

3. CEREAL AGRONOMY TRIALS

3.1 CEREAL FUNGICIDE TRIALS

3.1.1 FOLIAR FUNGICIDES FOR LEAF DISEASE CONTROL ON WHEAT AND BARLEY (GNARWARRE AND HAMILTON)

Location: "South Roxby" Gnarwarre, and Hamilton

Funding: Grains Research and Development Corporation

Researchers:

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Background:

Foliar leaf diseases such as leaf rust (*Puccinia recondita*) in cereals can become an issue for producers in the higher rainfall, cool climate zone of southern Australia. The impact of the disease on yield is dependent on the time when infection occurs, the severity of the disease and the yield potential of the crop. Most control data comes from much drier environments, where crop yield potential is generally much lower.

Whilst it is preferable to have genetic resistance as the primary defense against these foliar leaf diseases, unfortunately this is not always possible in cultivars suited to the southern high rainfall zone. The mutation rate of disease pathogens also means that cultivars resistant to the old strain may be susceptible to the new.

Work being undertaken in New Zealand under more similar growing conditions to that of southern Australia, suggests that foliar fungicides play a significant role in lifting crop yields in most years. Hence this study is being undertaken in close collaboration with Foundation for Arable Research (FAR), New Zealand. To optimize the use of fungicides in southern Australia, it is essential to understand the disease control provided by different products, rates and timings, in cultivars and seasons of different disease pressures and susceptibilities.

Aim:

- To test a number of fungicides at different crop growth stages to determine the impact of foliar diseases on grain yield and quality..

Take Home Messages:

- Foliar fungicides appear to increase the yield and economic return for susceptible wheat cultivars such as Kellalac, where leaf rust (*Puccinia recondita*) is present at low to moderate levels.
- An application of fungicide at GS39 (flag leaf stage) to Kellalac at Gnarwarre, appeared to give adequate fungal leaf disease control.
- Due to the late onset of leaf disease at the Gnarwarre site, there appeared to be little economic benefit derived from the additional fungicide application to Kellalac at GS32.
- Barley (var Gairdner) responded well to the use of foliar fungicides, despite the relatively low level of disease infection. This could be due to maintaining a green stem for longer.
- Even at a low disease site (Hamilton), there appeared to be some yield benefit from using fungicides to prolong the greenness of the plant leaf and stem.

Acknowledgements:

Rob Weppeler, DPI Horsham for assistance with disease ratings.

Discussion:

The Gnarwarre trial suggests that a range of fungicides were effective at giving some protection against leaf rust in var. Kellalac wheat and that the level of disease control was sufficient to give a significant increase in grain yield. The relatively low level of disease infection however, makes it difficult to draw any definite conclusions.

It appears that the fungicides applied late (GS39) or a combination of early (GS32) and late (GS39), gave better results (ie lower leaf disease and higher yields), than fungicides applied only at GS32 or where no fungicide was applied. This is consistent with the late occurrence of leaf rust disease in the trial. (Table 3)

The strobilurin products eg Amistar, normally expected to give good longer term control of foliar leaf disease, did not show any real benefit in lifting yield. Certainly the wheat leaves showed less signs of leaf rust, however the very dry finish to the crop at Gnarwarre may well have masked any yield effect. The Hamilton results seem to support this, with seemingly better results from the strobilurin fungicides due to the better finish to the season. (Table 5 and Table 7)

The percentage of leaf rust infection on Leaf 1 (L1), Leaf 2 (L2) and Leaf 3 (L3) at Gnarwarre appears to show some correlation with grain yield ($r = -0.459$). (Table 3) That is, the higher the level of infection, particularly on L2 and L3, generally the lower the yield. This is however not always the case, eg treatments 11 and 14.

It would appear that the two applications of the same fungicide gave better rust control, particularly on L3. For example, treatment 3 vs treatment 6.

The effect of fungicides on the variety MacKellar, a variety resistant to leaf rust, was much less than for Kellalac. There were no visible signs of leaf rust on the plants, although some low levels of Septoria (*Mycosphaerella graminicola*) infection was present. (Table 3)

A range of fungicides appeared to give some leaf disease control in the Barley, although there appears to be a very weak correlation ($r = 0.23$) with leaf rust and yield. (Table 9) There was a relatively low level of infection of leaf rust (*Puccinia hordei*), Scald (*Rhynchosporium secalis*) and spot form of net blotch (*Pyrenophora teres f. maculata*) present in the trial. These diseases also appeared very late in the crop growth stage.

There appears to be a correlation ($r = 0.606$) between leaf and stem greenness rating and yield (Table 9) for barley.

Overseas the effectiveness of the fungicide products for controlling disease has been determined. In this research the effectiveness of the fungicide products to control leaf rust aligns well with overseas data, with the newer triazoles such as Folicur and Opus appearing to give better control. Similarly the addition of the strobilurins appears to further enhance disease control, particularly with a later infection of disease and a longer finish to the growing season

Trial Design:

Wheat

- 18 Treatments * 2 Varieties * 4 Replications
- 13m plots of Kellalac and MacKellar at 90kg/ha 31/05/02
- Seed Treatment : Raxil (100ml/100kg)

Barley

- 18 Treatments * 4 Replications
- 13m plots of Gairdner sown at 90kg/ha 06/06/02
- Seed Treatment : Baytan at recommended rate

Fertiliser: 120kg/ha Granulock 15 at sowing
100kg/ha Urea applied 22/08/02

18 fungicidal treatments were applied, involving different products, rates and timings. Wheat varieties used were Kellalac (susceptible to leaf rust) and MacKellar (resistant to leaf rust). For Barley, Gairdner (susceptible to leaf rust) was the variety chosen.

Table 1: Fungicidal Treatments for Wheat

Treatment	Crop Growth Stage	Crop Growth Stage
	GS32	GS39
1	Nil	Nil
2	Nil	Impact 250 ml/ha
3	Impact 250 ml/ha	Nil
4	Nil	Folicur 145 ml/ha
5	Folicur 145 ml/ha	Nil
6	Impact 250 ml/ha	Impact 250 ml/ha
7	Impact 500 ml/ha	Impact 500 ml/ha
8	Folicur 145 ml/ha	Folicur 145 ml/ha
9	Folicur 290 ml/ha	Folicur 290 ml/ha
10	Folicur 145 ml/ha + Amistar 250 g/ha	Nil
11	Nil	Folicur 145 ml/ha + Amistar 250 g/ha
12	Folicur 145 ml/ha + Amistar 250 g/ha	Folicur 145 ml/ha + Amistar 250 g/ha
13	Folicur 290 ml/ha + Amistar 500 g/ha	Folicur 290 ml/ha + Amistar 500 g/ha
14	Opus + Pyraclostrobin 500 ml/ha	Opus + Pyraclostrobin 500 ml/ha
15	Nil	Opus + Pyraclostrobin 500 ml/ha
16	Nil	Bumper 250 ml/ha
17	Bumper 250 ml/ha	Bumper 250 ml/ha
18	Nil	Opus 250 ml/ha

GS 32 : Kellalac sprayed 04/09/02 (Gnarwarre), and 12/09/02 (Hamilton)

GS 32 : MacKellar sprayed 18/09/02 (Gnarwarre), and 30/09/02 (Hamilton)

GS 39 : Kellalac & MacKellar sprayed 10/10/02 (Gnarwarre)

GS 39 : Kellalac & MacKellar sprayed 28/10/02 (Hamilton)

Table 2: Fungicidal Treatments for Barley

Treatment	Crop Growth Stage	Crop Growth Stage
	GS31	GS45
1	Nil	Nil
2	Nil	Bumper 250 ml/ha
3	Bumper 250 ml/ha	Nil
4	Nil	Folicur 145 ml/ha
5	Folicur 145 ml/ha	Nil
6	Bumper 250 ml/ha	Bumper 250 ml/ha
7	Bumper 500 ml/ha	Bumper 500 ml/ha
8	Folicur 290 ml/ha	Folicur 290 ml/ha
9	Folicur 145 ml/ha	Folicur 145 ml/ha
10	Folicur 145 ml/ha + Flint 500 g/ha	Nil
11	Nil	Folicur 145 ml/ha + Flint 500 g/ha
12	Folicur 145 ml/ha + flint 500 g/ha	Folicur 145 ml/ha + flint 500 g/ha
13	Folicur 290 ml/ha + Amistar 250 g/ha	Folicur 145 ml/ha + Amistar 250 g/ha
14	Opus + Pyraclostrobin 500 ml/ha	Opus + Pyraclostrobin 500 ml/ha
15	Folicur 290 ml/ha + Amistar 500 g/ha	Folicur 290 ml/ha + Amistar 500 g/ha
16	Carbendizin 500 ml/ha + Folicur 145 ml/ha	Nil
17	Carbendizin 500 ml/ha + Folicur 145 ml/ha	Folicur 145 ml/ha + Amistar 250 g/ha
18	Opus + Pyraclostrobin 500 ml/ha	Nil

GS 31: Gairdner sprayed on 19/08/02

GS 45 : Gairdner sprayed on 16/10/02

Rainfall and Seasonal Effects:

It is important that we consider seasonal effects on the use of fungicides. There was moderate disease (mainly leaf rust) at Gnarwarre in 2002 and almost no visible signs of disease at Hamilton.

Both trial locations had below average rainfall for 2002. The rainfall for the growing season (May-Nov) was 333 mm at Gnarwarre and 438.8 mm at Hamilton. The finish was also tougher at Gnarwarre with 125.5 mm between September and November whilst Hamilton received 173 mm.

Results:

In a dry year there were reasonable levels of leaf disease in the wheat at Gnarwarre, albeit the major infection occurred late in the life of the crop.

Table 3 and Table 4 present the wheat data from the Gnarwarre site. There was no leaf rust present in the variety MacKellar. The severity of the leaf rust in Kellalac was higher on leaf 3, indicating that disease was present in the lower canopy and spread upwards in the plant. Although some disease was present earlier in the season, the severity was generally highest in treatments that received no fungicide at GS39, indicating that the major disease pressure was later in the season. Given this situation, the effectiveness of fungicides can best be assessed by comparing the severity of disease for treatments which just received the GS39 application of fungicide.

Table 3: Kellalac and MacKellar at Gnarwarre

Kellalac											
Treat- ment	Mean Yield kg/ha	1						Net Return \$/ha ²	Leaf Rust Rating (% leaf infected 17/11)		
									L1	L2	L3
4	5668	I						1492.25	0.7	1.5	3.3
8	5584	I	I					1446.88	0.8	0.8	0.8
7	5553	I	I	I				1422.33	1.2	3.3	5.3
6	5459	I	I	I	I			1422.83	1.9	4.5	5.9
13	5438	I	I	I	I			-	0.0	0.1	0.0
17	5323	I	I	I	I	I		1369.55	0.6	0.9	2.4
18	5281	I	I	I	I	I		-	0.6	0.7	0.7
12	5271	I	I	I	I	I		-	0.1	0.0	0.0
10	5075	I	I	I	I	I	I	-	2.4	9.5	20.0
9	5062	I	I	I	I	I	I	1281.79	0.4	0.3	0.2
5	4999		I	I	I	I	I	1315.80	3.0	11.5	13.2
15	4965			I	I	I	I	-	0.2	0.0	0.2
16	4957			I	I	I	I	1303.55	1.3	2.9	5.5
2	4933				I	I	I	1302.30	2.5	9.5	19.7
1	4800					I	I	1300.32	7.5	17.7	9.0
11	4748					I	I	-	0.2	0.1	0.0
14	4722					I	I	-	0.5	0.0	0.0
3	4518						I	1187.98	3.8	13.8	17.5
Average	5131										
LSD 5%	609										
CV	9.71										

MacKellar				
Treat-ment	Mean Yield kg/ha			
7	6792	I		
18	6191	I	I	
4	6149	I	I	
5	6149	I	I	
6	6024		I	
14	5914		I	
9	5898		I	
2	5846		I	
12	5828		I	
1	5820		I	
8	5783		I	
17	5689		I	
15	5647		I	
11	5626		I	
13	5626		I	
3	5584		I	
10	5545		I	
16	5538		I	
Average	5869			
LSD 5%	692			
CV	8.85			

¹ Those treatments joined by a "1" are not significantly different.

² Net return takes account of grain yield, grain quality and cost of fungicide application.

Table 4: Gnarwarre Analysis

Kellalac		
Treatment	Protein	Test Weight
8	10.45	79.75
13	10.90	79.35
12	10.72	79.30
4	10.13	79.20
10	10.28	79.15
11	10.75	79.05
14	10.60	79.05
9	10.72	79.00
16	10.38	78.95
5	10.30	78.85
17	10.05	78.75
6	10.30	78.65
7	10.27	78.60
18	10.63	78.55
2	10.13	78.40
3	10.03	77.95
15	10.25	77.90
1	10.85	76.75
Average	10.43	78.73
LSD 5%	1.14	1.49
CV	7.20	1.41

MacKellar		
Treatment	Protein	Test Weight
15	9.65	76.60
12	9.40	76.35
9	9.75	75.90
8	9.30	75.55
10	9.23	75.50
2	9.68	75.25
3	9.65	75.20
6	9.45	75.10
4	9.70	75.05
17	9.55	74.65
13	9.88	74.60
7	10.20	74.45
14	10.30	74.35
16	9.33	74.35
18	9.65	73.75
11	9.90	73.50
1	10.25	73.40
5	10.30	73.35
Average	9.73	74.83
LSD 5%	1.03	2.76
CV	7.24	2.65



Photo 1: Leaf Rust on Kellalac at Gnarwarre 2002

Table 5: Kellalac Hamilton

Treatment	Mean Yield kg/ha					Net Return \$/ha	Green Leaf Rating (16/12) ³		
							L1	L2	L3
14	5350	I				-	3.75	3.15	2.00
13	5271	I	I			-	3.80	3.05	1.5
12	5253	I	I			-	3.85	3.70	1.65
6	5248	I	I			1378.75	2.20	1.70	1.00
16	5212	I	I	I		1391.31	3.15	1.85	1.00
11	5207	I	I	I		-	3.60	3.00	1.30
5	5166	I	I	I		1372.48	2.95	1.80	1.00
17	5083	I	I	I		1328.72	2.55	2.00	1.00
10	5055	I	I	I		-	2.85	1.45	1.00
9	5028	I	I	I	I	1265.19	2.15	1.85	1.00
8	5028	I	I	I	I	1301.37	2.45	2.05	1.00
18	5005	I	I	I	I	-	2.65	1.30	1.00
15	4977		I	I	I	-	2.85	2.30	1.35
7	4954		I	I	I	1276.21	2.50	1.75	1.15
2	4950		I	I	I	1302.25	3.10	2.00	1.00
3	4922		I	I	I	1303.26	2.40	1.55	1.00
4	4881			I	I	1280.19	2.25	1.50	1.00
1	4688				I	1249.94	1.75	1.05	1.00
Average	5071								
LSD 5%	367								
CV	8.20								

³ Green leaf rating is 1 = dead, 9 = green.

Table 6: Kellalac: Green Leaf V Yield - Hamilton

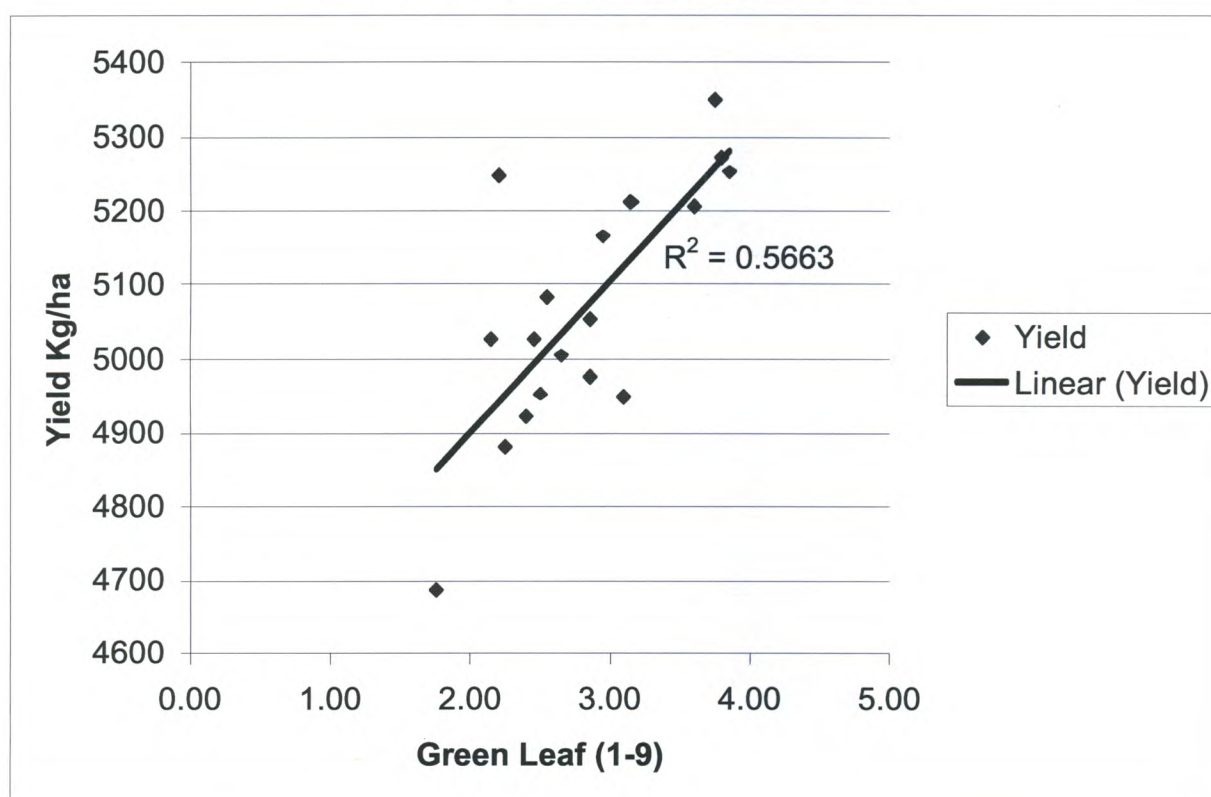


Table 7: MacKellar Hamilton

Treatment	Mean Yield kg/ha					Green Leaf Rating (16/12)		
						L1	L2	L3
14	5506	I				4.40	1.95	1.0
16	5451	I	I			2.90	1.05	1.0
13	5409	I	I			4.10	1.45	1.0
15	5377	I	I	I		3.00	1.50	1.0
6	5281	I	I	I		2.50	1.20	1.0
12	5271	I	I	I	I	3.30	2.20	1.0
7	5258	I	I	I	I	2.85	1.55	1.0
5	5258	I	I	I	I	2.65	1.05	1.0
11	5257	I	I	I	I	3.50	1.55	1.0
10	5212	I	I	I	I	3.25	1.41	1.0
8	5147	I	I	I	I	2.65	1.15	1.0
17	5133	I	I	I	I	2.40	1.25	1.0
3	5069	I	I	I	I	4.20	1.40	1.0
9	5060		I	I	I	3.40	1.55	1.0
18	4982			I	I	2.45	1.05	1.0
2	4858				I	3.15	1.65	1.0
4	4844				I	2.40	1.05	1.0
1	4780				I	2.35	1.20	1.0
Average	5185							
LSD 5%	443							
CV	9.01							

The Hamilton fungicide trial had almost no visible signs of disease. Results indicate that there was however a significant difference between treatments for grain yield, with a difference of 726 kg/ha between the nil (1) treatment and the Opus + Pyraclostrobin (14) treatment for Kellalac. (Table 5) There was also a 705kg/ha difference between nil (1) and Folicur + Amistar (12) for MacKellar. (Table 7)

Results also showed a significant difference between protein levels (Table 8), with almost a 1% difference between the nil (1) treatment and the best fungicide treatment (10). There was a correlation ($r = 0.753$) between leaf greenness and yield. These results seem to indicate that there is a yield benefit with certain fungicide treatments, even when disease is low, but the season must have a good finish.

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Table 8: Quality Data from Hamilton Site

Kellalac		
Treatment	Protein	Test Weight
10	10.80	76.50
16	10.80	76.75
5	10.65	76.85
13	10.65	76.65
17	10.65	77.15
18	10.60	76.60
12	10.60	77.45
7	10.57	76.60
6	10.57	76.40
15	10.43	77.15
11	10.40	76.80
14	10.40	77.20
8	10.35	77.25
9	10.32	76.75
3	10.27	76.35
4	10.03	76.65
2	9.93	76.75
1	9.83	76.00
Average	10.44	76.77
LSD 5%	0.78	0.95
CV	6.37	0.90

MacKellar		
Treatment	Protein	Test Weight
12	10.55	72.85
15	10.55	72.90
17	10.53	72.65
10	10.47	72.65
13	10.43	74.15
8	10.40	74.15
9	10.35	73.25
6	10.28	73.55
14	10.27	73.40
7	10.20	74.25
11	10.15	73.75
16	10.15	73.20
4	10.10	74.40
18	10.10	73.85
2	10.03	74.10
5	10.03	74.35
3	10.00	73.75
1	9.68	74.05
Average	10.24	73.63
LSD 5%	0.57	1.39
CV	4.57	1.38

Table 9 presents the Barley yield data from the Gnarwarre site. Disease was at low levels and appeared late in the life of the crop. The % of leaf rust and spot form of net blotch⁴ on L1, is also given in Table 9 (rated 13/11/02) along with a leaf (L2) and stem greenness rating (rated 18/11/02) where 1= completely dead and 9 = completely green.

Table 9: Barley Fungicide Gnarwarre

Treatment	Mean Yield kg/ha				% Leaf Rust L1	% SFNB ⁴ L1	Stem Greenness Rating	Leaf Greenness Rating
12	6863	I			0.28	0.15	6.35	2.35
3	6623	I	I		0.74	0.10	5.85	1.80
9	6449	I	I	I	0.28	0.13	5.35	1.90
4	6434	I	I	I	0.54	0.10	4.95	1.35
14	6373	I	I	I	0.08	0.03	6.05	2.50
6	6362	I	I	I	0.16	0.05	6.30	2.80
15	6318		I	I	0.00	0.05	5.65	2.70
7	6318		I	I	0.06	0.03	5.15	1.35
2	6297		I	I	0.42	0.03	5.10	1.50
10	6297		I	I	0.14	0.06	4.15	1.30
16	6264		I	I	0.62	0.00	5.40	1.30
8	6253		I	I	0.26	0.08	4.00	1.40
1	6158		I	I	0.49	0.13	4.10	1.50
18	6086			I	0.28	0.05	5.55	1.95
17	6071			I	0.18	0.08	4.20	1.70
13	6057			I	0.15	0.08	4.80	1.66
5	6035			I	0.45	0.13	4.85	1.20
11	6013			I	0.08	0.13	4.75	1.45
Average	6293							
LSD 5%	504							

⁴ Spot Form of Net Blotch.