Management strategies for foliar disease in cereals

Nick Poole[1], Tom Price[1], Darcy Warren[1], Max Bloomfield[1], Daniel Bosveld[1], Aaron Vague[1], Rajdeep Sandhu[1]

[1] Field Applied Research (FAR) Australia

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Take home messages

- At FAR Australia's NSW Crop Technology Centre near Wallendbeen, stripe rust was the major cause of yield loss in wheat, with susceptible cultivars giving yield responses of over 2 t/ha to a three-spray fungicide strategy
- Drier than average conditions during stem elongation and the emergence of the top three leaves significantly reduced Septoria tritici blotch (STB) development in the upper canopy but was still prevalent in Scepter®
- In 2023, fungicide management strategies for stripe rust and STB control in NSW and Victoria HRZ regions, lifted grain yield by 2 to 3 t/ha in susceptible varieties
- For the first time at the FAR Australia Research Centre in Victoria, net form net blotch (NFNB) was poorly controlled in RGT Planet®, even with four fungicide units, indicating that this pathogen is increasingly resistant to our fungicide arsenal, and we can see its effects in the field
- Avoid gaps between fungicide application greater than 3–4 weeks when disease pressure is high
- Avoid repeated use of the same fungicide active ingredients, and in the case of the newer Group 11 QoI (strobilurins) and Group 7 SDHIs, where possible restrict strategies to just one application per season to slow down and help prevent the selection of resistant pathogens.

Which disease caused the greatest yield loss in wheat

In 2023 in southern NSW, stripe rust caused by the pathogen *Puccinia striiformis* f. sp. *tritici* was the principal disease that caused yield loss in wheat. Despite well below average rainfall in the period from July to October, this disease was very aggressive in many cultivars and new lines evaluated. In contrast, the wet weather stubble-borne disease Septoria tritici blotch (STB) failed to develop substantially on the upper leaves as a result of drier conditions during the emergence of the top two leaves (often referred to as the money leaves) (Table 1). However, the exception at our Wallendbeen site was Scepter® which was badly affected by STB on the top three leaves.

Selecting high yielding varieties with good resistance to these two diseases should be at the core of your disease management strategy for 2025. A number of new lines with high yield and improved disease resistance were identified in Germplasm Evaluation Network (GEN) trials conducted across Australia by FAR in 2023 (Figure 1). The milling wheats resulted in the greatest dollar return for fungicide spend in our 2023 research in Victoria and NSW, with Scepter®, Willaura®, (Genie® and RockStar® data not shown) giving the greatest returns, between $4.80 and $10.40 for each dollar invested in a fungicide product and application (Table 2). The reward

for controlling disease in these cultivars came from both yield gain and grain quality improvement. Using the same risk reward ratios, it was shown that the yield increases achieved with fungicides were not effective with V14051-165ⓑ, LRPB Raiderⓑ, AGF010222, and AGTW005, all of which gave less financial return than dollars spent. The cost benefit ratio of using fungicides shown in Table 2 expresses the benefit of fungicide application in terms of $ return for each $ spent on the variety at the NSW trial site at Wallendbeen.

Table 1. Influence of variety and fungicide management on disease infection (Septoria tritici blotch (STB) and stripe rust (Yr)), assessed 24 October during grain fill at Wallendbeen NSW, 2023 (% Leaf area index LAI)

		Flag				Flag-1				Flag-2			
		STB		Yr		STB		Yr		STB		Yr	
	Nil Fungicide												
1	*Anapurna*	0.3	b	0.0	c	1.3	g	0.0	d	4.5	e	0.0	b
2	*Scepter*ⓑ	66.3	a	9.5	c	96.3	a	0.3	d	100	a	0.0	b
3	*RGT Accroc* ⓑ	0.0	b	7.3	c	1.3	g	18.8	a	15.3	de	6.0	a
4	LRPB Raiderⓑ	5.5	b	1.0	c	70.0	b	0.3	d	100	a	0.0	b
5	LRPB Mowhawkⓑ	0.8	b	23.0	b	53.3	cd	3.8	c	100	a	0.0	b
6	Willauraⓑ	1.0	b	70.0	a	57.5	c	9.3	b	100	a	0.0	b
7	V14051-165ⓑ	4.3	b	1.5	c	45.5	de	0.8	d	95.0	a	0.0	b
8	V14051-172	2.3	b	1.5	c	33.8	e	0.5	d	68.3	b	0.0	b
9	AGTW005	0.0	b	0.0	c	0.0	g	0.3	d	0.0	e	0.0	b
10	AGFWH010222	0.0	b	0.0	c	0.0	g	0.0	d	0.0	e	0.0	b
	Full Fungicide												
1	*Anapurna*	0.0	b	0.0	c	0.0	g	0.0	d	0.3	e	0.0	b
2	*Scepter*ⓑ	3.5	b	0.3	c	15.3	f	0.0	d	45.0	c	0.0	b
3	*RGT Accroc*ⓑ	0.0	b	0.0	c	0.8	g	0.0	d	4.3	e	0.0	b
4	LRPB Raiderⓑ	0.5	b	0.3	c	4.0	fg	0.0	d	6.8	e	0.0	b
5	LRPB Mowhawkⓑ	0.0	b	0.8	c	2.0	g	0.0	d	5.5	e	0.0	b
6	Willauraⓑ	0.5	b	0.8	c	8.3	fg	0.0	d	57.0	bc	0.0	b
7	V14051-165ⓑ	0.5	b	0.0	c	5.0	fg	0.0	d	23.8	d	0.0	b
8	V14051-172	0.3	b	0.0	c	1.3	g	0.0	d	4.3	e	0.0	b
9	AGTW005	0.0	b	0.0	c	0.0	g	0.0	d	0.0	e	0.0	b
10	AGFWH010222	0.0	b	0.0	c	0.0	g	0.0	d	0.0	e	0.0	b
	Mean	4.3		5.8		19.8		1.7		36.5		0.3	
	P Value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
	LSD (P=0.05)	9.0		11.0		12.0		2.6		16.8		1.6	

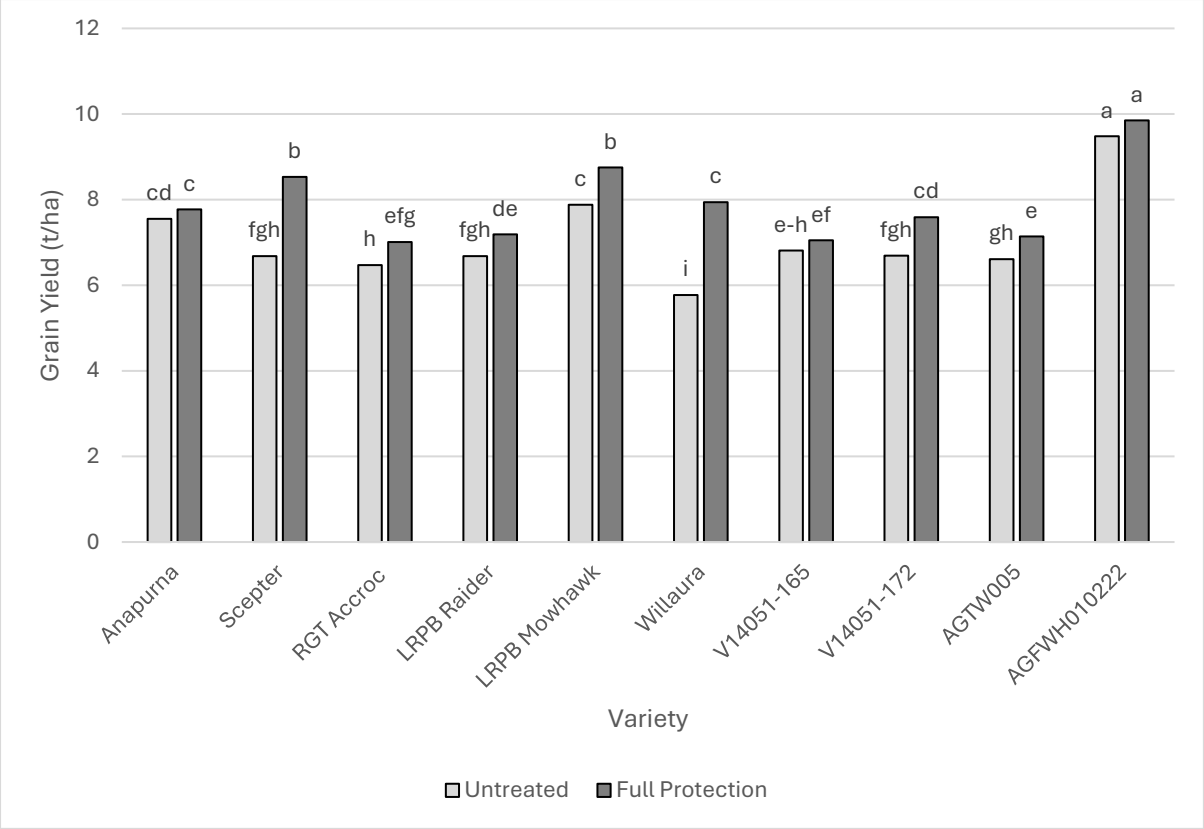

Figure 1. Influence of cultivar and fungicide application (based on three foliar sprays at GS31,39 & 59) on grain yield (t/ha) at Wallendbeen, NSW in 2023.
Bars with the same letters are not significantly different (*P* = 0.05).

Table 2. Influence of fungicide application on income return expressed as ratio of $ return/ha for each $ spent.

Cultivar	Gross income ($/ha) (see notes)		Income improvement over untreated ($/ha)	Cost benefit ratio ($ return for each $ spent)*
	Untreated	Full protection		
Anapurna	2,227	2,184	(-44)	(-0.4)
Scepter(þ)	2,271	2,792	520	4.8
RGT Accroc (þ)	1,909	1,959	51	0.5
LRPB Raider(þ)	2,271	2,336	65	0.6
LRPB Mowhawk(þ)	2,443	2,866	424	3.9
Willaura(þ)	1,443	2,591	1,149	10.6
V14051-165(þ)	2,111	2,077	(-34)	(-0.3)
V14051-172	2,074	2,244	170	1.6
AGTW005	1,950	1,998	48	0.4
AGFWH010222	2,797	2,797	1	0.0

** Cost benefit in red and brackets did not cover any of the fungicide costs & application i.e -0.4 = for each $1 spent you lost 40 cents.*

** Cost benefit less than 1.0 gave gross income higher than the untreated but the increase in gross income did not fully cover the fungicide costs i.e. 0.5= for each $ spent you gained 50 cents.*

***Notes**: Gross income of untreated and full protection (fungicide treated with 3 spray foliar program) based on the value of the grain yield and quality grade, with the full protection crop values expressed after fungicide and application cost ($/ha) has been subtracted. LRPB Mowhawk(b), V14051-165(b), and V14051-172 classed as ASW, AGTW005 and AGFWH010222 as FED1 for purposes of this calculation. Fungicide costs based on a three-spray program: Prosaro® 420 SC 300 mL/ha (Group 3 DMIs prothioconazole & tebuconazole) at GS31; Aviator® Xpro® 500 mL/ha (Group 3 DMI prothioconazole & Group 7 SDHI bixafen) at GS39; and Opus® 125 500 mL/ha (Group 3 DMI epoxiconazole) at GS59; all with $15/ha spray application cost. Total cost of fungicide program and application $108.55. Grain priced at FED1 – $250/t, SFW1– $295/t, ASW - $310/t and APW1 and AUH2 – $340/t.*

Poor field control of net form of net blotch (NFNB) in barley

A new 2023 GRDC research initiative is already indicating the importance of cultivar resistance in barley for net form net blotch (NFNB) control. Although fungicide resistance testing at the Centre for Crop and Disease Management (CCDM) is still taking place on samples taken from our Victorian trials, NFNB has been increasingly difficult to control in susceptible cultivars such as RGT Planet(b), with evidence of poor control now showing up in the field. In NSW trials there does not appear to be the same level of fungicide resistance or lack of control experienced in Victoria, but it does give an indication of what can happen if we continue to overuse fungicide against this disease. Unlike the situation in wheat where fungicides are still very effective on diseases such as stripe rust, NFNB in barley is not being adequately controlled by fungicide programs based on up to four units of fungicide. Whilst the research indicated a yield response (Table 3) to fungicide application, the grain yield responses were based on much poorer levels of disease control than those which have traditionally been experienced over the last four years. This would appear to indicate that the NFNB pathogen is becoming more resistant to our current fungicide groups (all of which were incorporated into these strategies). The research at the FAR Australia Victoria Crop Technology Centre near Bannockburn has indicated that, despite up to four units of fungicide, control of NFNB has been no better than 63% on the most important leaves in barley such as Flag-1 (Figure 2). When our fungicides give poorer than expected levels of control, it is essential to get the disease samples tested for fungicide resistance. In addition, and most importantly if resistance is confirmed, we need to look at better genetic resistance to reduce the threat of this disease. Figures 3 & 4 show the value of genetic resistance against NFNB at the same Bannockburn site.

Table 3. Influence of fungicide management strategy on grain yield (t/ha) of barley – cv RGT Planet(b) sown on 30 April 2023 at Bannockburn, Vic.

Treatment: Growth stage, product applied and rate					Yield (t/ha)		% of site mean	
No.	**Seed**	**GS30**	**GS39–45**	**GS59**				
1	---	---	---	---	5.04	cd	92.7	cd
2	---	Opera® 500 mL/ha	---	---	5.26	bcd	96.6	bcd
3	---	---	Aviator® Xpro® 500 mL/ha	---	5.38	bcd	98.8	bcd
4	---	---	Aviator® Xpro® 500mL/ha	Opus® 125 500 mL/ha	5.27	bcd	96.8	bcd
5	---	Opera® 500 mL/ha	Aviator® Xpro® 500 mL/ha	---	5.50	abc	101.1	abc
6	---	Opera® 500 mL/ha	Aviator® Xpro® 500 mL/ha	Opus® 125 500 mL/ha	5.70	ab	104.7	ab
7	Systiva®	---	---	---	4.85	d	89.2	d
8	Systiva®	Opera® 500 mL/ha	---	---	5.59	abc	102.7	abc
9	Systiva®	---	Opera® 500mL/ha	---	5.54	abc	101.7	abc
10	Systiva®	---	Opera® 500mL/ha	Opus® 125 500 mL/ha	5.35	bcd	98.3	bcd
11	Systiva®	Opera 500 mL/ha	Aviator® Xpro® 500 mL/ha	---	5.84	ab	107.2	ab
12	Systiva®	Opera 500 mL/ha	Aviator® Xpro® 500 mL/ha	Opus® 125 500 mL/ha	6.01	a	110.4	a
Mean					5.44		100.0	
Lsd (P=0.05)					0.60		11.1	
P-Value					0.026		0.026	

Notes: Systiva® seed treatment (Group 7 SDHI fluxapyroxad) applied at 150 mL/100 kg seed, Opera (Group 3 DMI epoxiconazole & Group 11 QoI pyraclostrobin), Aviator® Xpro® (Group 3 DMI prothioconazole & Group 7 SDHI bixafen) and Opus® 125 (Group 3 DMI epoxiconazole)

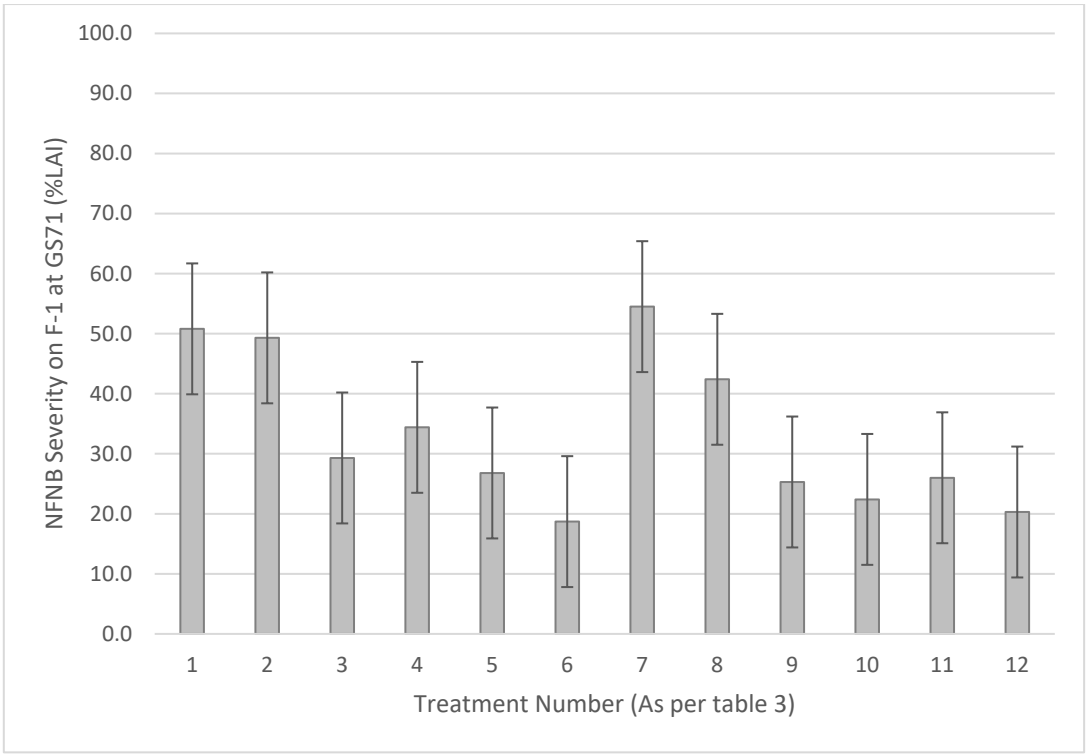

Figure 2. Influence of fungicide management on NFNB severity on flag-1 at GS71 (start of grain fill) in barley cv RGT Planet(b) sown 30 April and assessed 3 October at Bannockburn, Vic.

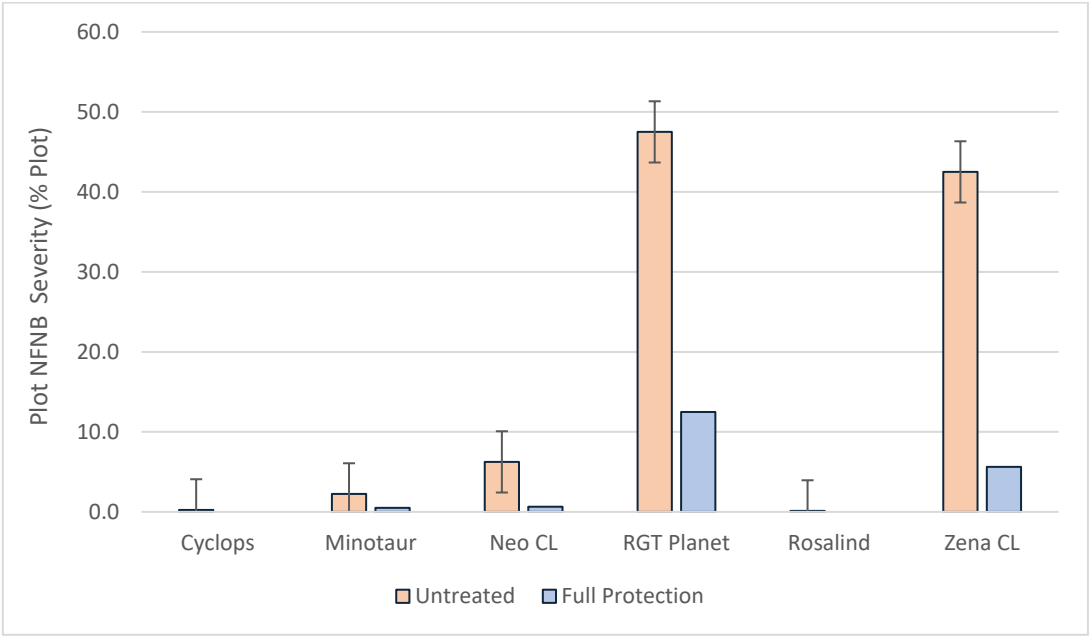

Figure 3. Influence of fungicide management on net form net blotch (NFNB) in six barley varieties (% Plot). Assessed on 3 October 2023 at Bannockburn, Vic.

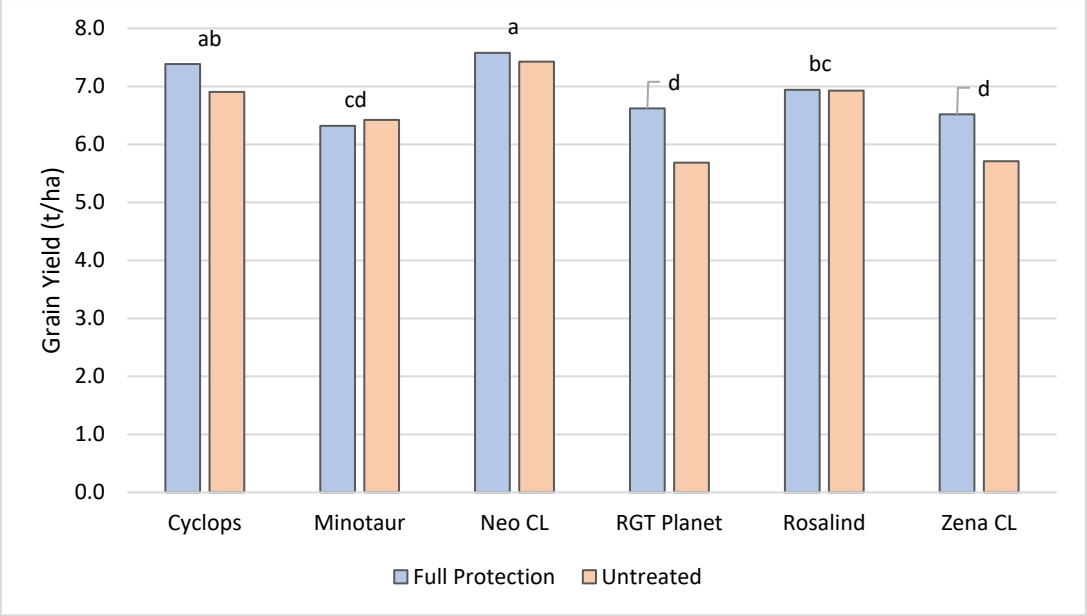

Figure 4. Influence of cultivar & fungicide management (four units of fungicide as Trt 12 in Table 3) on grain yield. (different letters refer to statical differences in mean variety yields)

Fungicide resistance and reduced sensitivity

The wider issue in these results is that pathogen resistance to fungicides is primarily driven by the number of applications of fungicides with the same mode of action. The more fungicides we apply, the more selection pressure we apply to the pathogen population, and the more resistant to fungicides the population becomes. For this reason, it is imperative to incorporate the most resistant, high yielding and adapted varieties available to reduce our dependence on fungicides.

The following are fungicide resistance management strategies for wheat and barley which should be used within broader integrated disease management (IDM):

- Where two to three fungicide applications occur within a season, avoid repeat applications of the same product/active ingredient and, where possible, also avoid the same mode of action in the same crop. This is particularly important when using Group 11 QoI (strobilurins) and Group 7 SDHIs, which preferably would only be used once in a growing season.
- Avoid using the seed treatment fluxapyroxad (Systiva) year after year in barley without rotating with foliar fungicides of a different mode of action during the season.
- Avoid applying the same DMI (triazole) Group 3 fungicide twice in a row.
- Avoid the use of tebuconazole alone and flutriafol for STB pathogen control in regions where reduced sensitivity is problematic, as these Group 3 DMIs are more affected by reduced sensitivity strains than other DMIs.
- Group 3 DMIs such as epoxiconazole (Opus) or triazole mixtures such as prothioconazole and tebuconazole (Prosaro) when used alone are best reserved for less important spray timings, or in situations where disease pressure is low in higher yielding scenarios.
- With SDHI seed treatments such as fluxapyroxad (Systiva) or QoI fungicides used in-furrow such azoxystrobin (Uniform®), use a subsequent foliar fungicide with a different mode of action.

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Useful resources

FAR Australia Resources and Publications (https://faraustralia.com.au/resource)

The Australian Fungicide Resistance Extension Network (https://afren.com.au/)

Contact details

Nick Poole
Field Applied Research (FAR) Australia
Shed 2/63 Holder Rd, Bannockburn VIC 3331
Ph: 03 5265 1290
Mb: 0499 888 066
Email: nick.poole@faraustralia.com.au

Tom Price
Field Applied Research (FAR) Australia
Shop 12, 95-103 Melbourne Street, Mulwala, NSW 2647 Australia+61 3 5744 0516
Mb: 0400 409 952
Email: tom.price@faraustralia.com.au

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