SA CROP TECHNOLOGY CENTRE

FAR AUSTRALIA

Industry Innovations
leading the way to a brighter grains industry

FIELD DAY

INCREASING PRODUCTIVITY & PROFITABILITY IN THE SA HRZ

Thursday 24th October 2024

Thanks to the GRDC for investing in some of the research we will be discussing today

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Thanks to the following event sponsor:

AGF seeds

SOWING THE SEED FOR A BRIGHTER FUTURE

Thanks to our host farmers James & Chris Gilbertson, Andrew and Megan Skeer and Brett and Mel Gilbertson

VISITOR INFORMATION

We trust that you will enjoy your day with us at our SA Crop Technology Centre Field Day. Your health and safety is paramount, therefore whilst on the property we ask that you both read and follow this information notice.

HEALTH & SAFETY

- All visitors are requested to follow instructions from FAR Australia staff at all times.
- All visitors to the site are requested to stay within the public areas and not to cross into any roped off areas.
- All visitors are requested to report any hazards noted directly to a member of FAR Australia staff.

FARM BIOSECURITY

- Please be considerate of farm biosecurity. Please do not walk into farm crops without permission. Please consider whether footwear and/or clothing have previously been worn in crops suffering from soil borne or foliar diseases.

FIRST AID

- We have a number of First Aiders on site. Should you require any assistance, please ask a member of FAR Australia staff.

LITTER

- Litter bins are located around the site for your use; we ask that you dispose of all litter considerately.

VEHICLES

- Vehicles will not be permitted outside of the designated car parking areas. Please ensure that your vehicle is parked within the designated area(s).

SMOKING

- There is No Smoking permitted inside any farm shed, marquee or gazebo.

Thank you for your cooperation, enjoy your day.

INCREASING PRODUCTIVITY AND PROFITABILITY IN THE SA HRZ

FEATURING INDUSTRY INNOVATIONS

On behalf of myself and the FAR Australia team, I am delighted to welcome you to our 2024 SA Crop Technology Centre Field Day featuring Industry Innovations covering canola, grain legume and cereal agronomy.

Industry Innovations (II) is a FAR Australia initiative which continues to engage with industry to provide innovative research solutions which are helping to create a more productive, profitable and sustainable future for the Australian grains industry. With our Crop Technology Centres (CTCs) operating nationally across the more productive growing regions of Australia, we provide the perfect platform to showcase new industry innovations, whether it be new crops, cultivars, agrichemicals, fertilisers or Ag technologies. More information on our Industry Innovations initiatives is available in the booklet.

Today will provide you with a unique 'seeing is believing' opportunity to experience the latest innovations in cereal germplasm, agronomy, and agrichemical usage. You will witness first-hand the impact of innovative treatments and techniques on enhancing crop performance and profitability.

Event Highlights:

- Cereal, Grain Legume and Canola Trials: Explore a range of trials featuring crops sown at different times, showcasing how timing can influence crop yields.
- Expert Presentations: Hear from industry leaders, who will share insights into the latest research and trends shaping the Australian grains industry.
- Interactive Discussions: Engage in group discussions on crucial topics such as fungicide management strategies and the future of crop profitability, particularly in light of the new GRDC Hyper Profitable Crops project.
- Innovative Research: Learn from the latest findings of the GRDC's Hyper Yielding Crops high rainfall zone project, and explore opportunities to enhance the use of winter germplasm in the lower to medium rainfall zones.

To make the programme as diverse as possible, I would like to thank all our speakers who have helped to put today's programme together; in particular our guest speakers Dr Angela van de Wouw from the University of Melbourne who will be discussing the economics of disease management in canola crops, James Manson from the University of Adelaide who will be presenting on the crop physiology and productivity of grain legumes, and Sam Trengove, Independent Ag Consultant who will provide the latest research results on wheat powdery mildew and soil amelioration on sandy soils.

Finally I would like to thank the GRDC for investing in some of the research that will be featured in today's programme, and also a big thanks to our host farmers James & Chris Gilbertson, Andrew and Megan Skeer and Brett and Mel Gilbertson for their tremendous practical support given to our team, and to today's sponsor AGF Seeds.

Should you require any assistance today, please don't hesitate to contact a FAR Australia staff member. We hope you find the day informative, and as a result, take away new ideas which can be implemented in your own farming business.

Nick Poole Managing Director
FAR Australia

TIMETABLE

SA CROP TECHNOLOGY CENTRE FIELD DAY
THURSDAY 24 OCTOBER 2024

9:45am **Coffee and registration followed by opening address by Nick Poole, FAR Australia's Managing Director**

Session	In-field presentations (canola and pulses)	Site	10:30
Canola	**Dr Angela van de Wouw, University of Melbourne** *Angela will discuss the economics of disease management in canola crops.*	Canola	All
Pulses	**James Manson, University of Adelaide** *The physiology of faba bean yield determination*	Pulses	All

Thanks to our lunch and post event refreshments sponsor:

AGF seeds

Session #	In-field presentations (cereals)	Station #	12:30	1:30	2:00	2:30	3:00	4:15
1	**Sam Trengove, Independent Ag Consultant** *Sam will discuss research results on wheat powdery mildew and soil amelioration on sandy soils.*	1	Lunch	1		2		Closing address and post event refreshments
2	***Daniel Bosveld, FAR Australia*** *Key results from the 2023 SA Millicent Crop Tchnology Centre*	2			1		2	
3	***Nick Poole, FAR Australia*** *Agronomic practices for hyper yielding wheat*	3		2		1		
4	***Nick Poole, FAR Australia and Gina Kreeck , Mackillop Farm Management Group*** *As the nation's economy moves to ways to reduce emissions where do we stand with crop profitability in VIC HRZ with our new GRDC Hyper Profitable Crops project?*	4			2		1	
	In-field presentations	**Station #**	**12:30**	**1:30**	**2:00**	**2:30**	**3:15**	**4:15**

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Advancing Agriculture through better seeds and service!

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STOCKADE
APW SPRING MILLING WHEAT

A unique APW Spring milling wheat that offers growers in long season environments a high yielding milling wheat that can compete with red wheats currently grown on farm. Built on Trojan with key improvements.

MATURITY SPEED (VERY QUICK – VERY SLOW)

SCEPTORIA RESISTANCE	POWDERY MILDEW	STRIPE RUST	LEAF RUST
MS	SVS	MR	MR

SPRING WHEAT · HIGH YIELDING · WHITE AWNED APW

CAPTAIN CL
WINTER CANOLA

The market leading winter canola, Captain CL, has proven itself again and again in independent trials and in the paddock it will produce market leading yields, biomass, and oil percentage. If you want to maximise your profits with winter canola then grow Captain CL.

MATURITY SPEED (VERY QUICK – VERY SLOW)

BLACKLEG RATING	BLACKLEG GROUP	POD SHATTER RESISTANCE
R	AH	

Clearfield® Production System · WINTER CANOLA · DUAL PURPOSE

LONGFORD
WINTER WHEAT

From the breeders who brought you BigRed, Longford is a long season high yield potential red wheat with a strong disease package and lodging tolerance. Longford is suited to dual purpose (graze/grain) or grain only farming systems

MATURITY SPEED (VERY QUICK – VERY SLOW)

SCEPTORIA RESISTANCE	POWDERY MILDEW	STRIPE RUST	LEAF RUST
MRMS	RMR	RMR	RMR

WINTER WHEAT · DUAL PURPOSE · AWNED RED FEED

TRIPLE 2
WINTER WHEAT (AGFWH010222)

Triple 2 is an awned, high yield potential, red winter wheat that is being released in 2025. A mid maturity wheat that is slightly slower than LRBP Beaufort, Triple 2 is suited to medium and long-environments and has shown incredible potential in years of independent trials.

MATURITY SPEED (VERY QUICK – VERY SLOW)

SCEPTORIA RESISTANCE	POWDERY MILDEW	STRIPE RUST	LEAF RUST
MRMS p	RMR p	RMR p	MRMS p

WINTER WHEAT · DUAL PURPOSE · AWNED RED FEED

BLACKLEG MANAGEMENT GUIDE
FACT SHEET

GRDC NATIONAL VARIETY TRIALS™

NATIONAL SEPTEMBER 2024

Spring 2024 update: Crown Canker and Upper Canopy blackleg ratings

Blackleg can cause severe yield losses in canola, but it can be successfully managed. Blackleg occurs in two forms in Australia; crown canker is still the main risk to growers, but upper canopy infection (UCI) can also cause significant yield losses

Crown canker results from infection of canola seedlings that allows the pathogen to grow from the cotyledons/leaves to the plant crown, causing vascular tissue damage within the crown.

UCI results from infection of flowers, stems and/or branches that allows the same process as crown canker, but the infection causes damage to the vascular tissue in the branches and stem and does not affect the crown.

Pod infection (not covered here) is a result of infection post-flowering, where lesions form directly onto the pods.

Is this a year of crown canker or UCI?
In most seasons crops will not be prone to both crown canker and UCI. Early sown crops that also germinate early, grow quickly avoiding seedling infection and therefore will also avoid crown canker (plant growth prior to winter may avoid blackleg infection). However, these early sown crops may start flowering early in mid-to-late winter when blackleg is still active. Flowering during winter is critical for UCI to occur.

KEY POINTS

- **Never sow your canola crop into last year's canola stubble**
- **Choose a cultivar with adequate blackleg resistance for your region**
- **Relying only on fungicides to control blackleg poses a high risk of fungicide resistance**
- **If your monitoring has identified yield loss is occuring, follow the steps in this guide to manage blackleg**
- **By monitoring your crops at maturity you can determine if you need to change your blackleg management in future years**

Leptosphaeria maculans, the causal agent of blackleg, is a sexually reproducing pathogen that may overcome cultivar resistance genes and fungicides. Fungal spores are released from canola stubble and spread extensively via wind and rain splash. The disease is more severe in areas of intensive canola production.

STEP 1: Identify your farm's blackleg risk.

Table 1: Regional blackleg factors.

Environmental factors that determine risk of severe blackleg infection	Crown canker and UCI blackleg severity risk factor								
	High risk			Medium risk			Low risk		
Regional canola intensity (% area sown to canola)	above 20	16–20	15	11–14	11–14	10	6–9	5	below 5
Annual rainfall (mm)	above 600	551–600	501–550	451–500	401–450	351–400	301–350	251–300	below 250
Total rainfall received March–May prior to sowing (mm)	above 100	above 100	above 100	above 100	91–100	81–90	71–80	61–70	below 60
Combined high canola intensity and adequate rainfall increase the probability of severe blackleg infection.									

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STEP 2: Determine each crop's blackleg severity at plant maturity (windrowing/swathing time).

Crown canker: Assess the level of disease in your current crop. Ideally, sample the crop within a few days after windrowing/swathing (prior to windrowing is OK but it is difficult to move within the crop and difficult to observe cankers). Look for plants that have fallen over and have external visible crown cankers. Pull 60 randomly selected stems out of the ground, cut off the roots with a pair of secateurs and, using the reference photos in Table 2a, estimate the amount of disease in the crown cross-section. Yield loss will commonly occur when more than 30 per cent of the cut crown is discoloured.

Upper canopy infection (UCI): Mid-flower is the first growth stage that UCI can be observed, although it is not a good indicator of yield loss. UCI mid-flower infection can cause lesions on the flowers and stems/branches (see reference photos in Table 2b). At windrowing/swathing, UCI symptoms can cause a range of symptoms including causing individual branches to die, individual branches to be dark in colour, and external cankers to be visible on the branches and stem. In addition, UCI will cause the pith within the stem and branches to become black in colour. Therefore, observe the external symptoms and then cut the plant with secateurs to confirm the blackened pith.

The following steps apply equally to crown canker and UCI.

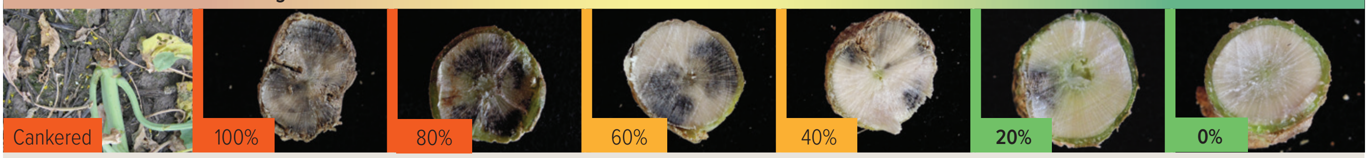
If you have identified that you are in a medium to high-risk situation (steps 1 and 2), use steps 3 and 4 to reduce your risk of blackleg in future seasons.

Cut a plant at the crown (into the top of the root) to assess internal infection. PHOTO: STEVE MARCROFT

If you are in a low-risk situation and you have not identified yield loss due to blackleg infection when assessing your crop, continue with your current management practices.

Table 2a: Crown canker blackleg severity.

High risk | Medium risk | Low risk



Yield loss occurs when more than half of the cross-section is discoloured.

Table 2b: Upper canopy infection symptoms.

External stem lesion. PHOTO: STEVE MARCROFT

Branch death. PHOTO: STEVE MARCROFT

Darkened branch that is indicative of yield loss. PHOTO: STEVE MARCROFT

Cut stems to observe for blackened pith. PHOTO: STEVE MARCROFT

Cutting branches to inspect for blackened pith. PHOTO: STEVE MARCROFT

Infected flower lesion. Blackleg will grow from the flower into the branch. PHOTO: STEVE MARCROFT

STEP 3: Change management practices to reduce the risk of blackleg infection.

If your crop monitoring (step 2) showed yield loss in the previous year, consider changing your management practices for each canola paddock to be sown to reduce blackleg severity. Review each management practice to determine which are increasing risk and how the risk can be reduced.

WARNING: 'CANOLA ON CANOLA' PLANTING WILL CAUSE A SIGNIFICANT YIELD LOSS AND WILL REDUCE THE EFFECTIVE LIFE OF CANOLA CULTIVARS AND FUNGICIDES.

There are several blackleg management practices that determine risk of blackleg infection, discussed here from highest (A) to lowest (H) effectiveness.

A. BLACKLEG RATING

The cultivar blackleg rating is the most important blackleg management tool. If your previous crop had a high level of disease, choose a cultivar with a higher blackleg rating. The 2024 blackleg ratings are listed in Table 3.

Crown canker

High risk				Moderate risk				Low risk
VS	S-VS	S	MS-S	MS	MR-MS	MR	R-MR	R

VS = very susceptible, S = susceptible, MS = moderately susceptible, MR = moderately resistant, R = resistant.

For UCI, the cultivar blackleg rating will reduce the probability of large yield losses. R-rated UCI cultivars are unlikely to have yield loss, whereas MR and MRMS will have increasing yield losses depending on starting date to first flower and disease severity. MS should only be used in environments of lower disease severity.

Upper canopy infection

High risk				Moderate risk				Low risk
		MS		MRMS	MR			R

B. DISTANCE FROM LAST YEAR'S CANOLA STUBBLE

The distance of your current crop from last year's canola stubble will determine disease severity. **NEVER** sow your canola crop into last year's canola stubble. Distances from last year's stubble of at least 500 metres will reduce blackleg severity.

High risk				Medium risk				Low risk
0m	100m	200m	300m	400m	500m	>500m		

C. FUNGICIDE USE

Reliance on fungicides to control disease poses a high risk of fungicide resistance.

Crown canker

Fungicides complement other management practices. Fungicides will provide an economic return only if your crop is at high risk of yield loss. Fungicides are generally warranted where crops have lower blackleg ratings, are sown into higher disease severity situations, and have germinated later so that plants are still small seedlings during early winter. The GRDC/DPIRD BlacklegCM app is an excellent economic fungicide application decision-support tool for crown canker.

High risk				Medium risk				Low risk
No fungicide		Foliar-applied fungicide		Seed dressing fungicide	Fertiliser-applied fungicide	Seed dressing + fertiliser-applied fungicide	Seed dressing or fertiliser-applied + foliar fungicide	

Upper canopy infection

Fungicides complement other management practices. Fungicides will provide an economic return only if your crop is at high risk of yield loss. Fungicides are generally warranted where crops have lower UCI/blackleg ratings, have started flowering early and are sown into higher disease severity situations. Fungicides cannot be applied after 50 per cent bloom due to maximum residue limit (MRL) restrictions. The GRDC/DPIRD UCI/BlacklegCM app is an excellent economic fungicide application decision support tool for UCI.

High risk				Medium risk				Low risk
	No fungicide						Foliar fungicide applied at early bloom	

D. YEARS OF SAME CULTIVAR GROWN

The pathogen will overcome cultivar resistance genes if the cultivars containing the same resistance genes are used each year. By sowing a cultivar based on different resistance genes, the ability of the pathogen to overcome resistance will be reduced. All cultivars have been placed into different blackleg resistance groups based on their resistance gene complement (see Table 3).

If you have:

- high or increasing levels of blackleg in your crop (from monitoring disease levels each year);
- used the management practices outlined in step 3; and
- sown cultivars from the same resistance group in close proximity (within two kilometres) for three or more years, then sow a cultivar from a different resistance group (see Table 3).

High risk				Medium risk				Low risk
Sown the same cultivar/resistance group for more than three years			Sown the same cultivar/ resistance group for three years			Sown the same cultivar/ resistance group for two years	Sown the same cultivar-resistance group the previous year	Sown cultivar from a different resistance group

E. DISTANCE FROM TWO-YEAR-OLD CANOLA STUBBLE

Stubble older than two years produces fewer blackleg spores and will normally have minimal effects on blackleg severity, even where canola is sown into two-year-old stubble. However, two-year-old stubble may cause disease if inter-row sowing canola (see point F, Canola stubble conservation) or if the cultivar resistance has been overcome.

High risk				Medium risk				Low risk
				0m	100m	250m	500m	>500m

F. CANOLA STUBBLE CONSERVATION

Stubble destruction is generally not effective in reducing blackleg infection. Inter-row sowing canola into two-year-old canola stubble, where germinating seedlings are immediately next to standing stubble, may result in higher levels of blackleg infection.

High risk				Medium risk				Low risk
			Inter-row sowing	Disc tillage	Knife-point tillage	Burning/burying tillage		

G. MONTH SOWN

Canola is most vulnerable to crown canker blackleg when infected in the seedling stage. If crops are sown early in warmer conditions and develop through the seedling growth stage quickly, they may escape high blackleg severity.

Crown canker infection only

High risk				Medium risk				Low risk
			June to August	15 to 31 May	1 to 14 May	15 to 30 April		

H. COMMENCEMENT OF FLOWERING DATE

Canola is only vulnerable to UCI if infection occurs early enough in the growing season for the pathogen to grow into the vascular tissue within the branches and stem to cause a blockage. Later infections can occur but are unlikely to cause yield losses. Short growing regions (mature in October) may have only a moderate risk if flowering commences early (June).

Upper canopy infection only

High risk				Medium risk				Low risk
June	1 to 15 July	15 to 30 July	1 to 15 August		15 to 30 August			September onwards

BlacklegCM app. Get the app for your iPad or tablet.
The app is an interactive format of this management guide that allows you to enter individual crop data and estimate blackleg severity for your crop.

Table 3: 2024 spring blackleg ratings and resistance groups.

Variety	2024 blackleg rating Bare	2024 blackleg rating ILeVo®	2024 blackleg rating Saltro®	2024 upper canopy infection blackleg rating	Type	Major gene resistance group of cultivar
CONVENTIONAL VARIETIES						
Outlaw⌽	RMR			MR-UCI	Open pollinated	A
Nuseed® Quartz	RMR			MR-UCI	Hybrid	ABD
Nuseed® Diamond	RMR	R	R	MR-UCI	Hybrid	ABF
TRIAZINE-TOLERANT VARIETIES						
HyTTec® Trifecta	R			MR-UCI	Hybrid, Triazine	ABD
HyTTec® Trident	R			MR-UCI	Hybrid, Triazine	AD
Monola® H524TT	R			MR-UCI	High stability oil, hybrid, Triazine	AD
DG Bidgee TT⌽	R	R	R	R-UCI	Open pollinated, Triazine	H
Pioneer® PY429T	R		R	R-UCI	Hybrid, Triazine	ABH
HyTTec® Trophy	R	R	R	MR-UCI	Hybrid, Triazine	AD
DG Torrens TT⌽	RMR			R-UCI	Open pollinated, Triazine	H
Hyola® Blazer TT	RMR		R	MR-UCI	Hybrid, Triazine	ADF
InVigor® T 4511	RMR	R		MR-UCI	Hybrid, Triazine	Unknown
Monola® H421TT	RMR			MR-UCI	High stability oil, hybrid, Triazine	BC
ATR-Bluefin⌽	RMR			MR-UCI	Open pollinated, Triazine	AB
DG Avon TT⌽	MR	R	R	MR-UCI	Open pollinated, Triazine	AC
SF Spark™ TT	MR	R	R	MR-UCI	Hybrid, Triazine	ABDS
Renegade TT⌽	MR			MR-UCI	Open pollinated, Triazine	A
HyTTec® Velocity	MR			MR-UCI	Hybrid, Triazine	AB
Monola® 422TT	MRMS			MRMS-UCI	Open pollinated, Triazine	BC
ATR-Swordfish⌽	MRMS			MRMS-UCI	Open pollinated, Triazine	AB
SF Dynatron™ TT	MRMS	R	R	MRMS-UCI	Hybrid, Triazine	BC
RGT Baseline™ TT	MRMS	R	R	MRMS-UCI	Hybrid, Triazine	B
Bandit TT⌽	MRMS	R	R	MRMS-UCI	Open pollinated, Triazine	A
RGT Capacity™ TT	MRMS	RMR	R	MRMS-UCI	Hybrid, Triazine	B
AFP Cutubury⌽	MS	MR	RMR	MS-UCI	Open pollinated, Triazine	AB
ATR-Bonito⌽	MS	RMR	R	MS-UCI	Open pollinated, Triazine	A
IMIDAZOLINONE-TOLERANT VARIETIES						
Hyola® Solstice CL	R		R	R-UCI	Hybrid, Clearfield®	ADFH
Captain CL	R			R-UCI	Winter, hybrid, Clearfield®	AH
Hyola® Feast CL	R		R	R-UCI	Winter, hybrid, Clearfield®	H
RGT Nizza™ CL	R			MR-UCI	Winter, hybrid, Clearfield®	B
Hyola® 970CL	R		R	R-UCI	Winter, hybrid, Clearfield®	H
Phoenix CL	R			MR-UCI	Winter, hybrid, Clearfield®	B
Pioneer® 45Y93 CL	R		R	MR-UCI	Hybrid, Clearfield®	BC
RGT Clavier™ CL	R			R-UCI	Winter, hybrid, Clearfield®	ACH
Pioneer® PN526C	RMR			MR-UCI	High stability oil, hybrid, Clearfield®	ABD
Pioneer® 45Y95 CL	RMR		R	MR-UCI	Hybrid, Clearfield®	C
Nuseed® Ceres IMI	RMR			MR-UCI	Hybrid, Imidazolinone	AD
Pioneer® 43Y92 CL	RMR		R	MR-UCI	Hybrid, Clearfield®	B
Pioneer® 44Y94 CL	RMR		R	MR-UCI	Hybrid, Clearfield®	BC
Pioneer® PY421C	RMR		R	MR-UCI	Hybrid, Clearfield®	A
VICTORY® V75-03CL	RMR			MR-UCI	High stability oil, hybrid, Clearfield®	AB

Continued on next page

Table 3: 2024 spring blackleg ratings and resistance groups (continued).						
Variety	2024 blackleg rating Bare	2024 blackleg rating ILeVo®	2024 blackleg rating Saltro®	2024 upper canopy infection blackleg rating	Type	Major gene resistance group of cultivar
IMIDAZOLINONE AND TRIAZINE-TOLERANT VARIETIES						
Hyola® Defender CT	R		R	MR-UCI	Hybrid, Clearfield®, Triazine	ADF
Hyola® Enforcer CT	R			MR-UCI	Hybrid, Clearfield®, Triazine	ADF
Nuseed® Griffon TTI	RMR			MR-UCI	Hybrid, Imidazolinone, Triazine	AC
Pioneer® PY520 TC	MR		R	MR-UCI	Hybrid, Clearfield®, Triazine	BC
GLYPHOSATE-TOLERANT VARIETIES						
DG Hotham TF	R			R-UCI	Hybrid, TruFlex®	ABH
Nuseed® Raptor TF	R			MR-UCI	Hybrid, TruFlex®	AD
Nuseed® Eagle TF	R			MR-UCI	Hybrid, TruFlex®	ABD
VICTORY® V55-04TF	R	R	R	MR-UCI	High stability oil, hybrid, TruFlex®	AB
DG Lofty TF	R			R-UCI	Hybrid, TruFlex®	ABH
Nuseed® Hunter TF	RMR			MR-UCI	Hybrid, TruFlex®	AB
Pioneer® 44Y27 RR	RMR	R	R	MR-UCI	Hybrid, Roundup Ready®	B
Pioneer® PY422G	MR		R	MR-UCI	Hybrid, Optimum GLY®	AB
Nuseed® Emu TF	MR			MR-UCI	Hybrid, TruFlex®	AB
Pioneer® PY525G	MR		R	MR-UCI	Hybrid, Optimum GLY®	AB
InVigor® R 4520P	MRMS	R		MRMS-UCI	Hybrid, Truflex®	B
Pioneer® PY323G	MRMS		R	MRMS-UCI	Hybrid, Optimum GLY®	BC
GLYPHOSATE AND IMIDAZOLINONE-TOLERANT VARIETIES						
Hyola® Regiment XC	R		R	R-UCI	Hybrid, TruFlex®, Clearfield®	ADFH
Hyola® Battalion XC	RMR			MR-UCI	Hybrid, TruFlex®, Clearfield®	ADF
Pioneer® PY424GC	MRMS		R	MRMS-UCI	Hybrid, TruFlex®, Clearfield®	BC
GLUFOSINATE AND TRIAZINE-TOLERANT VARIETIES						
InVigor® LT 4530P	RMR	R		MR-UCI	Hybrid, LibertyLink®, Triazine	BF
GLUFOSINATE AND GLYPHOSATE-TOLERANT VARIETIES						
InVigor® LR 5040P	RMR	R		MR-UCI	Hybrid, LibertyLink®, TruFlex®	AB
InVigor® LR 4540P	RMR	R		MR-UCI	Hybrid, LibertyLink®, TruFlex®	B
InVigor® LR 3540P	MR	R		MR-UCI	Hybrid, LibertyLink®, TruFlex®	AB

denotes Plant Breeder's Rights apply, (p) Provisional, R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible.

STEP 4: Manage variety resistance.

Blackleg disease is controlled by two forms of genetic resistance – major gene and quantitative. These two forms of resistance are both important for controlling blackleg and require management to maintain them. The blackleg rating for each variety takes in a combination both major gene and quantitative resistance.

Major gene resistance (MGR)

Major genes in canola varieties recognise the blackleg fungus, which creates an immune response in the plant and enables it to stop the fungus growing. Major gene resistance controls blackleg at all stages of plant development and therefore protects against leaf lesions, crown canker, upper canopy infection and pod infection.

The major genes are identified in all canola varieties. Each MGR is allocated a resistance group letter (A, B, C, D, F, H and S), as shown in Table 3. Varieties can have a single or multiple MGR. As MGR results in immunity, varieties will always receive an R blackleg rating while the MGR is effective and will not have any yield losses from blackleg. However, the blackleg fungus is adept at overcoming MGR and this will change the status of the blackleg rating (see next paragraph).

Effectiveness of MGR

MGR is only effective if the plant's MGR recognises the blackleg fungus. If the fungus evolves to overcome the plant MGR (via mutation, sexual recombination or population structure), the variety's MGR no longer recognises the blackleg fungus and the plants will become susceptible. The MGR will still be present in the variety, but it will no longer be effective. Most MGRs in Australian canola varieties are no longer effective; therefore, breeders combine MGRs to restore effectiveness and/or combine MGR and quantitative resistance (QR) to create resistance. MGRs can be partially effective; this scenario occurs when a blackleg population consists of a range of blackleg isolates, only some of which have evolved to avoid recognition by the plant.

MGR monitoring in Australia

MGR effectiveness is monitored each year across Australian canola growing regions (GRDC project MGP2307-001RTX).

Table 4 gives an indication of which MGR may be effective in your growing region. Varieties that contain these MGRs are likely to be highly resistant in your region. However, individual blackleg populations on your farm may have overcome the MGR. The best way to assess the effectiveness of the MGR on your farm is to consult Table 4 and to monitor the performance of the MGR in your crop (see Step 2).

If the MGR is effective, there should be no/few leaf lesions present. However, as the effectiveness of the MGR is reduced overtime you may observe increased leaf lesion severity and increased crown canker severity. It is advisable to monitor leaf lesion severity as well as cut crowns each year to determine if MGR is reducing on your property.

If you have grown a variety or varieties with the same MGR over several years and blackleg severity has increased, it may be beneficial to change to a variety with different MGR (Table 3). Use Table 4 to identify an MGR that is still effective in your region. If your variety has a MGR stack (multiple letters, e.g. ABD), then choose a cultivar that has at least one new letter that is green or yellow in Table 4. If all letters in your preferred variety are red in Table 4 you will need to rely on quantitative resistance. Many cultivars have excellent quantitative resistance and are very effective at controlling blackleg; see the section headed 'Quantitative resistance (QR)' for more information.

Blackleg resistance group monitoring

Representative cultivars from all blackleg resistance groups are sown in trial sites in all canola-producing regions across Australia and monitored for blackleg severity. This data provides regional information on the effectiveness of each blackleg resistance group.

Table 4: 2024 regional major gene resistance effectiveness.

2024 SITE	RESISTANCE GROUP						
NSW	A	B	C	D	F	H	S
Beckom	Red	Red	Red	Green	Red	Green	Yellow
Cootamundra	Red	Red	Yellow	Green	Red	Yellow	Yellow
Cudal	Red	Red	Red	Green	Red	Green	Green
Gerogery	Red	Red	Red	Yellow	Red	Green	Yellow
Lockhart	Red	Red	Red	Green	Yellow	Green	Green
Parkes	Red	Red	Red	Green	Yellow	Green	Green
Wagga Wagga	Red	Red	Red	Green	Yellow	Green	Green
Wellington	Red	Red	Red	Green	Yellow	Green	Green
SA	A	B	C	D	F	H	S
Arthurton	Red	Red	Red	Green	Yellow	Green	Green
Cummins	Red	Red	Red	Red	Red	Green	Yellow
Keith	Red	Red	Red	Green	Red	Green	Green
Riverton	Red	Red	Red	Green	Yellow	Green	Green
Spalding	Red	Red	Red	Green	Green	Green	Green
Wangary	Red	Red	Red	Red	Red	Green	Green
Wasleys	Red	Red	Red	Yellow	Yellow	Green	Yellow
Yeelanna	Red	Red	Yellow	Red	Red	Yellow	Red
Victoria	A	B	C	D	F	H	S
Charlton	Red	Red	Red	Yellow	Red	Green	Green
Diggora	Red	Red	Yellow	Yellow	Red	Yellow	Green
Hamilton	Red	Red	Yellow	Green	Red	Red	Green
Horsham	Red	Red	Red	Red	Yellow	Green	Yellow
Kaniva	Red	Red	Red	Yellow	Yellow	Green	Green
Lake Bolac	Red	Red	Red	Yellow	Yellow	Green	Green
Wunghnu	Red	Red	Red	Yellow	Yellow	Green	Yellow
Yarrawonga	Red	Red	Red	Yellow	Yellow	Green	Green
WA	A	B	C	D	F	H	S
Bolgart	Red	Red	Red	Yellow	Yellow	Green	Green
Gibson	Abandoned – waterlogging						
Kendenup	Insufficient disease						
Kojonup	Insufficient disease						
Munglinup	Red	Red	Red	Yellow	Yellow	Green	Yellow
Stirlings South	Red	Red	Red	Red	Green	Green	Green
Wagin	Red	Red	Red	Green	Yellow	Green	Green
Williams	Insufficient disease						

Green = effective   Yellow = partially effective   Red = ineffective

Quantitative resistance (QR)

Quantitative resistance (QR) is the combination of several resistance genes (of which there are many) where each gene has a small effect on reducing blackleg severity. Therefore, a greater number of these genes will result in higher blackleg resistance. The blackleg rating of a variety is used to indicate the level of QR. For example, an MR-rated variety may have more QR genes than an MS cultivar. Recent research has shown that QR controls both crown canker and UCI severity.

Quantitative resistance is difficult to characterise; therefore, we cannot characterise the precise QR genetics in a variety. Canola varieties may have the same or different QR genes or different combinations of these genes. QR may not completely protect against the blackleg fungus, so plants will likely still get some crown canker and UCI.

Effectiveness of QR

The blackleg fungus will overcome individual QR genes over time. If you sow the same cultivar intensively for more than three years, the effectiveness of that cultivar's QR may decline on your farm. Reduced resistance will be evident by increased crown canker severity observed by cutting stems at the windrowing maturity timing. For some QR, increased leaf lesion severity will also occur overtime. It is advised to cut crowns each year to determine if resistance is reducing (see step 2 of this guide).

If QR is being overcome on your farm, treat the variety as having a lower blackleg rating than advertised. That is, if the official rating of your variety is R but you have observed increasing crown canker on your property, then manage your variety as MR rated or change to a new variety. Although we do not necessarily know the genetics underlying QR, generally swapping to a variety with a higher blackleg rating will ensure sound QR in the new variety.

Blackleg ratings – definitions and management

Blackleg ratings are determined by the performance of each variety in blackleg disease nurseries. The ratings are a product of both the MGR and QR in each variety. Blackleg ratings are now available for both crown canker and UCI. The definitions and management options for these two types of blackleg rating are provided.

Crown canker blackleg ratings

R (resistant)
R-rated varieties have excellent crown canker blackleg resistance. These varieties are unlikely to have yield loss from blackleg even when grown in high-rainfall canola/cereal/canola rotations. They are unlikely to benefit from fungicide applications. Consult BlacklegCM app for more detail.

RMR (resistant moderately resistant)
RMR-rated varieties have excellent crown canker blackleg resistance. These varieties are unlikely to have yield loss from blackleg. However, if sown in high-rainfall canola/cereal/canola rotations small yield losses may be possible. They are also unlikely to benefit from fungicide applications. Consult BlacklegCM app for more detail.

MR (moderately resistant)
MR-rated cultivars have very good blackleg resistance. These cultivars are unlikely to have yield losses from blackleg where sound cultural practices are used, that is, 500m isolation between the crop and the previous year's canola stubble. When MR varieties are sown into high disease severity situations they may respond well to fungicide applications. Consult BlacklegCM app for more detail.

MRMS (moderately susceptible moderately resistant)
MRMS-rated varieties have moderate blackleg resistance. MRMS varieties should only be sown in situations of low blackleg severity, that is, 500m isolation between the crop and the previous year's canola stubble and moderate to lower-rainfall regions. When these varieties are sown into higher disease severity situations, they are likely to respond well to fungicide applications. In the event of above-average rainfall years in lower-rainfall regions, it is advised to apply fungicide to MRMS varieties. Consult BlacklegCM app for more detail.

MS (moderately susceptible)
MS-rated varieties have low blackleg resistance. They should only be sown into situations of low blackleg severity, that is, low canola intensity and lower rainfall. When MS varieties are sown into higher disease severity situations, they are likely to respond very well to fungicide applications. Consult BlacklegCM app for more detail.

Upper canopy infection blackleg ratings

R-UCI varieties are likely to have effective MGR and will therefore be unlikely to have yield loss associated with UCI. Check Table 4 for your region and the presence of leaf lesions in your crop to confirm that the MGR is effective. If leaf lesions are found, treat your variety as MR-UCI. Consult UCI-BlacklegCM app for more detail.

MR-UCI varieties have resistance to UCI. Yield losses will only occur if disease severity is high, that is, flowering starts early in the growing season, there is sufficient rainfall and higher risks such as high canola intensity. Fungicide application at 30 per cent bloom is recommended if flowering is early, there is higher canola intensity and there is rainfall during flowering. Consult UCI-BlacklegCM app for more detail.

MRMS-UCI varieties have low resistance to UCI. Yield losses will occur if disease severity is moderate, i.e., flowering starts early in the growing season. Fungicide application at 30 per cent bloom is recommended if flowering is early and there is rainfall during the flowering growth stage. Consult UCI-BlacklegCM app for more detail.

MS-UCI varieties have low or no resistance to UCI. These varieties should only be sown into situations of low blackleg severity, that is, low canola intensity and lower rainfall. Fungicide application at 30 per cent bloom is recommended if flowering is early and there is rainfall during the flowering growth stage. Consult UCI-BlacklegCM app for more detail.

USEFUL RESOURCES

BlacklegCM app, developed with GRDC investment, allows the user to input information such as paddock selection, variety choice, seed dressing and banded or sprayed fungicide, and takes into account costs, yield benefits and grain prices to give the best/worse-case scenario and likely estimated economic return. Growers can change the parameters on the app to tailor the output to their own individual crop. It can be downloaded onto tablets (not smartphones) from both the App Store and Google Play, agric.wa.gov.au/apps/blacklegcm-blackleg-management-app

UCI BlacklegCM is a new app to assist grain growers in managing blackleg UCI in canola during flowering stage and also to aid in fungicide management decisions.
agric.wa.gov.au/apps/uci-blacklegcm-blackleg-upper-canopy-infection-management-app

Diseases of Canola and their Management: The Back Pocket Guide
Available from *GroundCover*™ Direct, 1800 110 044,
grdc.com.au/GRDC-BPG-CanolaDiseases

Canopy Infection by Blackleg – a New Evolution, a podcast,
grdc.com.au/news-and-media/audio/podcast/canopy-infection-by-blackleg-a-new-evolution

Marcroft Grains Pathology marcroftgrainspathology.com

Fungicide Resistance Management
croplife.org.au/resources/programs/resistance-management/canola-blackleg

Blackleg upper canopy infection videos (follow link or search on GRDC website)
grdc.com.au/search?query=blackleg%20upper%20canopy&s&personal=false&form=search-new&collection=grdc-multi&profile=_default&smeta_error_not=found&sort=off&smeta_archive_not=1&f.Typelctype=Video

GRDC CODES

MGP1905-001SAX
MGP2307-001RTX

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The physiology of faba bean yield determination

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Introduction

Some comments on faba bean agronomy

There is a lot of evidence to show large yield responses to overcoming key constraints to faba bean yield. This evidence can be found in GRDC investments implemented by grower groups and research organisations, including FAR Australia.

Some key practices include:

- Overcoming soil constraints such as low pH and compaction
- Ensuring adequate nodulation with active nodules
- Achieving appropriately early emergence dates
- Achieving appropriately high plant densities
- Timely application of fungicides
- Growing newer cultivars with improved disease and lodging resistance (Manson et al., 2024a)

In other words, faba bean needs investment in inputs like other crops. This may be easier to justify if the break crop effects, including nitrogen fixation, are given their appropriate value.

Agronomy versus physiology

Here, we will focus less on *how* to increase faba bean yields, and more on *why* faba bean yields vary in the way that they do.

How do you explain yield variation? In other words, what is your theory of grain yield determination?

- **Agronomic theories** explain yield in terms of what we do to crops: genotype and management in an unknown but probabilistically predictable environment.
- **Physiological theories** explain yield in terms of what a crop does: crops capture resources to grow, and allocate some of this growth to offspring, in unfolding growing conditions.

The two frameworks are complementary. Agronomic theories screen out some of what the crop is doing, and physiological theories screen out some of what the people are doing. Here, we will focus on a physiological explanation of faba bean yield.

Faba bean responds to better environments with seed number not size See Figure 1. The R^2 for seed number and environmental yield is between 0.90 and 0.94; the relationship for seed size is very weak or non-existent. This is the same for all grain crops (Sadras, 2021), and all flowering plants for that matter (Sakai, 2007), and nearly all organisms for that matter (Smith and Fretwell, 1974). We'll leave the evolutionary theory for another time (see Recommended Reading).

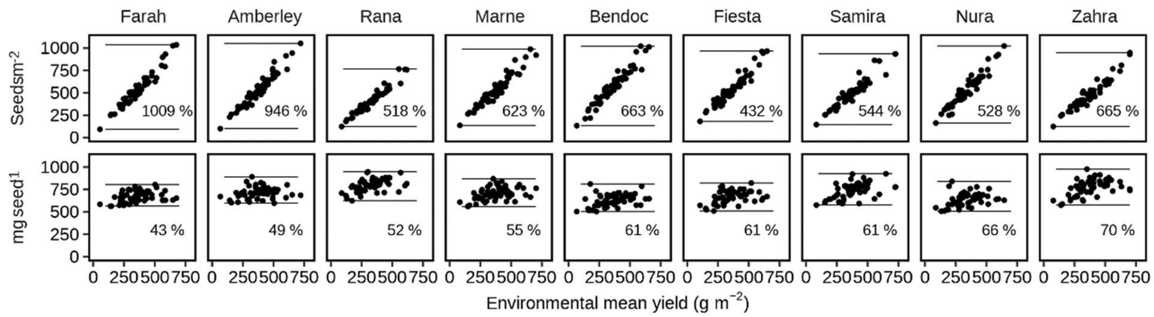

Figure 1. Faba bean, like all grain crops and nearly all flowering plants, responds to good conditions by making more seeds not bigger seeds. Data for 9 genotypes grown in 55 NVT site-years in South Australia, Victoria and southern New South Wales from 2016 to 2022. Environmental yield is the mean yield of the 9 genotypes in a site-year. Variation (%) = (maximum – minimum)/maximum * 100%. Source: Manson et al. 2024, PhD Thesis, forthcoming.

What is important to seed number?

Critical period growth

All crops have their own 'critical period of yield determination' (Carrera et al., 2024; Sadras and Dreccer, 2015). Growth during the critical period (CPG, critical period growth) determines seed number and size across genotypes, environments and management. The critical period for faba bean is centred on pod emergence, and possibly includes from flowering to seed-fill (Lake et al., 2019). Yield, seed number and pod number are strongly associated with CPG (Lake et al., 2019; Manson et al., 2024a). One requirement for maximum CPG is 100% light interception at flowering. If groundcover is low at flowering, the canopy is limiting yield potential; avoid this with appropriate sowing dates and plant densities, weighed against disease and lodging risk. With experimental treatments that increase biomass, harvest index tends to be lower but yield can be either higher or lower. This inconsistency is an important knowledge gap, but for now, it's important to recognise that the 'high biomass, low yield' situation is a special case, not the norm (if disease is controlled).

It's important to remember that we are aiming to maximise crop growth and yield, not plant growth and yield. Figure 2 shows how, across 110 experiments, plant density decreases plant yield but increases crop yield to an upper limit. This upper limit varies with environment and management, see Manson et al. (2024).

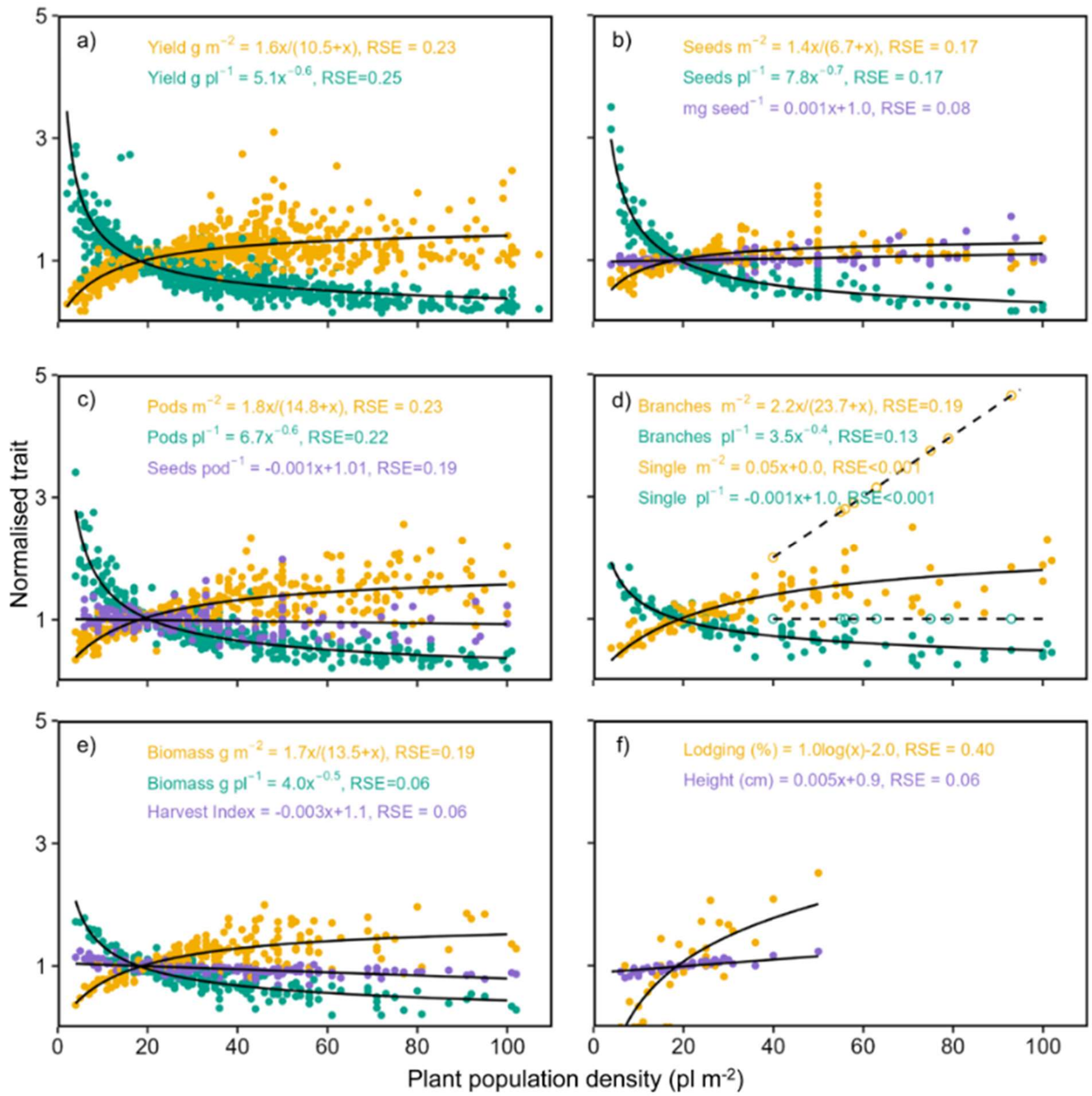

Figure 2. Responses of the faba bean phenotype to plant population density. Data includes up to 204 responses in 110 experiments. For each response, the data were normalised by dividing by the value at 20 plants m^{-2}, hence the curves pass through x = 20 and y = 1. Source: (Manson et al., 2024b).

Indeterminacy

Pod-set doesn't occur at a high intensity during podding, so faba bean needs time to set pods. The supporting evidence is that:

- Determinate varieties yield less than indeterminates, especially in higher yielding environments (Figure 3)
- In several experiments where the shoot tip was surgically removed, pod-set increased on remaining nodes but yield was reduced due to the lack of podding nodes.
- In a meta-analysis of 7 experiments using indeterminate cultivars, I found that the length of pod-set on a stem was more important for yield than high pods per node (Manson 2024, PhD Thesis, forthcoming).

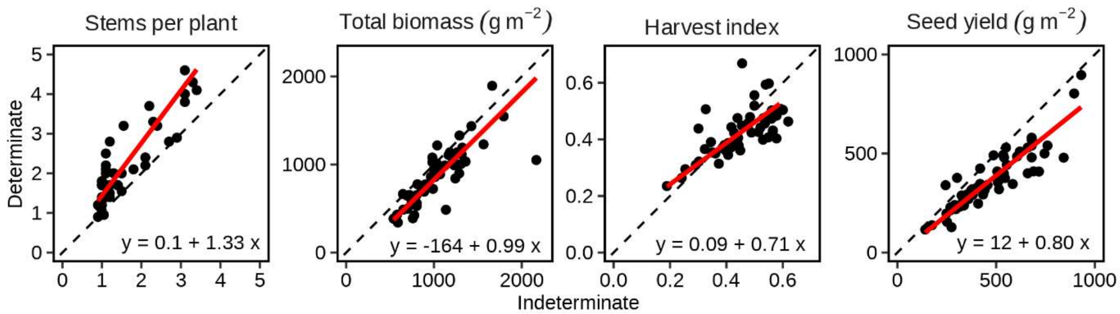

Figure 3. Pairwise comparisons of indeterminate and determinate varieties from 8 published experiments. The dashed line is the 1:1 line. Source: Manson 2024, PhD Thesis (forthcoming).

Flower 'overproduction'

There are many benefits to 'overproducing' flowers, then culling them to a final seed number (Sakai, 2007). Wheat does it too (Ghiglione et al., 2008). Growing pods suppress younger flowers and pods, but those pods will grow if resources are adequate. The flower:pod ratio is not the key thing to worry about, pods and seeds per m^2 are the key traits.

Some comments on phenology

It's common to explain pod-set at a node in terms of short-term weather around the time those flowers were opening. This is based on an old paper that was right about its main conclusion, but wrong about the details (Stoddard, 1993). The main conclusion of that paper was that even if all flowers were fertilised, pod-set would still be limited by resources – as we have discussed above. It was mistaken to explain pod-set at each node in terms of weather a few days around that node's flowering date. I conducted new experiments and trawled through the literature to demonstrate that:

1. Nodes share resources across the plant. Most pods set at lower nodes, and these don't have enough light to support themselves, so it comes from leaves at the top of the canopy. Furthermore, plants can store resources to buffer short term variation in supply.
2. Pods on lower nodes don't die, they go dormant. When I thinned the canopy from 25 to 5 plants m^{-2} at flowering, podding and grain-fill, I found pod-set recovering at those lower nodes 4 to 8 weeks after they had flowered.
3. If you remove older pods, the younger pods will replace them.

This shows that we need to think about pod-set at the whole-plant level throughout podding, not the node level at short intervals.

However, I found two interesting things about pod-set:

1. When you remove the lowest four racemes, they are replaced higher up the stem - if there is enough time and resources to do so.
2. Removing flowering racemes in one experiment increased yield because it allowed the plant to keep growing. In other words, pod-set depends on growth, but growth to some extent depends on pod-set. There might be a genetic way to take advantage of this.

All of this means we should focus on the duration of the whole critical period. The key phenological events are when it starts (flowering), when it reaches its centre (pod emergence) and when it ends (seed-fill). The only time that the phenology of individual nodes becomes relevant is when we are thinking about recovery from a stress like frost.

What could be a game-changer for faba bean yield potential?
In my view, there are a few genetic traits that are worth building on or testing:

- Better resistance to chocolate spot (ongoing)
- Improved resistance to lodging (ongoing)
- Semi-dwarfism (new trait)
- Semi-determinacy (new trait)
- Earlier flowering and appropriate maturity (ongoing/new)

In my view, we already know a lot of the management tools that can increase yield potential but there are risks of disease, lodging and low returns on investment. A key research question for high-yield environments is to better understand variation in harvest index of faba bean. A key factor that would change faba bean profitability is grain price, a lot of financial challenges would be solved if this was increased through better markets.

Conclusion: focus on what's important
It's easy to get distracted by management options that feel like quick fixes. The main thing for yield is maximising and protecting critical period growth. Other factors and options have at best a supporting role in determining yield (Figure 4).

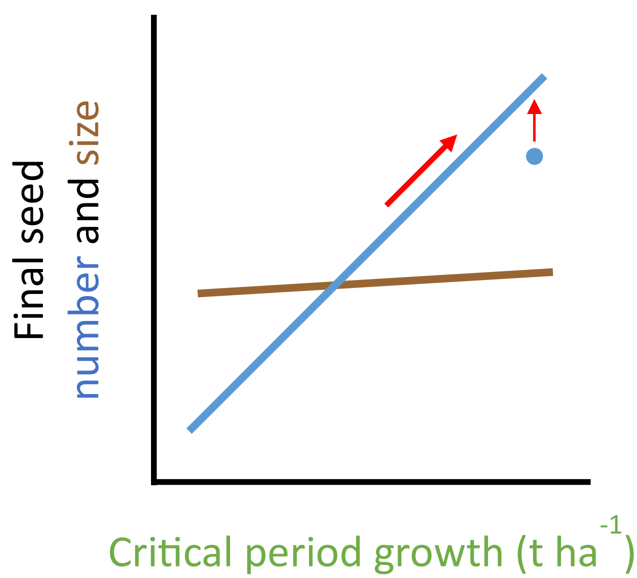

Figure 4. A physiological framework to think about yield determination. Yield is associated with variation in seed number not size. Seed number and yield are largely determined by critical period growth (diagonal red arrow). A value that falls below this relationship (blue dot) suggests an opportunity to increase yield in a way that complements critical period growth (vertical red arrow). Adapted from (Sadras and Dreccer, 2015).

Recommended reading

For the keen beans:

Carrera, C.S., Savin, R., Slafer, G.A., 2024. Critical period for yield determination across grain crops. Trends Plant Sci. 29, 329–342. https://doi.org/10.1016/j.tplants.2023.08.012

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Sakai, S., 2007. A New Hypothesis for the Evolution of Overproduction of Ovules: An Advantage of Selective Abortion for Females Not Associated with Variation in Genetic Quality of the Resulting Seeds. Evolution 61, 984–993. https://doi.org/10.1111/j.1558-5646.2007.00083.x

Smith, C.C., Fretwell, S.D., 1974. The Optimal Balance between Size and Number of Offspring. Am. Nat. 108, 499–506. https://doi.org/10.1086/282929

Stoddard, F.L., 1993. Limits to Retention of Fertilized Flowers in Faba Beans (Vicia faba L.). J. Agron. Crop Sci. 171, 251–259. https://doi.org/10.1111/j.1439-037X.1993.tb00137.x

Fungicide resistant wheat powdery mildew – update on resistance testing and management

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[1]Trengove Consulting, [2]Centre for Crop and Disease Management and [3]Field Applied Research

Key messages

- Wheat varieties with MSS/MS level resistance reduce mildew development significantly compared with SVS, and will rarely be responsive to fungicide for mildew control.
- Paddock surveys show Group 11 (QoI) resistance is generally low in the west and increases in the east of the southern region.
- Repeated paddock sampling over five seasons has shown an increase in Group 11 (Qol) resistance. Generally, there has been a two to three times increase in the mutation frequency in a single season.
- Permitted fungicides (current expiry May 2027) Legend®, Talendo® and Vivando® have provided high levels of WPM control when applied prior to or at the first sign of infection in those plant structures to be protected.

Wheat powdery mildew (WPM) has become wide spread across the southern region in recent years. There are a range of factors that have caused this including, the predominance of SVS varieties grown in most regions over a long period of time and early crop establishment. Favourable seasonal conditions resulting in large crop canopies which have been optimal for disease development and inoculum source carrying over from previous seasons.

Detection of fungicide resistance – Paddock surveys 2019 - 2023

Group 3 (DMI) resistance

The results from wheat powdery mildew samples showed there was a high level of reduced sensitivity and resistance to DMI fungicides in all samples collected from across the southern region.

Group 11 (Qol) resistance

The G143A mutation is associated with Group 11 (Qol) resistance. Isolates containing this mutation are completely resistant to group 11 fungicides.

Currently there is a regional difference in the frequency of the G143A mutation with the frequency increasing from west to east across the southern region. Only three paddocks from the 136 sampled in 2022 had nil mutation detected. This highlights that the mutation is present in nearly all paddocks across these regions and it is expected that the use of fungicides containing a strobilurin will further select for populations with this mutation.

The frequency of the G143A mutation is also changing overtime within regions. The highest values in mutation frequency have been observed in high rainfall areas of Victoria. Samples in 2020 showed a 32% mutation frequency and in two seasons had increased to 64%. Plant samples collected after the application of fungicides in field trials were also used to show the effect of single season selection pressure. Across six trials, there was generally a two to three times increase in the mutation frequency in a single season.

What are the other fungicide options to group 3 (DMI) & 11 (QoI) and how well do they work?

The APVMA has issued permits for three fungicides for the control of WPM. PER93197: Legend® and other registered products with 250 g/L quinoxyfen (group 13), PER93216: Talendo® 200 g/L proquinazid (group 13) and PER93198: Vivando® 500 g/L metrafenone (group U8) are currently able to be used for WPM control until May 2027. Refer to specific permits regarding application details, critical use comments and expiry details.

In field trial situations where WPM resistance has been high, the inclusion of one of the permitted products, Legend, Talendo or Vivando has been useful in SVS crops (Table 1). It is important to note that these fungicides have no or limited activity on any other diseases and need to be applied in combination with other fungicides for the control of diseases such as Septoria and rusts.

Performance of the permitted products varied across six trials, undertaken on the Northern Yorke Peninsula and South East, SA. The application timing of these fungicides when targeting WPM relative to disease build up was an important factor in WPM control. In four of the trials, the fungicide products almost eliminated WPM infection (Table 1). In these four trials, the WPM infection did not develop until after the first fungicide application. This highlights the importance of using these permitted fungicide products prior to or at the first sign of WPM infection.

Table 1. Performance of permitted products against WPM in trials at Bute and Malinong on wheat varieties rated SVS. Letters denote significant differences within a column (P≤0.05).

Treatment	**Bute 2020**	**Bute 2021**	**Bute 2022**	**Malinong 2022**	**Malinong 2023**	**Malinong 2023**
	Total pustule number per plant part/s					
Nil	28.7 a	4.1 a	16.4 a	13.4 a	10.1 a	9.2 a
Tebuconazole	8.4 b	1.6 ab	8.9 b	13.5 a		
Legend®	10.1 b	0.1 c	0.1 c	14.9 a	1.7 b	
Talendo®	9.0 b		0.7 c		1.2 b	
Vivando®	8.4 b					1.8 b

Interaction between varietal resistance and fungicide use

Planting less susceptible varieties will reduce disease pressure and the need for fungicide inputs. Recent field trials have shown WPM infection has generally followed the variety resistance ratings with MS performing better than MSS which performed better than SVS.

Varietal resistance has a significant effect on fungicide performance. A trial at Bute in 2021 (Figure 1) can be used to illustrate the impact of variety selection (disease rating) and fungicide management strategy on the resulting WPM severity.

Wheat varieties with SVS rating (Chief CL Plus and Scepter) had the highest level of susceptibility to WPM. For Chief CL Plus a one fungicide spray strategy was not sufficient to reduce canopy infection. The district practice strategy was able to reduce infection to a low-moderate level. Scepter was less susceptible to this WPM population, with the single spray strategy reducing infection to low-moderate levels. This was also equivalent to the district practice treatment.

A variety with MS rating (Grenade CL Plus) had less WPM infection in the nil compared to SVS varieties when treated with a two-spray 'district practice' fungicide strategy. In line with its R rating, Brumby had very low levels of WPM infection in the nil treatment.

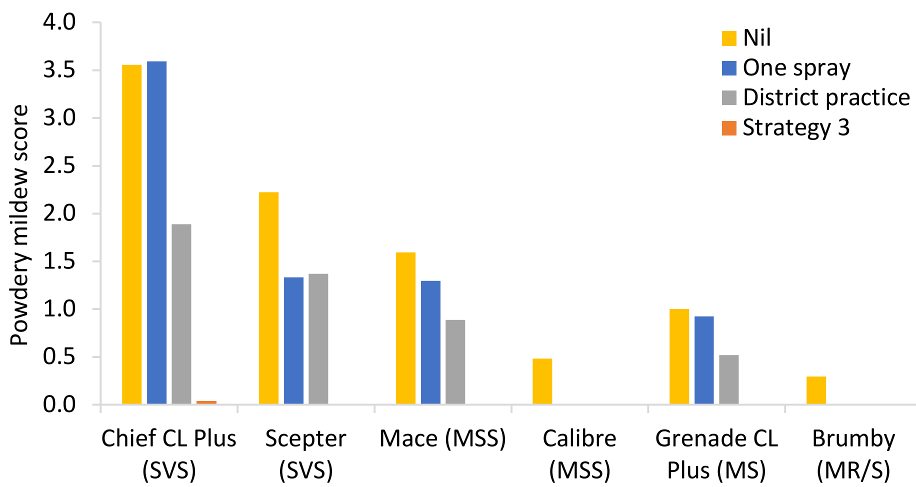

Figure 1. Wheat variety and fungicide management trial Bute, SA 2021. Wheat powdery mildew scored 22nd September. Calibre and Brumby only received nil treatment. Strategy 3 aimed for complete WPM control.

Wheat powdery mildew is a highly variable pathogen and in some season's varieties do not perform as expected based on their powdery mildew disease rating. For example, at Malinong SA in 2023, Mace (MSS) and Grenade CL Plus (MS) did not perform any better than the SVS variety Scepter. There were also observations of WPM infection in the variety Brumby at this site. Brumby is currently rated MR/S, to indicate an S rating to a rarer strain of WPM which is likely present at the Malinong site. There has potentially been some breakdown of resistance to local pathotypes that are more virulent on these varieties. However, more research in the area is required to understand this further.

Acknowledgements
The authors gratefully acknowledge the research investment from GRDC 'Validation and extension of management strategies for wheat powdery mildew (TRE2204-001RTX). We also thank all of the advisers and growers who have contributed to the field research program. Investments from GRDC and SAGIT for permits (PER93197, PER93216 and PER93198) are acknowledged and the support of Grain Producers Australia (GPA) as the permit holder.

Key Results from the 2023 SA Millicent Crop Technology Centre

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INDUSTRY INNOVATIONS: – Barley Germplasm Evaluation Network (GEN)
Sown: 10 May 2023
Harvested: 4 January 2024
Rotation position: 2022 Canola
Soil type & Management: Organosol over grey clay

The Germplasm Evaluation Network (GEN) is a FAR Australia Industry Innovations initiative that tests crop performance across FAR Australia's national network of Crop Technology Centres. GEN sites are situated in higher yielding regions of the country and tests crop performance plus and minus fungicide. FAR Australia provides the control varieties and breeders enter their chosen lines for evaluation.

Objectives:
To assess the performance of twelve spring barley varieties and one winter variety against two FAR control varieties RGT Planet (malt) and Rosalind (feed) plus and minus fungicide in the lower southeast of SA (Millicent).

Key Points:

- *Yields ranged from 5.44 – 9.15t/ha depending on variety and fungicide treatment.*
- *There was a significant response to fungicide (which averaged 0.64t/ha across all varieties) as a result of net form of net blotch (NFNB), leaf rust and scald infection depending on variety.*
- *The coded European barley SB1 was significantly higher yielding than all varieties other than Asteroid with both varieties exceeding 9t/ha when treated with fungicide.*
- *SB1 and Asteroid both had favourable grain characteristics, but Asteroid had significantly better test weight.*
- *RP 19013 exhibited significantly more lodging than other varieties/lines tested with a susceptibility to scald.*
- *Minotaur yields were disappointing with a large response to fungicide as a result of late leaf rust infection and noticeably higher Barley yellow dwarf virus infection (BYDV), data not shown.*
- *The winter barley Newton was potentially disadvantaged by May sowing and later development but was exceptionally disease resistant.*
- *Neo was lower yielding than in FAR Australia GEN trials in WA with leaf rust infection in the untreated becoming more severe from mid-October onwards.*

Table 1. Influence of fungicide on the grain yield (t/ha) of barley cultivars plus and minus fungicide – May 10 sown.

	Management Level					
	Untreated		Full protection		Mean	
Cultivar	Yield t/ha		Yield t/ha		Yield t/ha	
RGT Planet	7.98	-	8.48	-	**8.23**	**cd**
Rosalind	7.10	-	8.29	-	**7.70**	**ef**
Newton	5.99	-	5.94	-	**5.97**	**i**
AGTB0318	7.86	-	8.43	-	**8.14**	**cde**
Minotaur	5.69	-	7.09	-	**6.39**	**hi**
Asteroid	8.37	-	9.15	-	**8.76**	**ab**
RP 19034	8.15	-	8.99	-	**8.57**	**bc**
RP 19013	6.70	-	7.21	-	**6.95**	**g**
Laureate	7.82	-	8.15	-	**7.98**	**de**
Firefoxx	7.60	-	8.29	-	**7.94**	**def**
IGB21130	5.44	-	6.57	-	**6.00**	**i**
Neo	7.19	-	7.84	-	**7.51**	**f**
FAR SB2 (KWS Thalis)	6.29	-	6.69	-	**6.49**	**gh**
FAR SB1 (KWS Willis)	8.98	-	9.22	-	**9.10**	**a**
FAR SB5 (KWS 18/3518)	8.31	-	8.83	-	**8.57**	**bc**
Mean	**7.30**	**b**	**7.94**	**a**	**7.62**	
LSD Cultivar p = 0.05	0.47			**P val**	<0.001	
LSD Management p = 0.05	0.47			**P val**	0.022	
LSD Cultivar x Man. p = 0.05	N.S.			**P val**	0.227	

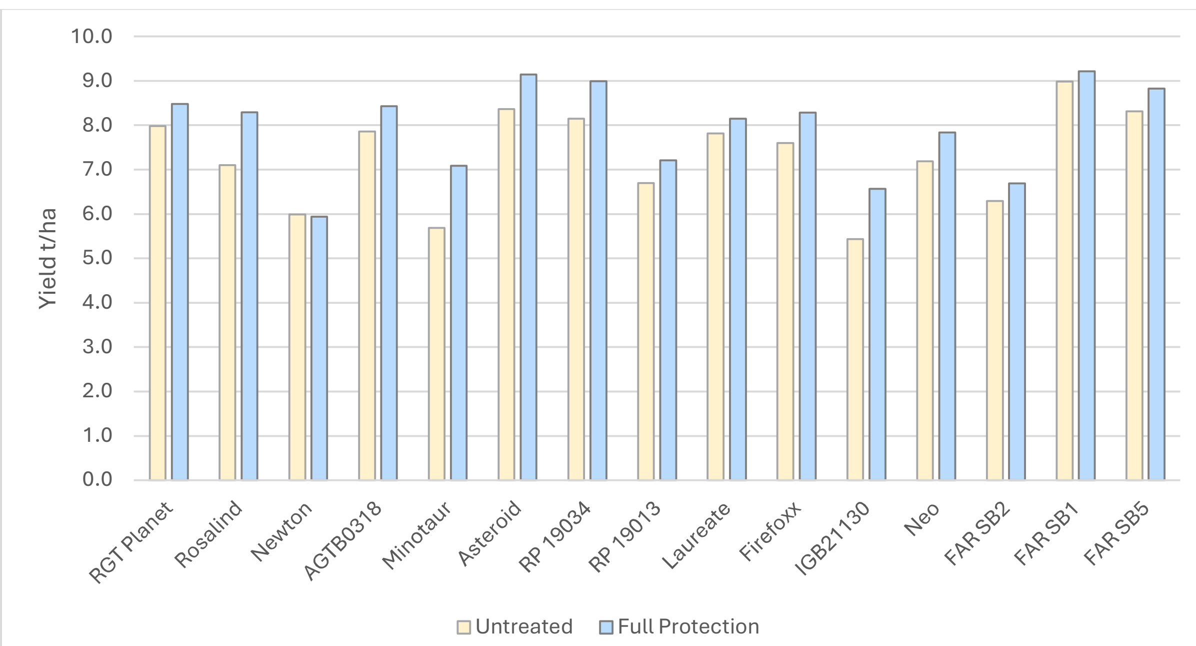

Figure 1. Influence of fungicide on the grain yield (t/ha) of barley cultivars plus and minus fungicide – May 10 sown.

Table 2. Influence of fungicide on the protein (%) and test weights (kg/hL) of barley cultivars plus and minus fungicide – January 4 sown.

	Management Level											
	Untreated		Full protection		Mean		Untreated		Full protection		Mean	
Cultivar	Protein %		Protein %		Protein %		Test weight kg/hL		Test weight kg/hL		Test weight kg/hL	
RGT Planet	12.2	-	12.3	-	**12.3**	**e**	60.4	ijk	63.3	abc	**61.8**	
Rosalind	12.6	-	12.8	-	**12.7**	**bcd**	62.2	c-f	63.3	bc	**62.7**	
Newton	14.7	-	15.4	-	**15.1**	**a**	60.6	h-k	61.2	f-j	**60.9**	
AGTB0318	12.3	-	13.0	-	**12.7**	**b-e**	59.3	k	60.7	g-j	**60.0**	
Minotaur	11.8	-	12.9	-	**12.4**	**de**	63.0	bcd	64.6	a	**63.8**	
Asteroid	11.9	-	12.6	-	**12.2**	**e**	63.0	cd	64.3	ab	**63.6**	
RP 19034	11.9	-	12.7	-	**12.3**	**e**	62.0	d-g	62.5	cde	**62.2**	
RP 19013	12.2	-	12.4	-	**12.3**	**de**	60.1	jk	61.7	e-i	**60.9**	
Laureate	12.9	-	12.8	-	**12.8**	**bc**	60.5	h-k	63.4	abc	**62.0**	
Firefoxx	12.5	-	12.7	-	**12.6**	**b-e**	61.1	f-j	63.1	bcd	**62.1**	
IGB21130	12.5	-	12.9	-	**12.7**	**bcd**	60.7	g-j	63.3	bc	**62.0**	
Neo	12.4	-	12.3	-	**12.3**	**de**	57.8	l	61.8	d-h	**59.8**	
FAR SB2	12.9	-	13.1	-	**13.0**	**b**	61.4	e-j	62.3	c-f	**61.9**	
FAR SB1	12.3	-	12.6	-	**12.5**	**cde**	61.3	e-j	63.4	abc	**62.3**	
FAR SB5	12.3	-	12.6	-	**12.4**	**cde**	60.7	g-j	61.1	f-j	**60.9**	
Mean	**12.5**	**-**	**12.9**	**-**	**12.7**		**60.9**		**62.7**		**61.8**	

Cultivar	**LSD p = 0.05**	0.44	**P val**	<0.001	**LSD p = 0.05**	0.9	**P val**	<0.001
Management	**LSD p = 0.05**	ns	**P val**	0.156	**LSD p = 0.05**	1.1	**P val**	0.016
Cultivar x Man.	**LSD p = 0.05**	ns	**P val**	0.336	**LSD p = 0.05**	1.3	**P val**	0.007

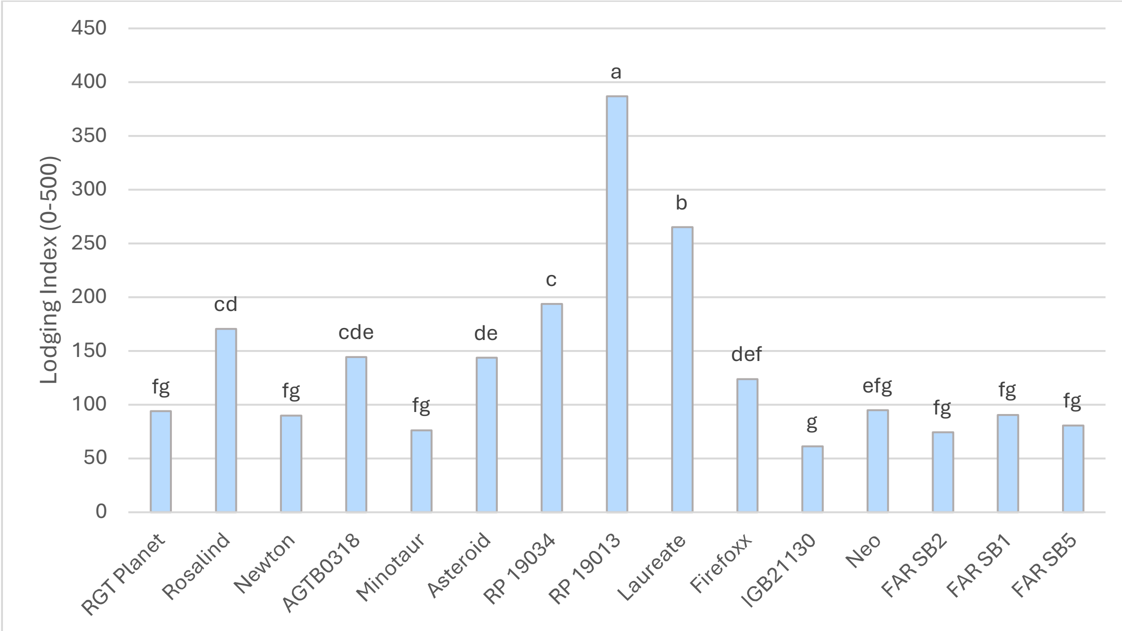

Figure 2. Influence of variety on the lodging index (0-500 scale) of barley cultivars assessed at harvest – January 4th.

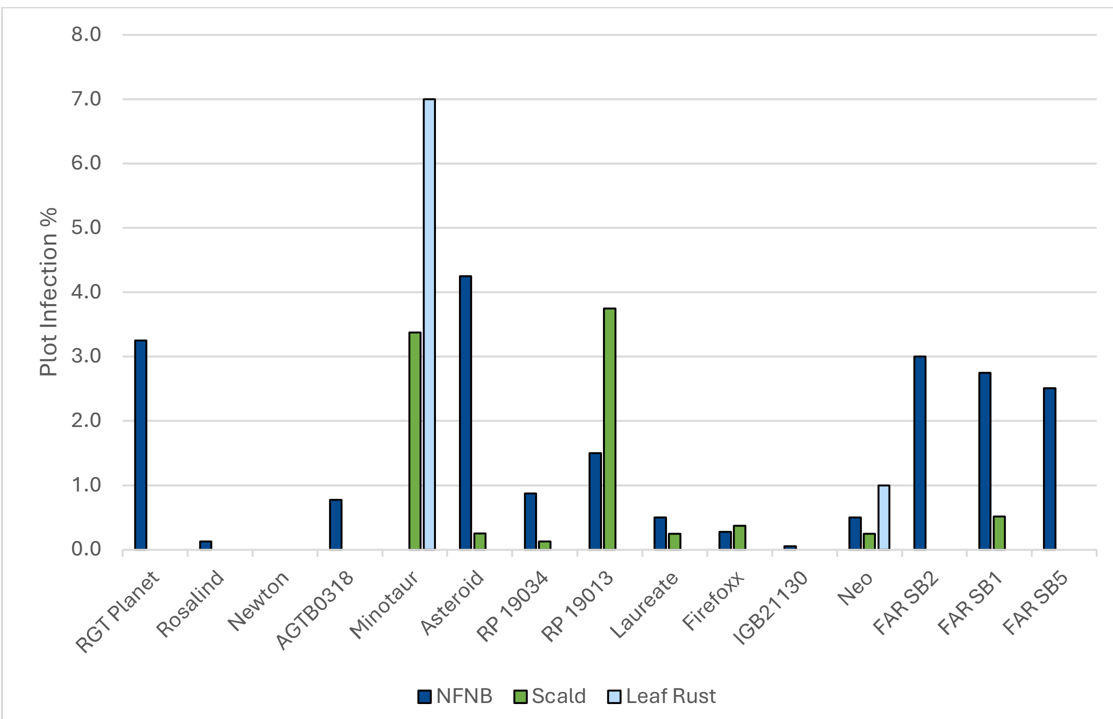

Figure 3. Influence of cultivar on the severity of Net Form of Net Blotch (NFNB), Scald and Leaf Rust (plot infection %) on barley cultivars untreated with fungicide (refer to table 4 for p values) – assessed October 18th.

Table 3. Trial input and management details (kg, g, ml/ha).

Sowing date:		**11 May**	
Harvest date:		**4 January**	
Seed rate:		180 seeds/m2	
Basal fertiliser:	11 May	100 kg MAP	
Herbicide:	9 May	TriflurX 3 L/ha	
	9 May	Spreadwet 0.2 L/ha	
	15 Aug	Broadside 1.4 L/ha	
Crop protection:	20 Jun	Metarex 3 kg/ha	
	10 Nov	Alpha Scud 0.08 L/ha	
	7 Jan	Metarex 3 kg/ha	
Trace elements:	15 Aug	SprayGro Smartrace Triple 5 L/ha	
	2 Sept	SprayGro Smartrace Triple 5 L/ha	
	5 Sept	SprayGro Smartrace Triple 5 L/ha	
	16 Sept	SprayGro Smartrace Triple 5 L/ha	
Nitrogen:	26 July	50 kg N/ha	
	19 Sept	100 kg N/ha	
Fungicide:		**Untreated**	**Full Protection**
	GS31	----	Prosaro 0.30 L/ha
	GS39	----	Aviator 0.50 L/ha

Hyper Yielding Crops – YieldMax Canola
(FAR SAC C23-02)
Sown: 9 May 2023
Harvested: 20 December 2023
Rotation position: 2022 Barley
Soil type & Management: Neutral-slightly alkaline Organosol (Peat soil)

Key Points:

- *Yield of the spring canola trials was lower than yield of the winter trials at this site. The spring canola varieties suffered from a major wind event in spring when winter canola varieties were still elongating.*
- *45Y95 CL was the standout variety for grain yield, averaging 3.35 t/ha across input treatments. This was ~0.4 t/ha higher yielding than the second ranked variety.*
- *45Y28 RR had the highest oil concentration, 1.3% oil above the second ranked variety (which is approximately 2% more value per tonne).*
- *Increasing crop nutrition input (including N, P and manure) resulted in higher biomass at three assessment timings, early flowering, end of flowering and maturity. The High Input treatment yielded 0.3 t/ha higher than the low input*

treatment but was taller and lodged more as a results of a major wind event mid-spring.

- *Yield components were assessed on three varieties at crop maturity. Pods/m² was well below target for high yielding canola crops, at ~3000 average across treatments (versus a target of 6-7000 pods/m²). Seeds/pod and seed size were above average and partly compensated for the low pod number, but the low number of pods set in spring limited overall yield potential.*
- *The large seed harvested in this trial indicates that climatic conditions post - flowering were good, and conditions post-flowering may have been better than pre-flowering.*

Table 1. Influence of management strategy and variety on grain yield (t/ha).

	Management Level		
	Low Input 150 kg/ha N	**High Input 225 kg/ha N + M**	**Mean**
Cultivar	**Yield t/ha**	**Yield t/ha**	**Yield t/ha**
1. 45Y28 RR	2.56 -	3.21 -	**2.88 b**
2. Eagle TF	2.63 -	2.83 -	**2.73 b**
3. HyTTec Trifecta	2.84 -	2.99 -	**2.92 b**
4. Hyola Blazer TT	2.88 -	3.02 -	**2.95 b**
5. 45Y95 CL	3.18 -	3.53 -	**3.35 a**
6. Hyola Solstice CL	2.56 -	2.81 -	**2.68 b**
Mean	**2.77 b**	**3.07 a**	**2.92**
LSD P=0.05 Cultivar	0.33	**P value**	0.010
LSD P=0.05 Management	0.18	**P value**	0.011
LSD P=0.05 Cultivar x Man.	ns	**P value**	0.689

Table 2. Cultivar start of flowering date and harvest grain quality assessment- oil (%), and test weight (kg/hL).

		Grain Quality Assessments	
Cultivar	**Flowering Date (BBCH 60)**	**Oil (%)**	**Test Weight (kg/hL)**
1. 45Y28 RR	22/08/23	48.2 a	64.4 b
2. Eagle TF	15/08/23	46.4 c	62.5 c
3. HyTTec Trifecta	22/08/23	45.8 d	65.2 a
4. Hyola Blazer TT	14/08/23	45.3 e	65.2 a
5. 45Y95 CL	25/08/23	46.0 cd	62.7 c
6. Hyola Solstice CL	21/08/23	46.9 b	64.8 ab
LSD P=0.05	-	0.5	0.4
P value	-	<0.001	<0.001
Nutrition			
1. Low Input	-	46.8 a	64.2 -
2. High Input	-	46.0 b	64.1 -
LSD P=0.05	-	0.2	ns
P value	-	<0.001	0.269

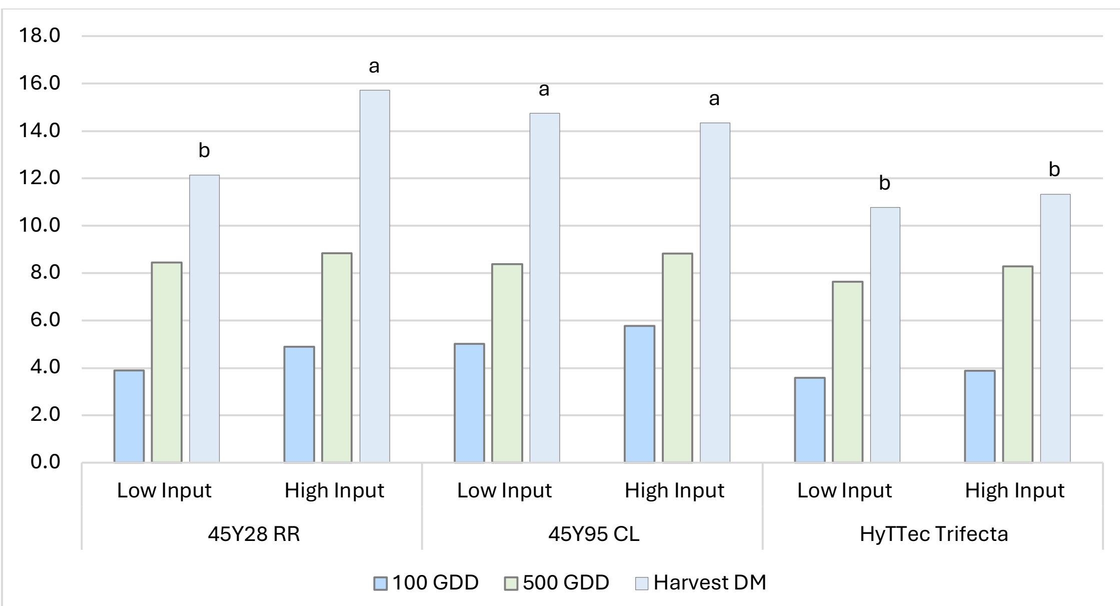

Figure 1. Dry matter (t/ha) 100 Growing Degree Days (GDD), 500 GDD and physiological maturity across three cultivars and two management strategies.

Table 3. Influence of variety on yield components 1000 seed weight (g), pods/m^2, and seeds/pod.

	1000 seed weight (g)	Pods/m^2	Seeds/pod
High Input - 45Y28 RR	4.70 -	2841 -	22.8 -
High Input - HyTTec Trifecta	4.63 -	2993 -	22.3 -
High Input - 45Y95 CL	4.88 -	3083 -	21.9 -
Mean	4.74	2972	22.3
LSD P=0.05	ns	ns	ns
P value	0.780	0.581	0.801

Table 4. Trial input and management details.

Sowing date:		**9 May 2023**		
Harvest date:		**20 December 2024**		
Plant population:		60 plants/m²		
		Low Input	**High Input**	
Basal Fertiliser:		145 kg/ha MAP (30 kg/ha P) (15 kg/ha N)	204 kg/ha MAP (45 kg/ha P) (22 kg/ha N)	
			5 t/ha pig manure*	
Nitrogen:	Basal			
	3-4-Leaf (30 May)	83.3 kg/ha ammonium sulphate (17 kg N + 20 kg S)	83.3 kg/ha ammonium sulphate (17 kg N + 20 kg S)	
	6-leaf (18 Jul)	37.5 kg N/ha as urea	104 kg N/ha as urea	
	Stem elongation (8 Aug)	37.5 kg N/ha as urea	104 kg N/ha as urea	
Total N Applied:		**107 kg N /ha**	**247 kg N/ha + Manure**	
Herbicides:	IBS (8 May)	TriflurX 2 L/ha Tenet 500 SC 1.5 L/ha		
	6-leaf (18 Jul)	**CL**	**TT**	**RR**
		Ammonium sulphate 800 g/ha Platinum Xtra 0.33 L/ha Lontrel Advanced 0.1 L/ha Expedient 1%	Intervix 750 mL/ha Expedient 1%	Weedmaster DST 1.3 L/ha Expedient 1%
Fungicide:	Seed treatment	Saltro Duo		

	6-Leaf (18 Jul)	Prosaro 450mL/ha
	20% Bloom (19 Sept)	Aviator Xpro 800mL/ha
Crop Protection	Pre-emergent	5kg/ha Metarex
		Pyrinex Super 500ml/ha

*Refer to 'Appendix. HYC Canola SA Crop Technology Centre' for manure analysis.

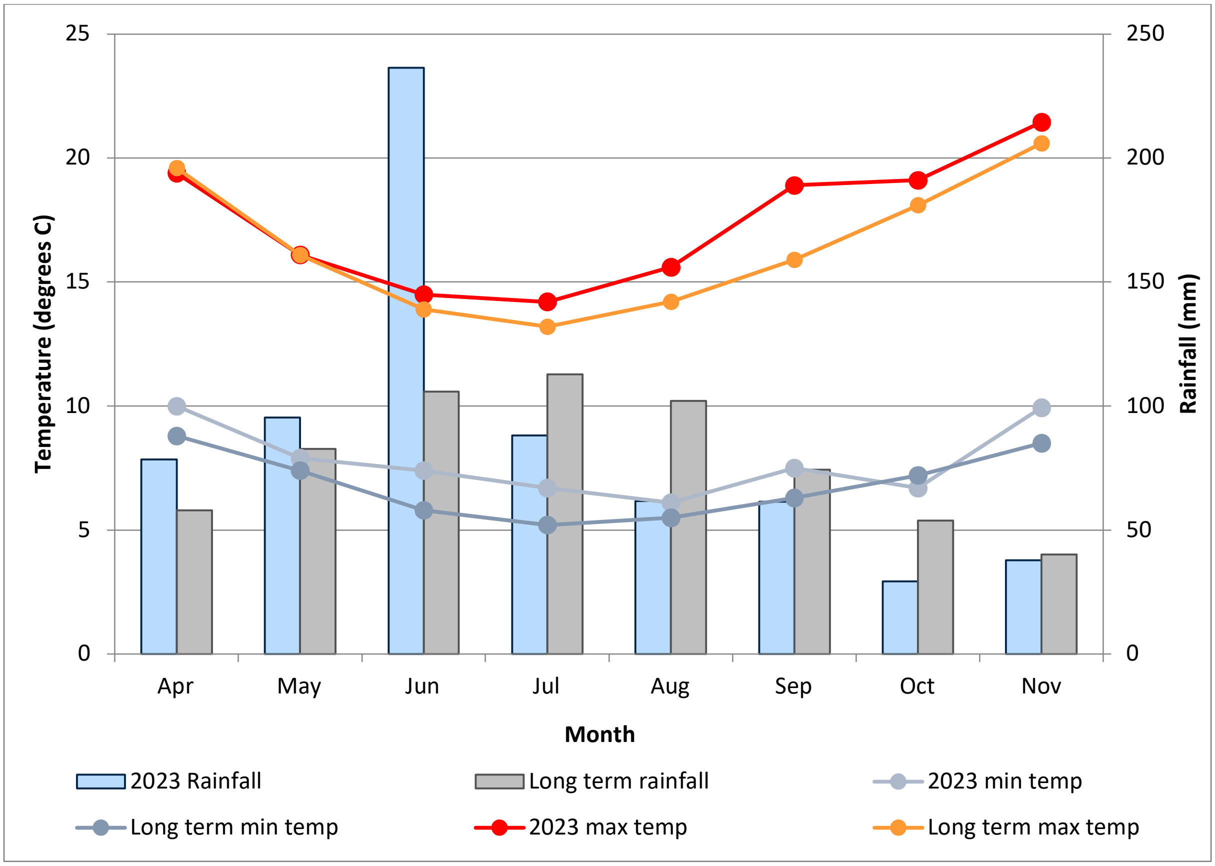

Figure 2. 2023 growing season rainfall and long-term rainfall recorded at Millicent (1878-2023). 2023 min and max temperatures, and long-term temperatures recorded at Mount Gambier (1942-2023). *Growing season rainfall April to October= 689 mm.*

These results are offered by Field Applied Research (FAR) Australia solely to provide information. While all due care has been taken in compiling the information, FAR Australia and employees take no responsibility for any person relying on the information and disclaims all liability for any errors or omissions in the publication.

GERMPLASM

evaluation network (GEN)

your trusted research partner for germplasm evaluation

HOW GOOD IS YOUR VARIETY? WHY NOT GET IT TESTED IN GEN?

An Industry Innovations (II) initiative

SOWING THE SEED FOR A BRIGHTER FUTURE

GERMPLASM EVALUATION NETWORK (GEN)

Background:

FAR Australia has been working with breeders to bring new products to the Australian Grains industry since its inception in 2012. It is a trusted development partner for many breeders, assisting with bringing in new germplasm to the marketplace, whilst ensuring the correct management to fulfil the genetic yield potential.

Industry Collaborations:

FAR Australia is partnering with industry to independently showcase ***germplasm*** performance in a series of high productivity ***evaluation*** trials across the country as part of its Industry Innovations (II) initiative.

FAR Australia has been delivering extremely successful germplasm evaluation network (GEN) pilot programmes across an established series of trial sites in order to test different germplasm in wheat and barley. The five Crop Technology Centres that test GEN are located in WA, SA, Vic, NSW and Tas.

What is Proposed:

Once again, the 2025 programme will focus on genetic yield potential and disease resistance. The trials, in wheat barley and canola, will be managed ‘plus and minus’ fungicide using FAR Australia’s expertise in disease management.

This independent initiative delivers a coordinated and independent network of high productivity trials in wheat and barley. The trials will be managed ‘plus and minus’ fungicide with control varieties provided by FAR Australia.

All trial results will be reported to the breeders within 21 days of harvest. FAR Australia will report results of all trials to the wider industry after all breeders have been informed of their results.

The breeders and FAR Australia will jointly own the results produced. Pre commercialisation breeding lines can be identified by the breeders or a FAR Australia code.

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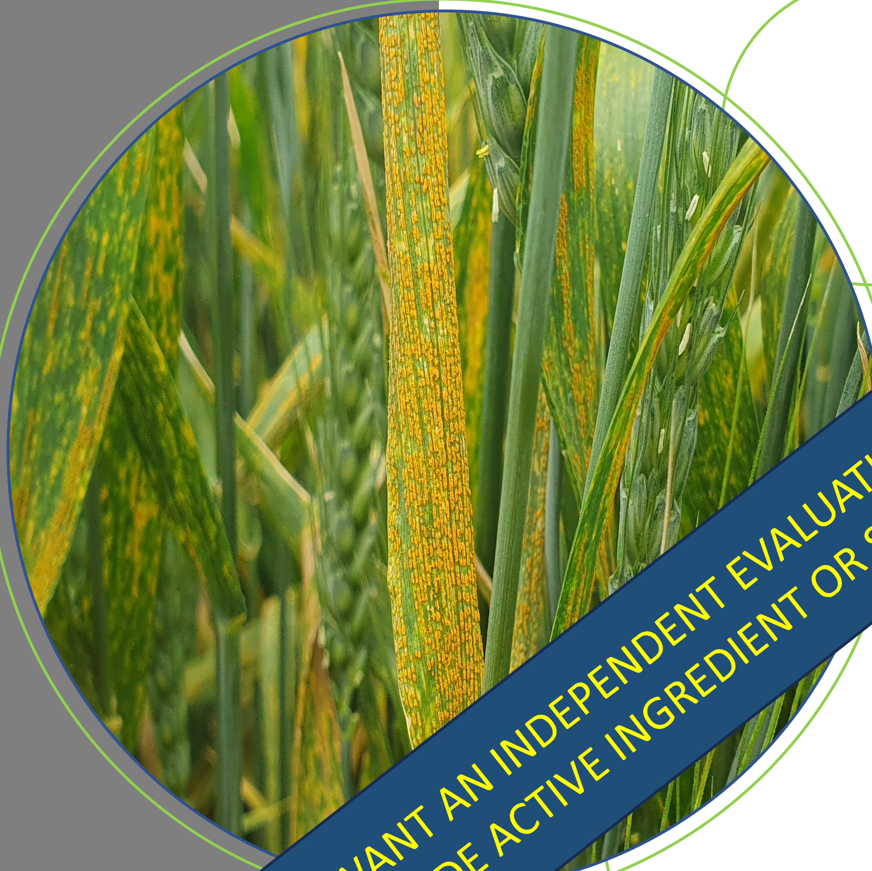
FUNGICIDE FINGERPRINTING

an independent fungicide evaluation network



DO YOU WANT AN INDEPENDENT EVALUATION OF YOUR FUNGICIDE ACTIVE INGREDIENT OR STRATEGY?

An Industry Innovations (II) initiative

SOWING THE SEED FOR A BRIGHTER FUTURE

FUNGICIDE FINGERPRINTING - FIRST IN ITS FIELD

Fungicide Fingerprinting, developed by FAR Australia, was launched in 2021 and is the first coordinated and independent fungicide evaluation network in Australia. This initiative aims to generate an independent evaluation of existing and newly developed fungicide strategies to help growers and advisers make better decisions when managing disease. It is:

- Independent
- accurate
- consistent in the approach to disease assessment
- within the label stipulations and AFREN compliant control framework

Collaborating Industry Stakeholders

This industry initiative is of benefit to agrichemical manufacturers involved in both new active and generic, fungicide resellers with agronomists in the field, private advisers and regional farming groups.

Overall Objective:

Individual objectives specific to the trial are:

- To assess the efficacy of different fungicide strategies and active ingredients against foliar pathogens prevalent in the HRZ of Australia.
- To assess the most <u>cost-effective</u> fungicide strategies in different HRZ regions of Australia (long season and short season) using less expensive generic chemistry alongside the latest development material.
- To evaluate whether newer generation fungicide chemistry is more effective than DMI based standard controls.
- To determine the impact of introducing Group 7 and QoI Group 11 chemistry SDHI into two spray programmes.
- To allow development material to be entered under a FAR code (where it is pre commercial) which is revealed when the new active is commercialised.

The Fungicide Fingerprinting initiative is conducted at FAR Australia's Crop Technology Centres in the HRZ regions of Australia where disease is more prevalent, thus an important component of cereal crop agronomy.

Costs:

Should you wish to invest in entries into FAR Australia's Fungicide Fingerprinting Evaluation Network or Germplasm Evaluation Network (GEN), please contact Rachel Hamilton on 0428 843 456 or email rachel.hamilton@faraustralia.com.au

FUNGICIDE FINGERPRINTING
an independent fungicide evaluation network

Agronomic Practices for Hyper Yielding Wheat

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GRDC project codes: FAR2004-002SAX, FAR00003

Keywords
disease management strategies, photothermal quotient (PTQ), red grained feed wheats, yield potential.

Take home messages
- The hyper yielding crops (HYC) project has successfully demonstrated new yield benchmarks for productivity of cereals in the more productive regions and seasons over the last four years.
- It is typically larger numbers of grains per head at harvest that generate high yields and increases the overall number of grains per unit area for wheat, barley and canola.
- At the HYC Millicent site in 2021–2023, fungicide management strategies for stripe rust and Septoria, combined with variety choice, were the most important factors in generating high wheat yields.
- Maximum wheat yields in southeast SA were achieved by red grained feed wheats and modern fungicide chemistry.
- Hyper yielding cereal crops require high levels of nutrition; rotations which lead to high levels of inherent fertility and judicious fertiliser application underpin high yields and the large nutrient offtakes associated with bigger crop canopies.
- The most important agronomic lever for hyper yielding wheat and closing the yield gap over the last four years has been the introduction of new germplasm and the correct disease management strategy, which was important despite the drier spring in 2023.

Hyper yielding crops research and adoption
The Hyper Yielding Crops (HYC) project, with assistance from three relatively mild springs (2020–2023), has demonstrated new yield boundaries for wheat, barley and canola, both in research and on commercial farms in the high rainfall zone (HRZ) of Australia. Five HYC research sites, with associated focus farms, and innovation grower groups have shown that wheat yields in excess of 11t/ha are possible in the southeast SA (Millicent). In the shorter season environments of WA, 7–9t/ha has been demonstrated at FAR Australia's Crop Technology Centres in Frankland River and Esperance in 2021.

Yield potential
Over the three years 2020–2023, yield potential at the HYC sites has been limited by solar radiation and temperature rather than soil water availability. Wheat and barley

yield potential is driven by grain number in these mild moist springs. Whilst head number clearly contributes to high yield, there is a limit to the extent it can be used to increase yield. In most cases with yields of 10–15t/ha, 500–600 heads/m^2 should be adequate to fulfil the potential.

So how do we increase grains per m^2

Whilst more heads per m^2 contribute to yield outcomes, it is typically larger numbers of grains per head at harvest that generates high yields and increases the overall number of grains per unit area in HRZ regions. It's been acknowledged for several years that increasing grain number is related to growing conditions prevalent in the period from mid-stem elongation to start of flowering (approximately GS33–61). This window of growth in cereals covers the period approximately 3–4 weeks (~300°C.days) prior to flowering and is described as the 'critical period' (Dreccer et al. 2018). This critical period encompasses when the grain sites are differentiating, developing and male and female parts of the plant are forming (meiosis). If conditions during this period of development are conducive to growth, with high solar radiation and relatively cool conditions (avoiding heat stress), then more growth goes into developing grain number per head. The Photothermal Quotient (PTQ) or 'Cool Sunny Index' is a simple formula (daily solar radiation/average daily temperature) that describes how conducive conditions are for growth and, when applied to the critical period, it assists in determining the yield potential. When applied to the critical period, a high PTQ means a longer duration for photosynthesis leading to more grain and yield. The relative importance of PTQ is increased in seasons where soil moisture stress is not a factor. The relationship between yield potential and PTQ has been updated based on results from the HYC research (Figure 1). Using this data we demonstrated the new upper yield boundary created using European feed wheat varieties.

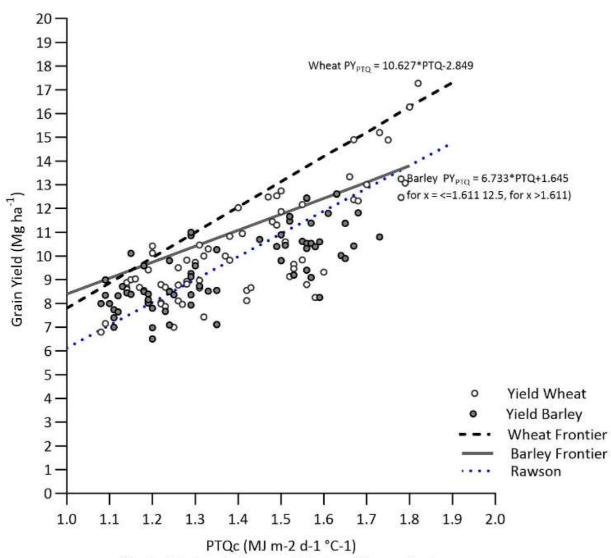

Figure 1. Relationship between photothermal quotient (PTQ) in the critical growth period and yield potential of cereals – a comparison of wheat and barley. Porker et al. (in press).

Rawson line in graph is associated with previous research on PTQ - Rawson HM (1988) Constraints associated with rice–wheat rotations

As growers and advisers, we understand the importance of cereal flowering date in order to minimise frost risk and heat/moisture stress. However, in high yielding crops, where moisture and heat stress are less problematic, optimising the flowering date enables us to maximise growth in the critical period for generating grain number per unit area. In 2021, the highest yield recorded in the HYC project on the mainland at Millicent (12.74t/ha) was achieved with a UK wheat cultivar, cv Reflection (a red grained winter wheat). Traditionally, this cultivar is considered too slow developing (i.e. flowers too late) for an Australian mainland HRZ environment, but in 2021, the mild spring and summer grain fill period allowed this cultivar to complete grain fill under more optimal conditions. The higher yield of this variety was associated with a lower thousand grain weight TGW (Figure 2). Whilst in this case, grains per head were not assessed, it was clear that to achieve such a high yield with small grains, must be a result of a high number of grains per unit area.

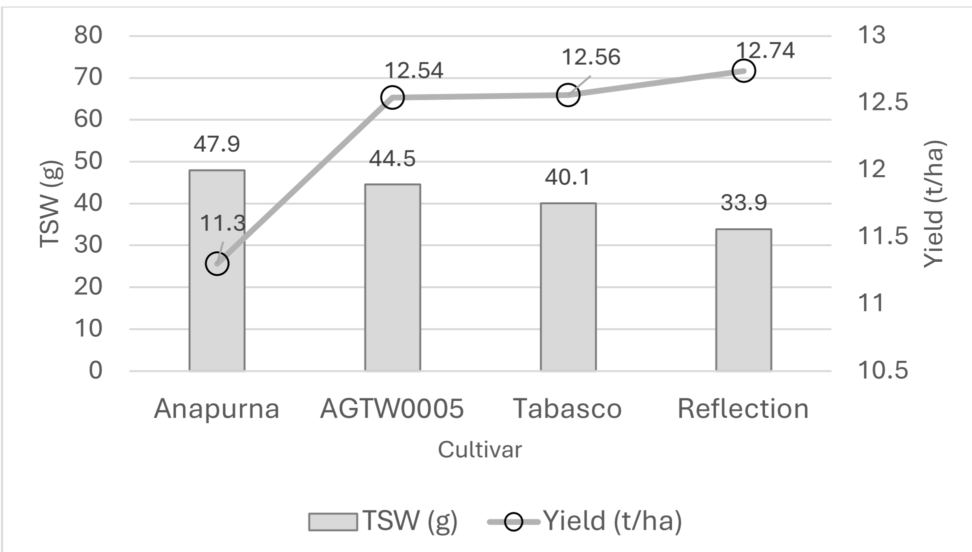

Figure 2. Relationship between highest yielding wheat cultivars in the HYC Elite Screen and thousand seed weight (tsw) – Millicent SA 2021.
Line figures represent yield, bars represent thousand seed weight (tsw)

Realising yield potential

It is one thing to create yield potential by maximising grain number per unit area, however higher grain numbers established during the critical period still must be realised during grain fill. For example, a very late developing wheat variety could benefit from optimal growing conditions associated with the critical period but then be subject to moisture and heat stress post flowering. This would result in a high harvest dry matter but a lower harvest index where less of the dry matter is realised as grain. Therefore, it remains a balance between setting potential and realising potential where the optimum flowering date and the phenology of the variety remain central to success in any season. However, recognising the importance of the critical period has been central to our understanding of higher yielding seasons.

Nutrition and rotation for hyper yielding wheat – farming system fertility to establish yield potential

The most notable results observed in the HYC project to date relate to nitrogen fertiliser. However, simply applying high rates of N fertiliser is not always the best option to achieve hyper yields. Nitrogen fertiliser rates should consider:

- N mineralising potential of the soil
- Carry-over N from previous years
- starting mineral N
- other factors, such as crop lodging potential, that may impact radiation efficiency.

It should be emphasised, however, that replacing N removal (N off-take in grain or hay) is required to maintain a sustainable farming system. Results from our southern NSW site at Wallendbeen provide an example of the conundrum with hyper yielding wheat crops. Established in a mixed farming system based on a leguminous pasture (six year phase) in rotation with a six year cropping phase, winter wheat yielded 8–9t/ha, however the application of N at rates greater than 120kg N/ha (2022) and 160kg N/ha (2023) in this scenario only served to reduce profit, while higher rates ≥160kg N/ha also reduced yield in 2022 (Figures 3 and 4). In 2022, despite an application of plant growth regulator (PGR) Moddus® Evo at 0.2L/ha + Errex® 750 at 1.3L/ha at GS31, higher applied N fertiliser rates (above 160kg N/ha) increased head numbers but also increased lodging during grain fill (data not shown), which led to reduced yield.

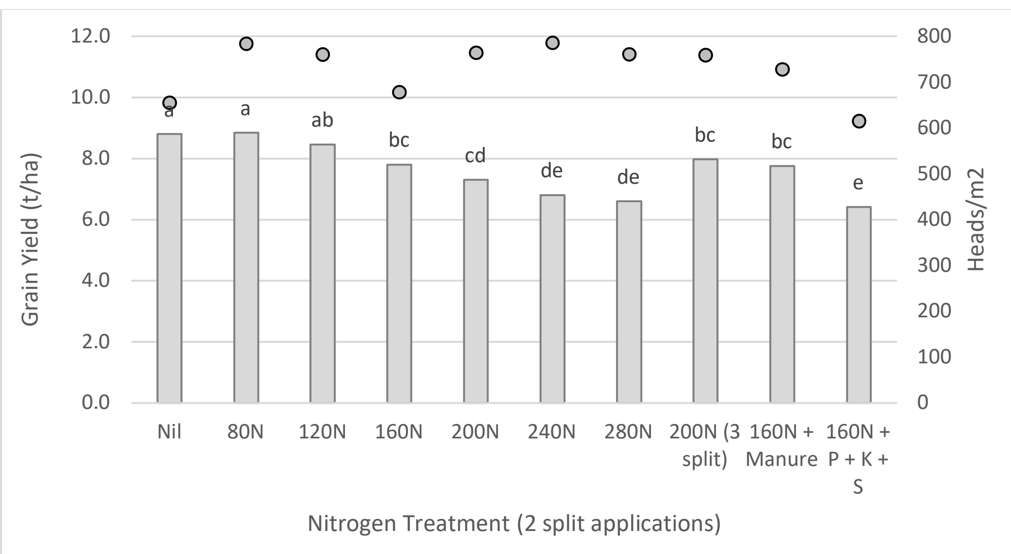

Figure 3. Influence of applied nitrogen, manure and other nutrients on yield and head number – HYC Wallendbeen, NSW 2022. Columns denote grain yield and dots show heads/m^2.

Notes: N applied as urea (46% N) was applied at tillering (21 June) and GS31 (27 August).

Soil available N in winter (4 July): 0–10cm 39kg N/ha; 10–30cm 56kg N/ha; 30–60cm 46kg N/ha.

Chicken manure pellets applied at 5t/ha with an analysis of N 3.5%, P 1.8%, K 1.8% and S 0.5%. Columns with different letters are statistically different P = 0.05, Lsd: 0.79t/ha.

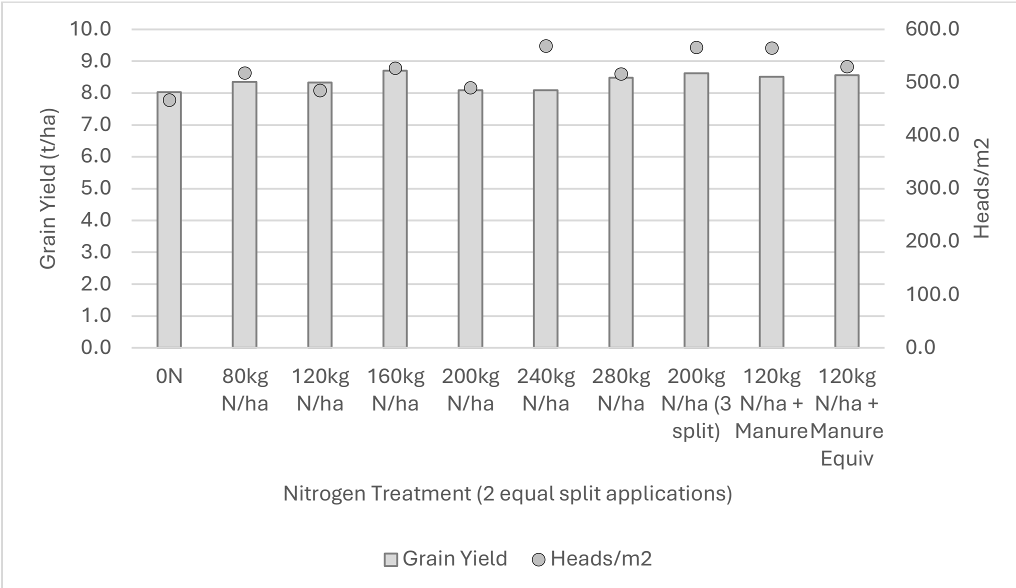

Figure 4. Influence of applied nitrogen, manure and other nutrients on yield and head number – HYC Wallendbeen, NSW 2023. Columns denote grain yield (*P* = 0.142) and dots show heads/m^2 (*P* =0.105).
Notes: N applied as urea (46% N) was applied at GS30 (22 July) and GS32 (9 August).
Soil available N in winter (10 Jul): 0–10cm 43kg N/ha; 10–30cm 70kg N/ha; 30–60cm 113kg N/ha.
Cattle feedlot manure applied at 5t/ha with an analysis of N 1.14%, P 0.68%, K 1.5% and S 0.4%.

Despite drier conditions in 2023, the results show that fertile soils with high soil organic matter (SOM) have the potential to mineralise sufficient N to achieve potential yield. This is shown by the nil fertiliser rate in Figures 3 and 4. In fact, since 2016 in HYC research, optimum applied fertiliser N rates have rarely exceeded 200kg N/ha for the highest yielding crops, even though the crop canopies (biomass) that these yields are dependent on, are observed to remove far more N than has been applied. This indicates N supply in the hyper yielding sites is most likely provided by the mineralisation of N from (SOM) pre-sowing and in-crop. The 8.0t/ha (2023) and 8.8t/ha (2022) yields from the nil N treatment are indicative of fertile farming systems, where N recovery efficiencies from SOM are typically much higher (70%, Baldock 2019) than those achieved with fertiliser N, which is often reported at 44% (Vonk et al. 2022; Angus and Grace 2017). Consequently, the same yield (8.8t/ha) supplied entirely by N fertiliser would require 400kg N/ha, assuming an N efficiency of 44%.

Protecting yield potential

Many regions experienced just how important it is to protect yield potential from stripe rust in 2022 and 2023, with many growers describing the stripe rust epidemic in 2022 as the worst in 20, if not 50 years. Disease management, over the last four years, has been shown to be a key factor in securing high yielding crops in HYC project trials. It is also one of the main factors in securing high yields and closing the yield gap in favourable seasons in low to medium rainfall zones (L-MRZ). Millicent Germplasm Evaluation Network (GEN) 2023 rials, in the drier season of 2023, again illustrated the importance of combining the best disease management strategy with the best germplasm (variety) (Figure 5).

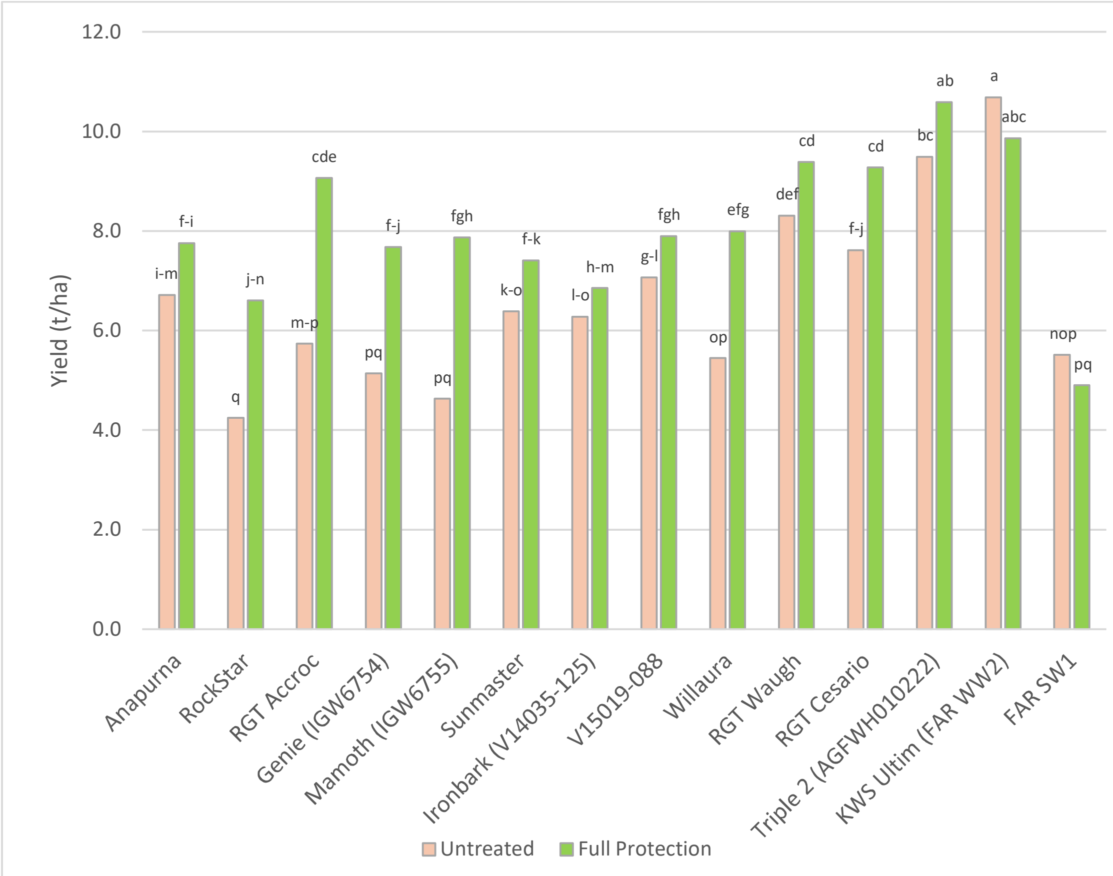

Figure 5. Influence of wheat cultivar and fungicide application (three foliar sprays GS31, GS39 and GS59) on grain yield (t/ha) when the principal diseases were stripe rust and Septoria tritici blotch – FAR Australia Germplasm Evaluation Network (GEN) 2023, Millicent, SA.
LSD Cultivar x fungicide management – LSD 1.11t/ha, p value <0.001
Varieties covered by Plant Breeders Rights (PBR)

When conditions are wet during stem elongation when the principal upper canopy leaves emerge (flag, flag-1, flag-2), fungicide application is essential to protect yield potential in these environments. Infection was so severe in 2022, that fungicide timing and the strength of the active ingredients being used made significant differences in productivity. Long 'calendar gaps' of over four weeks between fungicides resulted in the epidemic becoming out of control in many crops, as unprotected leaves became badly infected in the period between sprays, and applications became more dependent on limited curative activity rather than protectant activity. The wider issue that the success of fungicide management raises is that pathogen resistance to fungicides is primarily driven by the number of applications of the same mode of action. This is why it is imperative to incorporate the most resistant, high yielding and adapted (phenology) germplasm available to reduce our dependence on fungicide agrichemicals.

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GRAINS RESEARCH & DEVELOPMENT CORPORATION

HYPER YIELDING CROPS

2023 Annual Report

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Prepared by:

FAR AUSTRALIA

‘Growers Leading Change’
Hyper Profitable Crops

Overview:
The Hyper Profitable Crops (HPC) initiative is a new GRDC investment aimed at significantly boosting on-farm profitability for wheat and barley growers in Australia's high rainfall zones. Despite the progress made by previous research initiatives, a considerable gap remains between actual crop yields and the potential profitability in these regions. The HPC initiative seeks to bridge this gap by putting cutting-edge research into practice on the farm, enabling a wide range of growers to enhance their profitability.

Project Goals:
Building on the success of earlier GRDC Hyper Yielding Crops investment, which demonstrated improved crop water use efficiency and higher yields through informed decisions on variety, sowing date, fertiliser, and disease management, the HPC initiative will focus on translating this knowledge into actionable strategies for growers. The ultimate goal is to equip wheat and barley growers in high rainfall environments with the motivation, agronomic support, and expertise needed to close the yield gap while maximising profit by April 30, 2027.

Innovation and Benchmarking Hubs:
Central to the initiative are seven innovation and benchmarking hubs strategically located across key high rainfall zones, including the South Coast of Western Australia, South-eastern South Australia, Southern Victoria, Tasmania, and Southern New South Wales. These hubs will act as centres for knowledge exchange, facilitated discussions, and hands-on crop inspections. They will enable growers to learn from each other and explore and implement innovative agronomic practices that can lead to increased, on-farm profitability.

Discussion Groups and On-Farm Benchmarking:
As part of the HPC initiative, 17 discussion groups have been established across the high rainfall zones. These groups aim to not only boost on-farm profitability but also build confidence among Generation Y growers and advisors, who will play a pivotal role in leading change within their regions. Through on-farm benchmarking of paddock performance and smaller HPC-specific trial programs, growers will have the opportunity to refine their management practices, optimise crop yields, and achieve more profitable outcomes.

Collaboration and Support:
FAR Australia has partnered with regional farming systems groups to provide dedicated project officers in each region. These officers will work closely with farmers and agronomists to collect input and operational data, which will be costed generically per region using the Agworld data platform. Importantly, no individual financial data will be requested from participating growers. In addition to this support, the initiative will

produce a comprehensive high rainfall zone cropping manual, offering valuable insights and case studies to guide future decision-making.

How to get Involved:
To become involved in the Hyper Profitable Crops initiative, growers can contact the HPC Project Officer in their respective region:

- Mackillop Farm Management Group: Gina Kreeck (research@mackillopgroup.com.au)
- Farmlink: Caroline Keeton (caroline@farmlink.com.au)
- Riverine Plains Inc: Kate Coffey (kate@riverineplains.org.au)
- Southern Farming Systems:
    - (VIC) Ashley Amourgis (aamourgis@sfs.org.au) or Greta Duff (gduff@sfs.org.au)
    - (TAS) Brett Davey (bdavey@sfs.org.au)
- Stirlings to Coast Farmers: Dan Fay (dan.fay@scfarmers.org.au)
- South East Premium Wheat Growers Association (SEPWA): David Cook (david@sepwa.org.au)

Project Leadership:
The HPC initiative is led by Rachel Hamilton of FAR Australia, supported by a technical team including Dr. Ben Jones, Darcy Warren, Tom Price and Nick Poole.

For further information, please contact Rachel Hamilton at rachel.hamilton@faraustralia.com.au.

FAR Australia has collaborated with the following organisations:

The primary role of Field Applied Research (FAR) Australia is to apply science innovations to profitable outcomes for Australian grain growers. Located across three hubs nationally, FAR Australia staff have the skills and expertise to provide 'concept to delivery' applied science innovations through excellence in applied field research, and interpretation of this research for adoption on farm.

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