Hyper yielding and irrigated crop agronomy - cereal outcomes benchmark indicators, decision points, key levers and their interactions to capitalise on great seasons or irrigation. Varieties, N and fungicide lessons learnt.

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Key words

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GRDC codes

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Take home messages

- Increased yield potential of feed winter wheats and barley is expressed in better seasons from earlier sowing. RGT Accroc, RGT Cesario⊕ and Annapurna⊕ achieved yields of ~ 11 t/ha, 3t/ha higher yielding than the best milling wheat in NSW. Winter barley exceeded 10 t/ha (10.4) dryland in SA for the first time while Planet⊕ achieved 8.0 t/ha
- To maximise returns in milling wheats in better seasons, sound disease management is essential. Beckom⊕ and Scepter⊕ with either two or four units of fungicide produced the highest economic returns due to higher price per tonne compared to feed wheats ($356/t AH grade v $236/t for SFW1).
- The winter feed wheats are more disease resistant than milling wheats and gave their most profitable returns with a single flag leaf fungicide. Genetic resistance was insufficient alone to maximise returns without fungicide application
- Fertile soils in the high rainfall zone (HRZ) limit the ability to manage yield and early biomass production with applied nitrogen in wetter environments. Mineralised N timing, and other canopy management factors such as plant growth regulators (PGR) and fungicide are equally or more important
- Principles of canopy management also apply to irrigated scenarios, however the nitrogen rates required to achieve irrigated canola yields of greater than 4 t/ha are not as high as dryland budgets would suggest. Minimum durum protein requirements of 13% to achieve DR1 can be met with attention to nitrogen management in irrigated scenarios
- Canopy management benefits of PGR and fungicides extend beyond the growing season and limit pre harvest yield losses (lodging, brackling, head-loss) and improve harvest logistics
- Waterlogging tolerance of barley compared to wheat is poor in wetter seasons, however earlier sowing and slow developing cultivars increases the chances of improved yield recovery.

Hyper yielding crops research

Led by Field Applied Research (FAR) Australia, the Hyper Yielding Crops (HYC) project is a Grains Research and Development Corporation (GRDC) national initiative which aims to push the economically attainable yield boundaries of wheat, barley and canola in those regions with higher yield potential. The project team at the time of writing is just completing harvest of the second year of project trial results at five HYC research centres across the higher yielding regions of southern Australia (NSW, WA, SA, VIC and TAS) which have been established to engage with growers and advisers. With the 25 focus farms and the HYC community awards, the aim is to scale up the research results and create a community network aimed at lifting productivity.

Canopy management is key to building and protecting high yielding crops in wet environments (seasons) and irrigated crops

Canopy management is a broad term but fundamentally relies upon adopting techniques that allow crops to intercept more radiation (sunlight) and transpire more water into biomass at the right time in the season to contribute to yield. This is first achieved by ensuring flowering is matched to environment and secondly that a high proportion of the upper crop canopy leaves remain intercepting light (retain green leaf area, disease control) during the 'critical period' for grain number formation (month prior to flowering in cereals). Unlike low rainfall environments, excessive growth prior to stem elongation is unproductive and leads to lodging, shading and poorer light interception in the critical period. Equally nitrogen (N) limitation, and or poor disease control during this period will lower grain number potential and yield either by limiting biomass production or its conversion into yield (harvest index). Harvest indices of greater than 50% should be possible with good management. Therefore to achieve 10t/ha cereal grain yields, the final biomass needs to be greater than 20 t/ha.

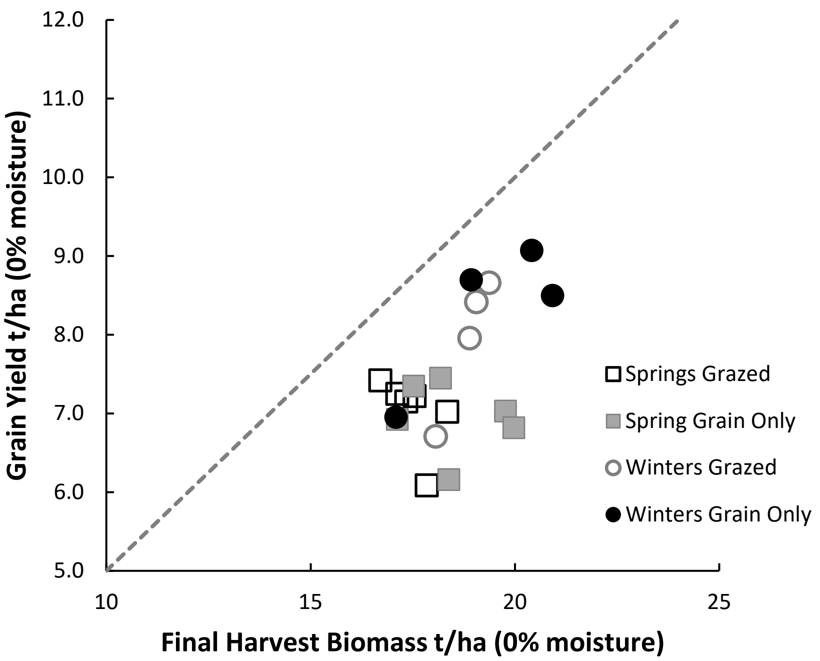

Figure 1. Relationship between dry matter and grain yield (t/ha) at 0% moisture across cultivars grouped as spring and winter types and when grazed or left for grain only in 2020 at Wallendbeen NSW. The dotted line represents aspirational yields that are possible with a harvest index of 50%.

While canopy management techniques can improve harvest index, they should not come at the expense of reduced final biomass. For example, grazing (mowing) spring and winter wheats at Wallendbeen 2020 increased harvest index (HI) but yields were not increased due to lower biomass (Figure 1). Spring wheats that achieved similar final dry matters as winter wheats yielded lower (lower HI) due to reduced light interception in the critical period from developing under sub-optimal conditions (early) and reduced green leaf area in upper canopy (increased disease infection).

Optimising irrigated grains research

The principles of canopy management also apply to irrigated scenarios and during 2020 and 2021, over 50 irrigated research trials (in six crops) were established at FAR Australia's Finley Irrigated Research Centre (Southern Growers Irrigation Complex) in southern NSW. This has been part of a major regional GRDC investment referred to as the 'Optimising Irrigated Grains' project with agronomy and soil amelioration research led by FAR Australia in collaboration with the Irrigated Cropping Council (ICC). Work in canola has been targeted at growing 5 t/ha crop of canola and 10 t/ha crop of durum wheat under irrigation. In particular, looking at the canopy management and nutritional requirements for high yielding crops. These canopy management factors include, cultivar crop development, genetic disease resistance, fungicide chemistry and timing, other intervention techniques such as the addition of a PGR, defoliation and additional nitrogen.

Two years of irrigated canola and durum research

Research in canola has indicated that extremely large doses of applied nitrogen fertiliser are not the route to the most economic returns and that crop establishment, absence of water logging and healthy soils with good available soil N reserves are the best combination of factors to maximise yield in irrigated canola. In 2020 following wheat, the hybrid 45Y28 RR gave a significant response to applied nitrogen that illustrated an optimum N rate for yield of approximately 160 kg N/ha with a yield of 4.55 t/ha (Table 1). In 2021 the optimum response was higher at 240 kg N/ha with a yield of 3.9 t/ha. Although yields in 2021 peaked at a nitrogen rate of 320 kg N/ha, the yield was not statistically greater than at 240 kg N/ha. Measured levels of available starting N were little different to 2020 (at 129 v 110 kg N/ha (0 – 90cm)) but unfertilised crops produced considerably lower yields in 2021 with significant evidence of water logging in the winter 2021 that may have both restricted the rooting of the crops and or generated losses of N from the soil under the anaerobic conditions. In 2020, differences in oil content were small but significant with a 1.2% oil content decline covering N rates between 80 – 320 N applied. There were no significant differences in oil content in 2021.

Table 1 Influence of applied nitrogen rate at stem elongation on grain yield (t/ha) and oil content (%) of canola across 2 years

				2020		**2021**	
Soil profile N prior to sowing (0-90cm)				**129 kg/ha**		**110 kg/ha**	
	Nitrogen timing and rate			**Grain yield and quality**			
	6 Leaf	**Green bud**	**Total**	**Yield**	**Oil**	**Yield**	**Oil**
	Kg N/ha	**Kg N/ha**	**Kg N/ha**	**t/ha**	**%**		
1	0	0	0	3.91 d	43.0 ab	2.21 f	48.3 -
2	40	40	80	4.30 c	43.3 a	3.38 e	46.9 -
3	60	60	120	4.41 bc	42.0 d	3.46 de	45.9 -
4	80	80	160	4.55 ab	42.4 bcd	3.56 cde	46.9 -
5	100	100	200	4.59 ab	42.4 bcd	3.76 bcd	47.4 -
6	120	120	240	4.62 a	42.8 a-d	3.90 abc	46.3 -
7	140	140	280	4.71 a	42.9 abc	4.05 ab	48.0 -
8	160	160	320	4.71 a	42.1 cd	4.22 a	46.3 -
	Mean			4.475	42.6	3.57	47.0
	LSD			0.19	0.84	0.35	n.s
	P Val			<0.001	0.032	<0.001	0.065

Durum research at Finley over the last two years (Table 2 and 3) illustrated much lower available soil N reserves in the 2021 season compared to 2020. 232 kg N/ha in the soil profile (0 - 90cm) following fallow in 2019 compared to 146 kg/ha over the same depth in 2021 following canola. Consequently, DBA Vittaroi gave no significant yield response to applied N fertiliser (urea 46% N) at levels between 10 – 350 kg N/ha in 2020, with yields ranging from 6.93 – 7.43 t/ha. By comparison, yields in 2021 were between 4.87 – 6.74

t/ha , with no significant yield response to N application above 100 kg N/ha. However, it required another 100 kg N/ha of applied fertiliser (200 kg N/ha total) to increase protein above 13%, the minimum required to achieve DR1 quality when applied N was split between GS30 and GS32 (pseudo stem erect & second node). However, in a separate experiment it was illustrated that when N timing was delayed until GS32 and GS37 (flag leaf visible) a protein of 13.4% was achieved with no more 100 kg N/ha of applied nitrogen (Table 3) and no loss of yield. (data not shown).

Table 2. Influence of applied nitrogen rate at stem elongation on grain yield (t/ha) and protein content (%) in durum across 2 years

					2020		2021	
Soil profile N prior to sowing (0-90cm)					**232 kg/ha**		**146 kg/ha**	
Nitrogen timing and rate					**Grain yield and quality**			
	GS30	**GS32**	**GS39**	**Total**	**Yield**	**Protein**	**Yield**	**Protein**
	Kg N/ha	**Kg N/ha**	**Kg N/ha**	**kg N/ha**	**t/ha**	**%**	**t/ha**	**%**
1	0	0		0	7.10 -	13.0 c	4.87 b	10.3 e
2	50	50		100	7.17 -	13.9 b	6.40 a	11.9 d
3	75	75		150	6.93 -	14.5 ab	6.43 a	12.5 d
4	100	100		200	6.97 -	14.4 ab	6.63 a	14.6 c
5	125	125		250	6.96 -	14.8 a	6.73 a	15.0 bc
6	150	150		300	7.05 -	14.9 a	6.74 a	15.5 b
7	100	100	100	300	7.43 -	14.5 ab	6.52 a	15.7 ab
8	125	125	100	350	7.11 -	15.0 a	6.51 a	16.3 a
	Mean				7.09	14.4	6.35	14.0
	LSD				0.33	0.7	0.57	0.8
	P Val				n.s.	<0.001	<0.001	<0.001

Table 3. Influence of N rate and timing strategies on grain protein (%) in durum grown at Finley in 2021, based on split application of N at total rates of 0, 100, 200 and 300kg N/ha.

	Nitrogen application rate				
	0kg/ha N	**100kg/ha N**	**200kg/ha N**	**300kg/ha N**	**Mean**
Nitrogen timing	**Protein %**	**Protein %**	**Protein %**	**Protein%**	**Protein%**
PSPE & GS30	10.9 -	12.4 -	13.8 -	15.0 -	13.0 b
GS30 & GS32	10.6 -	12.5 -	13.7 -	15.0 -	13.0 b
GS32 & GS37	10.9 -	13.4 -	15.3 -	16.4 -	14.0 a
Mean	10.8 d	12.8 c	14.3 b	15.5 a	
N timing	LSD	0.4		**P val**	<0.001
N rate	LSD	0.5		**P val**	<0.001
N timing x N rate	LSD	ns		**P val**	**0.235**

Hyper yielding research: achieving high yields from the better seasons

Consider the genetic potential of the cultivar and delivery price splits between feed and higher quality grades to maximise economic returns

The wet 2021 season and HYC research has highlighted that the increased yield potential of feed wheats and winter barley is expressed in the better seasons and exceeds current commercially available milling wheats and malt barley cultivars. While it is possible to grow higher yield of feed wheats and barley, they need to be profitable. The durum example above shows it possible to achieve high yields and higher proteins with N management and highlights possibilities to make the most of quality price spreads with management. The HYC results below demonstrate the milling wheats at Wallendbeen are capable of yielding 8 t/ha and milling grade with adequate disease control, whereas feed winter wheats achieved greater yields of ~ 11 t/ha.

Under this scenario milling wheats were more profitable at current feed price spreads despite yielding 3 t/ha less than feed winter wheats at Wallendbeen in 2021 (Table 8). Figure 2 below can be used to determine how much higher feed wheats need to yield across different quality grade yield potential environments to equal or exceed milling wheat gross margins. At Wallendbeen for example; at current feed splits of $100 between APW and feed wheat, a feed wheat would have to yield 12 t/ha (or an extra 4 t/ha) to equal the gross margin of APW yielding 8 t/ha (at $300/tonne delivery price). If the spread reduces to $50/t, the yield required by a feed wheat is 9.6 t/ha. This assumes higher quality grades are achieved in the milling wheat. The same applies to Durum in reverse, if Durum attracts a $50 price premium over milling wheat, then it would only need to yield 6.2 t/ha to match the gross margin of a milling wheat at 8 t/ha. These yields have been achieved under irrigation in 2020, and 2021. This may be a more profitable system than chasing the extra yields of feed wheat under irrigation.

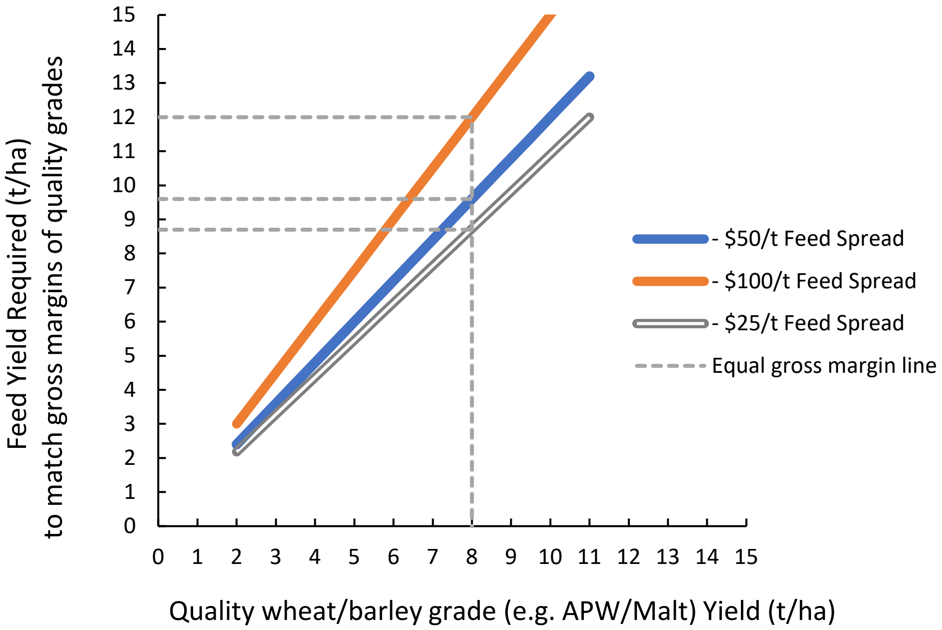

Figure 2. Relationship between the grain yield of feed cereals and quality grades required to achieve similar gross margin returns at different feed delivery price spreads (assuming quality delivery price is $300/t)

Barley is a different story, as high yields and malt can be achieved in spring barley. However, introduction of higher potential winter feed barley cultivars could raise yield expectations. The price spread is lower between feed and malt barley ($20 – $25) than feed and milling wheat. If 8 t/ha of malt barley was achieved with a price spread of $25 over feed, then an additional 0.7 t/ha (or 8.7 t/ha) of feed barley is required to provide and equal gross margin. This is an important comparison, because for the first time winter barley has now exceeded 10 t/ha under dryland conditions (Table 4). Yields of 10.4 t/ha were achieved in 6 row winter Pixel and 9.7t/ha in 2 row winters in the Southern HRZ, while Planet⦶ achieved 8.0t/ha from the same sowing date and 8.15t/ha from a later more optimal sowing date (yields not shown). Planet⦶ barley remains the benchmark cultivar for achieving high yields across all higher production environments. The key limitation to Planet⦶ is poor disease resistance.

Table 4. Grain yield (t/ha) and variety type evaluated under high yielding management conditions at Millicent in SA from early sowing 2021[1]

Variety		**Type**	**Grain yield (t/ha)**
1.	Planet⍭	2 Row Malt Spring (Control)	8.0 d
2.	Rosalind⍭	2 Row Feed Spring (Control)	8.0 d
Experimental Lines[2]			
3.	AGTB0244	2 Row Spring	7.9 d
4.	Laureate	2 Row Spring	8.0 d
5.	Cassiopee	2 Row Winter	7.9 de
6.	Madness	2 Row Winter	8.7 c
7.	Newton	2 Row Winter	9.7 b
8.	Memento	2 Row Winter	8.9 c
9.	Pixel	6 Row Winter	10.4 a
10.	Visual	6 Row Winter	7.5 de
		P Val <0.001, LSD 5% 0.64, Mean	8.10

[1] High yielding management conditions include a robust fungicide strategy, plant growth regulators and extra N described in the flow diagram below. [2] Lines are experimental and yet to be commercialised in Australia or receive a quality classification.

Feed winter barley is yet to achieve the same adoption as feed winter wheats. European introductions have demonstrated superior disease resistance to all spring cultivars, however, they grow too tall, and are more prone to yield losses from lodging, head loss, and grain shattering. These production constraints can be managed with principles of canopy management in both contrasting cultivar types highlighting the importance of disease resistance and fungicide lessons presented in the HYC wheat data below.

The summary of two wet seasons (three experiments) at Millicent SA, and Gnarwarre Vic of earlier sowing is below (Figure 3.). A key finding was that the addition of an SDHI fungicide in the susceptible cultivar Planet⍭ increased yield by 1.2 t/ha (6.1 – 7.3 t/ha) irrespective of any other management factor. Whereas in the winter barley, yields were 6.6 and 6.7 t/ha under standard and increased disease management respectively. The addition of plant growth regulators or defoliation by grazing, or an extra 80 kg of applied N did not increase yield and demonstrates in the barley variety Planet⍭, that **disease management is the number one factor to achieve high yields.**

In winter barley the use of plant growth regulators (PGRs) to reduce height, lodging and head loss increased yield and was more important than extra fungicide application alone, however in combination they both increased yield. Under standard management, grain yield increased by 0.4 t/ha (6.6 – 7.0 t/ha) with the application of a PGR, whereas the more robust fungicide strategy did not increase yield unless it was combined with the PGR, and then increased yield by 0.7 t/ha (6.6 – 7.3 t/ha). Grazing or extra N didn't further increase yield.

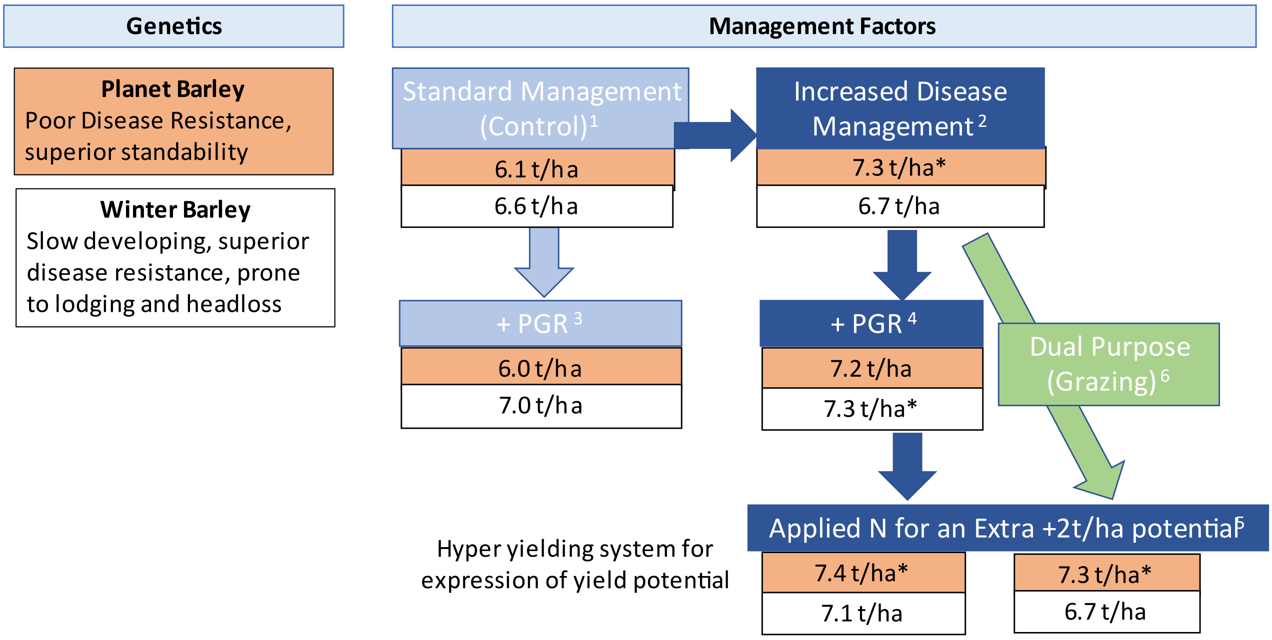

Figure 3. Mean yields and response to canopy management factors, fungicide, plant growth regulators (PGR), nitrogen, and grazing in two contrasting barley cultivars across 3 earlier sown experiments (~20 April) in the HRZ of SA, Vic (2020/2021).

Definitions of management factors

[1] Standard Management Control – 2 x cheaper foliar fungicide propiconazole (Tilt® 250 EC at 500mL/ha) @GS31 and tebuconazole(tebuconazole 430 SC 290 mL/ha) @GS39-49. Nitrogen managed for 8 t/ha yield potential

[2] Increased disease management – Systiva® seed treatment, 2 x foliar fungicides including QoI (strobilurin) & SDHI combinations with DMIs) with third fungicide if required.

[3,4] Plant growth regulation (PGR) (Moddus® Evo 200 mL/ha @GS30 & Moddus Evo 200mL/ha @GS33-37).

[5] Extra applied nitrogen (N) = Additional 80 units (kg of N) applied at GS31

[6] Defoliation = simulated grazing @GS16 and GS30 or before Aug 15 in winters.

All other inputs of insecticides and herbicides were standard across the trial. Timings of PGRs and fungicides were adjusted to take account of the differences in spring and winter barley phenology (development).

Essential role of disease management in better seasons with higher yield potential and in wheat and barley cultivars of poorer disease resistance.

Irrespective of whether its medium or high rainfall zone (M-HRZ), it's essential growers and advisers consider disease management as one of the most important components of growing high yielding cereal crops in seasons with higher yield potential. In HYC trials in 2020 and 2021 we have been looking at how to utilise and combine genetic resistance and disease management strategies to generate the most profitable crops. The primary research objective (first year reported at the 2020 GRDC Wagga Update) has been centred on examining whether newer wheat cultivars suitable for high yielding regions (correct phenology and standability) might have sufficient genetic resistance to delay fungicide intervention and as a result use fewer fungicide applications. If a cultivar has sufficient genetic resistance to prevent disease development, it may be possible to delay fungicide application until flag leaf emergence or at least later into stem elongation (GS33-37). This has two primary benefits; firstly, it allows a much better appraisal of whether the seasonal conditions have the potential to support fungicide expenditure and secondly it means that a fungicide can be applied to more of or all of the upper canopy leaves at the same time. In those seasons where the spring progressively cuts out, it means the flag leaf spray expenditure could be cut back or removed altogether. However, the industry needs good genetic resistance in our high yielding cultivars to make this a reality. ***So, of the cultivars tested so far do we have enough genetic resistance to make this reduced fungicide input an economic reality?***

Seven cultivars in 2021 were treated with four levels of fungicide management with timings adjusted to take account of the differences in phenology between winter and spring wheat (Table 5).

Table 5. Treatment and disease management applied to 2021 trials.

	Timing	Untreated	1 fungicide unit	2 fungicide units	4 fungicide units
Seed treatment		Vibrance®/ Gaucho®	Vibrance/ Gaucho	Vibrance/ Gaucho	As others + Flutriafol
Fungicide	GS31 (F-3 emerging)	---	---		Prosaro® 300 mL/ha
	GS33 (F-1 emerging)			FAR F1 -19 750 mL/ha	
	GS39 (Flag leaf emerged)	---	FAR F1 -19 750 mL/ha		FAR F1 -19 750 mL/ha
	GS59 (head emergence)	---	---	Opus® 125 500 mL/ha	Radial® 840 mL/ha
Total Cost ($/ha)		---	40	67	120

Notes: *Fungicide units include both application & fungicide cost. The pre commercial compound FAR F1-19 (not registered) has been used in this trial and has been given a nominal costing in terms of the economics table (Table 7&8).*

Septoria tritici blotch (STB) was the principal disease in untreated crops of Scepter⦶ and Beckom⦶, whilst stripe rust was the main disease to affect Trojan⦶ (strain 198 E16 A+ J+ T+ 17+), Catapult⦶ (239 E237 A- 17+ 33+) and Rockstar⦶ (239 E237 A- 17+ 33+) (Figure 4). Other cultivars were subject to low levels of both stripe rust, leaf rust and STB disease pressure. The yield results from the trial were exceptional and exceeded 2020 yields with the winter feed wheats. The data indicated for the second year running a large yield advantage to winter feed wheats over the spring milling wheats (Table 6). There was a significant interaction between cultivar and fungicide management that indicated large yield increases due to increasing fungicide application with cultivars such as Catapult and Trojan and no statistical difference between one and four fungicides with the more disease resistance cultivars such as Beckom and the winter feed wheats. Anapurna gave its highest yield with a single flag leaf fungicide but there were no statistical differences between any of the disease management treatments for this variety - including the untreated. The results at this higher altitude HYC research site in 2020 were similar with Anapurna and RGT Accroc producing almost 11t/ha with no advantage to applying more than a single flag leaf fungicide in order to achieve those yields. The grades achieved by the different treatment combinations improved significantly with the susceptible milling wheat cultivars, but all the winter feed wheats achieved a standard SFW1 grade.

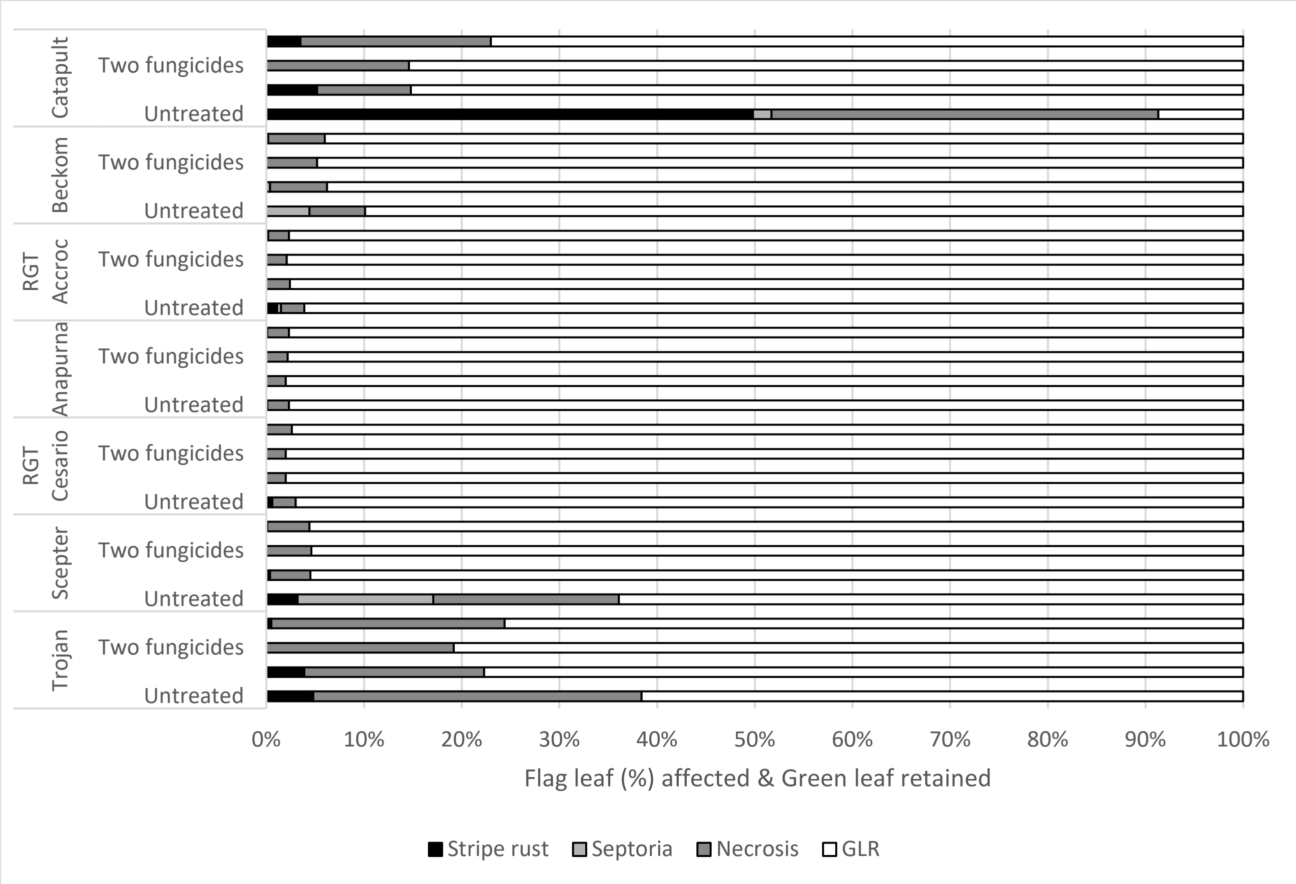

Figure 4. Influence of different fungicide input strategies on seven different cultivars in 2021 - HYC Wallendbeen, NSW.

Table 6 Influence of fungicide strategy and cultivar on wheat grain yield (t/ha) in 2021 –Wallendbeen, NSW.

	Management level (yield t/ha)								
Cultivar	**Untreated**		**1 Fungicide**		**2 Fungicide**		**4 Fungicide**		**Mean**
Trojan⦶ (S)	3.51	l	4.60	k	5.24	j	6.56	i	**4.98**
Scepter⦶ (S)	7.14	gh	7.67	efg	7.92	e	8.05	e	**7.70**
RGT Cesario⦶ (W)	10.50	bcd	11.14	a	10.89	abc	10.87	abc	**10.85**
Annapurna (W)	10.46	cd	10.84	abc	10.83	abc	10.79	abc	**10.73**
RGT Accroc (W)	9.99	d	11.05	a	11.01	ab	10.94	abc	**10.75**
Beckom⦶ (S)	6.94	hi	7.71	ef	7.84	e	8.10	e	**7.65**
Catapult⦶ (S)	3.18	l	6.76	hi	7.28	fgh	7.59	efg	**6.20**
Mean	**7.39**		**8.54**		**8.71**		**8.99**		
Cultivar		**LSD**	0.36 t/ha			P val			<0.001
Management		**LSD**	0.20 t/ha			P val			<0.001
Cultivar x Management		**LSD**	0.54 t/ha			P val			<0.001

** All timings for spring and winter wheat were adjusted to take account of cultivar phenology,*
W = winter wheat, S = spring wheat. Yield figures followed by the same letter are not considered to be statistically different (p=0.05).

The most profitable approach to growing each cultivar is specified in Table 7 & 8. This illustrated that the European longer season winter wheats gave their best returns relative to the untreated crop with only a single flag leaf fungicide applied. With the four more disease susceptible spring wheats, margins were optimised with either a two or four fungicide approach with little difference in margin between the two approaches.

Table 7. Increase or decrease in margin ($/ha) as result of fungicide expenditure relative to the untreated crop (extra income from fungicide minus fungicide and application cost).

	Management level (increase/decrease in margin $/ha)			
Cultivar	**1 Fungicide**	**2 Fungicide**	**4 Fungicide**	**Mean**
Trojan⦶ (spring)	365	493	**757**	**538**
Scepter⦶ (Spring)	149	**210**	**204**	**188**
RGT Cesario⦶ (Winter)	**111**	25	-33	**34**
Anapurna (Winter)	**50**	20	-42	**9**
RGT Accroc (Winter)	**210**	173	104	**162**
Beckom⦶ (Spring)	907	**926**	**966**	**933**
Catapult⦶ (Spring)	1232	**2046**	**2103**	**1794**
Mean	**432**	**556**	**580**	

Prices as of 11/1/21 trading at Cootamundra GrainCorp. (grade prices used SFW1- $236/t, AGP1-$241/t, AUH2-$286/t, AH2-$356t)

Table 8. Influence of disease management strategy and variety on margin ($/ha) (Gross income- fungicide cost)

	Management level (margin after fungicide cost $/ha)				
Cultivar	**Untreated**	**1 Fungicide**	**2 Fungicide**	**4 Fungicide**	**Mean**
Trojan⦶ (spring)	702	1067	1195	**1459**	**1106**
Scepter⦶ (Spring)	2540	2689	**2751**	**2744**	**2681**
RGT Cesario ⦶ (Winter)	2475	**2586**	2500	2442	**2501**
Anapurna (Winter)	2466	**2516**	2486	2424	**2473**
RGT Accroc (Winter)	2355	**2565**	2529	2459	**2477**
Beckom⦶ (Spring)	1796	2703	2722	**2761**	**2496**
Catapult⦶ (Spring)	477	1709	2523	**2580**	**1822**
Mean	**1830**	**2262**	**2386**	**2410**	

Prices as of 11/1/21 trading at Cootamundra GrainCorp. (grade prices used SFW1- $236/t, AGP1-$241/t, AUH2-$286/t, AH2-$356t)
**Price unavailable as poor quality in untreated crops of Catapult⦶ and Trojan⦶, nominal value used*

The other important lessons for the wetter seasons from these and adjacent experiments on the Hyper Yielding Crop centres will not be discussed here in great detail but have demonstrated in wheat and barley that:

- Fertile soils in the HRZ limit the ability to manage yield and early biomass production with applied nitrogen in wetter environments - other techniques such as PGRs, cultivar, and fungicide are more important for active management in the critical period
- Canopy management benefits extend beyond the growing season – disease control and the combined application of PGRs and timely harvest ensures pre harvest yield losses are reduced, particularly in barley (e.g., head loss and brackling)
- Waterlogging tolerance of barley compared to wheat is poor in wetter seasons, however earlier sowing of slow developing cultivars increases the chances of improved yield recovery post water logging.

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