the mutation frequency numbers had slightly reduced, but remained at high levels (more than 20 per cent).

Higher frequency in the northern Yorke Peninsula area than in the central Yorke Peninsula may be due to the high levels of wheat powdery mildew in the past five to 10 years, resulting in repeated fungicide applications and greater selection for the resistant mutation.

The Upper South-East of SA had nil to high mutation frequencies (mean 26 per cent, range nil to 71 per cent).

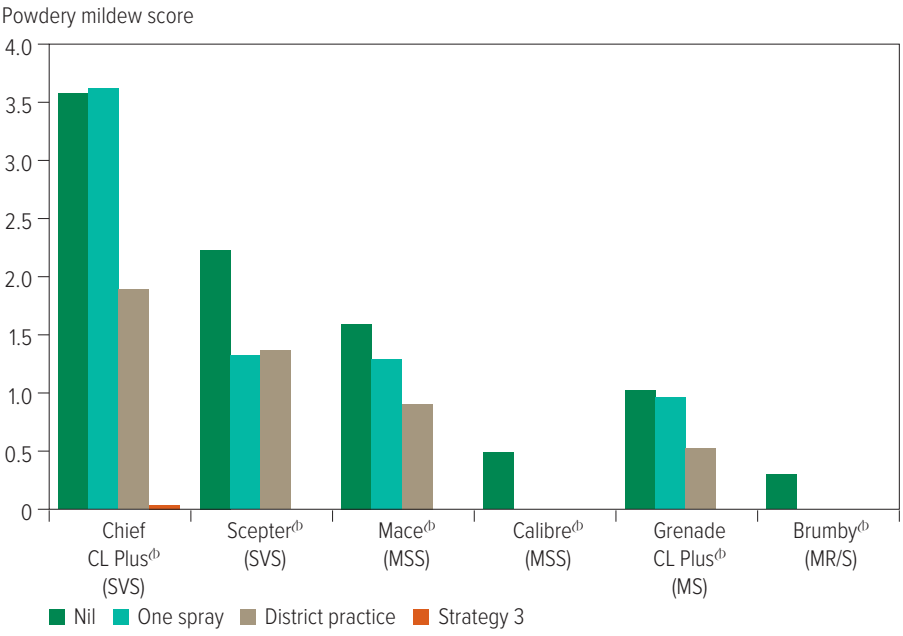
Mutation frequency was low on the Eyre Peninsula (three per cent) and Upper North of SA (five per cent), which indicates that the Group 11 (Qol) fungicides may still provide useful activity in many paddocks in these regions.

Table 3: Performance of permitted products against wheat powdery mildew in trials at Bute and Malinong on wheat varieties rated SVS. Letters denote significant differences within a column (P≤0.05).

Treatment	Bute 2020	Bute 2021	Bute 2023	Malinong 2022	Malinong 2022	Malinong 2023
	Total pustule number per plant part/s					
Nil	28.7 a	4.1 a	16.4 a	13.4 a	10.1 a	9.2 a
Tebuconazole	8.4 b	1.6 ab	8.9 b	13.5 a		
Legend®	10.1 b	0.1 c	0.1 c	14.9 a	1.7 b	
Talendo®	9.0 b		0.7 c		1.2 b	
Vivando®	8.4 b					1.8 b

Source: Trengove Consulting

Figure 3: Wheat variety and fungicide management trial Bute, SA, 2021. Wheat powdery mildew scored 22 September. Calibre(ф) and Brumby(ф) only received nil treatment.



Source: Trengove Consulting

RESPONSE TO SINGLE SEASON SELECTION PRESSURE IN GROUP 11 (QOL) RESISTANCE

Plant samples collected after the application of fungicides are able to show the effect of single season selection pressure. Across six field trials, the mutation frequency for G143A ranged from one to 24 per cent in the untreated control (Table 2).

Treatments containing the Group 11 fungicide, azoxystrobin, increased the frequency of the G143A mutation. Generally, there was a two to three-fold increase in the mutation frequency in a single season. Repeatedly exposing the pathogen to Group 11 fungicides increases selection pressure on the population.

Wheat powdery mildew stem infection.

Photo: Trengove Consulting

The application of Group 3 (DMI) products has also increased the G143A mutation frequency in several trials. In many cases, DMI and QoI resistances are present simultaneously in wheat powdery mildew, which results in the selection of QoI-resistant wheat powdery mildew when DMI fungicides are used. However, rotating and mixing fungicides/MOA groups remains an important part of reducing fungicide resistance risk.

Options

What are the alternative fungicide options to Groups 3 (DMI) and 11 (QoI) and how well do they work?

The APVMA has issued permits for three fungicides for the control of wheat powdery mildew.

PER93197– Legend® and other registered products with 250 grams per litre quinoxyfen (Group 13); PER93216 – Talendo® 200g/L proquinazid (Group 13); and PER93198 – Vivando® 500g/L metrafenone (Group U8) can be used for wheat powdery mildew control until 31 May 2027 (Talendo®, Vivando®) and 30 June 2027 (Legend®).

These products represent two fungicide MOAs not previously registered for use in wheat in Australia. Refer to the specific permits for application details, critical use comments and expiry details.

In field trial situations where wheat powdery mildew resistance has been high, the inclusion of one of the newly permitted products (Legend®, Talendo® or Vivando®) has been useful in SVS crops (Table 2). Note that these fungicides have no or limited activity on any other disease and need to be applied in combination with other fungicides for the control of diseases such as Septoria and rusts.

Performance of the permitted products varied across six trials on the northern Yorke Peninsula and south-east of SA. The application timing of these fungicides when targeting wheat powdery mildew relative to disease build-up was an important factor in wheat powdery mildew control.

In four of the trials, the fungicide products almost eliminated wheat powdery mildew infection (Table 3).

In these four trials, the wheat powdery mildew infection did not develop until after the first fungicide application. This highlights the importance of using these permitted fungicide products prior to, or at the first sign of, wheat powdery mildew infection.

Fungicides containing Group 7 SDHI actives have also been assessed; however, these were found to provide poor control of wheat powdery mildew and are not suitable fungicide alternatives.

Interaction between varietal resistance and fungicide use

Planting less-susceptible varieties will reduce disease pressure and the need for fungicide inputs.

Recent field trials have shown wheat powdery mildew infection has generally followed the variety resistance ratings, with moderately susceptible (MS) performing better than moderately susceptible to susceptible (MSS), which performed better than SVS.

Varietal resistance has a significant effect on fungicide performance.

A trial at Bute in 2021 (Figure 3) illustrates the impact of variety selection (disease rating) and fungicide management strategy on the resulting wheat powdery mildew severity.

Wheat varieties with SVS rating (Chief CL Plus$^{\Phi}$ and Scepter$^{\Phi}$) had the highest level of susceptibility to wheat powdery mildew. For Chief CL Plus$^{\Phi}$, a one fungicide spray strategy was not sufficient to reduce canopy infection.

The district practice strategy was able to reduce infection to a low-to-moderate level. Scepter$^{\Phi}$ was less susceptible to this wheat powdery mildew population, with the single spray strategy reducing infection to low-to-moderate levels.

A variety with MS rating (Grenade CL Plus$^{\Phi}$) had less wheat powdery mildew infection in the nil treatment compared to SVS varieties (Chief CL Plus$^{\Phi}$ and Scepter$^{\Phi}$) treated with a two-spray 'district practice' fungicide strategy. In line with its resistant (R) rating, Brumby$^{\Phi}$ had very low levels of wheat powdery mildew infection in the nil treatment.

The fungicide strategies were:

- Nil fungicides applied
- One spray = Amistar Xtra @ 400 millilitres per hectare GS39
- District practice = Epoxiconazole 125* @ 500mL/ha GS31 fb Amistar Xtra @ 400mL/ha GS39
- Strategy 3 = aimed for complete wheat powdery mildew control

**Epoxiconazole 125 label rate for powdery mildew is 250mL/ha, 500mL/ha is maximum label rate for wheat for control of leaf rust, stripe rust and Septoria nodorum blotch.*

Wheat powdery mildew is a highly variable pathogen, and changes in variety performance based on resistance rating may reflect the local pathotype that is present. In some seasons, wheat varieties do not perform as expected based on their powdery mildew disease rating. For example, at Malinong, SA, in 2023, the very susceptible (VS) variety Valiant$^{\Phi}$ had the highest wheat powdery mildew infection. However, both Mace$^{\Phi}$ (MSS) and Grenade CL Plus$^{\Phi}$ (MS) did not perform any better than the SVS variety Scepter$^{\Phi}$.

Similarly, there were observations of wheat powdery mildew infection in the variety Brumby$^{\Phi}$ at this site in 2023. Brumby$^{\Phi}$ is currently rated R/S, to indicate a susceptible (S) rating to a rarer strain of wheat powdery mildew, which is likely present at the Malinong site. In this trial, Brumby$^{\Phi}$ performed similarly to Calibre$^{\Phi}$ (MSS).

There has potentially been some breakdown of varietal resistance to local pathotypes that are more virulent on these varieties. However, more research in the area is required to understand this further.

- For the most up-to-date information on variety disease ratings, check the National Variety Trials (NVT) nvt.grdc.com.au/nvt-disease-ratings.

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MORE INFORMATION

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USEFUL RESOURCES

Wheat Powdery Mildew Fact Sheet (2022), afren.com.au/wp-content/uploads/2022/03/5542-AFREN-Wheat-Powdery-Mildew-Fact-Sheet_FA_online.pdf

Fungicide Resistance in Wheat Fact Sheet (2022), afren.com.au/wp-content/uploads/2022/06/AFREN-Wheat-Fact-Sheet_Jun22_FA_online.pdf

Australian Fungicide Resistance Extension Network afren.com.au

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