Adult Plant Resistance and Strategic Fungicide Use for Integrated Management of Cereal Rust

By Nick Poole & Tracey Wylie - Foundation for Arable Research Australia

This is a Sydney University led project funded by GRDC

Background/Aim:
This nationwide GRDC funded project led by University of Sydney has three overall objectives which are being addressed with controlled environment experiments and field trials, specifically the project will:

- Define the expression of Adult Plant Resistance (APR) in a range of wheat cultivars in relation to environmental conditions and growth stage.
- Develop improved strategies for intervention with fungicides in the control of stripe rust and yellow leaf spot in susceptible and resistant wheat, and the communication of the strategies to industry stakeholders.
- Develop a model to support growers on the relative merits of applying fungicide for disease control, which takes account of climate, expected yield, economic outlook and genetic inputs including Adult Plant Resistance (APR).

The Westmere trial is one of 13 trials across the country and is being run by the Foundation for Arable Research Australia (FAR Australia) and Southern Farming Systems.

Method:
A replicated factorial wheat trial was established at the Southern Farming Systems Westmere Research site on 30th May in a first wheat rotation position following canola. The trial aimed to examine the interaction between cultivar resistance to stripe rust and fungicide management. Three cultivars of varying resistance were established and managed with eight different fungicide management strategies.

Treatment application:
Fungicides were applied on two different dates; an early timing at second node GS32 on 4th September and a later timing at booting GS45 (target of GS39) on the 2nd October.

1. Impact in furrow 400ml/ha (full rate)
2. Impact in furrow 400ml/ha (full rate) f.b. Folicur 145 ml/ha (GS32)
3. Impact in furrow 400ml/ha (full rate) f.b. Folicur 145 ml/ha (GS39)
4. Impact in furrow 400ml/ha (full rate) f.b. Folicur 145 ml/ha x 2 (GS32 plus GS39)
5. Untreated f.b. Folicur 145ml/ha (GS32)
6. Untreated f.b. Folicur 145 ml/ha (GS39)
7. Untreated f.b. Folicur 145 ml/ha x 2 (GS32 plus GS39)
8. Untreated

f.b. – followed by. All seed was treated for seed borne disease with Raxil.

Cultivar ratings to stripe rust, stem rust and tan spot (yellow leaf spot)

	Stripe Rust	Stem Rust	Tan Spot (Yellow Leaf Spot)
Chara	MS-S	MR-MS	MS-S
Yitpi	MR-MS	S	S
Beaufort	R-MR	S	MR-MS

Results and discussion:
i) Disease control
Stripe rust was first observed in the trial on the 19th September in the untreated plots at very low levels when the three cultivars were at different stages of flag leaf emergence. By 10th October the crop was at the end of booting GS49 and stripe rust affected approximately 60% of plants in the most susceptible cultivar Chara when assessed on flag-1. Disease severity was still less than 1% infection. This assessment timing (132 days after sowing) was the first instance where stripe rust infection was evident in the Impact (flutriafol) treated plots; the highest level of disease incidence being 10% in Chara where no follow up fungicides had been applied. Yitpi had an untreated disease incidence of 15% of plants infected verse 2.5% disease incidence where flutriafol had been employed at sowing. No stripe rust was evident in Beaufort.

At the end of flowering GS69 disease severity had reached approximately 20% on the flag leaf in Chara, 7% on Yitpi and less than 0.8% on Beaufort. In Chara Impact (flutriafol) alone was still giving 80% control of stripe rust, the same level of control achieved with a GS32 application of Folicur (145ml/ha). Where the crop had received a flag leaf spray at booting GS45 (late flag leaf spray) there was 99-100% control of stripe rust on the flag leaf (Table 1). The results were almost identical in Yitpi at a lower level of stripe rust infection. In the trial at this stage the disease control achieved with a single flag leaf spray was equal or better than that achieved with the early GS32 fungicide.

Table 1. Influence of fungicide treatment and cultivar on % stripe rust infection control relative to untreated set at 0) on the flag leaf assessed at GS61-69 – 27th October and GS71-11th November.

In Furrow	Fungicide		GS61-69 – 27th October.			GS71– 11th November		
Trt	GS32	GS45	Beaufort	Yitpi	Chara	Beaufort	Yitpi	Chara
Impact	-	-	---	75	80	---	66	69
	+	-	---	84	90	---	70	83
	-	+	---	100	100	---	100	99
	+	+	---	100	100	---	100	99
Untreated	-	-	---	0	0	---	0	0
	+	-	---	76	80	---	70	71
	-	+	---	100	99	---	100	99
	+	+	---	100	100	---	100	99

**Note: Fungicide refers to both in furrow treatment and foliar applications*

Untreated infection levels; 27th Oct – Chara 20.2% & Yitpi 6.9% severity of infection; 11th Nov - Chara 35.5% & 9.8%Yitpi severity of infection

During grain fill (11th November assessment) disease levels peaked with 35% of the flag leaf of Chara infected with stripe rust (Table 1). At this stage any fungicide programs incorporating a flag leaf fungicide application at the booting stage GS45 still gave 99-100% control of stripe rust in both Chara and Yitpi. Fungicide programs based on an earlier fungicide application at GS32 or Impact alone gave approximately 70% control of disease. On the leaf below the flag (Flag-1) where disease levels were higher (55% leaf area infected) Impact with no follow up fungicide gave approximately 80% control of stripe rust.

Stem rust infection developed to low levels at the late milk stage of grain fill (GS77) 27th November. Beaufort and Yitpi showed the highest level of infection on the flag leaf sheath (approximately 3%) with only traces of disease in Chara. All fungicide programs gave some control of this infection, particularly those incorporating a GS45 booting spray.

ii) Yield data

Influence of cultivar

When all treatments were averaged Beaufort (7.31 t/ha) significantly out yielded Chara (7.07 t/ha), which in turn significantly out yielded Yitpi (6.35 t/ha). Chara gave an 18% yield increase from the use of fungicide, averaged across all fungicide treatments, Yitpi gave a 2.5% yield increase and Beaufort gave no response despite a late low level stem rust infection. In Beaufort and Yitpi there was no significant yield response from the application of fungicide, however with Chara all fungicide treatments produced a significant yield increase (0.74 – 1.64 t/ha or 12-27%).

Influence of in-furrow flutriafol

When the treatment/cultivar yields with and without flutriafol were meaned there was no significant influence of flutriafol. In Chara where stripe rust developed to the highest levels, flutriafol with no foliar follow ups gave a 12% yield increase. This yield response to fungicide was increased to 24% when two follow up fungicides were applied at second node GS32 and booting GS45.

Influence of fungicide timing

When yields from all cultivars were averaged, three fungicide programmes were significantly higher yielding than the fully untreated crop and the flutriafol alone treated crop (Figure 1); these were those programs receiving two foliar fungicides and the impact followed by a foliar fungicide applied at booting (GS45).

There was no significant yield difference between fungicide programmes that applied a single fungicide at second node (GS32) or booting (GS45), though with the more disease susceptible cultivar Chara the later spray appeared more advantageous in terms of disease control and yield when no flutriafol was used (Table 2). There were statistical yield interactions between the value of a fungicide spray and cultivar, the stripe rust susceptible cultivar generating significant yield increases whilst the more resistant cultivars gave no significant yield effects.

In Beaufort there was a trend for fungicide application to reduce grain yield despite the control of a late stem rust infection, the reduction in yield being statistically significant (P=0.05) when two foliar fungicides were applied.

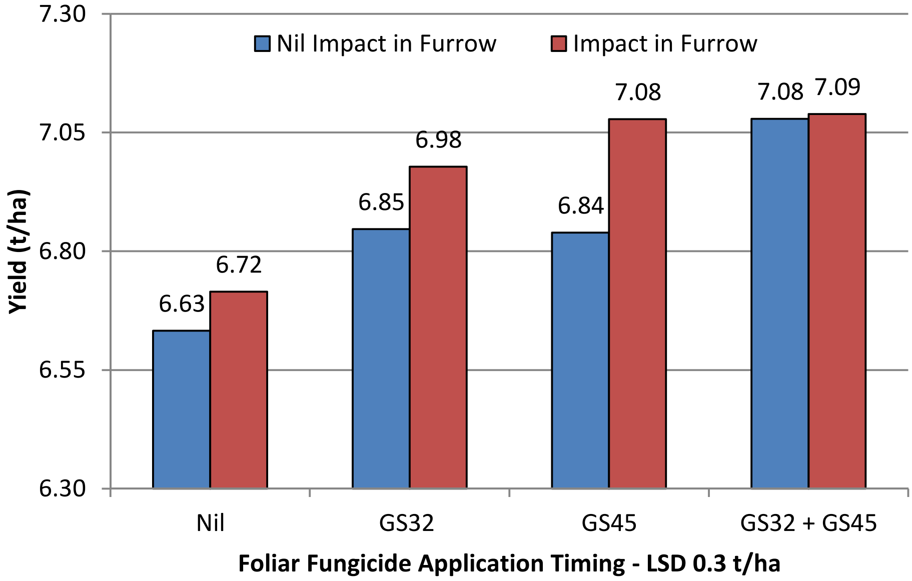

Figure 1. Influence of fungicide treatment when averaged over the three cultivars tested – Westmere (HRZ), VIC

Table 2. Influence of fungicide treatment and cultivar on grain yield (t/ha) and (% of untreated cultivar yield)

In Furrow	Fungicide		Beaufort			Yitpi			Chara		
Trt	GS32	GS49	Yield		%	Yield		%	Yield		%
Impact	-	-	7.09	bcd	94	6.23	g	100	6.83	d-f	112
	+	-	7.38	abc	98	6.44	fg	103	7.12	b-d	117
	-	+	7.7	a	102	6.43	fg	103	7.11	b-d	117
	+	+	7.32	a-d	97	6.4	fg	103	7.55	ab	124
Untreated	-	-	7.52	ab	100	6.23	g	100	6.09	g	100
	+	-	7.4	abc	98	6.44	fg	103	6.87	c-f	113
	-	+	7.09	bcd	94	6.43	fg	103	7.24	a-d	119
	+	+	6.98	cde	93	6.4	fg	103	7.73	a	127
Mean			**7.31**	**a**		**6.35**	**c**		**7.07**	**b**	
LSD (5%)	Cultivars		0.19								
	Fungicides*		0.31								
	Cult x Fung		0.53								

**Note: Fungicide refers to both in furrow treatment and foliar applications*

iii) Quality data

When averaged over the three cultivars fungicide treatment did not significantly influence grain protein and screenings, however it was shown to significantly influence test weight, better disease control leading to higher test weights.

iv) Green leaf retention

Green leaf retention on the flag-1 when assessed on the 11th November at GS71, significantly ($p<0.001$) correlated to yield, when all cultivars were included (Figure 2). However when single cultivars were considered the correlation was only significant with the susceptible cultivar Chara (Figure 3).

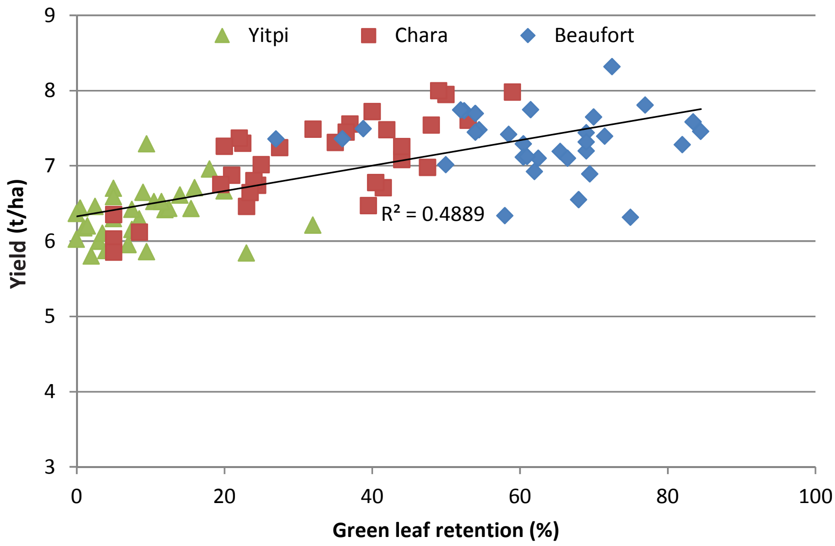

Figure 2. Correlation between Green leaf retention (%) assessed on the flag-1 on 11th November at GS71 and yield (t/ha)

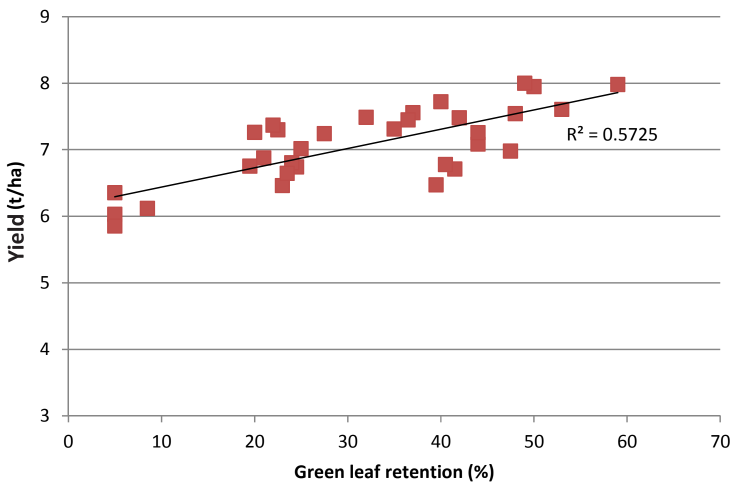

Figure 3. Correlation between Green leaf retention (%) assessed on the flag-1 on 11th November at GS71 and yield (t/ha), cultivar Chara.

Key points:

- Where Flutriafol in furrow was used at establishment no stripe rust was observed in the MS-S cultivar Chara until approximately 130 days after establishment at third –fourth node GS33-34.
- In Chara Flutriafol alone was still giving 80% control of stripe rust at the end of flowering, the same level of control achieved with a GS32 application of Folicur (145ml/ha). Where the crop had received a flag leaf spray at booting GS45 (late flag leaf spray) there was 99-100% control of stripe rust on the flag leaf throughout grain fill.
- All fungicide programmes applied to the cultivar Chara produced a significant yield increase (0.74 – 1.64 t/ha or 12-27%). The greatest yield increase of 1.64t/ha was the result of Flutriafol in furrow with two foliar fungicides follow ups at GS32 and GS45.
- Chara gave an 18% yield increase from the use of fungicide, averaged across all fungicide treatments, Yitpi gave a 2.5% yield increase and Beaufort gave no response despite a late low level stem rust infection.
- Three of the eight fungicide programmes produced significantly higher yields than the fully untreated crop and the flutriafol alone when meaned across the three cultivars, they were the two programmes receiving two foliar fungicides and the flutriafol followed by a foliar fungicide applied at booting (GS45).