NSW CROP TECHNOLOGY CENTRE

FAR AUSTRALIA

Industry Innovations
leading the way to a brighter grains industry

FIELD DAY

INCREASING PRODUCTIVITY & PROFITABILITY IN THE NSW HRZ

Thursday 17th October 2024

SOWING THE SEED FOR A BRIGHTER FUTURE

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

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Thanks to our host farmer: Charlie Baldry

VISITOR INFORMATION

We trust that you will enjoy your day with us at our NSW 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.

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- 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 NSW HRZ

FEATURING INDUSTRY INNOVATIONS

On behalf of myself and the FAR Australia team, I am delighted to welcome you to our 2024 NSW Crop Technology Centre Field Day featuring Industry Innovations covering canola 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 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 guests speakers Terry Rose from Southern Cross University who will be discussing phosphorous nutrition, and Maurie Street from Grain Orana Alliance who be presenting on canola agronomy.

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 farmer Charlie Baldry for his tremendous practical support given to our team, and to today's sponsors AGF Seeds and Delta Agribusiness.

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

NSW CROP TECHNOLOGY CENTRE FIELD DAY
THURSDAY 17 OCTOBER 2024

11:00am **Coffee and opening address by Nick Poole, FAR Australia's Managing Director**

Session	Panel session	Site	11:30
Panel discussion	***The cost of production in an era of growing compliance and the need for reduced emissions*** *Facilitated by Nick Poole, the Panel includes host farmer Charlie Baldry, grower and GRDC Northern Panel deputy chair Roger Bolte, agronomist Tim Condon, grower Stuart Tait and Tom Price (FAR Australia).*	**Farm shed**	**All**

Thanks to our Keynote Speaker sponsor:

Thanks to our lunch and post event refreshments sponsor:

Session #	In-field presentations (cereals)	Station #	12:30	1:30	2:00	2:30	3:15	4:15
1	***Nick Poole, FAR Australia***	**1**	Lunch	**All**				Closing address and post event refreshments
2	***Tom Price, FAR Australia***	**2**			**All**			
3	***Ben Morris, FAR Australia***	**3**				**All**		
5	***Terry Rose (Southern Cross University) and Maurie Street (Grain Orana Alliance)***	**Canola Researh Site**					**All**	
	In-field presentations	**Station #**	**12:30**	**1:30**	**2:00**	**2:30**	**3:15**	**4:15**

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MATURITY SPEED
VERY QUICK — VERY SLOW

SCEPTORIA RESISTANCE	POWDERY MILDEW	STRIPE RUST	LEAF RUST
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R	AH	

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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

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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

‘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:

- 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)
- Mackillop Farm Management Group: Gina Kreeck (research@mackillopgroup.com.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:


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Agronomic practices for hyper yielding crop (HYC) years and environments

Nick Poole[1], Tom Price[1], Darcy Warren[1], Max Bloomfield[1], Aaron Vague[1], Ben Morris[1], Rebecca Murray[1], Daniel Bosveld[1], Kenton Porker[2], Rohan Brill[3]

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[2] CSIRO
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Photothermal quotient (PTQ), red grained feed wheats, yield potential, disease management strategies

GRDC codes
FAR2004-002SAX, FAR00003

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
- At the HYC Millicent site in 2021 and 2023, fungicide management strategies for stripe rust and Septoria control combined with variety choice was shown to be the most important factors in generating high yields
- Maximum wheat yields in south east 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 fertilizer 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 new germplasm and 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 been able to demonstrate new yield boundaries of wheat, barley and canola both in research and on commercial farms in southern regions of Australia with higher yield potential. Five HYC research sites with associated focus farms and innovation grower groups have helped establish that wheat yields in excess of 11 t/ha are possible in the southeast SA (Millicent. In the shorter season environments of WA, 7–9 t/ha has been demonstrated at FAR's Crop Technology Centres in Frankland River and Esperance in 2021.

Yield potential

Over the three years 2020 – 2023, the relative absence of soil moisture stress at HYC locations has allowed the project team to look more closely at yield potential from the perspective of solar radiation and temperature rather than soil water availability. **High yielding crops of wheat and barley are about producing more grains per unit area in these mild moist springs.** This has been demonstrated in several projects and is a key factor in producing very high yields. Whilst head number clearly contributes to high yield, there is a limit to the extent to which head number can be used to increase yield. In most cases with yields of 10–15 t/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 contributes 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 three – four 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 and therefore per unit area for a given head population. 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 more photosynthesis for more days and more grain and more yield. **The relative importance of PTQ is increased in seasons where soil moisture stress is not a factor** (since soil moisture stress limits the ability of the crop to fill grain and fulfil its potential). HYC research has now been used to update the relationship between yield potential and PTQ (Figure 1). Using the graphed relationship established between yield and PTQ, it has been possible to demonstrate with HYC trial results that newer higher yielding European feed wheat varieties have resulted in a new upper yield boundary for given spring PTQ.

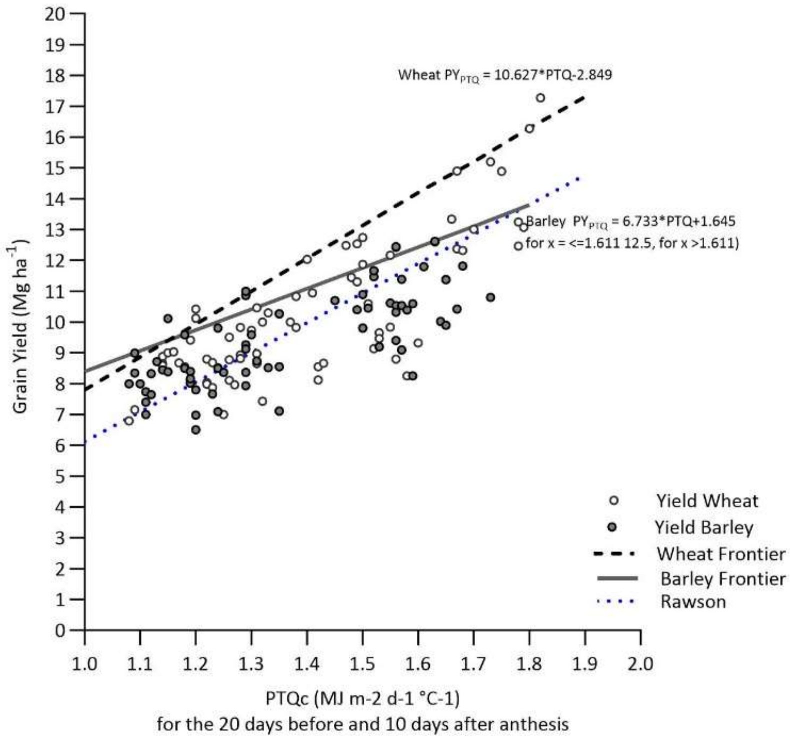

Figure 1. Relationship between photothermal quotient (PTQ) in the critical growth period and yield potential of cereals – a comparison of wheat and barley. Porker et al., (in press).

As growers and advisers, we are already aware of 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.

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 a later flowering date and critical period i.e., longer sunny days that are not excessively hot. This might well maximise final harvest dry matter and growth during the critical period, but not the final grain yield as the crop does not have a sufficiently high photothermal quotient (PTQ) to maximise growth during grain fill post flowering (i.e., it's too hot post flowering with later development and the crop has a low harvest index or soil moisture stress occurs during grain fill and there is insufficient soil water to finish the crop). Therefore, it remains a balancing act of setting potential and realising potential where the optimum flowering date and the phenology of the variety date for the variety remain central to success in any season. 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 (i) N mineralising potential of the soil, (ii) spared N from previous years, (iii) starting mineral N and other factors such as (iv) crop lodging potential that may impact radiation efficiency. It should be emphasised however that replacing N removal (N off-take in grain or hay) has to be an objective if we are 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 8–9 t/ha, however the application of N at rates greater than 120 kg N/ha (2022) and 160 kg N/ha (2023) in this scenario only served to reduce profit while higher rates ≥160kg N/ha also reduced yield in 2022 (Figures 2 & 3). In 2022 despite an application of plant growth regulator (PGR) Moddus® Evo at 0.2 L/ha + Errex™ 750 at 1.3 L/ha at GS31, higher applied N fertiliser rates (above 160 kg N/ha) increase head numbers but also increased lodging during grain fill (data not shown) which led to reduced yield.

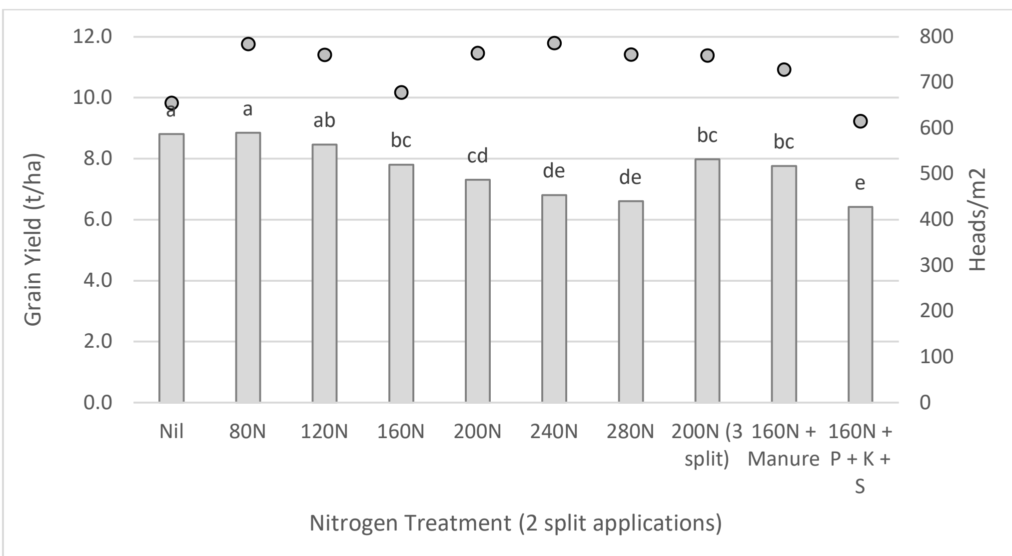

Figure 2. Influence of applied nitrogen, manure and other nutrients on yield and head number – HYC Wallendbeen, NSW 2022. Columns denote grain yield and dots show heads/m^2.

Notes: N applied as urea (46% N) was applied at tillering (21 June) and GS31 (27 August) Soil available N in winter (4 July): 0–10 cm 39 kg N/ha; 10–30 cm 56 kg N/ha; 30–60 cm 46 kg N/ha.

Chicken manure pellets applied at 5 t/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: 0.79 t/ha.

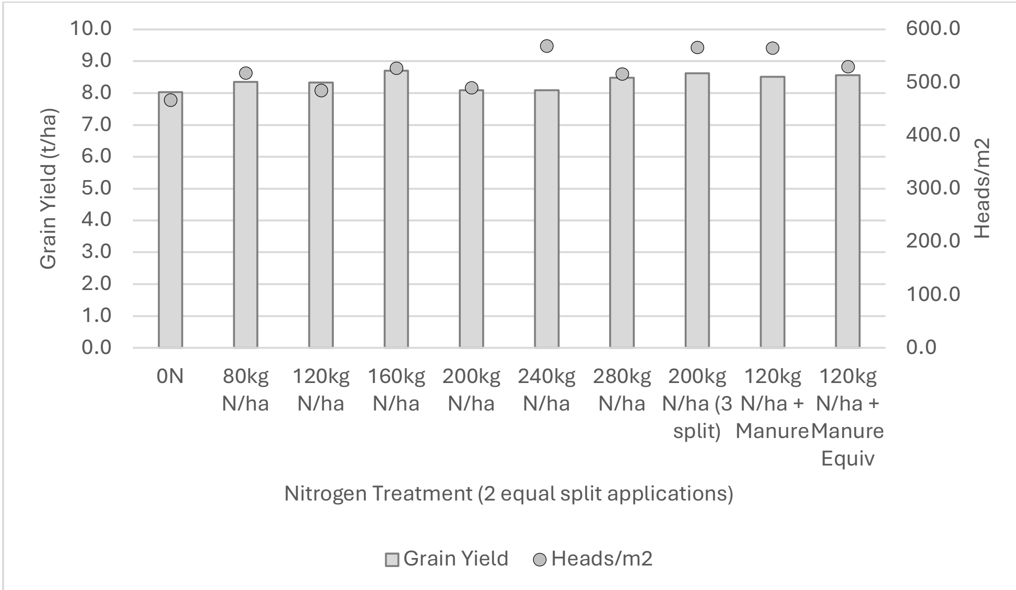

Figure 3. Influence of applied nitrogen, manure and other nutrients on yield and head number – HYC Wallendbeen, NSW 2023. Columns denote grain yield (*P* = 0.142) and dots show heads/m^2 (*P* =0.105).
Notes: N applied as urea (46% N) was applied at GS30 (22 July) and GS32 (9 August)
Soil available N in winter (10 Jul): 0–10 cm 43 kg N/ha; 10–30 cm 70 kg N/ha; 30–60 cm 113 kg N/ha.
Cattle feedlot manure applied at 5 t/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 serve to illustrate that fertile soils with high soil N supply capacity have the potential to mineralise sufficient N to achieve potential yield. This is illustrated by the nil fertiliser rate in Figures 2 & 3. In fact, since 2016 in HYC research, optimum applied fertiliser N rates have rarely exceeded 200 kg 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 that (assuming N is baled or burnt at harvest). This indicates N supply in the hyper yielding sites is most likely provided by the mineralisation of N from soil organic matter (SOM) pre-sowing and in-crop. The 8.0 t/ha (2023) and 8.8 t/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%, 2019 Baldock) than those achieved with fertiliser N which is often reported at 44% (Vonk *et al.,* 2022; Angus and Grace 2017). Consequently, the same yield (8.8 t/ha) supplied entirely by N fertiliser would require 400 kg N/ha assuming an N efficiency of 44%.

Protecting yield potential
Many regions experienced just how important it is to protect yield potential in 2022, 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 one of, if not the most important factors in securing high yielding crops in HYC project trials. It has also been demonstrated to be one of the most important factors in securing high yields and closing the yield gap in favourable seasons in low to medium rainfall zones (L-

MRZ). In Wallendbeen HYC trials in 2022 and the drier season of 2023 trials illustrated the importance of combining the best disease management strategy with the best germplasm (variety) (Figure 4). Seven wheat varieties (three milling wheats and four red grained feed wheats) were grown with four levels of fungicide protection (Table 1).

Table 1. Fungicide management treatments at Wallendbeen HYC, 2022 & 2023.

Treatment	
Treatment 1	**Untreated control**
Treatment 2	**One Unit approach**, a single flag leaf fungicide applied at GS39 – Revystar® (mefentrifluconazole 100 g/L, fluxapyroxad 50 g/L) applied at 750 mL/ha (75g ai/ha & 37.5g ai/ha)
Treatment 3	**Two-unit (straddle) approach** at GS33 (3rd node) Revystar® (mefentrifluconazole 100g/L, fluxapyroxad 50g/L) applied at 750 mL/ha (75g ai/ha & 37.5g ai/ha); and GS59 (head emergence) Opus® 125 (epoxiconazole 125 g/L) applied at 500 mL/ha (62.5 g ai/ha)
Treatment 4	**Four-unit approach** combining at sowing flutriafol on the fertiliser (MAP) with three foliar applications – GS31 Prosaro® 420 (prothioconazole 210 g/L, tebuconazole 210 g/L) applied at 300 mL/ha (63g ai/ha of each ai); GS39 (flag leaf emergence) Revystar® (mefentrifluconazole 100g/L, fluxapyroxad 50g/L) applied at 750 mL/ha (75g ai/ha & 37.5g ai/ha); and GS59 (head emergence) Opus® 125 (epoxiconazole 125 g/L) applied at 500 mL/ha (62.5 g ai/ha)
Treatment 5 (2023 only)	**Three-unit approach** combining at sowing flutriafol on the fertiliser (MAP) with a two spray straddle at GS33 (3rd node) Revystar® (mefentrifluconazole 100 g/L, fluxapyroxad 50 g/L) applied at 750 mL/ha (75g ai/ha & 37.5g ai/ha).; and GS59 (head emergence) Opus® 125 (epoxiconazole 125g/L) applied at 500 mL/ha (62.5 g ai/ha).

Table 2. Dates for key stages of crop phenology for spring and winter wheat varieties in the Wallendbeen HYC trial in the cool and very wet season of 2022 and drier and warmer season of 2023

Year	Wheat type	GS31	GS33	GS39	GS59
2022	Spring	14-Jul	9-Aug	26-Aug	20-Sep
	Winter	26-Aug	20-Sep	3-Oct	30-Oct
2023	Spring	3-Jul	2-Aug	17-Aug	10-Sep
	Winter	9-Aug	4-Sep	19-Sep	2-Oct

With the principal diseases being stripe rust and Septoria tritici blotch caused by the pathogens *Puccinia striiformis f.sp. tritici* and *Zymoseptoria tritici,* respectively, the levels of infection in 2022 at this site were so severe that not even the four-unit approach to disease management gave full control in the more stripe rust susceptible varieties. In 2023 the levels of disease were more typical with much smaller fungicide responses which were however still very cost effective in susceptible varieties. In 2022 none of the varieties had sufficient genetic resistance to be farmed more profitably with no fungicides, whilst in 2023 that was the case with AGTW005 (unfortunately this feed wheat was not commercialised after four years of testing). In ScepterⒹ, the response to the four-unit approach was almost 6 t/ha in 2022 (Figure 4) and 1.9 t/ha in 2023 (Figure 5). In 2022 the varieties AnapurnaⒹ, RGT CesarioⒹ and Big RedⒹ showed no significant yield advantage to four units of fungicides compared to one. With RGT CesarioⒹ, stripe rust resistance was not complete and a spray at GS31 did reduce disease levels. It should be noted that with these high yielding feed wheats, the response to fungicide was still 1.5 – 3.0 t/ha.

Whilst fungicides can only be considered an insurance (i.e., we don't know what the economic return will be when they are applied), it is clear that when conditions are wet during the stem elongation period as the principal upper canopy leaves emerge (flag, flag-1, flag-2), fungicide application is essential to protect yield potential. 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 (as was the case in own our study) 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 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 for HYC research to incorporate the most resistant, high yielding and adapted germplasm available in order to reduce our dependence on fungicide agrichemicals.

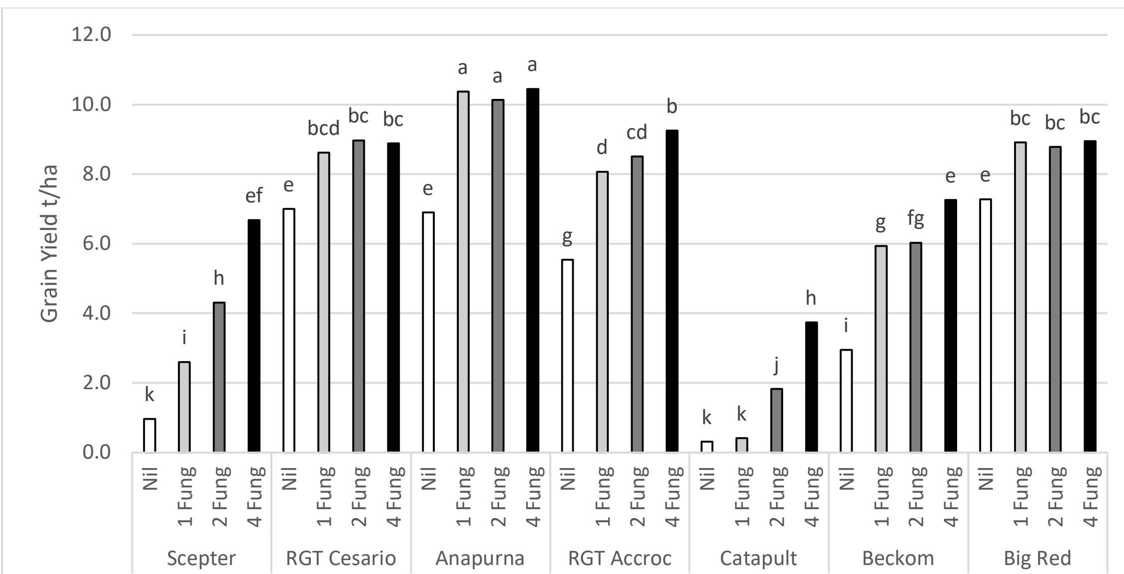

Figure 4. The influence of the number of applied fungicide sprays on grain yield of different varieties at the HYC trial at Wallendbeen, NSW 2022. All varieties presented are protected by plant breeder's rights.

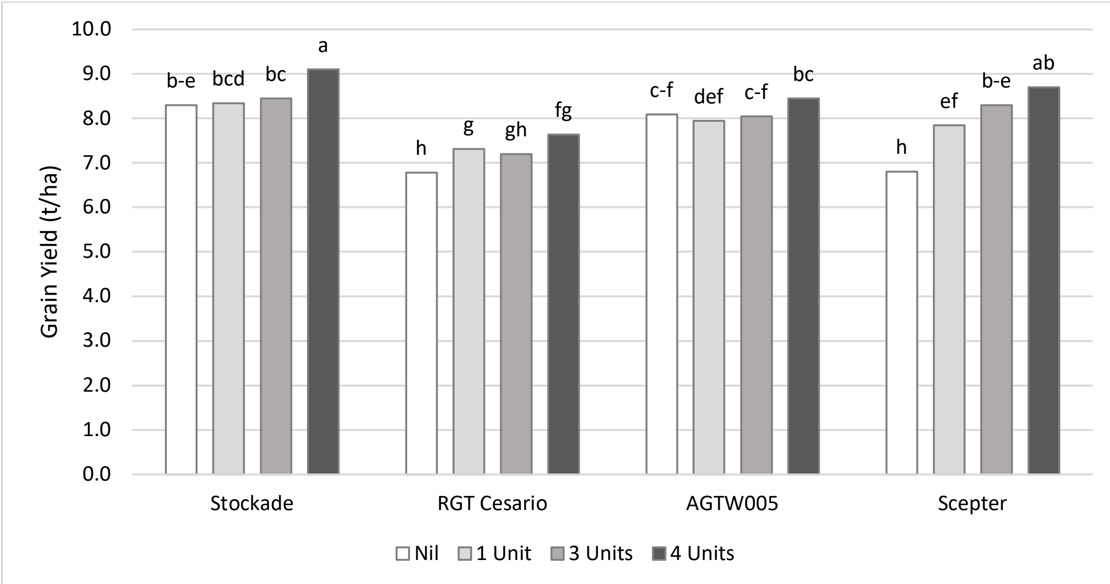

Figure 5. Influence of fungicide strategy on grain yield (t/ha) of wheat cultivars at the HYC trial at Wallendbeen, NSW 2023. *P* value=0.001, LSD (*P* = 0.05) = 0.47.

References and further reading

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More results from previous HYC research can be found on the FAR website https://faraustralia.com.au/resource

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INDUSTRY INNOVATIONS: PROVISIONAL HARVEST YIELD RESULTS – April Sown Wheat

2023 NSW Wallendbeen Crop Technology Centre

Sown: 20 April 2023
Harvested: 18 December 2023
Rotation position: Canola 2022, Wheat 2021, Canola 2020, Pasture 2019
Soil type & management: Red clay loam

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 test crop performance plus and minus fungicide. FAR Australia provides the control varieties and breeders enter their chosen lines for evaluation.

Objectives:
To assess the yield performance of a range of winter and spring wheats, managed with and without fungicide, sown in late April in the Wallendbeen (NSW) environment.

Key Points:

- There was a significant interaction between wheat variety and fungicide response (p<0.001) with three varieties Anapurna, V14051-165 and AGFWH010222 giving a no significant yield response to fungicide.
- In contrast Scepter and Willaura gave a 1.85t/ha and 2.17t/ha response to a three-spray fungicide programme.
- The new European winter feed wheat AGFWH010222 which exhibits shorter season phenology than RGT Accroc and Anapurna was significantly higher yielding than all other varieties/lines tested irrespective of whether it was treated or untreated.
- The drier and warmer season compared to 2020-22 put Scepter at the top of the list being significantly higher yielding than other quality milling wheats, albeit with a need for fungicide.
- LRPB Raider (long spring) yielded similar results to the two shorter season winter white wheat lines V14051-165 and V14051-172, however all were 1 – 1.5t/ha lower yielding than Scepter.
- LRPB Mowhawk a short season winter wheat, which has AH quality in western Australia, was the second highest yielding variety with and without fungicide.
- Despite there being no observable disease infection the red feed wheat AGTW005 still produced a 0.53t/ha significant response to fungicide application.
- Except for Willaura, grain quality was similar with most varieties achieving just under 76kg/hL with approximately 5% screenings.

Issue date 23rd January 2024

Table 1. Influence of fungicide on the grain yield (t/ha) of wheat cultivars plus and minus fungicide.

	Nil Fungicide		Full Fungicide		Mean	
Anapurna (w)	7.55	cd	7.77	c	**7.66**	c
Scepter (s)	6.68	fgh	8.53	b	**7.60**	c
RGT Accroc (w)	6.47	h	7.01	efg	**6.74**	e
LRPB Raider (s)	6.68	fgh	7.19	de	**6.93**	de
LRPB Mowhawk (w)	7.88	c	8.75	b	**8.31**	b
Willaura (s)	5.77	i	7.94	c	**6.85**	e
V14051-165 (w)	6.81	e-h	7.05	ef	**6.93**	de
V14051-172 (w)	6.69	fgh	7.59	cd	**7.14**	d
AGTW005 (w)	6.61	gh	7.14	e	**6.87**	de
AGFWH010222 (w)	9.48	a	9.85	a	**9.66**	a
Mean	**7.06**	**b**	**7.88**	**a**		

Fungicide	P Val	0.014	LSD (P=0.05)	0.50
Cultivar	P Val	<0.001	LSD (P=0.05)	0.29
Fung x Cultivar	P Val	<0.001	LSD (P=0.05)	0.41

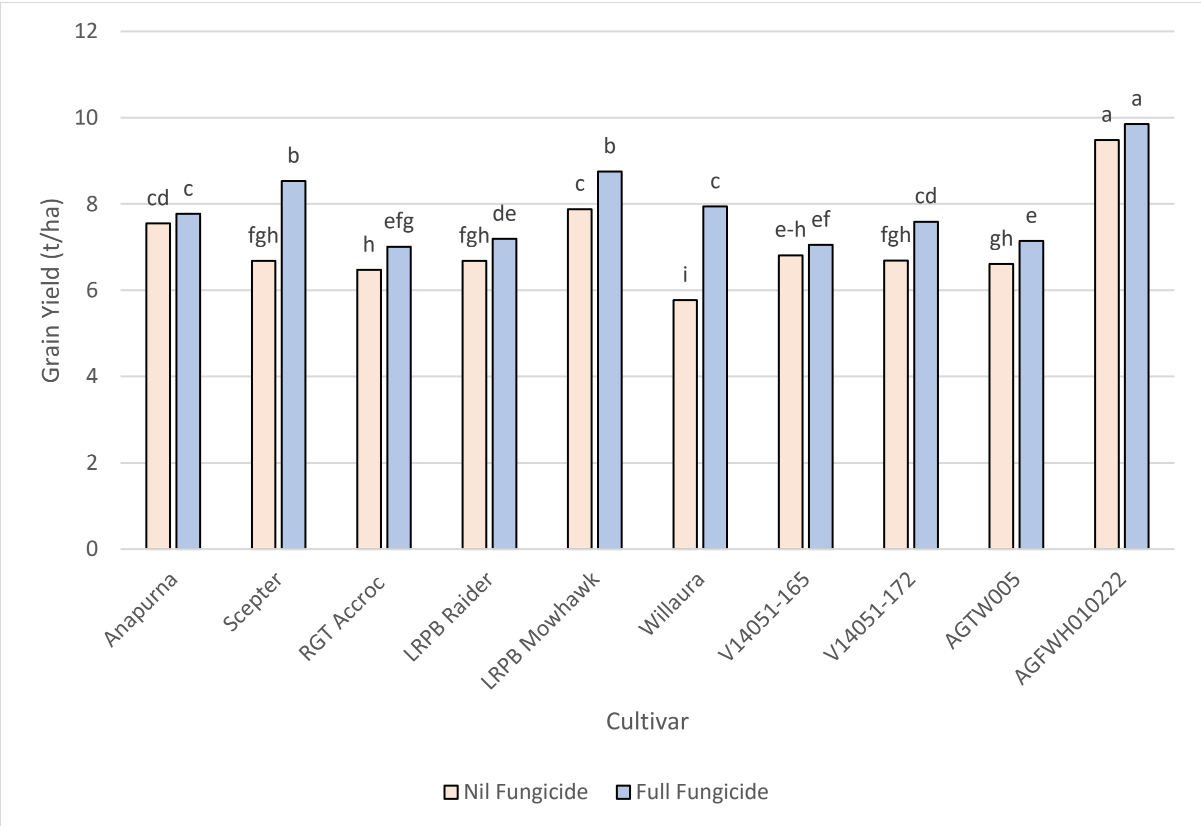

Figure 1. Influence of cultivar and fungicide application on grain yield. Bars with different letters are statistically different, P<0.001 LSD=0.41t/ha.

The highest grain yield was achieved by the coded line AGFWH010222, yielding 9.85t/ha.

Three out of the ten lines assessed did not respond to fungicide application, these were Anapurna, V14051-165, and AFGWH010222. The largest yield response to fungicide was seen in Willaura with a 2.17t/ha yield increase to fungicide application, Willaura also had the highest level of stripe rust infection of all varieties tested (table 3).

Table 2. Influence of cultivar and fungicide management on grain quality (protein, test weight, screenings and thousand seed weight (TSW)).

		Protein (%)		**Test Weight (kg/hL)**		**Screenings (%)**		**TSW (g)**	
	Nil Fungicide								
1	*Anapurna*	12.8	c	77.3	ab	6.3	cd	36.7	c-g
2	*Scepter*	11.2	k	76.1	b-e	4.4	ghi	41.0	b
3	*RGT Accroc*	12.1	efg	73.4	g	7.0	c	32.4	hij
4	LRPB Raider	12.0	f-i	73.2	g	5.0	fgh	35.8	d-i
5	LRPB Mowhawk	11.5	jk	76.6	a-d	3.8	ij	36.4	d-h
6	Willaura	11.8	g-j	66.4	h	14.0	a	26.7	k
7	V14051-165	12.0	f-i	75.9	b-f	4.5	ghi	35.6	d-i
8	V14051-172	12.0	fgh	75.0	c-g	5.5	d-h	34.6	e-i
9	AGTW005	13.9	a	74.6	efg	5.5	d-g	32.0	ij
10	AGFWH010222	11.5	jk	76.5	a-d	5.2	e-h	40.9	bc
	Full Fungicide								
1	*Anapurna*	13.2	b	76.8	abc	6.1	cde	36.9	b-f
2	*Scepter*	11.3	k	78.3	a	3.3	j	46.9	a
3	*RGT Accroc*	12.6	cd	74.1	fg	6.0	c-f	32.6	g-j
4	LRPB Raider	12.0	fgh	73.4	g	4.4	hij	37.0	b-f
5	LRPB Mowhawk	11.7	hij	74.5	efg	3.4	ij	37.6	b-e
6	Willaura	11.6	ijk	73.9	g	8.8	b	32.9	f-j
7	V14051-165	12.3	def	76.0	b-f	4.9	fgh	32.5	g-j
8	V14051-172	12.5	cde	76.0	b-f	5.1	e-h	34.1	e-j
9	AGTW005	13.5	b	74.7	d-g	5.4	d-h	30.4	jk
10	AGFWH010222	11.5	jk	76.5	a-d	5.3	d-h	39.8	bcd
	Mean	**12.2**		**75.0**		**5.7**		**35.6**	
	P Value	0.025		<0.001		<0.001		0.049	
	LSD (P=0.05)	0.4		1.9		1.1		4.2	

Overall, grain quality was similar with varieties sitting just under 76kg/hL with approximately 5% screenings the current minimum specifications for milling wheats. Without fungicide intervention Willaura was the exception with low test weight (66.4kg/hL) and high screenings (14%) due to the high stripe rust infection present during grain fill. With fungicide, grain quality was improved but test weight and screenings were still inferior to other varieties tested.

The milling wheat Scepter produced the largest grains with a thousand seed weight (TSW) of 46.9g when treated with fungicide and 41.0g without fungicide. The only other cultivar to see an increase in grain size due to fungicide application was Willaura.

Table 3. Influence of variety and fungicide management on disease infection (Septoria tritici blotch (STB) and stripe rust (Yr)), assessed 24 October during grain fill.

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

Table 4. Trial input and management details (kg, g, ml/ha).

Sowing date:		**20 April**	
Harvest date:		**18 December**	
Seed rate:		180 seeds/m2	
Basal fertiliser:	20 April	120kg/ha MAP	
Herbicide:	29 April	Sakura 118g/ha	
		Avadex Xtra 1.6L	
		Roundup 2L/ha	
	1 June	LVE MCPA 440ml/ha	
		Lontrel 60g/ha	
		Paradigm 25g/ha	
		Wetter 1000 0.2%	
	25 August	Paradigm 25g/ha	
		Chemwet 0.2%	
Insecticide:	25 August	Cyhella 18ml/ha	
Nitrogen:	2 August	100 kg N/ha	
	5 September	50 kg N/ha	
		162 kg N/ha (incl. 12 kg N/ha at sowing)	
Fungicide:		**Untreated**	**Full Protection**
	GS31-32	----	Prosaro 0.3L/ha
	GS39-41	----	Aviator Xpro 0.5L/ha
	GS61-71	----	Opus 0.5L/ha

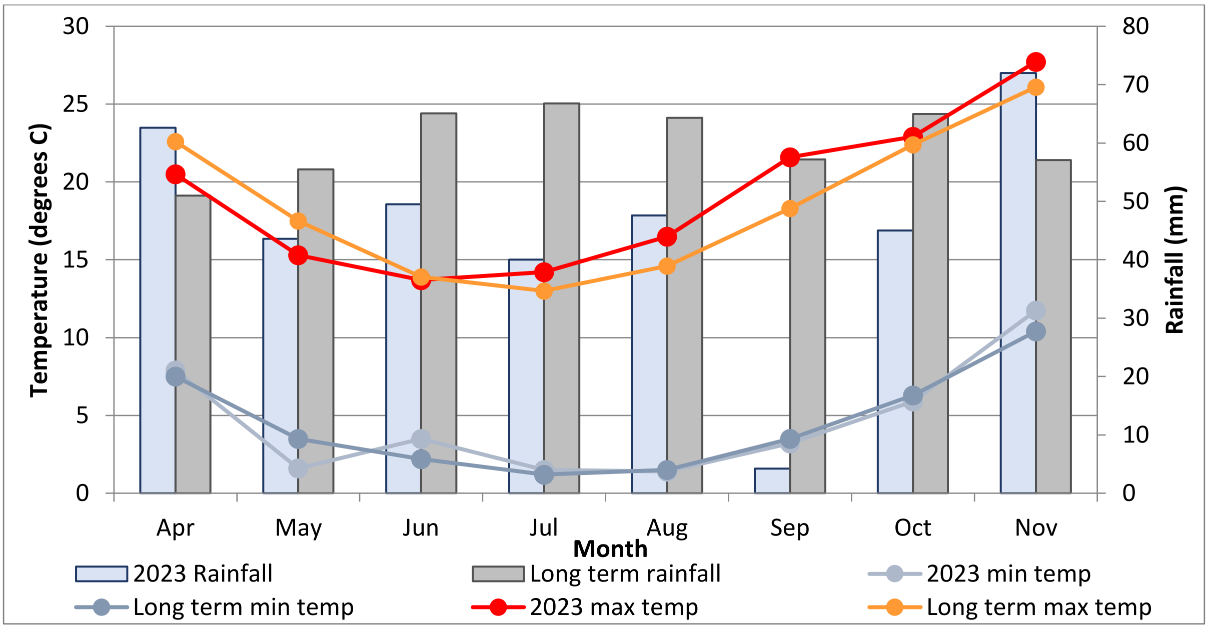

Figure 2. 2023 growing season rainfall and long-term rainfall recorded at Wallendbeen (Corang) (1914 -2023) and long-term min and max temperatures recorded at Cootamundra Airport (1995 to 2023) for the growing season (April to November). *Rainfall April to November = 364.5mm.*

GERMPLASM

evaluation network (GEN)

your trusted research partner for germplasm evaluation

FAR AUSTRALIA

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

SOWING THE SEED FOR A BRIGHTER FUTURE

An Industry Innovations (II) initiative

Industry Innovations

leading the way to a brighter grains industry

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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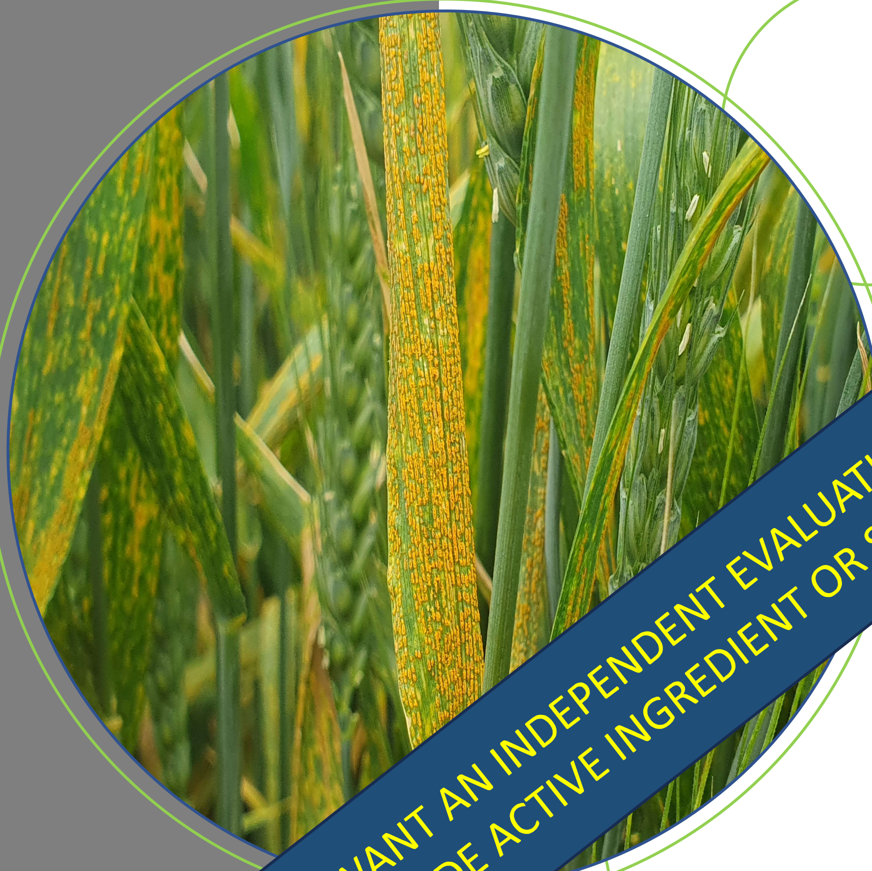
FUNGICIDE FINGERPRINTING

an independent fungicide evaluation network



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

An Industry Innovations (II) initiative

Industry Innovations
leading the way to a brighter grains industry

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 cost-effective 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

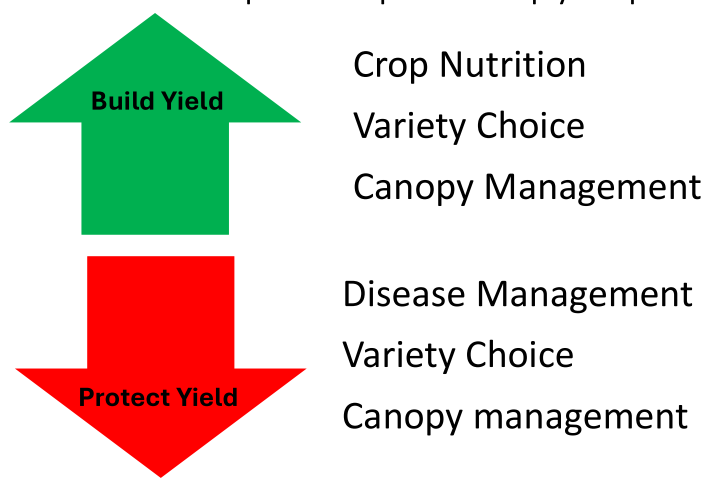
FUNGICIDE FINGERPRINTING
an independent fungicide evaluation network

Management factors for Hyper Yielding Canola

Rohan Brill, Brill Ag

Hyper yielding canola research from 2020 to 2023 focussed on two aspects:

- Research and development to increase crop yield potential
- Research and development to protect crop yield potential



To increase crop yield potential, we focussed research and development on:

- Crop nutrition
  - Nitrogen rate and timing
  - Organic fertiliser input (e.g. chicken litter)
- Variety choice
  - Understanding the best varieties with the highest yield potential and the physiology behind these varieties
- Canopy management
  - Effects of plant population

To protect crop yield potential, we focussed research and development on:

- Disease management
  - Fungicide choice and timing
- Variety choice
  - Disease resistance
  - Standability
- Canopy management
  - Effect of plant populations on lodging.

The biggest achievement in the canola component of the project was showing that with strong fertility and the use of elite commercial canola cultivars, we could increase yield potential that growers can achieve. The trials showed that 6 t/ha of grain yield is possible in the Hyper Yielding Crops environments of Australia, with this being achieved at two sites in 2021 (Table 1). To achieve highest yield at individual trial sites over the four project years, there was consistency in the variety choice and nutrition required, for example:

- The highest yielding variety at 13/15 sites was a mid-season Pioneer Seeds hybrid. This included 45Y28 RR (Roundup Ready) in six instances and 45Y95 CL (Clearfield) in six instances.
- In two of the four seasons at Millicent in South Australia, the winter canola variety Captain CL was the highest yielding variety at the site, highlighting the difference in type of variety required in the long season Millicent environment.
- At 11/15 sites, the highest yielding treatments had animal manure (poultry or pig) or its inorganic fertiliser (N, P, K & S) equivalent applied.

The benefit of choosing the best variety and providing sufficient nutrition was evident by the difference between the highest and lowest yielding treatments at each site. This ranged from 1.0 to 3.7 t/ha.

***Table 1**. Yield of the highest yielding treatment (predicted mean from 3 or 4 replicates) at each HYC canola site from 2020 to 2023; the variety grown and whether manure was applied to achieve this yield. The lowest yield from each site is also shown.*

Site	Season	Highest Yield (t/ha)	Variety	Manure Applied	Lowest Yield (t/ha)
Gnarwarre	2020	4.8	45Y28 RR	Yes	1.1
Millicent		4.5	45Y93 CL	Yes	2.6
Wallendbeen		5.4	45Y28 RR	No	3.6
Gnarwarre	2021	5.9	45Y28 RR	Yes	3.5
Kojonup		4.7	45Y28 RR	Yes	1.8
Millicent		6.5	45Y95 CL	Yes	3.3
Wallendbeen		6.4	45Y95 CL	Yes	3.5
Gnarwarre	2022	5.1	45Y28 RR	Inorganic Equivalent[1]	1.9
Kojonup		4.3	45Y95 CL	Yes	1.8
Millicent		4.6	Captain CL	No	2.0
Wallendbeen		4.8	45Y28 RR	No	2.9
Gnarwarre	2023	5.1	45Y95 CL	Yes	2.8
Kojonup		3.4	45Y95 CL	Yes	2.4
Millicent		5.7	Captain CL	No	2.5
Wallendbeen		4.3	45Y95 CL	Yes[2]	2.7

[1]Inorganic Equivalent had the same Nitrogen, Phosphorus, Sulfur and Potassium applied as synthetic fertiliser as what was contained in the animal manure treatment.
[2]Inorganic fertiliser equivalent yielded the same as the manure application.

Evolution of crop nutrition findings
The benefit shown by the application of animal manure (or its inorganic equivalent) highlights the need to fund a body of work over several seasons as new hypotheses can be developed and tested thoroughly. The use of animal manure in trials evolved over the course of the project and is in no way finalised.

The evolution included:

1. In 2020 and 2021 animal manure was used as a treatment to mimic a soil with high background fertility. In 2021 animal manure increased grain yield by 0.5 to 1.2 t/ha at all sites, over and above yields achieved where high rates of

phosphorus and nitrogen were applied. Was the manure yield response due simply to its nutrient content or a more complex biological effect?

2. In 2022 the application of animal manure increased grain yield above where a high rate of N (300 kg/ha) was applied at Gnarwarre (Vic), Kojonup (WA) and Wallendbeen (NSW). Where the nutrient equivalent of manure was applied as inorganic fertiliser (including MAP, Urea, potash) yield increased even further at both Gnarwarre and Wallendbeen. This showed that the manure response is likely a nutrition response rather than a more complex biological response. But which nutrients were responsible for driving the yield response from manure?
3. In 2023 extra treatments were included at Wallendbeen to determine the nutrients responsible for the manure benefit. Manure and its inorganic equivalent yielded more than where 300 kg N/ha was applied (with 45 kg /ha P at sowing). When the phosphorus was subtracted from the inorganic equivalent treatment, grain yield dropped back to the same as where no manure was applied, suggesting at this site that the manure nutrition response was driven by phosphorus (Table 2).

***Table 2**. Grain yield, oil, and protein concentration of 45Y95 CL canola with twelve different nutrition levels at Wallendbeen NSW, 2023.*

Treatment	Grain yield (t/ha)	Oil (%)	Protein (%)
Nil N	3.1	47.7	16.5
75 kg N/ha	3.5	46.8	17.5
150 kg N/ha	3.7	45.8	18.8
225 kg N/ha	3.8	45.5	19.5
300 kg N/ha	3.8	44.9	20.2
Nil N + 3 t/ha Chicken Manure*	3.2	47.7	16.5
225 kg N/ha + 3 t/ha Chicken Manure*	4.2	45.2	19.8
225 kg N/ha + Inorganic Nutrients	4.2	44.8	20.6
225 kg N/ha + Inorganic Nutrients – K	4.1	45.6	19.4
225 kg N/ha + Inorganic Nutrients – N	4.2	45.2	19.8
225 kg N/ha + Inorganic Nutrients – P	3.8	44.6	20.6
225 kg N/ha + Inorganic Nutrients – S	4.3	44.7	20.6
l.s.d. p=0.05	*0.22*	*0.60*	*0.80*
p value	*<0.001*	*0.002*	*<0.001*

*Dry basis. See Table 3 for detailed nutrient analysis of chicken manure.
Inorganic Nutrients: Application of inorganic fertiliser (Urea, single super, potash, MAP) to the equivalent NPKS rates supplied by 3 t/ha chicken manure.

Other aspects of crop nutrition

There was a focus on determining the nitrogen requirement of Hyper yielding canola crops. From 2021 to 2023 consistent rates of N were tested (12 site year combinations). Key findings were:

- Response to nitrogen plateaued at an N rate of 75 kg/ha at eight of the 12 site year combinations.
- At the Gnarwarre sites, N response plateaued at 150 kg/ha in 2021 and 300 kg/ha in 2022 and 2023.

Apart from the Gnarwarre site (where N response was possibly amplified due to waterlogging in 2022 especially), overall nitrogen input required for high yield was lower than expected. The trials were often sown in soils with a high level of nutrition which meant that more nitrogen came from background fertility than from added fertiliser. Importantly, the average canola protein throughout the project was less than 19%, which means that, on average, there was ~29 kg N removed per tonne of grain removed. This is much less than industry 'rules of thumb' for N removal of 40 kg N per tonne of grain.

What are the characteristics of a Hyper yielding variety:
The yield results showed consistent high yields from the Pioneer mid-season hybrid varieties. At Wallendbeen across 2021 and 2022 there was a close relationship between seeds/m² and grain yield but little relationship between seed size (thousand grain weight) and grain yield. This is common in grains across Australia. Of the yield components seeds/pod and pods/m², neither appeared to be a major driver of grain yield and these two components were often negatively correlated (seeds/pod reduced as pods/m² increased). High yielding varieties were ranked above average for both seeds/pod and pods/m². In fact, in 2021 at Wallendbeen when 45Y95 CL yielded 6.4 t/ha, it had 8422 pods/m² and 21 seeds per pod. Comparing to high yielding canola from the UK, this is approximately 30% more seeds/pod than would be expected for the high number of pods/m².

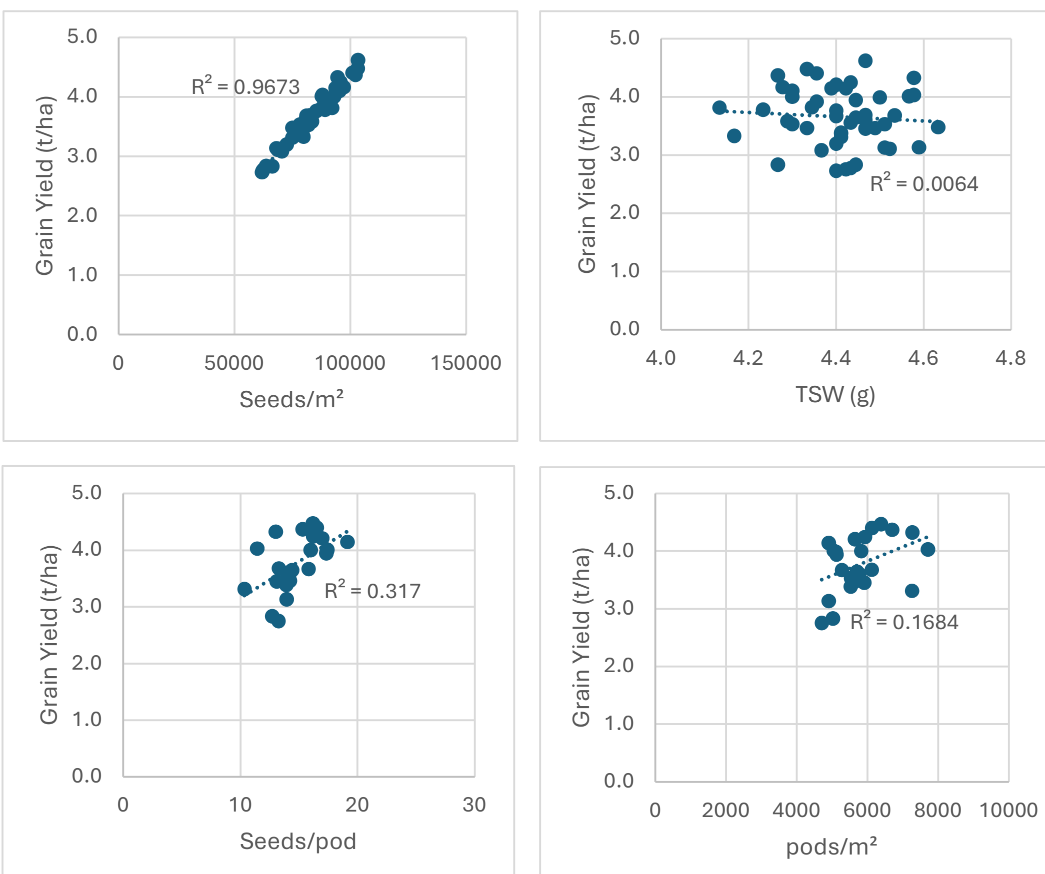


Figure 1. *Relationship between seeds/m², thousand grain weight (g), seeds/pod, pods/m² and grain yield across two seasons at Wallendbeen, NSW.*

More rain = more disease = more fungicide?

When comparing nil fungicide (including bare seed) to a complete fungicide program (fungicide applied to seed, at crop 4 leaf stage and during reproductive growth) there was an average grain yield response of 0.28 t/ha (6% of grain yield) in 10 trials on spring canola from 2020 to 2022. Canola has in the past had a bad reputation for its susceptibility to disease, but our findings show that the risk may be overstated and the response to fungicide input was much less than was observed in certain varieties in nearby cereal trials.

Optimising canola establishment and performance by phosphorus fertiliser placement

Maurie Street and Ben O'Brien (Grain Orana Alliance)

Key words

Phosphorus, canola, fertiliser, placement, establishment

GRDC code

GOA00002

Take home message

- Traditional methods of applying phosphorus-based starter fertilisers with the seed is often reducing canola establishment, in some cases, by well over 50%
- This is costing growers through the need to increase seeding rates to compensate for losses, reduced yields through low populations or, in extreme cases, the need to resow crops
- Placing fertiliser away from the seed, either below or broadcast on the soil surface either before or after sowing largely eliminated the negative impacts on crop establishment
- These alternate application placement options produced similar yield responses as the traditional option of putting the fertiliser with the seed
- Applying phosphorus fertilisers by these alternate methods may also offer some logistical advantage in timing of operations
- Dry soil conditions may hinder access to applied phosphorus in the surface applied options, but in these trials, there was limited occurrences at commercial rates of phosphorus.

Background

Phosphorus (P) is an important nutrient to optimise canola production. Traditionally, P fertiliser has been applied at planting, banded near the seed. This approach is likely to be based on the premise that P is relatively immobile in the soil and needs to be placed close to the developing root systems of crops to be readily accessible early in the crop cycle.

However, damage to establishing crops by placing fertiliser close to seed has long been accepted. Trials in 2013, by Jenkins and Brill from the Department of Primary Industries demonstrated significant reductions in canola establishment with increasing rates of P (up to 20 kg/ha) applied at seeding. However, yields still increased with increasing rates of P despite the suppression in emergence, demonstrating the ability of canola to compensate for lower plant populations in the circumstances tested.

So, if the crop can compensate and maintain yield despite lower establishment, what is the problem?

Firstly, seed costs for growing canola can be high. When only a fraction of the seed purchased results in an established plant, this inefficiency represents a significant cost, particularly where seed can cost more than $80/ha. Secondly, the impacts on plant establishment can be variable and un- predictable which has resulted in growers increasing seeding rates to cover the possibility of decreased establishments. Thirdly, in extreme cases crop establishment impacts may be so severe, that yields are impacted, or crops need resowing.

Recent changes to farming systems may further increase risk of damage. The adoption of wider row spacings and sowing with knife points or disc seeders all have the effect of increasing fertiliser concentration within the drill line, thus increasing potential for damage. Furthermore, the move to earlier sowing, into warmer and potentially more rapidly drying soils could only be thought to further exacerbate the risks of variable crop establishment.

A field survey undertaken in 2017 (McMaster, C. 2019) assessed canola establishment across 95 commercial crops in the central west of NSW. This survey showed that crop establishments ranged from as low as 17% up to 86% with an average of 48%. Whilst the report suggested that seed size had the greatest influence over establishment it also mentioned several other factors also correlated well, including stubble loads, sowing speed, seeding depth and starter fertiliser and its proximity to the seed.

So how do we apply enough P to optimise yields, without a negative impact on establishment while maintaining or even improving P fertiliser efficiencies? Could altering our way of applying P fertilisers to canola crops also improve the reliability of crop establishment which is a key deterrent to many growers from growing canola (GRDC Grower Network, 2020)?

Trial work undertaken by GOA under the Grower Solutions Group Project since 2015 has been investigating alternate options for applying conventional P fertilisers in canola to address these key questions.

This paper details the outcomes from this series of trials and proposes alternate ways to apply P in winter grown canola crops.

Methodology

The hypothesis was 'can we apply P fertiliser in an alternate manner to the standard approach of banding it with the seed, that minimises the impact on crop establishment whilst maintaining the fertiliser response in crop performance (yield)?'.

A series of 15 trials have been run since 2015 investigating alternate methods of P starter fertiliser placement as detailed below-

- With seed (with)- fertiliser applied through the same seed boot as the seed is delivered
- Below seed (below)- delivered though a second boot set to deliver the fertiliser below the seed with at least 2-3 cm separation from the seed position
- Incorporate by sowing (IBS)- fertiliser was broadcast just prior to sowing and incorporated by the seeder (knife point and press wheel- 27cm row spacing)
- Top-dressed- fertiliser was broadcast just after seeding to the soil surface with no incorporation.

Initially the P fertiliser used was Trifos (triple super) because of the absence of N in its makeup. However, this product is now largely unavailable, and many growers were simply using ammonium phosphate fertilisers such as DAP or MAP as their P source and as such MAP, was used in more recent trials. Details of the fertiliser type, rates tested, and the range of placements is detailed in Table 1 below. Although this report does report the treatments in terms of the rate of P applied, it should be considered that with P supplied as MAP there is an associated amount of N delivered with that rate of P. This Nitrogen may be also contributing to damage but as most starter fertilisers contain both these elements, apportioning the blame to P or N is difficult but also somewhat academic.

However, in trials where MAP was used, the differing nitrogen levels applied were balanced out with urea across all rates to ensure any yield responses were not influenced by differences in N rates applied.

Table 1. Details of trial site and treatments

Year	Location	Site Colwell P (0-10cm)	Fertiliser tested	P rates applied kg P/ha	Fertiliser placement treatments
2015	Wellington	21 ppm	Trifos	0, 10, 20	With, below, IBS
2015	Gilgandra	12 ppm	Trifos	0, 10, 20	With, below, IBS
2016	Gilgandra	18 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2016	Alectown	10 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2017	Nyngan	33 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2017	Jemalong	19 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2017	Gilgandra	21 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2017	Geurie	<5 ppm	Trifos	0, 15, 30, 45	With, below, IBS, top-dressed
2018	Wellington	20 ppm	Trifos	0, 10, 20, 40	With, below, IBS, top-dressed
2018	Canowindra	36 ppm	Trifos	0, 10, 20, 40	With, below, IBS, top-dressed
2019	Gilgandra	23 ppm	MAP	0, 10, 20, 40	With, below, IBS, top-dressed
2020	Gilgandra	39 ppm	MAP	0, 10, 20, 40	With, below, IBS, top-dressed
2020	Gollan	23 ppm	MAP	0, 10, 20, 40	With, below, IBS, top-dressed
2020	Wongarbon	32 ppm	MAP	0, 10, 20, 40	With, below, IBS, top-dressed

Results

Table 2 summarises the statistically analysed responses on two main measures- plant population and yield response to P rate and placement. As the traditional method of P placement is ’with’ this is a common comparison made. Further detail on individual trial reports can be found at www.grainorana.com.au.

The ‘>’ indicate the yields from the aforementioned treatment exceeds the following treatment, ’&’ between two treatments indicates there was no difference between those treatments. Alternate placement methods in **bold** highlight only cases where yields are lower than the traditional ‘with’ placement.

Table 2 also details the rainfall received for the 60 days following seeding for each site/year, as this is thought to influence nutrient access for some of the placement methods. The yield range of the site is also included for the reader to consider the nutrient requirement for the crop as a pseudo indicator of crop growing conditions throughout the year.

Table 2. Trial results from 15 trials on P rate and placement in canola, summarising the impact on plant population and yield when P fertiliser was applied 'with seed', 'below seed', top-dressed or incorporated by sowing (IBS).

Site/year	Impact on plant populations	Impact on yields	Rainfall 60 days post planting ^	Yield range t/ha
Wellington 2015	P rate applied or placement had no impact	P rate applied or placement had no impact	118 mm	1.4- 1.9
Gilgandra 2015	20 kg/ha P 'with seed' resulted in lower populations than 10 kg/ha. 'Below seed' & IBS had no impact on populations regardless of P rate	Site was rate responsive when P was applied 'with seed' 10 & 20 kg/ha > Nil P At 10 kg/ha P- No impact of placement At 20 kg/ha P- 'with seed' & 'below seed' > **IBS**	159 mm	1.3 – 2.1
Gilgandra 2016	All rates of P applied 'with seed' resulted in lower plant populations by around 30%, compared to 'below seed', IBS & top-dressed in all but one case.	Site was rate responsive when P was applied 'with seed' 30kg/ha > 15 & 45kg/ha > Nil P At 15kg/ha P- No impact of placement At 30kg/ha P- No impact of placement At 45 kg/ha P- IBS, top-dressed & 'below seed > 'with seed'	256 mm	1.8- 2.7
Alectown 2016	At 30 & 45 kg/ha of P 'with seed' resulted in up 40% lower plant populations than 'below seed, IBS or top-dressed which were not different to one another At 15 kg/ha P 'with seed' was lower than IBS & 'below seed' but not different to top-dressed	Site was rate responsive when P was applied 'with seed' 30 kg/ha > 45, 15 kg/ha & Nil At 15kg/ha P- no impact of placement At 30kg/ha P- No impact of placement At 45 kg/ha- IBS & top-dressed > 'with seed & 'below seed'	172 mm	2.3 – 3.4
Nyngan 2017	At 45kg/ha of P 'with seed' or 'below seed' plant populations were reduced by 65% and 40% respectively compared to the best treatment, top-dressed.	Site was rate responsive when P was applied 'with seed' 15, 30 & 45 kg/ha > Nil At 15 kg/ha P- no impact of placement At 30 kg/ha- 'below seed' > IBS, top-dressed & 'with seed'	27 mm	0.3 – 0.5

Site/year	Impact on plant populations	Impact on yields	Rainfall 60 days post planting ^	Yield range t/ha
	At 15kg/ha & 30 kg/ha of P 'with seed' there was no impact by placement.	At 45 kg/ha- 'with seed' & top-dressed > **IBS** & **'below seed'**		
Jemalong 2017-	P rate applied, or placement had no impact	P rate applied or placement had no impact	13 mm	0.3 – 0.9
Gilgandra 2017-	P rate applied, or placement had no impact	Site was rate responsive when P was applied 'with seed' 45 kg/ha & 30 kg/ha >15kg/ha > Nil At 15 kg/ha P- No impact of placement At 30 kg/ha- 'below seed', 'with seed' & top-dressed > **IBS** 45 kg/ha- 'below seed' > 'with seed', IBS and top-dressed	11.6 mm	0.9 – 1.4
Geurie 2017-	P rate applied, or placement had no impact	Site was rate responsive when P was applied 'with seed' 45 kg/ha, 30 kg/ha > 15 kg/ha > Nil At 15 kg/ha P- 'below seed' > 'with seed' & top-dressed > I**BS** At 30 kg/ha P- 'below seed' & 'with seed' > **top-dressed** & **IBS** 45 kg/ha P- 'below seed' & 'with seed' > **IBS** & **top-dressed**	47 mm	0.2 – 1.2
Wellington 2018	At 45 kg/ha P applied 'with seed' resulted in a lower plant population (~37%) than when applied 'below seed', IBS or top-dressed At 10 or 20 kg/ha there was no impact of placement.	Site was not rate responsive when P was applied 'with seed' At 10 kg/ha P- no impact of placement At 20 kg/ha P- 'with seed', 'below seed' & top-dressed > **IBS** At 40 kg/ha P- no impact of placement	37 mm	1.0 – 1.4
Canowindra 2018	At 40 kg/ha P 'with seed' resulted in lower plant populations than top-dressed and IBS At 20 kg/ha there was	Site was rate responsive when P was applied 'with seed' 40 & 20 kg/ha > 10 kg/ha & Nil At 10 kg/ha P- below> 'with seed', top-dressed & IBS At 20 kg/ha P- top-dressed & 'below	31.5 mm	0.4 – 0.5

Site/year	Impact on plant populations	Impact on yields	Rainfall 60 days post planting ^	Yield range t/ha
	no impact of P placement. At 10 kg/ha 'with seed' & 'below seed' resulted in lower plant populations.	seed' > 'with seed' & IBS At 40 kg/ha P- 'below seed' & 'with seed'> **top-dressed** and **IBS**		
Gilgandra 2019	At all rates of P applied 'with seed' resulted in the lower plant populations than IBS, top-dressed & 'below seed' except at 10 kg/ha P where 'below seed' only was no different to 'with seed'.	Site was rate responsive when P was applied 'with seed' 40 kg/ha >10, 20 kg/ha & Nil At 10 kg/ha P- no impact of placement At 20 kg/ha P- top-dressed & 'below seed' > 'with seed' & IBS At 40 kg/ha P- 'below seed' &, top-dressed > IBS & 'with seed'	18.6 mm	0.6 – 0.9
Gilgandra 2020	At any rate of P applied 'with seed' resulted in the lowest plant population. At 40 kg/ha placed 'with seed' the seed reduced establishment by 81% compared to top dressed	There was an inverse response to P rate when applied 'with seed' # No impact when applied by the alternate placements. At 10 kg/ha P- no impact of placement At 20 kg/ha P- top dressed, IBS & 'below seed' > 'with seed' At 40 kg/ha P- IBS, top-dressed & 'below seed' > 'with seed'	52 mm	1.7 – 2.4* *Site was hail damaged prior to harvest-treat results with caution*
Gollan 2020	At any rate of P, establishment was lowest when applied 'with seed'. At 40 kg/ha establishment was reduced by ~58% compared with IBS, top-dressed & 'below seed'. At both 20 & 40 kg/ha there was no difference between IBS and top-dressed but better than 'with seed'	Site was P rate responsive when applied 'with seed' 40 kg/ha >20 kg/ha>10 kg/ha > Nil At 10 kg/ha P- no impact of placement At 20 kg/ha P- no impact of placement At 40 kg/ha P- no impact of placement	58 mm	2.2 – 3.7
Wongarbon 2020	At 10 kg/ha 'with seed', 'below seed' &	Site was P rate responsive when applied 'with seed'- 40, 20 & 10 kg/ha	93.6 mm	3.7 – 4.1

Site/year	Impact on plant populations	Impact on yields	Rainfall 60 days post planting ^	Yield range t/ha
	top-dressed had lower plant populations than IBS, at 20 & 40 kg/ha ‘with seed’ was lower than IBS and top-dressed all which were no different	> nil At 10 kg/ha P- no impact of placement At 20 kg/ha P- no impact of placement At 40 kg/ha P- ‘with seed’, IBS and top-dressed > ‘below seed’		

*- *Site was hail damaged prior to harvest- treat results with caution*

#- *Increasing P applied ‘with’ the seed reduced yields suggested to be because of very significant reductions in plant populations.*

^- *rainfall data from the nearest BOM or other automatic weather stations*

Summation of trial outcomes

As evidenced above, the P placement and rate can impact on plant populations (crop establishment), and it can be variable. In 11 out of 15 trials, plant populations were lower when P fertiliser was placed ‘with the seed’ when compared with alternate placements tested, in some cases by up to 80%. In general, the negative impact on plant populations increased as the P rate increased, but in some cases as little as 10 kg/ha of P was sufficient to reduce plant establishment.

Three trials in 2017 showed no impact of P rate or placement on plant populations, but all sites experienced very dry soil conditions just after planting. The only other site to show no impact of P on plant population was Wellington in 2015. This site was also not yield responsive to P rate or placement.

In contrast, where fertiliser was placed away from the seed using either IBS or top-dressed, there was no reduction in plant populations. In all cases, plant populations were comparable to where nil fertiliser was applied (data not shown), suggesting that any impact of P fertiliser on plant population had been negated by changing its position relative to the seed.

Placing P fertiliser below the seed did sometimes, but not always avoid impacts on plant populations.

In eight out of the 15 sites the yields of the alternate placements matched the performance of the traditional ‘with seed’ placement and in a small number of cases yields were improved.

Three sites, Gilgandra 2015 & 2017 and Wellington in 2018 had instances where only the IBS option had lower yields than the ‘with seed’ treatment. At Gilgandra in 2017, only the 30 kg/ha of P IBS treatment had lower yields. At all other rates (15 & 45 kg/ha) ‘with seed’ performed equally or worse than the alternates. At Gilgandra 2015 and Wellington 2018 the difference in the IBS treatment was only apparent at 20 kg/ha of P. At all other rates there no difference between placements.

Two sites had instances where the IBS and top-dressed had lower yields than the ‘with seed’ treatment, although only at the higher rates of 30 & 40 kg/ha , but not at the lower, ‘more commercial’ rates tested. It should be noted that most of these cases where differences occurred were in the drier years of 2017 and 2018.

The remaining two sites were non-responsive to both placement and rate for yield and establishment (Wellington 2015 and Jemalong 2017).

This body of work demonstrates that if P fertiliser is placed away from the seed, either IBS or top-dressed and to a lesser extent below the seed, this avoids the negative impacts on plant populations.

It has also shown that in most cases, the yield response to the applied rate of P, matched the response where the P was applied 'with' the seed.

The placement 'below seed' resulted in only two cases where the yield was lower than the 'with seed' treatment, though this effect was only evident at the highest rate (45kg/ha) of P, rates that may be considered experimental rather than commercial. This however is not unexpected given the fertiliser was directly under the seed separated by only 2-3 cm where roots would naturally extend through this fertiliser band. However, placement of P 'below seed' did not always avoid reduction in plant populations as did IBS or top-dressed.

Interestingly, in most cases both the IBS and top-dressed treatments recorded a yield responseeven thoughthe resting position of the fertiliser would have been above and or to the side of the seed. Large proliferations of surface roots were commonly observed in these trials, and it is assumed that these facilitated crop P uptake in sufficient quantity and time frame so as not to penalise crop performance.

The notable exception was the drier years, primarily 2017 where the rainfall received in the 60 days post planting was very low and may have limited the development and ability of surface roots to access fertiliser. It these years, in some cases, the 'with seed' or 'below seed' treatments did outperform the IBS and top-dressed options, but only at the higher rates tested of 30-45 kg/ha. At the more commercially relevant rate of 15 kg/ha, there was no impact of P placement. In a stark contrast, in many other trials applying such high rates of P with the seed was highly detrimental to plant populations and in some cases yields.

Given that not all farmers have the option to apply fertiliser below the seed and there may be some cases, in dry years when IBS and top-dressing may risk underperforming, another option may be to 'split' the starter fertiliser application. That is, apply a proportion of the P fertiliser at sowing, say 5-10 kg P/ha, with the seed and apply the balance IBS or top-dressed. In this scenario smaller amounts of P applied with the seed may be sufficient to meet crop requirements in a dry period/season, while reducing the impact on establishment. The remainder of the fertiliser applied IBS or top-dressed, becoming available if wetter (and higher yielding) conditions prevail.

This 'split' approach has been tested on a limited basis in the past few years, but further work is needed before this can be recommended.

What does this mean to canola growers?

Clearly placing fertiliser away from seed improving the rate and reliability of establishment of canola crops is a key advantage of this alternate approach. However, there may be further advantages.

In the case of surface applications growers may be able to apply most of their canola P fertiliser requirements ahead of seasonal breaks or the busy sowing periods and this will have significant logistic advantages. The low sowing rates of canola combined with reduced rates (if split) or nil P fertiliser will greatly increase the area that can be sown in any given period, as the number of seeder refills could be greatly reduced.

For growers that have very low seed bed utilisation (wider row spacing, knife points or disc openers), this approach may be the most practical option to apply higher rates of P fertiliser to canola crops without the associated risks and downsides. An alternative that is often considered is applying higher rates in the previous crop. However, this may increase the risk of nutrient tie up and it will extend the time until cash invested in fertiliser is recouped.

Conclusions

The traditional placement of P fertilisers such as MAP/ DAP or other high analysis starter fertilisers can reduce crop establishment by 50% or more. Factoring in these typical losses combined with the need for increased seed rates could potentially be costing growers more than $45/ha. In extreme cases the costs could be greater where yields are impacted or resowing is required. The impact of P fertilisers with seed is also likely to be contributing to the variable establishments growers often experience.

Over five years and 15 trials GOA has looked at alternate placements of P to avoid this issue. This work has shown that reductions in plant populations can be avoided by moving P away from intimate contact with the seed. This work has also shown that in most cases fertiliser efficiency has been maintained and in some cases of high rates of P, improved.

Placing the fertiliser below the seed maybe preferred if growers have suitable machinery. However, for growers who do not have this option, simply broadcasting the fertiliser and incorporating it by sowing (IBS), or even top-dressing post sowing has proven to be similarly effective.

The risk for the latter two approaches is likely to occur when dry soil conditions occur post sowing, which limit the crops ability to forage for that fertiliser, as was experienced in the drought year of 2017. However, in those years, crop fertiliser requirement was less, and yield differences were not apparent at commercial rates of 15 kg/ha. These alternate surface application approaches will have logistical advantages by offsetting some of the fertilising task from away sowing, which alone may be a key attraction.

GOA is planning to fine tune an approach of splitting the P fertiliser application, i.e. small basal amount with the seed and the balance applied to the soil surface. It is hypothesised that this approach may deliver the following advantages: minimise crop establishment impacts, reduce risks in dry conditions whilst maintaining fertiliser responses and improve sowing efficiencies (logistics).

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