Foliar fungicide strategies for Managing Wheat Powdery mildew

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Key messages

- Application of a single foliar fungicide spray at a registered rate to a susceptible variety gave a significant yield response in four out of six trials located across the wheatbelt in 2015, when powdery mildew infection occurred from stem extension onwards. Average yield response across all trials to a single fungicide spray was 8%. Timing of application (as soon as possible after disease observed moving up canopy) was more important than product choice. In 6 trials, the difference between untreated versus treated yield was more significant than differences between product or active ingredient used.
- The best timing was: 1) before disease became severe and before flag leaves and particularly heads were infected and 2) where disease onset was later, once all leaves had emerged (i.e. after Z39) so maximum canopy area was protected. An earlier sown crop was more vulnerable to head infection than a later sown crop alongside it. Fungicide application after head emergence was too late to provide effective head protection and was not economic.
- Fungicides are more efficient as protectants than eradicants. To get most value from fungicides and achieve optimal yield benefit it is crucial to control the disease before it becomes too severe and develops in upper canopy and on heads. The value of applying a second fungicide was variable and in the two trials where it was tested was not justified by a significant yield response, possibly due to the dry hot spring in most locations.

Aims

In a range of locations: 1) Research the best foliar fungicide strategy for managing powdery mildew in wheat from stem extension onwards in the 2015 season, 2) Gather data on disease, yield and quality responses to a range of fungicides.

Background

Powdery mildew has become more prevalent in WA wheat crops over the past few years, particularly late in seasons. In 2015, it was widespread and damaging on wheat crops in the northern and central wheatbelt and in the Esperance region. The degree of damage and best management has not been tested in detail for more than 15 years in WA. The disease persisted through winter and into spring and proved difficult to control in 2015 crops. Prominent questions facing growers and advisers during 2015 centred around potential yield losses, profitability of applying fungicides, best timing and product, value of multiple sprays and potential risk of fungicide resistance. This paper investigates impact of fungicide management of powdery mildew infection that occurs after stem extension.

Method

Replicated field trials were conducted in a range of rainfall zones and areas of the wheatbelt in 2015 by DAFWA (Geraldton, Moonyoonooka and Gibson), Landmark (Munglinup), and Imtrade Australia with the Liebe Group (Buntine). A demonstration trial was conducted by Northampton Agri Services (Sandy Gully). All of the research was established opportunistically during the season in grower paddocks of susceptible varieties where powdery mildew was found to be present from stem extension onwards. Details of each trial or demonstration are listed in Table 1. Two trials were conducted side by side at the Geraldton site, both the same variety and same fungicide treatments, just two different times of sowing (designated early and late). Fungicides were applied by machine mounted boomspray or hand boom. There was a buffer area between each plot. Not all fungicide products tested are registered for wheat powdery mildew control but were included to generate scientific discussion and are not intended as recommendations. A majority of the fungicides tested are registered in wheat at the same application rate for control of other foliar diseases. Two are not currently registered in wheat and so were not named. All sites had yellow spot or septoria nodorum also present at generally low levels which were also scored but not presented here (further details on site disease levels in Table 1). In the majority of trials, powdery mildew disease was assessed as percentage leaf area affected (LAA) of each of the top three leaves on 10 random tillers from each treatment at time of assessment. Where possible, head infection was also scored. The Gibson trial used a head scoring method which was a rating score of most diseased to least diseased. Leaf disease at the Munglinup trial was rated from 0-10 as a per cent control with zero being no control and 10 being full control. Trials were harvested for yield and a one kilo grain sample taken from each plot for grain quality testing, no quality testing was done on the demonstration done at Sandy Gully.

Table 1. Details of each trial/demonstration referred to in this paper.

	Gibson	Munglinup	West Buntine	Moonyoonooka	Geraldton (Early sown)	Geraldton (Late sown)	Sandy Gully
Plot size & replication	1.75m x 28m, 3 replicates	1.6x10m, 3 replicates	2m x 10m, 3 replicates	1.8m x 20m, 3 replicates	1.8m x 20m, 4 replicates	1.8m x 20m, 4 replicates	2m x 20m, no replication. Demo
Wheat variety (PM resistance rating)	Trojan (SVS)	Mace (MSS)	Mace (MSS)	Wyalkatchem (S)	Wyalkatchem (S)	Wyalkatchem (S)	Wyalkatchem (S)
Soil type	Grey deep sandy duplex	Sand over gravel	Yellow sandplain	Sandy loam	Sandy loam	Sandy loam	Red loam
Sowing	26/05/2015 at 75kg/ha	22/05/2015 at 70kg/ha	15/05/2015 at 80kg/ha	7/06/2015 at 87kg/ha	19/5/15 at 80kg/ha	29/5/15 at 80kg/ha	15/05/2015 at 75kg/ha
Paddock rotation	2014: canola, 2013: pasture, 2012: pasture	2014: TT canola, 2013: pasture, 2012: pasture	2014: wheat, 2013: wheat, 2012: wheat	2014: canola, 2013: barley, 2012: wheat	2014: wheat, 2013: wheat, 2012: oat hay	2014: wheat, 2013: wheat, 2012: oat hay	2014: oats, 2013: oats, 2012: wheat
Fertiliser (kg or L/ha)	70kg Ktill extra	80kg KTill xtra 60kg Urea, 80L FlexiN	15/05/2015: 85kg K-Till Extra and 1t lime sand, 15/06/2015: 90 kg Urea, 27/07/2015: 25 L Flexi-N	At seeding: MAPSZC 50kg and Urea 50kg, 22/07/2015: Urea Plus 60kg	80kg Agras at sowing, 70kg NS41	80kg Agras at sowing, 70kg NS41	75kg Dapscz 40L UAN at 4-5 leaf, 10L Coron at Flag leaf
Growing Season Rainfall (May-Oct)	320mm	355mm	290mm	204mm	202mm	202mm	213mm
Water volume fungicides applied in	min 80L/ha	80L/ha	87L/ha	80L/ha	80L/ha	80L/ha	70L/ha
Other diseases present	SNB/YS# (25% on top 3 leaves includes necrosis from PM)	SNB/YS# (present on F -2 and below at second assessment)	Not on top 3 assessed leaves, minimal down canopy	SNB/YS# moderate levels (20% top 3 leaves at Z65)	SNB/YS# low levels (9% top 3 leaves at last assessment)	SNB/YS# low levels (9% top 3 leaves at last assessment)	SNB/YS# low levels (16% flag leaf at assessment)
Research team	DAFWA, Andrea Hills	Landmark, Brad Westphal and Phil Smyth	Imtrade Australia, Michael Macpherson; Liebe Group, Elly Wainwright; and DAFWA, Geoff Thomas	DAFWA, Ciara Beard and Anne Smith	DAFWA, Ciara Beard and Anne Smith	DAFWA, Ciara Beard and Anne Smith	Northampton Agri Services, Leigh Nairn

SNB/YS Necrosis associated with Septoria nodorum blotch &/or yellow spot

Results

Table 2. Powdery mildew response to fungicide treatments at the six sites, 6 trials and one demo (Sandy Gully). If there was no statistically significant (ns) yield response compared to the untreated, a 0% was allocated.

	Gibson	Munglinup	West Buntine	Moonyoonooka	Geraldton Early sown	Geraldton Late sown	Sandy Gully
First application	7/09/2015 Z54	7/08/2015 Z37	29/08/2015 Z41	06/08/15 Z32	30/07/15 Z60	30/07/15 Z39	18/08/15
Second application in two spray strategy	--	7/09/2015 Z59	--	--	18/08/15 Z69	18/08/15 Z41	-
Crop stage at disease assessment	72	49	45	41 / 65	na	na	57
Days after treatment (DAT)	25	24	14 / 28 / 42	13 / 33	14 / 26	14/26	7
Leaves assessed	top three	flag	top three	top three	top three	top three	flag
Leaf disease on untreated (%)	1.5	5	2 / 5 / 8	6 / 28	12 / 15	13/15	20
Head incidence (%)	0.2	na	42 DAT 87	na	38/85	0/40	70
Disease response on leaves at last assessment (p value)	P = 0.146 top 3 P=0.005 flag	P<0.001	P = 0.016	P = 0.056	P = 0.002	P = 0.002	na
Yield response (p value)	P = 0.006	P<0.001	P = 0.071	P = 0.957 ns	P = 0.093	P = 0.010	na
Yield (t/ha) Untreated	4.4	3.7	2.9	2.2	2.6	2.0	3.1
Yield response to One Application	7-13%	8-14%	3-19%	0%	0%	26%	1-4%
Yield response to Two Applications	--	11-19%	--	--	14%	30%	-
Combined response Untreated v single spray	11%	11%	11%	0%	0%	26%	0%

'na' – indicates not available. Incidence = average presence of disease on nominated head as a percentage infected per plot. Severity = average percentage of head area infected on nominated head per plot.

Table 3. Statistically significant yield impacts from a single fungicide application at the 6 trials and one demo (Sandy Gully). If there was no statistically significant yield response compared to the untreated, a 0% was allocated. No statistics on Sandy Gully as not replicated.

Active fungicide ingredient Product name **(application rate)**	**Gibson**	**Munglinup**	**West Buntine**	**Moonyoonooka**	**Geraldton Early sown**	**Geraldton Late sown**	**Sandy Gully**
Treatment Response % yield increase over untreated (single application)							
Triadimefon 500g/L							
Triadimefon 500WG **(250g/ha)**			10%				
Tebuconazole 430g/L							
Tebuconazole 430SC* **(290mL/ha)**	9%	8%	12%	0%			
Folicur® 430SC* **(145mL/ha)**			11%				
Folicur® 430SC* **(290mL/ha)**							0%
Tebuconazole 800g/Kg							
Turbulence® 800WG* **(156g/ha)**							0%
Epoxiconazole 125g/L							
Opus® 125SC **(500mL/ha)**		14%					
Epoxiconazole 800g/Kg							
Octopus® 800WG* **(78g/ha)**			14%	0%			
Propiconazole 250g/L							
Tilt®/Relic®/Propiconazole 250EC **(500mL/ha)**	7%	11%		0%			
Propiconazole 550g/L							
Cracker Jack 550EC **(230mL/ha)**			0%				
Azoxystrobin 75g/L + Epoxiconazole 75g/L							
Radial® **(420mL/ha)**		11%	0%				
Azoxystrobin 80g/L + Epoxiconazole 31g/L							
Tazer Xpert **(500mL/ha)**		11%					
Azoxystrobin 200g/L + Cyproconazole 80g/L							
Amistar Xtra **(400mL/ha)**	13%	14%					
(600mL/ha)			19%				
Propiconazole 250g/L+ Tebuconazole 250g/L							
Cogito **(187mL/ha)**			9%				
(250mL/ha)							4%
Tebuconazole 210g/L+ Prothioconazole 210g/L							
Prosaro **(150mL/ha)**	12%	11%		0%			
(300mL/ha)	13%	11%		0%	0%	26%	
Bixafen 75g/L+Prothioconazole 150g/L							
Product A **(300mL/ha)**		11%					3%

* indicates this product is not registered for powdery mildew control but is registered for other foliar diseases in wheat. Product A is an upcoming product, not yet registered in wheat.

Yield response and fungicide product comparison

In all trials, most fungicide products provided significant disease control compared to the untreated control (including those not registered for wheat powdery mildew but registered for other wheat foliar diseases). There were some differences between products but in the majority of trials there was no significant difference between fungicide products in terms of yield response (Table 3). Average yield response across all the trials to a single fungicide application between Z32 and Z60 was 8%. A yield response to fungicide application for powdery mildew is however not guaranteed and one of the trials had no yield response. At this site at Moonyoonooka the crop was late sown and hot dry spring conditions hastened disease demise, reduced fungicide impact and limited crop yield potential. If disease is not severe or diminishes naturally (due to warm dry conditions for example), then fungicide is unlikely to provide significant yield benefit.

In DAFWA trials conducted during the last major powdery mildew outbreak in late 90s/early 2000s, similar yield responses were evident in trials across the wheatbelt where powdery mildew was the dominant disease. Yield responses from a single spray application ranged from <5% to 15-17% (when fungicide was applied from flag leaf to head emergence). This historical data is available on the DAFWA website (https://www.agric.wa.gov.au/newsletters/northern-agtactics-august-2015-issue-4).

Greater yield responses can occur where powdery mildew is present with other diseases. In the majority of these trials, yellow spot and/or septoria nodorum blotch (YS/SNB) were present at low levels in addition to powdery mildew so unlikely to be much yield response for leaf spot control. Gibson and Moonyoonooka however had moderate levels of YS/SNB so fungicide application would have given added yield response in these trials. In the Geraldton trials, a horticultural mildewicide not registered for wheat, was used as a control as it provides powdery mildew protection only and not protection from yellow spot or septoria nodorum blotch. The yield response in the full control in the two Geraldton trials (Table 5) demonstrates the yield response due to powdery mildew control alone.

Timing of application

Fungicide application times in the trials ranged from Z32 to Z60. It was evident that leaves or heads that were not emerged at the time of fungicide application were not directly protected from disease and were a source to reinfect the crop. In the West Buntine trial, where fungicides were applied before head emergence (at Z41, flag leaf fully emerged) there were potentially damaging levels of disease observed on heads in all treatments. Fungicide sprayed plots had reduced level of head infection, due to reduced canopy inoculum, however re-infection was evident in both sprayed and unsprayed plots (Table 4). This is expected as most fungicides available in WA have minimal capacity to move systemically within the plant to protect plant parts not exposed at the time of spraying, so only the plant material emerged at the time of application is protected. Hence a follow up application may be warranted, if disease is continuing and weather outlook favours disease, but profitability needs to be weighed up (see section on value of a second spray).

Table 4: Fungicide effect on incidence and severity of powdery mildew on grain head and leaves, and yield response on Mace at West Buntine 28 days after treatment at Z41.

Fungicide Treatment (rate/ha)	**Head Incidence** (%)	**Head Severity** (%)	**LAA Severity (%)**			**Yield** (t/ha)	**Profit above untreated** ($/ha)
			Flag	Flag-1	Flag-2		
1. Untreated	86.7	9.6	1.2	7.6	4.7	2.9	
2. Triadimefon 500WG (250g)	63.3	**2.6**	**0**	**0**	**0.4**	**3.2**	70
3. Turbulence 800WG (156g)	73.3	**3.4**	**0**	**1.2**	**1.7**	**3.2**	na
4. Tebuconazole 430SC (290ml)	76.7	**2.2**	**0**	**2.2**	4.1	**3.2**	71
5. Octopus 800WG (78g)	73.3	**2.2**	**0**	**4.3**	4.5	**3.3**	na
6. Cracker Jack 550EC (115ml)	56.7	**2.2**	**0**	**3.6**	2.5	-	na
7. Cracker Jack 550EC (230ml)	70	**2.9**	**0**	**1.9**	**2.2**	3.0	na
8. Radial (420ml)	63.3	**3.2**	**0.3**	**0.9**	**2.1**	3.1	33
9. Amistar Xtra (600ml)	76.7	**2.9**	**0**	**0**	**0.7**	**3.4**	107
10. Cogito (187ml)	66.7	**1.9**	**0**	**1.2**	**3**	**3.1**	na
P value	0.226	0.002	0.001	0.002	0.016	0.071	
Lsd (5%)	ns	**3.06**	**0.46**	**3.17**	**2.47**	**ns**	
Lsd (10%)						**0.26**	

Bold type indicates significant difference to the untreated. 'na' indicates price of fungicide not available to calculate profitability. Profitability was calculated with wheat price of $278/t, current fungicide prices, and an application cost of $9/ha.

In the Geraldton trials, early sown plots were more vulnerable to upper canopy powdery mildew infection than later sown plots, particularly to head infection due to the heads emerging earlier during the part of the season most favourable for the pathogen (moist humid winter) (Figure 1a and b).

In adjacent trials with Wyalkatchem wheat at this site, fungicide was applied on the same date, being Z39 (flag leaf emergence) in the late sown trial and Z60 (end of ear emergence) in the earlier sown trial. At time of application there was 4% disease on the top three leaves of the late sown (0% on flag emerging) and 23% on the top three leaves of the early sown (17% on flag leaf). A fortnight later, infection on the leaves of the late sown plots was observed to be more responsive to fungicide than the early sown plots, likely due to higher original disease levels on the early sown. During fortnightly assessments, head infection (severity and most noticeably incidence) was observed to increase rapidly in the early sown plots indicating the fungicide application was too late to provide adequate head protection. Though head infection still developed in the late sown plots that were sprayed before head emergence, it did not reach the levels of the early sown plots and the single fungicide spray gave a significant yield response ($p<0.05$) for the late sown (26%) and not for the early sown (Table 5).

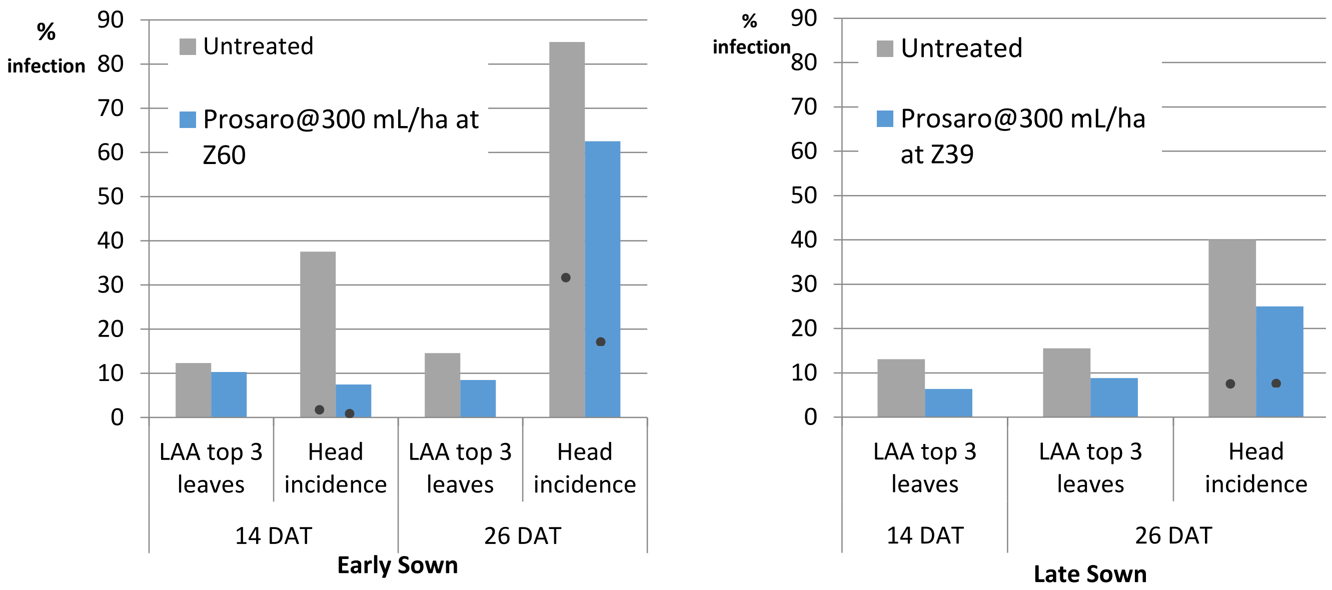

Figure 1a and b. Average percentage leaf area affected (LAA) on top three leaves 14 days after treatment (DAT) (Z40/65) and 26 DAT (Z59/grain fill), average head infection severity (indicated by black dot) and average incidence of head infection on a) early sown and b) late sown Wyalkatchem at Geraldton. Early sown was sown on 19/05/15 and late sown on 29/05/15. Both had fungicide applied on the same date 30/07/15. 14 DAT – LAA top 3 leaves: p value<0.001, Lsd 5% = 2.02; head severity: p value=0.021, Lsd 10% =1.31; head incidence: p value =0.003; Lsd 5% =13.83. 26DAT – LAA top 3 leaves: p value<0.001, Lsd 5% = 2.02; head severity: pvalue=0.085, Lsd 10% =6.3; head incidence: p value = 0.009, Lsd 5% =15.4.

Table 5. Yield results of Geraldton powdery mildew trials, both Wyalkatchem with same sowing rate and fungicide treatments, sown 10 days apart. Early sown was sown on 19/05/15 and late sown on 29/05/15.

	Yield (t/ha)	
Fungicide treatment	**Early sown**	**Late sown**
Untreated	2.6	2.0
Prosaro at 300mL/ha at Z39/60	2.9	2.6
Full control (Product B* at Z39/60 and second application at Z41/69)	3.0	2.7
P value	0.093	0.010
Lsd (5%)	ns	0.396
Lsd (10%)	0.363	-

* Product B is not registered for wheat but is used for powdery mildew control in horticulture, it was used as a research control as it provides protection from powdery mildew but not yellow spot or septoria nodorum blotch.

Comparative Disease control

Most of the fungicide products tested in these trials gave good control of powdery mildew in all trials. For example, see Figure 2 illustrating leaf infection progress at the West Buntine trial. The only fungicide active ingredients that did not perform in some trials quite as well as other products were tebuconazole and eppoxiconazole 750/800 gai at West Buntine and Moonyoonooka but this was not reflected in differences in yield response. Neither of these are registered for wheat powdery mildew control but are registered at these rates for control of other wheat foliar diseases.

Length of protection provided by fungicides

Fungicides provided at least four weeks protection as illustrated in the Geraldton (Figure 1 a and b), West Buntine and Moonyoonooka trials (latter two not illustrated). Figure 2 shows disease progress in the West Buntine trial on Flag-1 in the untreated was significantly greater than in the fungicide treatments applied at Z41 (flag leaf fully emerged).

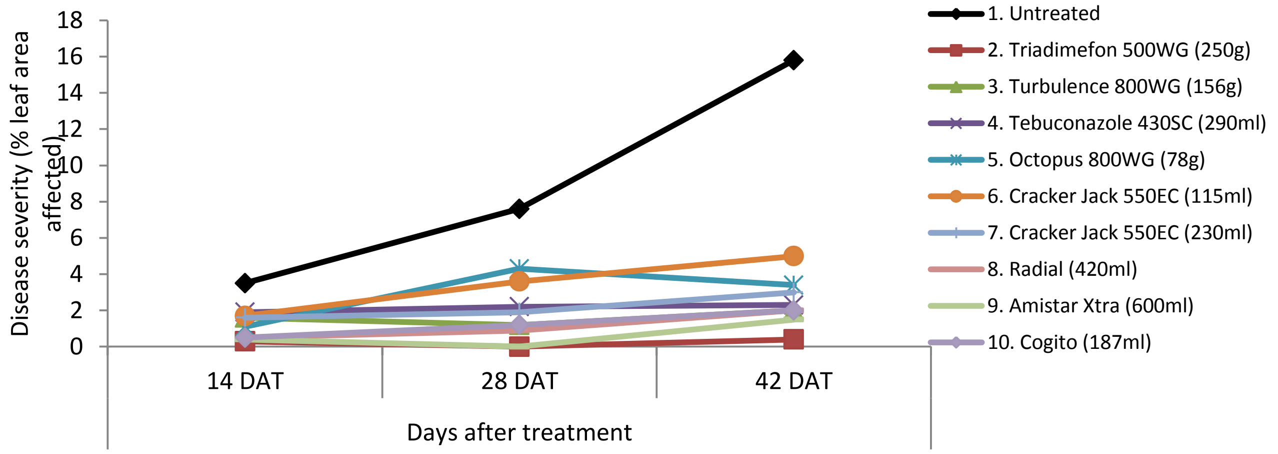

Figure 2. Fungicide effect on disease progress of powdery mildew on Flag-1, Mace at West Buntine, 14DAT (p value=0.013, Lsd=1.6), 28DAT (p value=0.002, Lsd=3.17), and 42DAT (p value=<0.001, Lsd=2.64).

Value of a second spray

The Munglinup and Geraldton trials had a second foliar fungicide application. In Geraldton, the second application did not provide any significant additional yield benefit above the single application (Table 5). In Munglinup, the second foliar application yielded significantly better for one fungicide treatment only, Radial (Table 6) and across all treatments, the average difference from untreated was 0.1t/ha.

Table 6. Yield (t/ha), profitability and quality results for fungicide treatments applied to Mace at Munglinup.

		Yield (t/ha) and Profitability ($/ha)		
Fungicide treatment	**Rate (ml/ha)**	**First spray applied Z37 (Profit above untreated ($/ha)**	**Second spray applied Z59 of double spray strategy (Profit above untreated ($/ha)**	**Screenings % average for fungicide treatment across both spray timings**
Untreated	‘-	3.7		7.1
Tebuconazole	**290**	**4.0 ($71)**	**4.1 ($86)**	6.6
Propiconazole	**500**	**4.1 ($96)**	**4.2 ($108)**	**5.1**
Opus	**500**	**4.2 ($92)**	**4.1 ($73)**	**5.5**
Prosaro^	**150**	**4.1 ($92)**	**4.2 ($100)**	**5.4**
Prosaro^	**300**	**4.1 ($81)**	**4.3 ($107)**	**5.7**
Product A^	**300**	**4.1 (na)**	**4.2 (na)**	**5.7**
Radial^	**420**	**4.1 ($88)**	**4.4 ($149)**	**5.6**
Amistar Xtra^	**400**	**4.2 ($115)**	**4.2 ($91)**	**5.9**
Tazer Xpert#	**500**	**4.1 (na)**	**4.2 (na)**	6.1
P value		0.037		0.019
Lsd (5%)		0.234		1.03

^Applied with 0.5% Liberate; # applied with 1% Banjo. ‘na’ indicates price of fungicide not available to calculate profitability. Profitability was calculated with wheat price of $278/t, current fungicide prices, and an application cost of $9/ha.

Grain quality

Three out of six trials had a significant quality response to fungicide. In the Munglinup trial, all the fungicide applications resulted in significantly less screenings (an average 19% reduction compared to the untreated, Table 6).

In the Gibson trial, Amistar Xtra significantly increased hectolitre weight and percentage protein (data not shown). In the Geraldton trial fungicide application significantly increased hectolitre weight by 2% (data not shown). Despite head infection being observed in most of the trials, it only caused significant grain quality issues at Munglinup. Warm dry spring conditions at several of the sites, potentially reduced the impact of head infection and directly impacted on grain quality (in particular screenings).

Profitability and best strategy for 2015 with hindsight

With hindsight the best strategy was a single fungicide application applied: 1) before disease became severe and before flag leaves and particularly heads were infected and 2) where disease onset was later, once all leaves had emerged (i.e. after Z39) so maximum canopy area was protected. Tables 4 and 6 show that all the fungicide active ingredients that gave a yield response at West Buntine and Munglinup were all profitable. Profit above untreated ranged from $33 - $115/ha at these two sites.

Reinfection of crop is most likely due to new unprotected foliage rather than fungicide resistance

Observations during 2015 by researchers determined that reinfection of sprayed crops was more likely due to high air-borne spore burden and a rapid infection cycle (as little as 7 days under optimal conditions) than the development of fungicide resistance. Trials outlined here have shown that fungicide application should protect sprayed leaves for a period of up to four weeks and slow disease development in the crop. However, fungicides are unlikely to totally eradicate disease and, with the scope and severity of the epidemic in the wheatbelt producing masses of airborne inoculum, infection of newly emerged unprotected foliage can still occur. Later germinating plants/tillers that do not have all their leaves out at time of fungicide application may harbour disease and be a source of ongoing infection for the crop if not controlled by a second fungicide application. Difficulties in controlling the disease are most likely related to high inoculum pressure, suitability of weather for infection, variety susceptibility, poor canopy penetration, inadequate fungicide rate or use of an outdated product.

Curtin University's Centre for Crop and Disease Management which monitors fungal crop diseases to look for any mutations within disease populations have reported no incidences of fungicide resistance in wheat powdery mildew in WA to date (December 2015).

Conclusion

Application of fungicide sprays can reduce the impact of disease, however yield responses and positive economic benefits from fungicide application are never guaranteed. Factors which favour a positive response from fungicide application include: having powdery mildew present, time of sowing and growth stage of disease onset, presence of other diseases, variety susceptibility, weather (high humidity and mild temperatures) favourable for disease development and crop growth, increased disease risk from presence of inoculum (infested stubble or green bridge). In regions with high yield or quality expectations, fungicide sprays should be applied prior to infection becoming too severe, using a fungicide rate sufficient to provide longer protection and reduce need for follow-up treatment.

It is crucial to target management strategies at controlling the disease in the canopy before it infects the heads. Fungicides can struggle to manage disease once it has become rampant in a crop and once heads are infected control is extremely difficult. Fungicides are more efficient as protectants than eradicants, therefore application of fungicide prior to disease becoming severe provides the greatest opportunity for the fungicide to effectively protect leaves from infection and delay the progress of infection up the canopy. Application of fungicide for powdery mildew is recommended when the disease is present and moving up the canopy and the outlook is for continuing moist/humid conditions. If all the leaves/heads are not yet out then a second application of fungicide is likely to be required, the profitability of which depends on the favourable disease conditions continuing into spring.

Preparing for this year

Variety choice – varieties range in susceptibility from Very Susceptible to Resistant (Mace⏀ is Moderately Susceptible-Susceptible). Variety trials in 2015 (not shown here) showed that varieties of >MS resistance provide significant reduction in disease severity. If using MS-S or worse varieties, then prepare a disease management strategy relevant to the variety resistance ranking.

Inoculum pressure – Powdery mildew is carried between seasons on infested stubble and multiplied by the presence of a green bridge. Therefore significant levels of inoculum are present within the wheatbelt currently. The presence of susceptible regrowth at the start of the season will multiply this risk and likely necessitate disease management in crops and potentially increase benefits from any at-seeding fungicide responses.

Time of sowing – Powdery mildew risk is greatest for early sown or short season varieties where upper canopy and heads are exposed to disease in most favourable environments. Early sown susceptible varieties should be monitored closely to avoid significant damage occurring before management is instigated.

Fungicide in-furrow or on seed dressing – Registered in-furrow or seed dressing fungicides have been used to delay the onset of powdery mildew infection in barley, providing early season protection and helping reduce early inoculum build up in the canopy, particularly in areas of high early disease risk. It is probable that similar responses could occur in wheat but no in—furrow fungicides or seed dressings are currently registered for powdery mildew in wheat. A list of registered foliar fungicides is available on the DAFWA website (https://www.agric.wa.gov.au/barley/seed-dressing-and-furrow-fungicides-cereals-wa).

Foliar fungicides – For susceptible varieties, budget for application of a foliar fungicide for powdery mildew control, 2015 trials indicate that yield responses average ~8%. Some differences between products may occur but a general recommendation is to use a registered product at full label recommendation. A list of registered foliar fungicides is available on the DAFWA website (https://www.agric.wa.gov.au/barley/registered-foliar-fungicides-cereals-western-australia-wa).

To reduce risk of development of fungicide resistance:

- Where possible use registered fungicide mixtures that contain different modes of action, rotate fungicide active ingredients, use recommended fungicide label rates and avoid using more than two sprays of any product per season.
- Control the disease as early as practical and before it becomes severe, spray fungicides when disease becomes evident in a crop, particularly when if weather conditions are conducive to disease development,

Crop rotation and health - rotate wheat crops with non-host crops such as canola, barley or legumes; keep crops healthy particularly with adequate potassium, but avoid over application of nitrogen as that may increase powdery mildew risk.

Further information on this and fungicide resistance testing is available in online article http://ccdm.com.au/2015/08/25/avoiding-a-slippery-slope-in-wheat-powdery-mildew/.

Key words

Powdery mildew, wheat, disease, fungicide

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