Spiroxamine offers an additional cost effective mode of action against fungicide resistant powdery mildew

Andrea Hills and Kithsiri Jayasena, DAFWA Esperance and Albany

KEY MESSAGES

- If the permit for Prosper (spiroxamine) use is renewed, then growers have another profitable option for rotating fungicides to minimise the further development of resistance in the powdery mildew pathogen.
- Three fungicide modes of action (DMI, QoI, Amine) are represented in products such as Prosaro, Amistar Xtra, Tilt Xtra and Prosper that controlled fungicide resistant powdery mildew and gave economic returns in trials at Gibson in 2009 and 2012.
- Spiroxamine (Prosper) offers a third fungicide mode of action and was cost effective in control of barley powdery mildew. The temporary permit for Prosper currently expires in April 2013 but renewal is being investigated by the grower group, SEPWA.

BACKGROUND

There are only two fungicide modes of action (MOA) available to Western Australian growers in spite of the emergence of powdery mildew that is resistant to some triazole fungicides (Table 1). On 27 July 2012, the SEPWA grower group received approval from the APVMA for a temporary use permit for Prosper 500 EC which contains the active ingredient spiroxamine (FRAC MOA No 5, Amine), adding a third MOA (Table 1) to our arsenal for use in high disease risk areas against barley powdery mildew that has developed resistance to one of the fungicide MOAs.

Statewide, 18 per cent of barley acreage is sown to Baudin, a variety which is very susceptible to powdery mildew and which comprises 30 per cent of the barley sown in the Esperance Port Zone (CBH data, 2012).

Table 1. Foliar fungicides, their active ingredients and FRAC mode of action code.

Product Name	Active ingredients	FRAC MOA No.#
Folicur	Tebuconazole	3
Tilt Xtra	Propiconazole + cyproconazole	3 + 3*
Prosaro	Prothioconazole & tebuconazole	3* + 3
Opus	Epoxiconazole	3*
Amistar Xtra	Azoxystobin & cyproconazole	11 + 3*
Opera	Epoxiconazole & pyraclostrobin	3* + 11
Prosper^	Spiroxamine	5

Fungicide Resistance Action Committee (FRAC) code 3 = DMI, 5 = Amine, 11 = QoI
* Indicates that the fungicide is one of the triazoles that remains fully active against powdery mildew (R Oliver, pers. Comm..)
^ Indicates that the product is on a temporary use permit from the APVMA until April 2013

AIM

Our aim is; using grain yield and quality results, current price estimates and delivery grade specifications, to compare the performance and gross returns from the use of a range of foliar fungicides available in Western Australia that have different modes of action.

Fungicide costs for the control of powdery mildew have changed considerably in the last few years. In this paper, a trial from 2009 will be updated using current grain and fungicide prices to broaden product comparisons and complement new data from a 2012 trial.

METHOD

Fungicide trials sown at Gibson (Esperance Downs Research Station) in 2009 (27 May) and 2012 (15 May) were used to calculate a gross margin calculated using the measured yield and grain quality (CBH 2012/13 delivery grade specifications) of Baudin barley minus the current costs of the fungicide applications (product, any adjuvants used and cost of application). Prices used to calculate gross margins were Baudin Malt1= $310 /t, Malt2= $290 /t, Feed1= $280 /t. Fungicide application cost used was $9 /ha per spray. Product costs are shown in

Table 2. EPR rates for Baudin of $1 /t for feed grade and $3 /t for malting grade were also deducted. Plot returns per treatment were averaged over four replicates.

Please refer to the 2010 GRDC Perth Crop Update paper "*Fungicides for the future: Management of Barley Powdery Mildew and Leaf Rust*" by Kith Jayasena, Kazue Tanaka and William MacLeod for the details of the 2009 trial.

In 2012, an untreated (no seed dressing) 60 m square area of Baudin barley was divided so that the trial design was a randomized block of four replicates with 20 x 2.0 m wide plots with similar size alternating untreated buffers. Fungicides were applied when plants were approaching second node on 9 August. Four fungicides at various rates were applied once only and disease levels were assessed at four weeks after spraying when heads were close to full emergence (Z58). See Table 2 for the 2009 and 2012 treatments.

Table 2. Fungicide and adjuvant products applied (mL/ha unless specified), with the rate of application, the cost per rate ($/ha), the rate used in each trial and the number of times it was applied in 2009.

Product	Rate (mL/ha)	Cost ($/application)	2009 trial rates (mL/ha)	2012 trial rates (mL/ha)
Tilt Xtra	500	20	500 (2)#	-
Amistar Xtra	400	22	400 (2)	-
Prosaro	150	10.50	150 (2)	150
Opus	500	14	500 (2)	250, 500
Prosper	600	27	144 (2)	150, 300, 600
Prosper + Folicur mix	500 + 145	24.50	-	500 + 145
Opera	500	21	500 (2)	-
Folicur	145	2	-	145
Baytan SD	1.5 L/t	2.5^	105	-
Adigor (adjuvant)	2 % v/v*	1	2 %	-
Hasten (adjuvant)	1 % v/v**	3	1 %	1 %

Numbers in brackets is number of applications; ^Assumes a sowing rate of 70 kg/ha seed;
* Used with AmistarXtra; ** Used with Prosaro

RESULTS AND DISCUSSION

In both trial years at Gibson, the foliar diseases powdery mildew and barley leaf rust were present, although in 2009 leaf rust was at a much higher level (33 %) (Table 3) than in 2012 (2 %) (Table 4).

Disease levels, yields and gross returns for the 2009 trial are shown in Table 3. All fungicide treatments significantly increased yield and gave positive economic returns from $276 - $452 above untreated. With a general decrease in fungicide prices since this trial was done, AmistarXtra now gave the highest return ($1512 /ha) with Prosaro returning $1479 /ha. TiltXtra also gave a favourable return of $1461 /ha.

Table 3. 2009 Baudin barley disease levels at the end of flowering (30 Sept) showing grain yield (t/ha), yield relative to untreated barley (% Nil), gross margin ($/ha) and gross margin minus costs ($/ha).

	% LAA (*ang)		Grain yield		Gross return	Gross return minus costs^
Product	Powdery mildew	Leaf Rust	t/ha	% Nil	($/ha)	($/ha)
Untreated	32^{a}**	33^{a}	3.8^{e}	100	1064	1060
Baytan + Prosper X 2	5^{d}	16^{b}	4.8^{d}	127	1392	1336
Baytan + Prosaro X 2	3^{d}	6^{cde}	5.3^{ab}	140	1537	1479
Baytan + Opera X 2	9^{c}	9^{c}	5.1^{c}	135	1479	1404
Baytan + Tilt Xtra X 2	4^{d}	6^{cde}	5.3^{ab}	140	1537	1461
Baytan + Opus X 2	4^{d}	5^{de}	5.2^{bc}	137	1508	1444
Baytan + Amistar Xtra X 2	5^{d}	5^{de}	5.5^{a}	144	1595	1512
LSD 5%	3	3	0.2			

*Angular transformed data; **Means followed by the same letter in the same column are not significantly different at p=0.05 level
^Costs deducted are product, application and EPR

As the 2012 trial had been sown with no seed dressings and the Prosper permit only became available in late July, the timing of the single spray was late (plants were at second node) and the level of powdery mildew present on the top

leaves of the plants was above the threshold of 5 % LAA. The average amount of powdery mildew (which accounted for 98 % of the leaf disease present) and leaf rust on the top three leaves (Flag-1 to Flag-3) at spraying averaged 6 % LAA; ranging from <1 % LAA on Flag-1 to 10 % LAA on Flag-3.

Table 4. 2012 Baudin barley disease levels four weeks after product application when heads were close to full emergence (7 Sept) showing the grain yield (t/ha), yield relative to untreated barley (% Nil), gross return ($/ha) and gross return minus costs ($/ha).

	% LAA		Grain yield			
Products and rate of application	Powdery mildew	Leaf rust	t/ha	% Nil	Gross return ($/ha)	Gross return minus costs^ ($/ha)
Untreated	19^{c}	2.0	2.9^{e}	100	803^{g}	795^{f}
Folicur 145 mL/ha	19^{c}	1.7	3.0^{de}	107	854^{defg}	833^{def}
Prosper @ 150 mL/ha	18^{c}	1.5	3.1^{de}	109	871^{cdef}	846^{def}
Prosper @ 300 mL/ha	17^{bc}	1.2	3.2^{de}	112	897^{cde}	864^{cde}
Prosper @ 600 mL/ha	13^{a}	0.9	3.5^{bc}	122	981^{b}	917^{bc}
Folicur @ 145 + Prosper @ 500 mL/ha	13^{a}	0.4	3.8^{a}	134	1112^{a}	1038^{a}
Prosaro @ 150 mL/ha	14^{ab}	0.5	3.7^{ab}	129	1060^{a}	975^{ab}
Opus @ 250 mL/ha	17^{bc}	1.1	3.3^{cd}	115	918^{bcd}	892^{cd}
Opus @ 500 mL/ha	16^{abc}	0.9	3.3^{cd}	115	925^{bc}	891^{cd}
LSD 5%	3.0	0.7	0.2	8	66	66

** Means followed by the same letter in the same column are not significantly different at p=0.05 level;
^ Costs deducted are product, application and EPR.

In 2012, Prosper at 600 mL/ha and the Folicur + Prosper mix were the most effective at reducing the amount of mildew present while Folicur and the lowest levels of Prosper (150 and 300 mL/ha) had no effect on levels of powdery mildew or grain yields relative to the untreated plots (Table 4).

The Folicur + Prosper mix and Prosaro increased yields by 34 and 29 % respectively (Table 4) and improved grain quality with reduced screenings, increased hectolitre weight and slightly brighter grain (Table 5).

The ranking of products for gross return and gross margin were similar. The gross margin for the Folicur + Prosper mix were $1038 /ha and Prosaro was $975 /ha representing an increase of $243 and $180 over the untreated (Table 4). The lowest gross marings were from the untreated ($795 /ha), Folicur ($833 /ha) and Prosper at 150 mL/ha ($846 /ha).

Table 5. The effect of fungicide treatments on the grain quality of Baudin in 2012; screenings (%< 2.5 mm), hectolitre (kg/hL) and grain brightness (NIR *L).**

	Grain yield				
Products and rate of application	t/ha	% Nil	Screenings (% < 2.5 mm)	Hectolitre (kg/hL)	Grain brightness (NIR L*)
Untreated	2.9^{e}	100	69^{e}	66.6	59.3
Folicur 145 mL/ha	3.0^{de}	107	62^{cde}	66.7	59.1
Prosper @ 150 mL/ha	3.1^{d}	109	66de	66.4	59.5
Prosper @ 300 mL/ha	3.2^{de}	112	57^{cde}	67.0	58.8
Prosper @ 600 mL/ha	3.5^{bc}	122	50^{abc}	68.7	59.4
Folicur 145 + Prosper 500 mL/ha	3.8^{a}	134	39^{a}	70.0	59.9
Prosaro @ 150 mL/ha	3.7^{ab}	129	37^{ab}	69.9	59.5
Opus @ 250 mL/ha	3.3^{cd}	115	54^{cd}	68.4	59.7
Opus @ 500 mL/ha	3.3^{cd}	115	50^{abc}	68.3	59.9
LSD 5%	0.2	8	13	1.5	0.5

** Means followed by the same letter in the same column are not significantly different at p=0.05 level

In the 2012 trials, grain quality traits of brightness, screenings and hectolitre improved significantly over the untreated with all fungicide applications apart from the two lower rates of Prosper (150 and 300 mL/ha). There was a 43 - 46 % reduction in screenings from the use of Prosaro and the Folicur + Prosper mix (Table 5) and a few plots of these two

treatments and one of Prosper at 600 mL/ha achieved a Malt grade through lower screenings (data not shown) with all remaining plots being Feed grade.

CONCLUSION

Having access to a number of cost effective modes of action is crucial to managing fungicide resistance in powdery mildew and to prevent reliance on the two groups present in WA, one of which, the strobilurins, are known to be in a high risk category for the development of resistance in powdery mildew.

Prosper (FRAC MOA code 5), Prosaro (FRAC MOA code 3 + 3), TiltXtra (FRAC MOA code 3 + 3) and AmistarXtra (FRAC MOA code 11 + 3) are cost effective fungicides for the control of fungicide resistant powdery mildew (and other leaf diseases) and maximise the number of modes of action available for farmers to rotate. Unfortunately Prosper is on a temporary use permit until April 2013 and it is unknown if this will be renewed.

Although it is difficult to compare trials that contain different products, Prosaro, which was present in both 2009 and 2012, performed consistently well, as did Amistar Xtra and Tilt Xtra (2009) and the Prosper @ 600 mL/ha in 2012.

Be aware that any use of tebuconazole can increase selection pressure for mutants that will render the other triazoles (DMI's) less effective. Don't forget that the timeliness of application is vital to maximising your fungicide's effectiveness and rotate to use two different products in a season!

KEY WORDS

Barley, fungicide mode of action, powdery mildew, fungicide resistance, gross return

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