Barley varieties with adult plant resistance stand up for leaf rust

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Key Messages

- Leaf rust pressure was moderate.
- Varieties such as Bass which possess the *Rph3* gene only, need to be managed with foliar fungicides to control leaf rust.
- No fungicide responses were observed in varieties such as Flinders, Shepherd and Westminster, which possess the gene *Rph20* in addition to other rust resistance genes. These varieties didn't require foliar fungicides for leaf rust control in 2014. However in 2013, Flinders and Shepherd showed a marginal response to fungicides. No fungicide response in these two varieties in 2014 may be due to higher temperatures activating the genes.
- Granger possesses an unidentified adult plant resistance gene in addition to two rust resistance genes and does not require fungicidal protection from leaf rust.
- La Trobe showed a fungicide response even though the variety possesses gene suspected to be *Rph20* in leaf rust control and increase in yield but the treatment differences between single and multiple foliar applications were not significant.
- The performance of La Trobe differed from the other four varieties tested except for Bass and needs to be further tested in our environment to understand why.

Background and Aims

Selection of varieties with genetic resistance for a particular disease is the most economical and environmentally friendly way to manage disease. The genetic resistance can be either pathogen race specific or non-race specific. The race specific resistance is governed by a single major gene and confers resistance from the seedling stage to the adult plant stage, but can be overcome the changes in the pathogen population. In contrast to above non race specific resistance is more durable and is expressed during the latter part of the plant development.

Barley leaf rust has become an issue in recent years in the south coast of Western Australia (WA). Most of the current barley varieties grown in WA are susceptible to leaf rust which is managed by fungicides.

The disease response to the fungicide is often determined by the level of resistance of a particular variety. The resistance can be from moderately resistance (MR) to resistance (R). The varieties with MR tend to be effective at adult plant stage and commonly known as Adult Plant Resistance (APR). The expression of APR in a variety varies from tillering (Z20) to full head emergence growth stage (Z59) and is primarily influence by temperature and other factors (Park R, *pers. comm.*).

The information on the expression of APR against leaf rust on a particular variety, in our environmental is lacking and is required for effective disease management. Therefore it is important to test these varieties in our environment against leaf rust and to determine when to protect the crop with fungicides against the disease.

The scope of the present study is to determine how some of the new varieties with APR respond to fungicide that control leaf rust.

Table 1. Barley varieties tested in 2014 and their leaf rust resistance levels and genes.

Variety	*Leaf rust resistance levels	Type of resistance genes involved
Bass	S	*Rph3*
Flinders	MR-MS	*Rph20*
Granger	R-MR	*Rph3 + RphCantala + APR?*
La Trobe	MS-S	*RphCantala + Rph20?*
Shepherd	MR-MS	*Rph20*
Westminster	MR-MS	*Rph2+Rph12+Rph20*

*Resistance rating: S = susceptible, MR = moderately resistant, MS = moderately susceptible, R = resistant

Method

Experiments were conducted in 2014, at a site close to Kojaneerup Spring Road near Wellstead (50 0629265E, 6173465N). Seeds obtained from six barley varieties (La Trobe, Bass, Flinders, Shepherd, Westminster and Granger) which possess range of leaf rust resistant genes (Table 1) were sown at 75 kg/ha on the 25th of May using a 6 row cone seeder with knife points and harrows on Waychinicup sandy soil (0-10 cm dark greyish brown loamy fine sand with very few ironstone nodules, pH 4.9) to 2013 canola stubble. The plot size was 15 m by 1.8 m with Latinised split – plot design with 3 replications.

Pre sowing weed control was achieved with Roundup® at 1.5 L plus 3 gm/ha Ally® plus 0.3% LI700® and 1% AMS in 77 L of water/ha applied on the 19th of May followed by 300 gm/ha Diuron 900 plus 2L/ha Treflan® plus 1.5 L/ha Paraquat250 applied on the 21st of May in 77 L of water/ha. Post seeding weed control was achieved with mixture containing Tigrex® at 500 mL/ha plus 3 gm/ha Ally® with 0.2% wetter in 77 L of water/ha on 12th July. Zinctrace at 300 mL/ha plus 500 mL/ha Mantrac and 5 gm/ha Moly was also added to the tank mix at the time of post seeding weed control. Alphamethrin insecticide as Dominex® 100 at 125 ml/ha was applied on the 8th July to limit possible spread of barley yellow dwarf virus (BYDV). DAPSZn fertiliser at 85 kg/ha was applied at seeding. Urea at 50 kg/ha was spread on 7th of August.

Fungicide Cogitto® (active Propiconazole + Tebuconazole) was applied at 125 mL/80L water/ha during early tillering growth stage (Z24) on the 17th of July and subsequent foliar spray, Prosaro® 420SC (active Prothioconazole + Tebuconazole) was applied at 150 mL/80L water/ha with 1% v/v Hasten 4 weeks later during early stem elongation growth stage (Z32) on the 15th of August.

Since the trial site was heavily affected with Rhizoctonia, yield assessments of 1 square metre quadrat cuts was performed and converted to t/ha. Grain quality was assessed by Co-operative Bulk Handling (CBH) Ltd, Australia on 1 kg harvest grain samples.

GenStat 16th Edition (2013 Lawes Agricultural Trust, VSN International Ltd) was used to analyse data using one-way analysis of variance (ANOVA). To reduce the variance in the % leaf area diseased, the data was angular transformed and analysed.

Results

Barley leaf rust and powdery mildew were first detected at trace levels on the 15th of July on the Bass variety.

Table 2. Interaction between foliar fungicide spray timing and barley varieties on leaf rust control near Wellstead, 2014.

Varieties	**Treatments**											
	% leaf area diseased											
	*Z31 (6 Aug, Bass)			Z37 (22 Aug, Bass)			Z55 (16 Sept)			Z75 (2 Oct)		
	(av. Leaf 1 to av. Leaf 4)			(av. Leaf 1 to av. Leaf 4)			(av. Flag to av. Flag -3)			(av. Flag necrosis to av. Flag -2 necrosis)		
	**Nil	T1	T1 & T2	Nil	T1	T1 & T2	Nil	T1	T1 & T2	Nil	T1	T1 & T2
Bass	24a†	10b	-	26a	21b	19b	24a	24a	19b	32a	24a	24a
Flinders	0c	0c	-	3c	0c	0	7d	6d	4d	40a	31a	25a
Granger	0c	0c	-	1c	0c	0c	7d	6d	6d	24a	22a	21a
La Trobe	0c	0c	-	3c	1c	2c	11c	9cd	6d	50a	42a	29a
Shepherd	0c	0c	-	0c	0c	0c	5de	4de	3e	43a	29a	28a
Westminster	0c	0c	-	0c	0c	0c	3e	3e	2e	6b	5b	4b
p	<0.001			<0.024			<0.009			0.424		
lsd5% between treatments	2			3			3			ns		

Note: * Zadok's (Z) growth stage reflects to Bass; **Nil = untreated control, Time 1 (T1) spraying Cogitto at 125 mL/ha on Z24/Z26 (17 July); Time 2 (T2) spraying Prosaro at 150 mL/ha on Z32 (15 Aug) with Hasten at 1% v/v in 80L of water. † same letter across the row for the each growth stage column not significant at $p = 0.05$% level.

On the 6th of August at early stem elongation growth stage (Z31) and prior to the 2nd foliar fungicide spraying lea rust severity was assessed (Table 2). The disease severity on the open top four leaves in untreated Bass was 24% and

10% when treated with fungicide at Z24/Z26. The rest of the varieties (Flinders, Granger, La Trobe, Shepherd and Westminster) were clean. Application of fungicide significantly reduced leaf rust on Bass.

The second disease assessment was done at the late stem elongation growth stage (Z37, Bass) and the results are shown in Table 2. The leaf rust progressed further on Bass. Flinders, Granger and La Trobe showed low levels of leaf rust. Application of foliar fungicide significantly reduced rust compared to untreated on Bass. There were no significant treatment differences between foliar fungicide treatments.

At the ear emergence stage (Z55) all of the barley varieties started to show leaf rust. Bass and La Trobe untreated plots showed greater levels of leaf rust followed by Flinders, Granger, Shepherd and Westminster (Table 2). There were no significant treatment differences between varieties such as Flinders, Granger, Shepherd and Westminster. Also there were no significant treatment differences between single application of foliar fungicide spraying and untreated on Bass and La Trobe. Multiple foliar sprays significantly reduced leaf rust compared to untreated and single foliar spray against the Bass variety. In La Trobe, there was no significant foliar fungicide treatment difference between untreated vs single spray or between single spray vs two sprays (Table 2).

Final disease assessment was done at the medium milk stage (Z75) on the 2nd of October. It was difficult to assess the live rust pustules due to fast drying off of the crop and assessment was based on % leaf area necrosis (Table 2). At this stage in all varieties treatment differences were not significant.

Table 3. Interaction between foliar fungicide spray timing and barley varieties on yield near Wellstead, 2014.

Treatments	**Yield (t/ha)**					
	Bass	Flinders	Granger	La Trobe	Shepherd	Westminster
Untreated (Nil)	0.71a*	5.0a	5.6a	4.0a	4.7a	4.5a
T1	2.4b	5.1a	5.6a	4.5b	4.8a	4.6a
T1 & T2	3.0c	5.5a	5.7a	4.7b	4.9a	4.8a
p	<0.001					
lsd (5%)	0.36					
Variety	2.0a†	5.1d	5.6e	4.4b	4.8c	4.6bc
lsd (5%)	0.28					

*At each column with the same letter not significantly different at *p* = 0.05% level. †same letter in the row not significantly different at *p* = 0.05% level.

The yield for untreated plots varied from 0.7 t/ha (Bass) to 5.6 t/ha (Granger), as shown in Table 3. Application of foliar fungicides significantly increased the yield on Bass and La Trobe but treatment differences on yield were not significant on other varieties. Variety responses were varied from 2.0 t/ha to 5.6 t/ha and they were significant (Table 3).

Table 4. Interaction between fungicide spray timing and varieties on grain quality near Wellstead, 2014.

Varieties	**Treatments**											
	Nil	T1	T1 & T2	Nil	T1	T1 & T2	Nil	T1	T1 & T2	Nil	T1	T1 & T2
	% Screening (<2.5mm)			% Protein			Colour (Minolta)			Density kg/hL		
Bass	89	88	85	14	14	14	54	55	55	54	54	55
Flinders	34	25	22	14	14	13	55	55	56	63	63	64
Granger	20	18	15	13	13	13	53	54	53	64	64	64
La Trobe	36	23	18	13	13	13	54	55	55	64	63	63
Shepherd	24	20	18	14	14	10	55	56	56	62	62	62
Westminster	32	25	21	14	14	13	53	53	54	63	63	65
p	0.722ns			0.535ns			0.22ns			0.887ns		
Treatments	39a	33b	30c	14	14	13	54	55	55	61	62	62
p	0.002			0.217			0.653			0.458		
lsd (5%)	2.8			ns			ns			ns		

Grain quality such as % screening, % protein, colour and density results are shown in Table 4. None of the varieties met the malting standards. The % screening varied from 18% to 89% among the treatments but untreated varieties varied from 20% to 89 percent. The least screenings was observed on Granger and highest was on Bass. Fungicide treatments significantly reduced screening regardless of variety (Table 4). Protein was found to vary from 10% to 14% among the treatments across the varieties. The treatment differences were not significant (Table 4). The grain colour varies from 53 to 56 across the varieties but treatment differences were not significant. The grain colour was low in Granger and Westminster. Hectolitre weight varies from 54 to 56 kg/hL and treatment differences were not significant.

Conclusion

The leaf rust pressure was moderate at the trail site. Bass followed by La Trobe had more disease compared to Flinders, Granger, Shepherd and Westminster and the latter four varieties were not responsive to application of fungicides.

Application of foliar fungicides significantly increased the yield on Bass and La Trobe but the treatment differences were not significant on other varieties tested. Except for Bass, all other varieties tested yielded between 4.0 and 5.6 t/ha (Table 3). The % screenings, % protein were high and grain colour was low in Bass, Flinders, Granger, La Trobe and Westminster and therefore did not meet malting quality standards. This may be due to combined effects of lack of soil moisture during the grain filling and to some extent disease pressure.

Key words

barley, leaf rust, fungicide, disease resistance,

Acknowledgments

The authors acknowledge the trial site provided by Mark and Pamela Wood and financial assistance from Grains Research and Development Corporation.

GRDC Project Number: DAW00229

Paper reviewed by: John Moore, DAFWA, Albany and Prof. Robert Park, University of Sydney.