2024

BCG SEASON RESEARCH RESULTS

BCG
SHARED SOLUTIONS

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FRONT COVER: BCG Main Field Day 2024, Nullawil.

BCG
SHARED SOLUTIONS

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This compendium belongs to

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CONTENTS

CHAIR'S WELCOME

Welcome to the 2024 BCG Season Research Results Compendium. It's been another remarkable year for BCG, with new milestones reached in research, extension, and community engagement. This compendium is a reflection of the dedication, innovation, and collaboration that underpins everything we do.

In 2024, BCG conducted 176 trials across 50 sites, delivering robust, regionally relevant data to help growers tackle challenges and seize opportunities. These trials remain the backbone of our work, driving innovation and empowering members to make more informed decisions on their farms.

The year also saw 27 BCG events, attracting over 1,500 attendees eager to learn, network, and share insights. The Chair's Breakfast was a standout, with Professor Richard Eckard presenting a thought-provoking session on what "Net Zero 2050" means for the grains industry. His address sparked meaningful discussions about reducing emissions while maintaining productivity and profitability.

BCG's efforts to support young farmers gained further momentum in 2024. The Young Farmer Network continues to go from strength to strength, providing tailored learning opportunities and fostering connections that are vital for the next generation of growers. The Young Farmer Network Ball, a sold-out event that brought together 300 attendees for an evening of networking, was a fantastic way to broaden BCG's reach, providing a fresh and diverse platform to engage with younger members of the farming community.

The Main Field Day, hosted by the Watts family, was another success, offering attendees an engaging platform to explore the latest research and technologies. These flagship events are a testament to the value of bringing people together to share knowledge and strengthen our farming community.

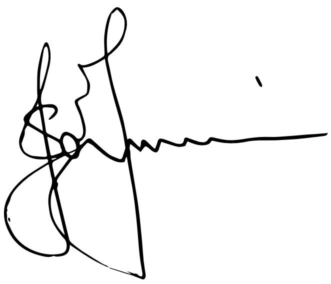
This year, we also bid farewell to long-serving board members James Hunt and Simon Craig, whose contributions have left a lasting legacy. Their strategic insights and commitment have been pivotal to BCG's success, and we extend our heartfelt gratitude for their service.

Looking ahead, the research showcased in this compendium offers a wealth of knowledge for the future. From variety performance to nutrient strategies and weed management, these findings equip our members with tools to make informed and sustainable choices.

As always, our achievements are made possible by the collaboration and support of our partners, including GRDC, and by the hard work of our dedicated BCG staff, led by CEO Fiona Best. Their expertise and tireless efforts ensure that BCG continues to deliver value to our members and the broader farming community.

Finally, I would like to thank you – our members. Your commitment, whether through hosting trials, attending events, or sharing feedback, is what drives us forward. Together, we are building a resilient and prosperous future for farming in our region.

I hope this compendium serves as both a reference and an inspiration as you plan for a successful 2025.



John Ferrier
Chair

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

THE BIG 9

1. There's power in knowing your numbers.

Be aware of your production costs and the impact they have on your business.

2. Summer moisture conservation is essential.

The next season starts where rainfall events are greater than 50 mm. Capturing and storing that moisture through effective summer weed management is critical for crop success.

3. Time of sowing determines success.

Late sowing or delayed crop emergence increases the risk of frost and heat stress during the critical grain fill period. Prioritise sowing early or on time to maximise yield potential.

4.

Timing is everything – rainfall, nitrogen and inputs.

Rainfall at the right time can outweigh lower totals, just as timely nitrogen application maximises yield potential. Proactively secure inputs and labor to ensure tasks are completed when they matter most.

5.

Develop your A-game N strategy.

Estimate your current crop N supply by utilising available decision support tools such as Yield Prophet® and N Bank. Set realistic yield targets then monitor weather forecasts for the opportunity to apply N if it's needed.

6.

Small details can have a big impact in dry years.

Attention to things such as timing, input management, and resource allocation can significantly influence outcomes in tough seasons. Minor adjustments can make all the difference.

7.

Drought conditions can drive strategic innovation.

Extended dry periods can catalyse positive changes, from revisiting enterprise mixes to restructuring business operations. Use these challenging times to future-proof your farm.

8.

Your health is the foundation of success.

Knowing your capacity and prioritising well-being are essential. Recognise the limits of what you can achieve and build support systems for yourself and your team.

9.

Learning from others fills the experience gap.

Sharing knowledge and experiences, particularly with younger generations, is key to bridging gaps in understanding. Collaboration can spark fresh perspectives and guide better decision-making in challenging seasons.

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Dr Tony Gregson (Warracknabeal farmer)

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Dr Steve Jefferies AM (Director Jefferies Ag Solutions)

Invited guests: Tim McClelland (Birchip farmer and GRDC Southern Panel member)
John Ferrier (BCG Chair)

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THE YEAR THAT WAS

The 2024 cropping season provided challenges for decision making, but also presented valuable production opportunities, thanks to sound research principles, advances in technology, and the sharing of knowledge and experience among growers.

The 2023 season ended on a rewarding note for many, paving the way for a productive start to the year. Whilst significant summer rainfall set the stage for an intensive summer weed control program, it also provided an excellent foundation for cropping programs.

Good subsoil moisture from summer rainfall gave growers the confidence to proceed with a typical cropping rotation. As seeding began, patchy rainfall during April, May, and June led to staggered emergence, with some seed sitting in dry soil for three weeks or more. Early sown crops such as vetch and barley were planted with little to no moisture in the seedbed, while sporadic thunderstorms provided relief in isolated areas. Regardless, growers pushed on with optimism, sowing wheat, canola, and lentils with confidence in the season thanks to good subsoil moisture and targeted management strategies.

There was a silver lining to the dry conditions, which allowed for uninterrupted sowing, perhaps minimising fatigue. However, crop emergence – particularly in canola – was affected, highlighting the challenges of managing crops in variable conditions.

Widespread rain in June rejuvenated crops and brought new decisions into focus, including weed control strategies, nitrogen management, and livestock feed options. Though economic pressures from rising interest rates, increasing production costs, and volatility in global trade added complexity to farm business decisions, including capital investments, growers leaned on their strategic acumen to make informed choices.

Heading into the cooler months, growers were hopeful of a favourable finish to the season.

Early-July climate outlooks offered little certainty, with equal chances of a dry or wet spring. In August, early frosts exacerbated the dry conditions, underscoring the importance of adaptability. Weather forecasts pointed to a dry spring, influenced by a weak La Nina.

Insights shared at the BCG Main Field Day on 11 September at Nullawil inspired growers to refine their management practices. There were discussions around the impact of the dry start to the season, including 'Can my crop catch up?' and 'What will my weed burden look like after dry sowing?'.

In the hyper-yielding cereals session, BCG senior research manager Dr Yolanda Plowman and University of Melbourne Professor James Hunt discussed how late emergence could affect critical grain fill and flowering periods, increasing the risk of combined drought and heat stress.

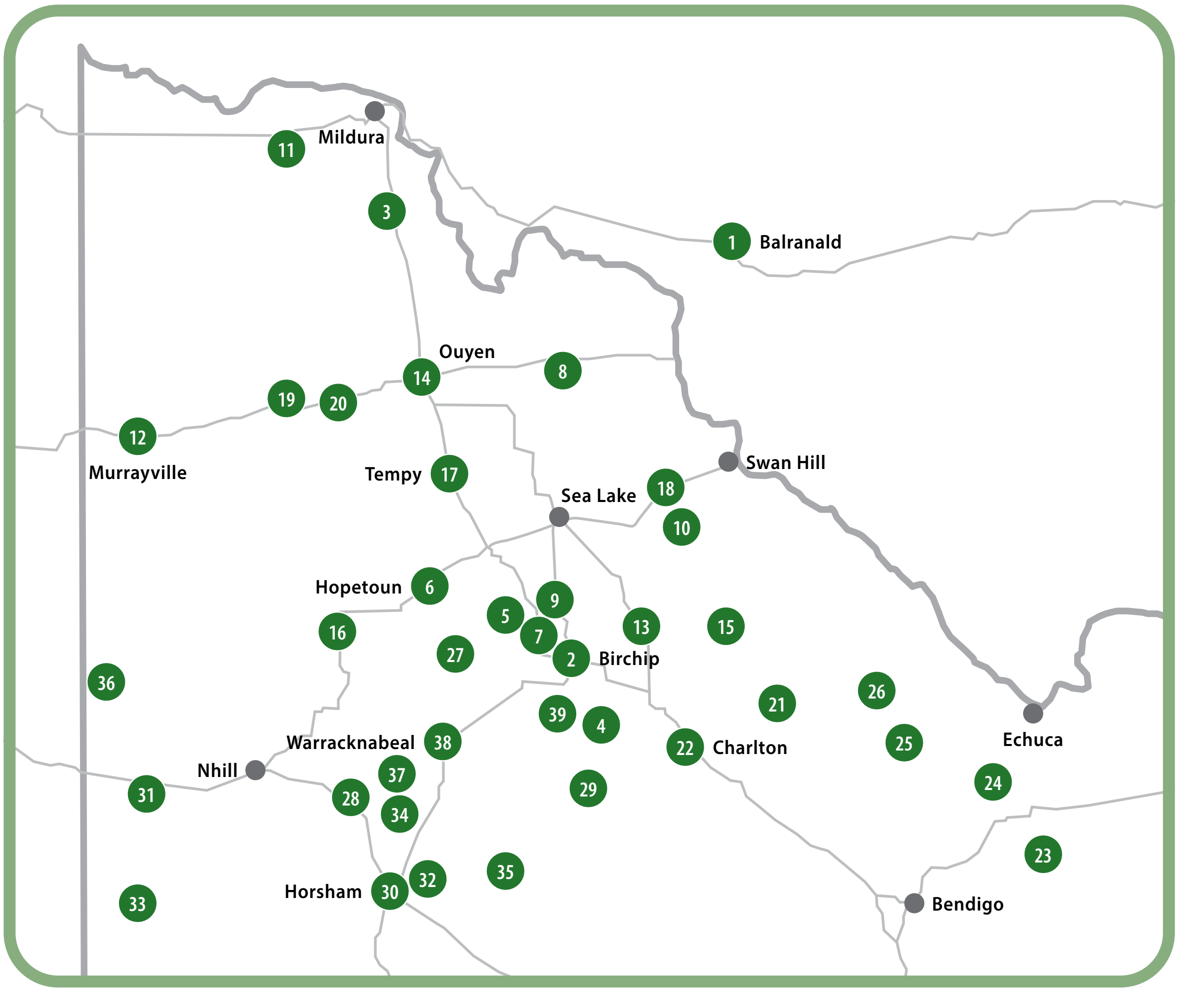
DPIRD WA economist Dr Ross Kingwell shared insights from a decade-long study of 250 farms. He highlighted that successful farmers weren't those who worked the longest hours, but those who prioritised strategic planning, strong social networks, and personal development.

The season's challenges culminated in September with unusually severe frost events across the Mallee and surrounding regions. Lentils, wheat, and barley sustained significant damage in many areas, prompting some growers to pivot toward hay production. The dry weather supported efficient hay curing and baling, while irrigation and livestock producers adjusted their strategies to maintain productivity.

Late season rainfall in October and November marked a significant shift in weather patterns. While this stalled harvest and introduced new challenges, such as seed quality concerns and flystrike, some areas benefited from the much needed moisture.

Harvest outcomes varied across the region, but the season reinforced the critical role of summer weed control and moisture conservation in setting up future success. Advances in no-till farming, precision machinery, and agronomic expertise once again demonstrated their value in ensuring crop emergence, even under challenging conditions.

2024 RESEARCH SITES



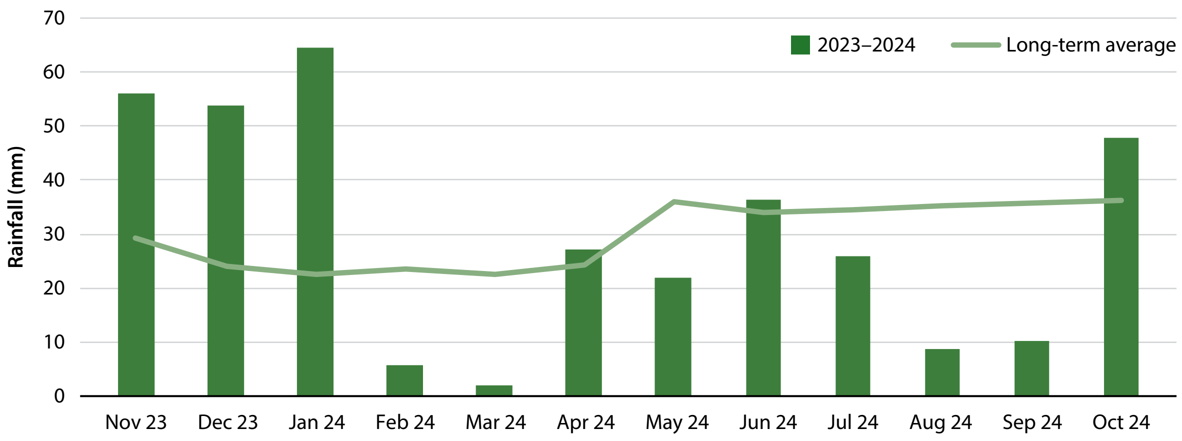
Reference	Location	Research areas	Host
Mallee			
1	Balranald	NVT wheat	Jake and David Lockhart
2	Birchip	Soil nutrition	Birchip P–12 School
3	Carwarp	Nitrogen management	Marc Nulty
4	Corack	Weed management	Richard Reilly, Paul Lowry
5	Curyo	Nitrogen management, cover cropping, summer weed management	Trevor Grogan, Paul Barclay, Edward Rickard
6	Hopetoun	NVT, Soil nutrition	Hopetoun P–12 College, Devon Mill, Lucas Puckle
7	Kinnabulla	Farming systems, Vetch agronomy	Linc Lehmann
8	Manangatang	NVT, Farming systems	Brad Plant
9	Marlbed	Nitrogen management	Andy Barber

Reference	Location	Research areas	Host
10	Meatian	Industry trials	Jarrod Brown
11	Merrinee	NVT cereals	Matt Curtis
12	Murrayville	NVT barley	Giles Oster
13	Nullawil	Canola establishment, Weed management, Vetch agronomy, Disease, Long coleoptile, NVT, Pulse protein, Hyper yielding cereals	David and Daniel Watts
14	Ouyen	NVT, Vetch agronomy	Scott Anderson
15	Quambatook	NVT wheat	Ash and Bec Marshall
16	Rainbow	NVT	Brett Fisher
17	Tempy	Weed management, Vetch agronomy	Scott Anderson
18	Ultima	NVT	Warrick Grey
19	Underbool	Wetting-agent	Garth Aikman
20	Walpeup	NVT, Wetting-agent, Silicon on droughted wheat	Ross Stone, Mick Pole
North Central			
21	Boort	Pest management	Jarrod Brown
22	Charlton	NVT, Microbiome, Oat agronomy	Jon Whykes
23	Colbinabbin	NVT barley	Darryl Rathjen
24	Diggora	NVT, Wheat trial, Canola disease	Anthony Lees
25	Mitiamo	Grazing cereals, Pulse varieties and agronomy, Cereal diseases	Adam Gould
26	Pyramid Hill	Pulse end-use	Ash Gould
Wimmera			
27	Brim	NVT	Graeme Holland
28	Dimboola	NVT	John Polack
29	Donald	NVT	Jono Robinson
30	Horsham	NVT, Industry lentil trial	Alex Foreward, Karl Beddison, Jason Pymer
31	Kaniva	NVT, Durum wheat	Alywn Dyer, Ben Crouch
32	Longerenong	Nitrogen management	Longerenong College
33	Minimay	NVT	Ollie Gabe
34	Murra Warra	Weed management, Canola establishment, Seeder demonstration	David Jochinke
35	Rupanyup	Industry agronomy trials	Site sourced by Nutrien Ag Solutions
36	Telopea Downs	NVT	Michael Norton
37	Wallup	Farming systems	Alexander McCrae
38	Warracknabeal	NVT	Geoff Morcom
39	Watchem	Oat trial, Oaten hay	Adam Campbell

SITE DESCRIPTIONS

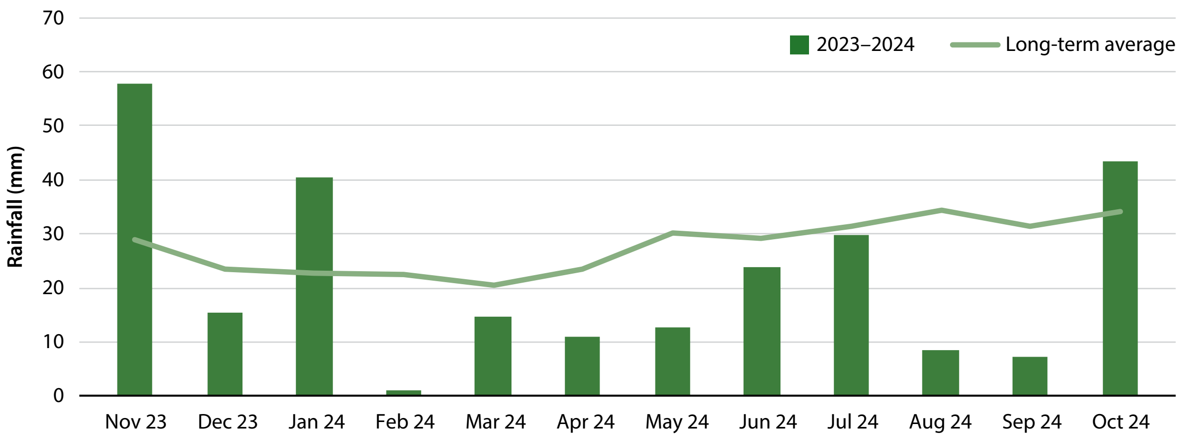
NULLAWIL

Growing season rainfall	178mm
Decile	1
Crop year rainfall (Nov 23 – Oct 24)	361mm
Decile	7
Soil type	Loamy clay
Stubble type	Vetch brown manure
Soil sampling date	12/03/2024
Plant available water (0–100cm)	72mm
Available nitrogen (0–100cm)	100 kg/ha
Colwell P (0–10cm)	33 mg/kg
PBI	53
Organic carbon (0–10cm)	1%



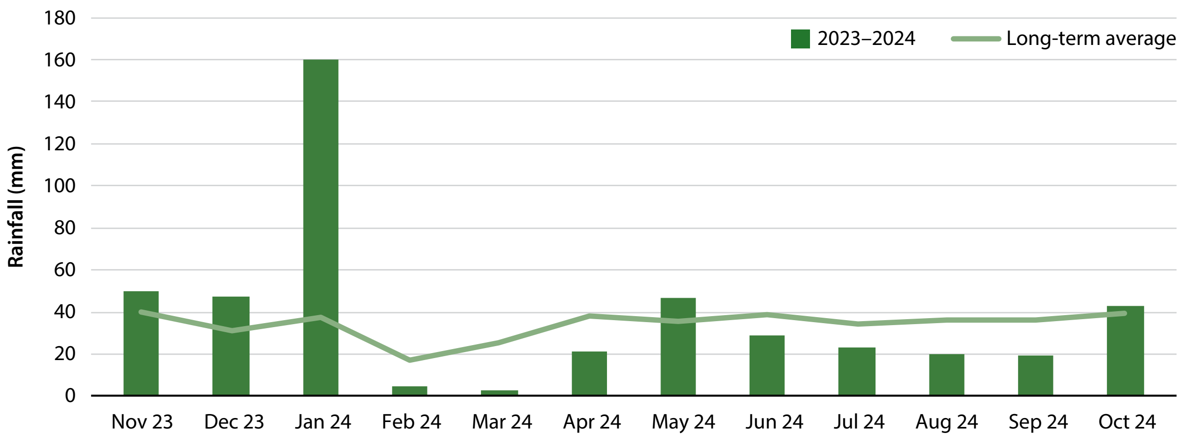
WALPEUP (PULSES)

Growing season rainfall	137mm
Decile	2
Crop year rainfall (Nov 23 – Oct 24)	266
Decile	3
Soil type	Clay loam
Stubble type	Cereals
Soil sampling date	08/04/2024
Plant available water (0–100cm)	38mm
Available nitrogen (0– 00cm)	51 kg/ha
Colwell P (0–10cm)	29 mg/kg
PBI	23
Organic carbon (0–10cm)	0.4%



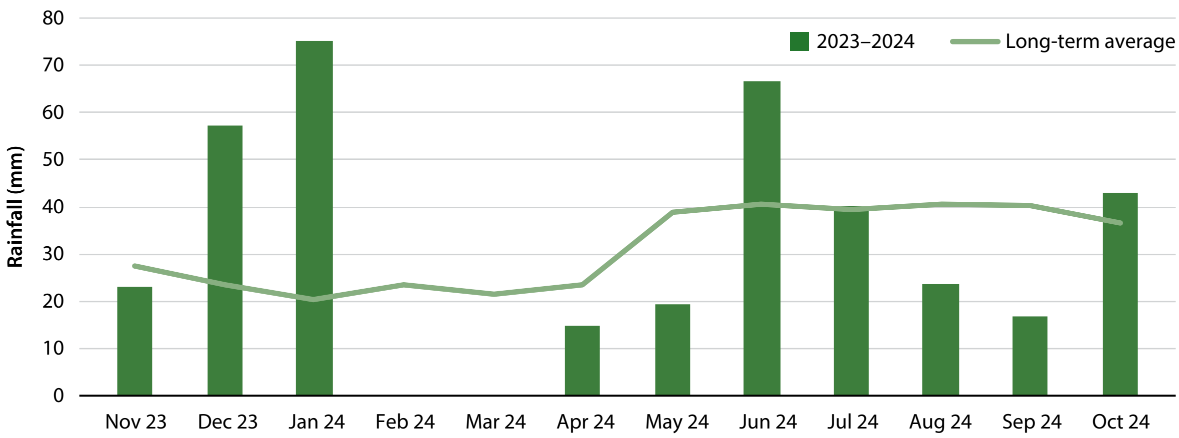
MITIAMO

Growing season rainfall	202mm
Decile	4
Crop year rainfall (Nov 23 – Oct 24)	467mm
Decile	7
Soil type	Silty clay loam
Stubble type	Oaten hay
Soil sampling date	27/04/2024
Plant available water (0–100cm)	66mm
Available nitrogen (0–100cm)	125 kg/ha
Colwell P (0–10cm)	36 mg/kg
PBI	83
Organic carbon (0–10cm)	1.5%



MURRA WARRA

Growing season rainfall	225mm
Decile	4
Crop year rainfall (Nov 23 – Oct 24)	380mm
Decile	6
Soil type	Clay
Stubble type	Lentil
Soil sampling date	30/05/2024
Plant available water (0–100cm)	44mm
Available nitrogen (0–100cm)	103kg/ha
Colwell P (0–10cm)	14 mg/kg
PBI	130
Organic carbon (0–10cm)	1%



CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

BCG RESEARCH METHODOLOGY

TRIAL SITES

BCG managed 60 research and demonstration sites across the Wimmera, Mallee and North Central in 2024. The sites are repositioned each year in order to generate results representative of a range of soil types, paddock history and climatic conditions. BCG research trial sites included replicated experiments investigating a range of issues, such as weed control, herbicide resistance and efficacy, varietal assessments, crop nutrition, disease management, barley agronomy, crop sequencing, frost management and season-specific issues.

REPLICATED TRIALS AND EXPERIMENTS

Replicated trials and experiments are those in which the treatments are repeated more than once (usually four times). This allows for the use of statistical tests which can determine whether differences observed in average (mean) results are likely to be due to the treatments or if they occurred purely by chance.

INTERPRETING BCG TRIAL RESULTS

Interpreting and understanding trial results is not always easy. In this publication, BCG attempts to present the results in a standard format. Results from replicated trials can be used to assist in making confident on-farm decisions.

Statistical tests

The results of replicated trials are presented as the average (mean) for each of the replicated treatments.

BCG usually conducts statistical tests at a 95 per cent (%) confidence level. This means that if a 'significant' result is reported, the author is 95% confident that there is a difference between treatments. Statistical tests such as t-tests and analysis of variance (ANOVA) give a 'P' value which signifies the probability of two results being different due to chance. A P-value less than 0.05 ($P<0.05$) indicates there is at least a 95% chance the results are different and that the difference is considered to be significant (S). A P-value greater than 0.05 ($P>0.05$) indicates there is a less than 95% probability the results are different and that the difference is considered to be not significant (NS).

In the case of ANOVA, in which the means of more than one treatment are compared, those which are significantly different from each other are shown using the Least Significant Difference (LSD), which is calculated at the 95% confidence level. Average results that lie within the mean of another result (+/- the LSD) are considered to be not significant.

Demonstrations

Each year, BCG conducts a number of single treatment demonstrations. Without the need for replication, demonstrations allow the exhibition of a large number of treatments. However these cannot be statistically analysed. Observed differences cannot be validated and may be the result of paddock variability or chance. Demonstrations are usually conducted in conjunction with a replicated trial to ensure some scientific rigour in the findings.

Coefficient of variation

The coefficient of variation (CV) is a measure of the variability of data used to calculate a treatment average. It is expressed as a percentage. A low CV (<10%) suggests that a treatment performed similarly across all replicates within a trial. A high CV (>20%) suggests that a treatment performed inconsistently across the replicates within a trial. This can be due to differences in environmental conditions such as soil type or rainfall, variations in weed density and disease pressure, or a measurement error.

Replicated results: an example

In this publication, statistical results will be displayed either as a table or as a chart. Below is an example of the same set of results for a replicated trial containing wheat yield and quality data, with statistical interpretation in both table and chart form. *Please note these figures are hypothetical and are not based on any replicated trials performed by BCG.*

Table 1. Wheat variety yield, protein and screenings results from a hypothetical example using a table to illustrate LSD.

Variety	Yield (t/ha)	Protein (%)	Screenings (%)
Lincoln	4.6^{d}	9.5^{b}	3.7
Axe	4.0^{c}	10.7^{cd}	3.6
Correll	3.9^{bc}	10.6^{c}	3.5
Gregory	3.5^{ab}	8.5^{a}	4.0
Mace	3.3^{a}	11.4^{d}	4.1
Yitpi	3.2^{a}	11.3^{c}	3.4
Sig. diff.	**0.001**	**<0.001**	**0.06**
LSD (P=0.05)	**0.4**	**0.9**	**NS**
CV%	**5.2**	**2.0**	

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

In the example in Table 1, mean yields, protein and screenings of the different varieties were analysed. Significant differences were found between varieties in yield and protein, but not in screenings. The LSD of 0.4t/ha for yield shows that there must be more than 0.4t/ha difference between yields before that variety's performance is significantly different from another. In this case, the yields of Yitpi and Mace were not significantly different from each other. Both varieties are labelled with an identical superscript letter (^{a}). This illustrates that there was no significant difference between the yields of the two varieties.

However, Yitpi (^{a}) yielded significantly lower than Correll (^{bc}), Axe (^{c}) and Lincoln (^{d}), as there was more than 0.4t/ha difference between varieties. The superscript letters which are different from those on other varieties denote significant differences. If the letters between varieties are the same, they are not significantly different from one another. Where there are no significant differences between treatments, NS, meaning not significant, will be displayed.

In Table 2, the mean yields of all varieties and both time of sowing (TOS) were analysed, and the interaction between variety and TOS. This means three sets of statistics are produced, two main effects of either variety, or TOS, and then also the interaction effect (variety x TOS).

Table 2. Wheat variety yield from two TOS results from a hypothetical example using a table to illustrate a two-way interaction.

Variety	TOS 1 yield (t/ha)	TOS 2 yield (t/ha)
Trojan	7.4^{a}	6.8^{bcd}
Cosmic	7.2^{ab}	6.5^{defg}
Scepter	7.1^{abc}	6.7^{de}
Derrimut	6.8^{bcd}	6.1^{fgh}
Corack	6.6^{de}	6.6^{def}
Mace	6.4^{defg}	6.1^{ghi}
Wallup	6.2^{fg}	6.7^{cd}
Kord CL Plus	6.1^{ghi}	5.6^{ij}
Scout	6.1^{ghi}	5.7^{hj}
DB Aurora	5.5^{j}	6.2^{efg}
Sig. diff. Variety	**<0.001**	
TOS	**0.536**	
Variety x TOS	**<0.001**	
LSD (P=0.05) Variety	**0.3**	
TOS	**NS**	
Variety x TOS	**0.4**	
CV%	**4.3**	

Variety is the main effect and it is significant (P<0.001) meaning the average yield of variety (from both TOS) shows differences. The LSD is the number that needs to be met to represent a significant difference, which in this case is 0.3t/ha. So, if the average yield of a variety is more than 0.3t/ha different to another, they are significantly different. The second main effect, TOS is not significant (P=0.536) meaning the average overall yield of TOS1 is equal to TOS2. The LSD that would have been required for TOS to be significant was 3.4t/ha.

The interaction of variety and TOS was significant (P<0.001) and the LSD was 0.4t/ha. This means if a variety in TOS1 is more than 0.4t/ha different to a variety in TOS2 they are statistically different. For example, Trojan in TOS1 yielded 7.4t/ha and Trojan in TOS2 yielded 6.8t/ha, meaning they are significantly different. Trojan TOS1 is also significantly different to Cosmic in TOS2 (6.5t/ha). On the other hand, Corack in TOS1 is not significantly different to Mace in TOS2 as they do not meet the LSD of 0.4 t/ha between means.

Throughout this publication, statistical results may also be presented as graphs. Error bars at the top of each solid column within graphs can represent the LSD or Standard Error.

As the error bars in Figure 1 extend only upwards, they are expressing the LSD between the yields of wheat varieties. Whether a variety (or treatment) is significantly different from another can be determined by looking at the LSD error bars. When the LSD bar does not reach the top of a solid column, a significant difference is evident. In Figure 1, there is no significant difference between the grain yields of Yitpi, Mace and Gregory. The yield of Gregory however is significantly different from those of Axe and Lincoln, but not of Correll.

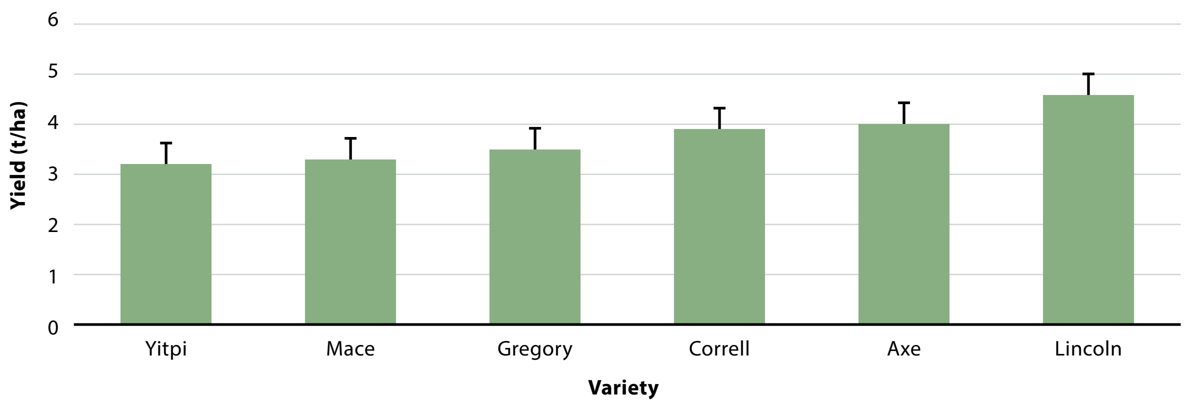


Figure 1. Wheat variety yields from a hypothetical example using error bars to illustrate LSD.

Error bars that express the standard deviation extend both up and down from the top of each solid column. A standard deviation is a statistical measurement used to show how much variability exists in a set of data around the average or expected value. A long standard deviation bar indicates a broad range of possible values relative to the expected value. A short standard deviation bar means the data points are considered close to the expected value.

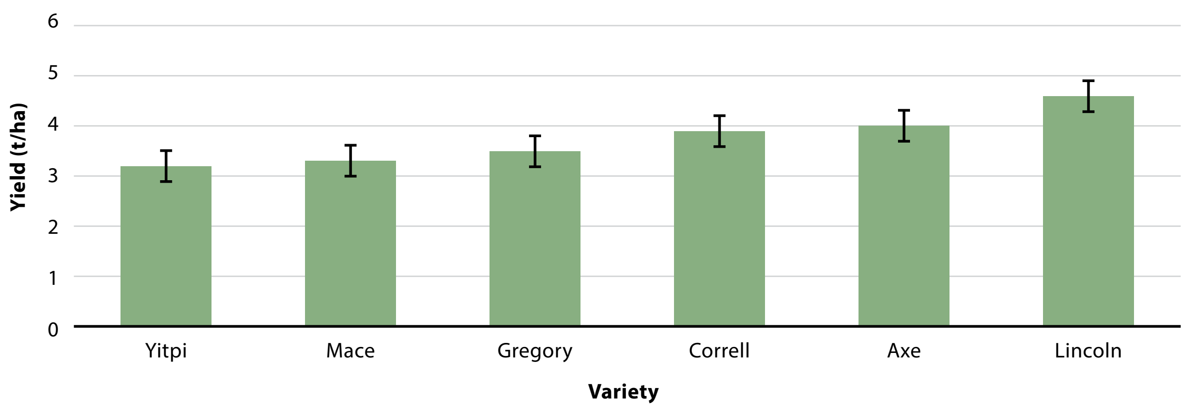


Figure 2. Wheat variety yields from a hypothetical example using error bars to illustrate standard error.

REGRESSION ANALYSIS

Regression analysis is a statistical technique used to assess the relationships between two variables: a dependent variable (such as grain yield) and an independent variable (such as weed density). Regression analysis helps explain what will happen to a dependent variable as the independent variable changes. For example, what happens to yield as weed density increases?

Regression analysis allows a set of data points to be simplified into a line of best fit: a line which passes through the set of data points and indicates the relationship between the two variables. When looking at the relationship between two variables, we need to understand how close the relationship is. To achieve this, a statistical measure known as R^2 is used. R^2 is the variation between the data points and the line of best fit. It indicates how well a group of points on a graph adheres to a straight line. Essentially, the closer the points are together, and the more closely they resemble a straight line, the stronger the relationship between the data points.

Figure 3 is an example of regression analysis. This graph shows how summer weed density (plants/m^2) influences yield (t/ha). It is clear from this example that, as weed density increases, yield decreases. Figure 3 shows an R^2 value of 0.72 or 72%. This means 72% of the variation in yield can be explained by changes in summer weed density. The higher the R^2 value, the stronger the relationship. In this instance, we can see the relationship is quite strong. It is dependent on the variables under consideration.

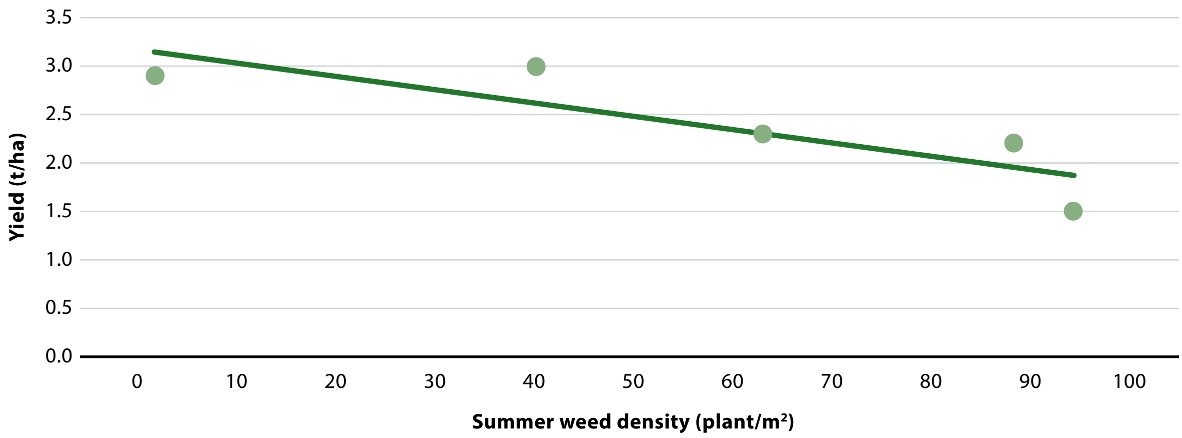


Figure 3. Using regression analysis to determine the effect of summer weed density on yield. R^2=0.72.

GROSS MARGINS OR ECONOMIC ANALYSIS

Where appropriate, gross margins have been calculated to compare treatments. No statistical analysis has been calculated on the gross margins unless stated. In some instances, statistical analyses have been performed on the economics. While gross margins can be a good guide to show the expected return of different treatments, many variables are involved. If there are no significant differences realised at one of these levels, gross margins may become misleading. Gross margin outputs should be treated with caution. Accompanying comments that outline the parameters employed in the development of gross margin outputs must be taken into consideration.

Gross margins do not take into account fixed or capital cost, which is one of the primary reasons they can be ambiguous. They should be treated with caution.

NORMALISED DIFFERENCE VEGETATION INDEX (NDVI)/GREENSEEKER®

In trials conducted by BCG, NDVI (Normalised Difference Vegetation Index) is used as a substitute measure of crop biomass and greenness. The NDVI sensor is directed over the trial plots and emits brief bursts of red and infrared light. Optical sensors measure the amount of each type of light reflected from the target area, which is a measure of the amount and intensity of greenness in the target. The sensor records the measured value in terms of an NDVI reading ranging from 0.00 to 0.99. High values indicate intensely green covering 100 per cent of the ground and lower values may indicate less ground cover or a less green crop.

GUIDELINES FOR INTERPRETING SOIL TEST RESULTS

Nutrient	Unit	Optimal range	Notes
Ammonium (NH_{4+})	mg/kg	0–5	Nitrogen in organic matter must first be converted to ammonia or nitrate before it is in a state available for plants.
Nitrate nitrogen (NO_3)	mg/kg	10–50	Nitrate nitrogen makes up the largest proportion of nitrogen in the soil and is the form most readily available for plants.
Phosphorus buffering index (PBI)		0–20 limited P fixation 20–70 small P fixation 70–100 moderate P fixation >100 high P fixation	If the PBI is high, soil will bind to P quicker making it unavailable to the plant. At higher PBI levels more P is required to preserve maintenance levels than in a soil with a low PBI.
Phosphorus P: (Colwell)	mg/kg	Wimmera clay: 15–35 Mallee SCL: 20–25 Acid soils: 25–30	Colwell P test can be unreliable on alkaline clays. Most likely to see a P response if Colwell P is less than 15 mg/kg.
Phosphorus (P) DGT	C_{DGT} µg/L	Marginal: 47–60 C_{DGT} µg/L Low: 18–47 C_{DGT} µg/L	Trials across southern Australia have demonstrated the DGT method is producing more consistent response predictions than the Colwell P test across soil types.
Organic Carbon (OC)	%	0.9–1.5 The higher the better	Organic carbon varies, depending on soil type and management. Highest OC% comes from clay soils under long-term pasture.
pH_{H2O}		6.5–8	pH determines the availability of nutrients in the soil.
pH_{CaCl}		5–7.5	
EC 1:5 (soil:water)	dS/m	<0.2–0.4 but depends on soil type	EC is the electrical conductivity of the soil. Pulses could encounter problems if above 0.21ds/m. Issues if above 0.4dS/m in subsoil (below 10cm).
ECe	dS/m	<4–8	ECe is the EC calibrated for soil type.

Nutrient	Unit	Optimal range	Notes
Chloride	mg/kg	<700–800	Levels above 800mg/kg cause impaired root growth and become toxic at 1300mg/kg.
Exchangeable sodium percentage (ESP)	%	<6 topsoil <15–19 subsoils	ESP gives a measure of sodicity. A soil is defined as sodic when ESP is above 6% and highly sodic when ESP is above 15%.
Zinc Zn (EDTA)	mg/kg	Neutral pH: 0.7–1.2 adequate Alkaline soils: Add Zn or Cu if < 2mg/kg	It is difficult to make fertiliser recommendations from soil tests for Zn and Cu. Use tissue testing to confirm whether trace elements are required before applying in the fertiliser.
Copper Cu (EDTA)	mg/kg		
Potassium (K)	mg/kg	60–160	Wimmera/Mallee soils are generally high in K. Potassium responses are rare, even when levels are low. K is easily leached.
Sulfur (S) – (KCL)	mg/kg	5–6+ topsoil tests <2 subsoil tests	Surface (0–10 cm) tests can be a poor indicator as crops can access S in the subsoil. Canola has a higher requirement for S than other crops. S levels will be very high after gypsum applications.
Boron (B)	mg/kg	<10 in 0–60cm <14 over a 20–30cm increment	Tests of 10 and above in a 0–60cm soil test can indicate a problem, as the level is averaged across 60cm of soil. Re-test in increments to see where the B becomes a problem.
Aluminium (Al)	%	<5	These elements comprise the cation exchange capacity which measures the ability of the soil to 'hold' and exchange cations (aluminium, calcium, magnesium, sodium, potassium, hydrogen).
Calcium (Ca)	%	60–85	
Magnesium (Mg)	%	6–18	
Sodium (Na)	%	<6	
Potassium (K)	%	0.26–0.4	
Ca:Mg		<5	

GRAIN AND COMMODITY PRICES

Cash prices taken from *The Weekly Times*, 11 December 2024, unless otherwise stated.

BARLEY

Grade	Ouyen	Beulah	Murtoa	Ultima	Charlton	Elmore	Wycheproof	Average
Malt 1: PL1	284	293	298	291	300	306	298	296
Maximus (MX1)	284	293	298	291	300	311	298	296
BAR2	264	275	278	271	287	301	282	280
Difference malt v feed	20	18	20	20	13	7.5	16	

CANOLA

Grade	Ouyen	Beulah	Murtoa	Ultima	Charlton	Elmore	Wycheproof
CAN: non-GM	754	765	770	761	770	776	768
CAN: GM	694	705	710	701	710	716	708

WHEAT

Grade	Ouyen	Beulah	Murtoa	Ultima	Charlton	Elmore	Wycheproof
H2	322	329	334	329	338	344	336
APW1	309	318	323	316	325	331	323
ASW	289	303	308	296	305	319	303
AGP	272	283	278	279	288	301	286

OATS

Grade	Ouyen	Beulah	Murtoa	Ultima	Charlton	Elmore	Wycheproof	Average
Milling	374	383	398	388	407	421	402	396
Feed	314	323	338	328	347	361	342	336
Difference	60	60	60	60	60	60	60	60

PULSES

Type	Piangil	Beulah	Nhill	Charlton	Murtoa	Elmore
Lupins	535	539	538	559	555	573
Field peas	524	548	552	541	565	553
Desi chickpeas	859	883	887	876	900	888
Lentils (Nugget)	849	873	877	866	890	878
Faba beans	599	623	627	616	640	623

HAY

Type	Swan Hill	Elmore	Horsham
Lucerne large bales	410	410	390
Pasture large bales	265	255	245
Cereal large bales	290	285	295
Vetch large bales	375	375	380
Straw large bales	130	130	130

DURUM

Type	
DR1	475
DR2	455
DR3	415

FERTILISER

Type	
Urea	$700/t*

*Supplied by Western Ag.

VARIETIES AND THEIR MANAGEMENT

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

BARLEY VARIETIES IN THE MALLEE, NORTH CENTRAL AND WIMMERA

Ashlee Tierney (BCG)

TAKE HOME MESSAGES

- The top yielding barley varieties in the Mallee in 2024 were Combat, Beast, and Compass.
- The top varieties in the North Central for 2024 were Minotaur, Neo CL, Rosalind, and Cyclops.
- The highest yielding varieties in the Wimmera in 2024 were Neo CL, Fandaga, Minotaur, and Combat.

BACKGROUND

The 2024 season began with high January rainfall across much of the Mallee, North Central and Wimmera. This weather pattern did not continue through the year, and by April and May many farmers were deliberating the best approach to their sowing program: whether to sow dry, or wait for the break to come. Like many growers across the regions, some National Variety Trials (NVT) were dry sown (Table 1).

Barley varieties are constantly changing and evolving as plant breeders release new varieties to combat the latest challenges facing growers. When considering a new variety, think about the traits needed to increase productivity on the farm and what best fits the system. Considerations may include whether a variety is classified as malt or feed – and potential price differences – lodging susceptibility and head loss risk, herbicide tolerance, or maturity timing.

In 2024, BCG established 12 main season barley trials: seven in the Mallee, two in the North Central and three in the Wimmera (Table 1). These trials were about 40 per cent breeding lines and the rest released varieties.

The combination of NVT data, individual site reports, and multi-environmental trial analysis (MET) long-term data provides a useful tool for growers to determine which varieties are performing well and may be suitable for their farming system.

AIM

To compare the performance of new and existing barley varieties in the Mallee, North Central and Wimmera NVT.

TRIAL DETAILS

Crop type:	Barley, refer to Figures 1–3 for varieties
Target plant density:	130 plants/m^2 (Mallee), 160 plants/m^2 (North Central and Wimmera)
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Replicates:	Three

Nutrition, weeds, insects and disease were managed as per best practice. For individual trial details see <https://nvt.grdc.com.au>.

METHOD

This research was conducted through the NVT program delivered by GRDC. The program involves a series of replicated field trials that test varieties from different crop types. These trials aim to maximise genetic potential yield, rather than profitability. The sites receive multiple fungicide applications and are managed to ensure they are not nitrogen limited to avoid confounding factors when assessing the genetic potential of varieties. The data displayed in this article are a combination of NVT results, individual site reports, and multi-environmental trial analysis (MET) long-term summaries. Variety performance is presented as the grain yield percentage of the site average, with MET data indicating performance in 2024, relative to the previous five years (2019–2023).

Table 1. Sowing date, paddock details, rainfall, and harvest date of 2024 barley NVT trials in the Mallee, North Central, and Wimmera regions.

Location	Sowing date	Germinating rainfall date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Mallee							
Birchip (Nullawil)	12 May	12 May	Loamy clay	Vetch	361 (7)	178 (1)	13 Nov
Hopetoun	9 May	30 May	Clay	**	266 (3)	100 (1)	22 Nov
Manangatang	16 May	16 May	Sand (0–10cm) Clay (10–100cm)	Chickpeas	296 (5)	100 (1)	18 Nov
Merrinee	14 May	30 May	Sand (0–10cm) Clay (10–100cm)	Vetch	224 (2)	115 (1)	20 Nov
Murrayville	17 May	30 May	Clay	Lentils	239 (2)	113 (1)	20 Nov
Ultima	14 May	14 May	Clay	Lentils	356 (6)	143 (2)	14 Nov
Walpeup	16 May	30 May	Sandy loam	**	266 (3)	137 (2)	*
North Central							
Charlton	29 May	30 May	Clay	**	311 (2)	208 (3)	*
Colbinabbin	20 May	20 May	Clay	Canola	479 (5)	244 (3)	17 Dec
Wimmera							
Brim	28 May	30 May	Clay	**	320 (4)	226 (6)	2 Dec
Horsham	28 May	30 May	Clay	Lentils	401 (5)	262 (5)	*
Kaniva	8 May	30 May	Clay	Lentils	427 (5)	184 (1)	13 Dec

*Trial was not harvested. **Information not available. Number in brackets () denotes decile.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

RESULTS AND INTERPRETATION

New varieties released in 2024

Bigfoot CL is a quick-to-mid maturing, high yielding Clearfield variety from Australian Grain Technologies (AGT). It is closely related to Compass, with its good early vigour, and has reduced plant height compared with other Compass types to reduce risk of lodging. It only has a feed classification but offers high yield in low-to-medium rainfall areas.

Granite CL is a new Clearfield variety for the low-medium rainfall zones bred by InterGrain. It is high yielding, has a feed classification, quick-to-mid maturity, and has strong lodging tolerance with low head loss risk. It has a MRMS rating for both spot form and net form of net blotch, but is rated S to leaf rust and powdery mildew.

RGT Atlantis is a new waterlogging-tolerant barley from RAGT Australia. This variety has been bred from RGT Planet and is combined with a waterlogging tolerant barley. Under non-waterlogged conditions, RAGT claims it has a similar yield potential to RGT Planet, and when waterlogged can outyield RGT Planet by 20 per cent or more.

Pegasus AX is a new variety from AGT with CoAXium® herbicide tolerance. This Hindmarsh plant type variety gives it a shorter, compact plant type, lowering lodging risk, and is suited to medium-high rainfall zones. It has a quick-to-mid maturity and is a feed quality variety. The CoAXium® herbicide tolerance allows early post-emergent control of problem grass weeds such as brome grass, barley grass, annual ryegrass, and wild oats with Sipcam's Group 1 Aggressor® AX herbicide, which contains the active ingredients quizalofop-p-ethyl and cloquintocet-mexyl. Note: this only applies to grass weeds which are not resistant to group 1 herbicides.

Yield results

Table 2. 2024 barley NVT yield results across the Mallee, North Central, and Wimmera regions.

Region	Location	Average trial yield (t/ha)
Mallee	Birchip (Nullawil)	5.0
	Hopetoun	Data not released
	Manangatang	2.5
	Merrinee	2.5
	Murrayville	2.0
	Ultima	Data not released
	Walpeup	Trial was abandoned
North Central	Charlton	Trial was abandoned
	Colbinabbin	6.9
Wimmera	Brim	1.5
	Horsham	Trial was abandoned
	Kaniva	6.9

Table 3. Disease ratings of selected barley varieties.

Variety	Maturity	Quality	SFNB	NFNB	Leaf rust	CCN resistance	Leaf scald
Combat	M	Feed	MRMS	MRMS	S	MR	S
Cyclops	Q-M	Feed*	MS	MRMS	SVS	S	S
Minotaur	M-S	Malt	MRMS	S	VS	R	VS
RGT Planet	M	Malt	SVS	SVS	MRMS	R (P)	SVS
Spinnaker	M-Q	Feed**	SVS	S	S	S	S
Bigfoot CL	Q-M	Feed	MRMS (P)	MRMS (P)	S (P)	R	VS (P)
Maximus CL	M-Q	Malt	MS	MRMS	S	R	SVS
Neo CL	M-S	Feed*	MR (P)	MS (P)	S (P)	R	S (P)
Spartacus CL	Q-M	Malt	S	S	S	R	SVS
Pegasus AX	Q-M	Feed	MSS (P)	MR (P)	MRMS (P)	R	S (P)
Titan AX	M-S	Feed*	MS	MS	SVS	MR (P)	VS

R= Resistant, RMR= Resistant to Moderately Resistant, MR= Moderately Resistant, MRMS= Moderately Resistant to Moderately Susceptible, MS= Moderately Susceptible, MSS= Moderately Susceptible to Susceptible, S= Susceptible, SVS= Susceptible to Very Susceptible, VS= Very Susceptible. (P)= Provisional rating. *= Malt accreditation expected in 2025 (Grains Australia, 2024). ** = Malt accreditation expected 2026 (Grains Australia, 2024). Disease ratings for all varieties and diseases can be found at <https://nvt.grdc.com.au/nvt-disease-ratings>.

In the Mallee, the top yielding varieties over the past five years have been Neo CL, Combat, Cyclops, Bigfoot CL, and Minotaur (Figure 1). The two Clearfield varieties in this group, Neo CL and Bigfoot CL, have only two years of NVT data. In 2024, the highest yielding varieties for the Mallee as a percentage of the region mean were Combat (112 per cent), Beast and Compass (both 111 per cent).

At an individual site level, the top variety varied between locations. At Birchip, the highest yielding was Compass at 109 per cent, Compass and RGT Planet both yielded 114 per cent at Manangatang, Combat yielded 116 per cent at Merrinee, and Beast yielded 129 per cent of the site mean at Murrayville.

Numerous varieties yielded above the site mean at all the individual sites in 2024. These were Beast, Combat, Commodus CL, Compass, and Leabrook. From 2019 to 2023, all Clearfield varieties, excluding Scope CL, yielded above the region mean. Neo CL and Bigfoot CL are at the top with two years of data, and in 2024 Commodus CL and Neo CL were the higher yielding Clearfield varieties.

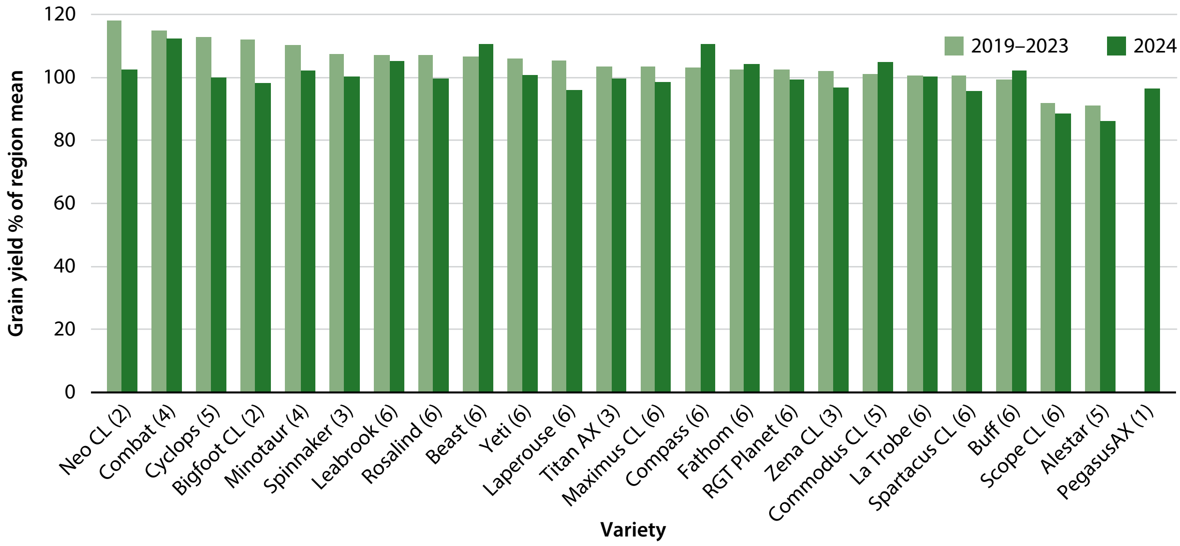


Figure 1. Mallee barley NVT average yield as a percentage (%) of region mean, 2019–2023 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note 2024 data only includes Birchip, Manangatang, Merrinee, and Murrayville.

The only 2024 data included in Figure 2 is from Colbinabbin, so bear that in mind when looking at 2024 data from other parts of the North Central region. Historical data from the past five years in the North Central has Neo CL, Combat, Spinnaker, Zena CL, and RGT Planet (Figure 2) as the top performers. The highest yielding varieties at Colbinabbin as a percentage of the site mean in 2024 were Minotaur (115 per cent), Neo CL (113 per cent), Rosalind and Cyclops (109 per cent), and Granite CL (108 per cent). Looking at the Clearfield varieties, Neo CL and Zena CL are both averaging above the region mean in the historical data, although Neo CL is only in its second year of NVT. Granite CL is another newer variety to keep an eye on as it performed well in 2024 but has just one year of data. Looking at the two CoAXium® herbicide tolerant varieties in 2024, Pegasus AX (107 per cent) was only in its first year of NVT but outperformed Titan AX (90 per cent), which was in its in its third year of NVT.

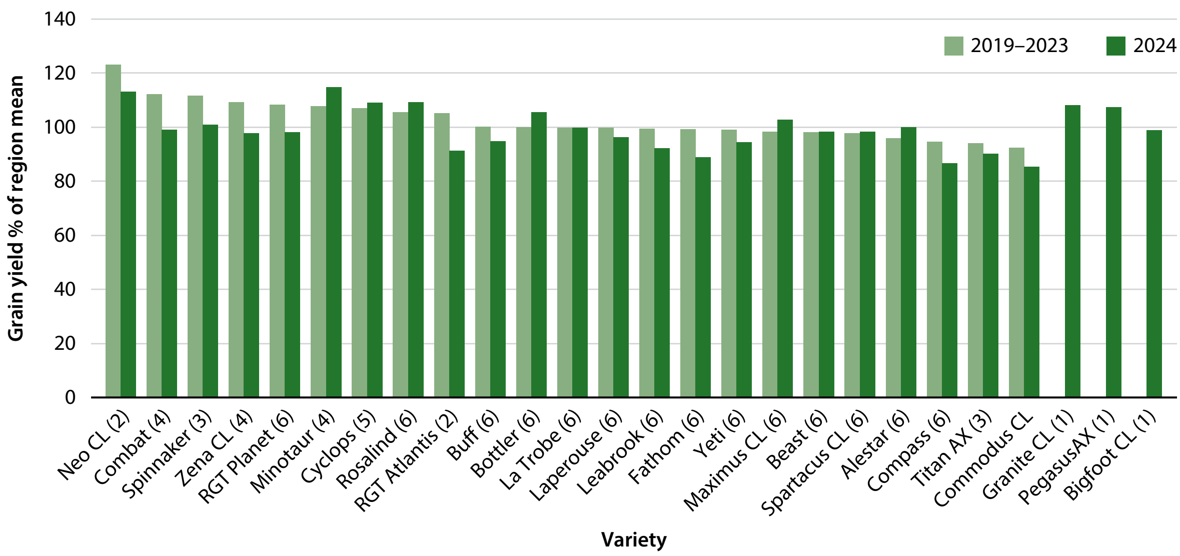


Figure 2. North Central barley NVT average yield as a percentage (%) of region mean, 2019–2023 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data only include the Colbinabbin site.

The top yielding varieties over the past five years in the Wimmera region have been Combat, Neo CL, Minotaur, Cyclops, and Spinnaker (Figure 3). Neo CL was released in 2023 and has again yielded highly in its second year in the NVT, producing 114 per cent of the region mean. The other top yielding varieties for 2024 were Fandaga and Minotaur (109 per cent), Combat (108 per cent), and RGT Planet and Spinnaker (107 per cent). Combat was the highest yielding variety at Brim, yielding 120 per cent of the site mean. At Kaniva, Neo CL yielded 118 per cent of the site mean, which was 9 per cent or 0.6t/ha higher than the next variety, Spinnaker. Neo CL and Zena CL are the higher yielding Clearfield varieties in both 2019–2023 and 2024. Bigfoot CL, a new variety in its first year of NVT was just above the region mean at 102 per cent in 2024. Seven varieties yielded above their individual site means at both Brim and Kaniva: Combat, Fandaga, Minotaur, RGT Atlantis, RGT Planet, Titan AX, and Zena CL.

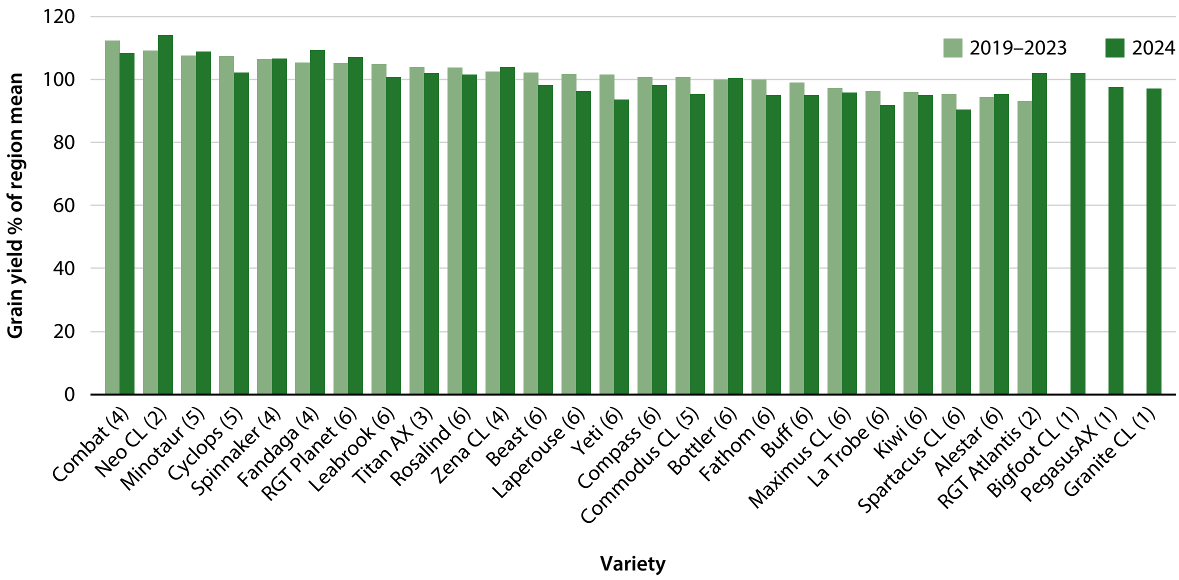


Figure 3. Wimmera barley NVT average yield as a percentage (%) of region mean, 2019–2023 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data only include Brim and Kaniva.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The NVT network allows growers to compare different varieties based on yield, grain quality, and disease ratings. These data can be used by growers to see which varieties are performing well in their area, and to compare newly released varieties with those currently in their rotations. It is important to take note of historical data and not just the current year, as the historical data is a better guide to what will perform well under a variety of seasonal conditions.

The price difference between malt and feed barley was only small, and varying from about $7/t to $20/t (*The Weekly Times*, 2024) across the regions in 2024. The top barley variety in the Mallee was Combat, a feed variety which yielded on average 3.39t/ha, compared with malt varieties RGT Planet and Maximus CL which yielded 3t/ha and 2.97t/ha. Growers should consider the likelihood of achieving malt grade versus the yield advantages often seen in feed varieties. Neo CL is worth keeping an eye on as it has been yielding well and is targeted for malt accreditation in 2025 (Grains Australia, 2024).

There were numerous frost events across the regions in 2024. As frost varies in frequency and severity, growers should assess frost risk early and implement management strategies to reduce the risk of losses from frost. Barley is most susceptible to frost damage during flowering and grain fill, and variety choice is one strategy that can be implemented to reduce risk (DPIRD, 2024). Sowing during the optimum period is important for avoiding flowering during times of high frost risk. Selecting varieties with varied maturity timing can help spread the risk. Sowing the right variety at the right time is typically a key message in minimising crop damage from frosts during their more sensitive growth stages (GRDC, 2024). This however may not always work, such as in seasons similar to 2024 when hit with a late frost.

Grain quality data from NVT was not available at the time of compiling this report.

NVT results compromised due to frost and drought are not released publicly. They will be made available within the 'Quarantined trials report' section of the website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

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CANOLA VARIETIES IN THE MALLEE, NORTH CENTRAL, AND WIMMERA

Pip Lees (BCG)

TAKE HOME MESSAGES

- Pioneer PY424GC achieved the highest yields in the Mallee, demonstrating strong performance in low rainfall environments.
- Pioneer PY421C, the top performing IMI variety, provided yield stability across multiple regions, highlighting its versatility in diverse conditions.
- InVigor LR 4540P and InVigor LR 5040P demonstrated competitive yields in the North Central and Wimmera regions, respectively.

BACKGROUND

The 2024 growing season presented several challenges for canola growers. A late break and subsequent patchy germination impacted crop establishment in many areas across the Mallee, North Central, and Wimmera regions. Dry conditions persisted throughout much of the season, and crops were hit by several significant frost events and high aphid pressure, all of which negatively influenced yields.

The frequent release of new canola varieties underscores the ongoing relevance of National Variety Trials (NVT). Many new varieties have limited multi-season data due to the rapid evolution of breeding programs, making varietal selection highly dependent on seasonal conditions.

Canola has an important role in herbicide rotation strategies, allowing growers to consider factors beyond yield, such as weed management benefits.

AIM

To compare the performance of canola varieties across the Mallee, Wimmera, and North Central Regions within the NVT for the 2024 season.

TRIAL DETAILS

Crop type: Canola (varieties detailed in Figures 1–3)

Target plant density: 40 plants plants/m^2 (Mallee), 50 plants/m^2 (Wimmera and North Central)

Seeding equipment: Knife points, press wheels, 30cm row spacing

Replicates: Three

Trials were managed as per best practice. For individual trial details see <https://nvt.grdc.com.au>.

Table 1. Sowing date, paddock details, rainfall, and harvest date of 2024 canola NVT trials in the Mallee, North Central, and Wimmera regions.

Location	Sowing date	Germinating rainfall date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Mallee							
Birchip (Nullawil)	22 Apr	22 Apr	Clay	Vetch	361 (7)	178 (1)	7 Nov
Hopetoun	23 Apr	30 May	Clay	**	266 (3)	100 (1)	29 Oct
North Central							
Charlton	28 May	30 May	Clay	**	311 (2)	208 (3)	13 Nov
Diggora	8 May	9 May	Clay	Peas	456 (6)	228 (3)	*
Wimmera							
Horsham	9 May	30 May	Clay	**	401 (5)	262 (5)	2 Dec
Kaniva	8 May	30 May	Clay	Vetch	427 (5)	184 (1)	26 Nov
Minimay	3 Jun	3 Jun	Clay	Wheat	561 (8)	385 (7)	4 Dec

*Trial was not harvested. **Information not available. Number in brackets () denotes decile.

METHOD

The research was conducted through the NVT program delivered by GRDC. The program involves a series of replicated trials across diverse locations and crop types. The trials are designed to evaluate the maximum yield potential of varieties under optimal conditions, ensuring minimal interference from pests, diseases, or nutrient limitations. This approach isolates genetic performance to provide reliable comparisons.

RESULTS AND INTERPRETATION

NEW VARIETIES RELEASED IN 2024

Clearfield tolerant

Pioneer PY327C is a new, early maturing hybrid canola designed for a shorter growing season and lower rainfall zones, with blackleg rating to be determined.

Glyphosate tolerant

DG Buller G is a new hybrid product that has an extended application window and greater range of rates with Optimum GLY® herbicide tolerant traits. It has early to mid-maturity and is suited to medium to high rainfall zones, with blackleg rating to be determined.

Pioneer PY428R is a new early to mid-season, hyper-yielding Roundup Ready® hybrid canola. It has a rating of R for blackleg and is suited for diverse conditions.

Triazine tolerant

Monola H524TT is a new early to mid-season maturing hybrid with good early vigour. This is Nuseed's second monola hybrid and has oil and yield improvements.

Pioneer PY429T is a new hybrid canola that is early to midseason maturing. Developed from the Y series with the addition of the triazine tolerant trait, with blackleg rating to be determined.

Dual tolerance – Clearfield + Triazine

Nuseed Griffon TTI is Nuseed's first dual herbicide resistance hybrid. It is an early to mid-season maturity canola with fast pod development for a shorter growing season. Blackleg disease rating of RMR.

Dual tolerance Glufosinate + Glyphosate

Invigor LR 3540P is suited to lower rainfall environments with early maturity and a blackleg rating of R. The chemical package includes use of TruFlex® and LibertyLink®.

InVigor LR 5040P is similar to Invigor LR 3540P with a mid-maturity, resistant blackleg rating and the same chemical package. It has a higher yield and oil package.

Table 2. Average canola NVT yield results across the Mallee, North Central, and Wimmera.

Region	Location	Average trial yield (t/ha) IMI	Average trial yield (t/ha) TT	Average trial yield (t/ha) GT
Mallee	Hopetoun	Data not released	Data not released	Data not released
	Birchip (Nullawil)	2.1	1.7	2.1
North Central	Charlton	2.7	1.9	2.5
	Diggora	Trial abandoned	Trial abandoned	Trial abandoned
Wimmera	Horsham	2.1	2.1	2.0
	Kaniva	2.8	Trial abandoned	Trial abandoned
	Minimay	2.8	2.6	-

REGIONAL RESULTS

Mallee

The highest yielding varieties in the Mallee region were Pioneer PY424GC (2.4t/ha), InVigor R 4520P (2.4t/ha), and Pioneer PY421C (2.4t/ha). On average, the highest performing chemical group was GT and IMI at 2.1t/ha (Figure 1).

TT Varieties: Average yields of 2.1t/ha. InVigor T 4511 was the highest performer for yield (2.2t/ha; 125 per cent of the site mean). Other high performing varieties included Hyola Defender CT, Hyola Blazer TTi, and Nuseed Griffon TTI. Yields ranged from 1.3t/ha to 2.2t/ha.

IMI Varieties: The highest yielding variety from the small group of IMI varieties was Pioneer PY421C (111 per cent of the site mean; 2.4t/ha). All varieties yielded closely ranging from 2t/ha to 2.4t/ha. Pioneer 44Y94 CL also performed well in the Mallee over three years (110 per cent of site mean).

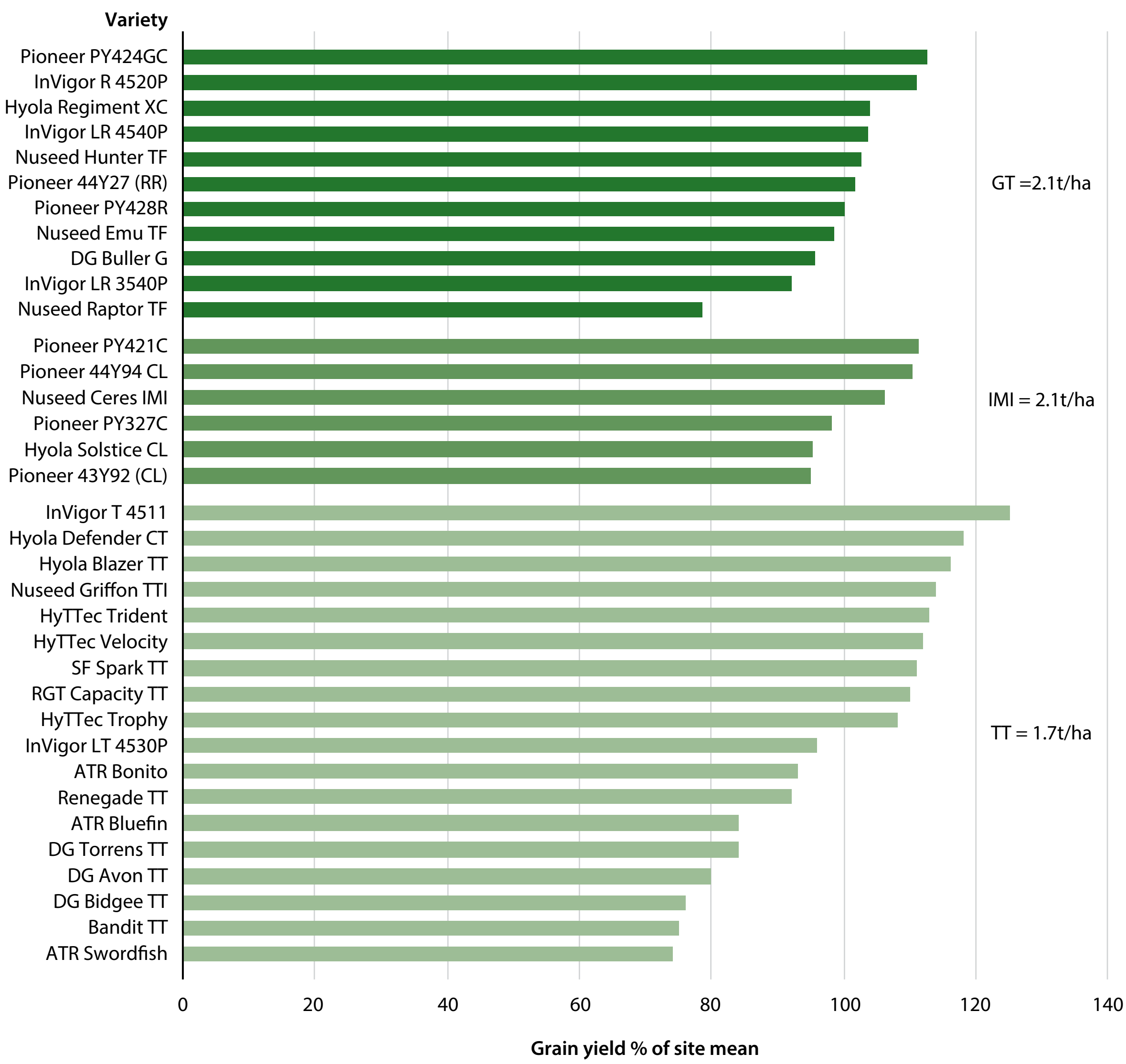

Figure 1. Mallee canola NVT average yield as a percentage of site mean (%). Note: data only include Birchip (Nullawil).

North Central

GT Varieties: InVigor LR 4540P and DG Buller G were the highest yielding varieties (2.7t/ha). It is important to note that DG Buller G is a new variety, with just one year of NVT data. The next best was InVigor R 4520P yielding 2.7t/ha, followed by Nuseed Hunter TF which yielded 2.6t/ha.

IMI Varieties: The highest yielding variety was Pioneer PY421C (3.3t/ha).

TT Varieties: HyTTec Trifecta was the highest yielding at 2.5t/ha, followed by HyTTec Trident which yielded 2.4t/ha.

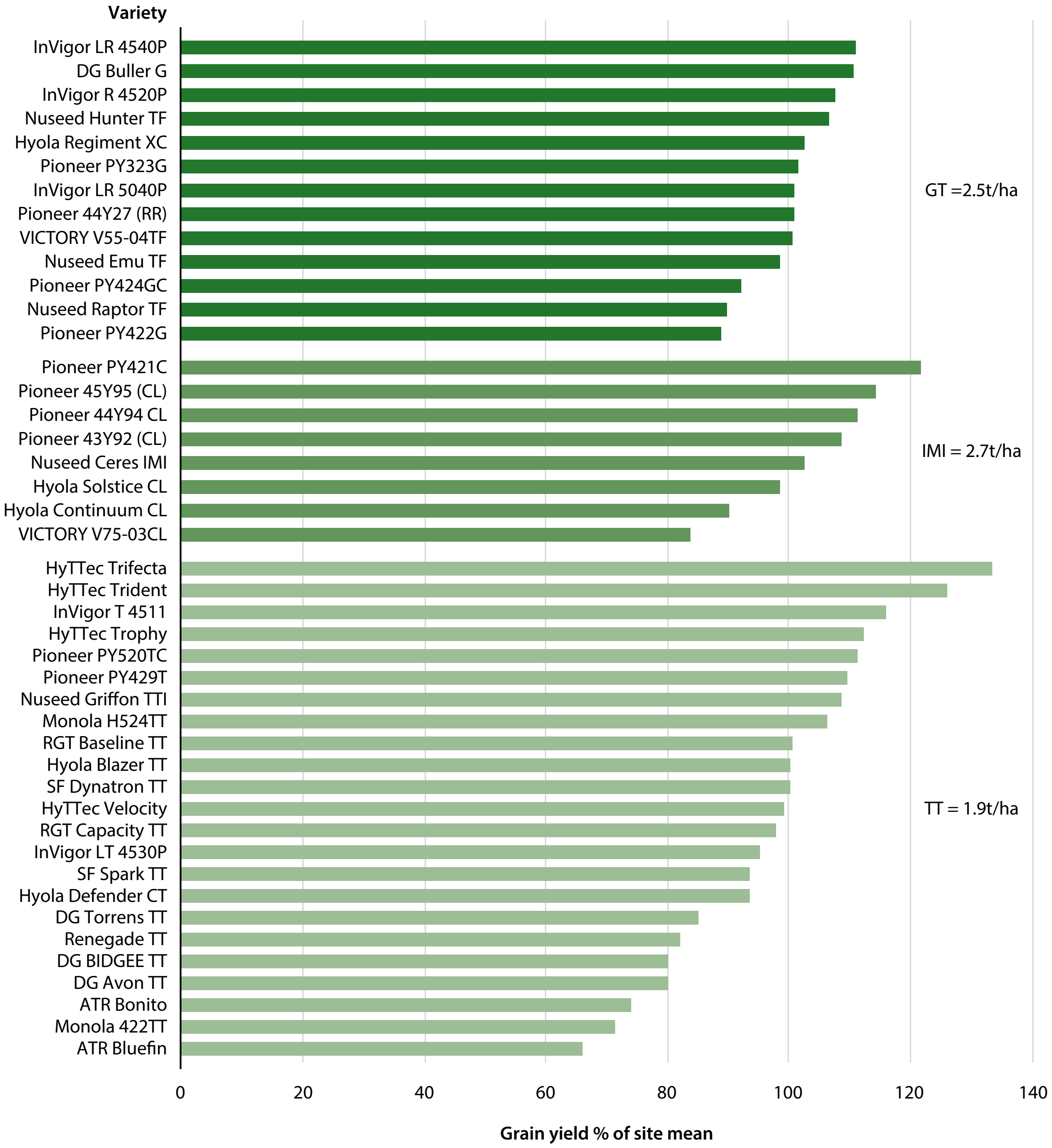

Figure 2. North Central canola NVT average yield as a percentage of site mean (%). Note: data only include Charlton.

Wimmera

GT Varieties: The highest yielding variety was InVigor LR 4540P (2.3t/ha). As a new release for 2024, InVigor LR 5040P has shown promise across the Wimmera region. However, these results should be interpreted cautiously, as the variety has only been included in NVT data for a single season, and robust conclusions require multi-year performance data to account for seasonal variability. Nuseed Hunter TF was the second highest yielding GT variety in the Wimmera (2.2t/ha). It is also important to note that this data reflects findings from the single Horsham GT trial site.

IMI Varieties: The highest yielding IMI variety was Pioneer PY421C (2.9t/ha), followed by Pioneer 45Y95 (2.8t/ha).

TT Varieties: HyTTec Trophy, HyTTec Trident, and HyTTec Trifecta were the top performers (2.6t/ha). Other top performers included Pioneer PY429T (2.5t/ha).

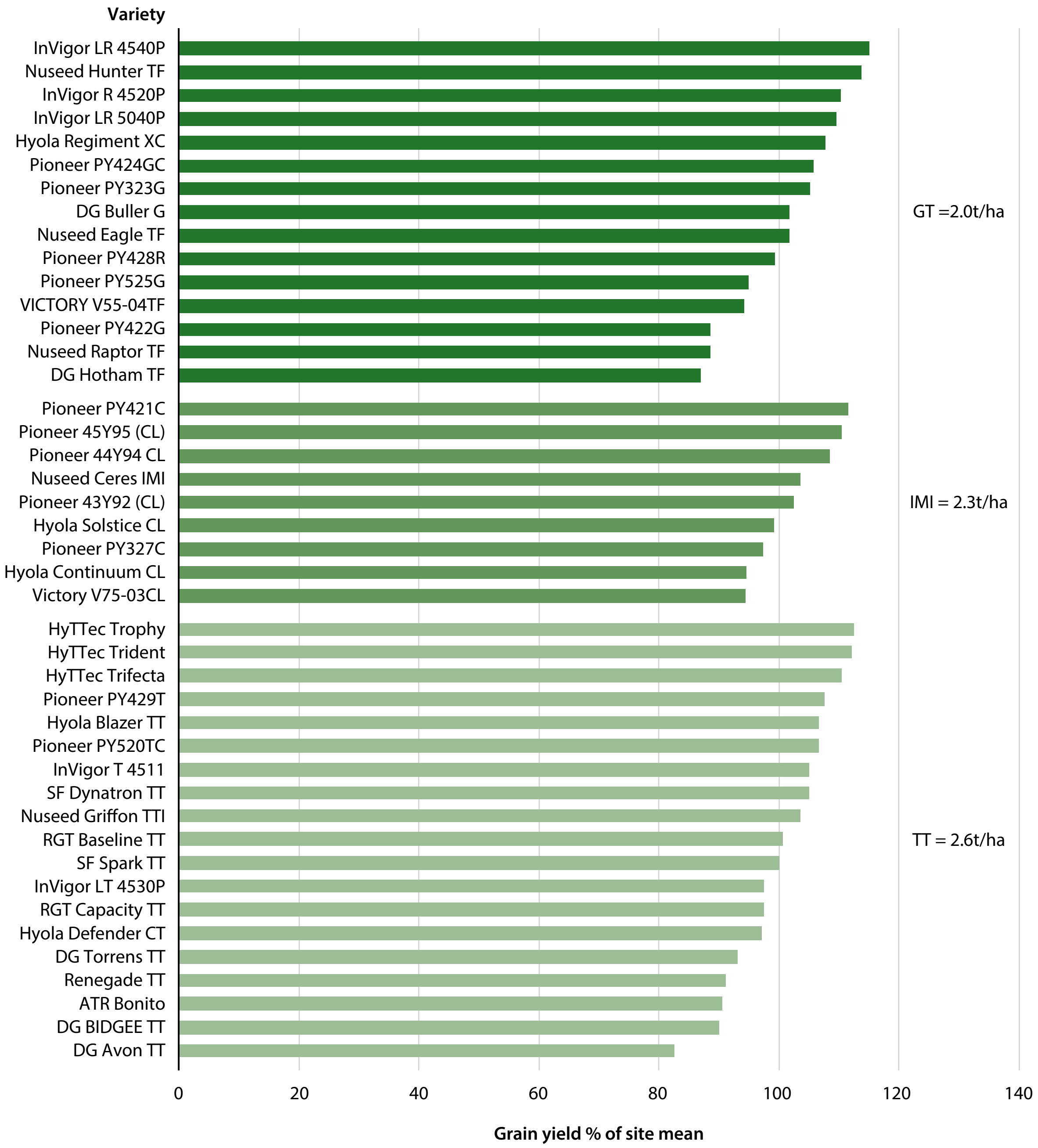

Figure 3. Wimmera canola NVT average yield as a percentage of site mean (%). Note: data excludes Kaniva GT, TT and Minimay GT.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Canola can be highly profitable but poses significant risks in adverse seasons, such as 2024, when split germinations and frost significantly reduced yields. The increasing prevalence of dual herbicide tolerance varieties enhances flexibility in weed management strategies, offering benefits beyond yield potential, such as improved weed control and resistance management. We have also seen TruFlex® and Optimum GLY® incorporated to allow for greater flexibility with the spraying window.

Analysis of NVT canola results indicates most of the top-performing varieties across all regions and herbicide tolerance groups fall within the early to mid-maturity range (Table 6). Additional details on variety performance, maturity timing, and resistance packages are provided in Table 6. Clearfield (IMI) varieties demonstrated strong adaptability under challenging conditions, highlighting their suitability for a range of environments.

Glyphosate-tolerant (GT) varieties, while yielding higher overall, incurred increased input costs associated with herbicide applications along with a receival cost that fluctuates season to season. Historically, this cost has been about $10/t to $30/t, but discounts on GM canola were noted between $100/t and $130/t this harvest. Despite the additional costs, these varieties remain a valuable option for growers requiring flexibility in weed management or aiming to capitalise on high-yielding conditions.

TT varieties, although often associated with lower yields, offer a cost-effective option due to reduced herbicide costs and robust performance in less intensive systems. This makes them an attractive choice in specific environments or for growers prioritising cost management over yield maximisation.

The ongoing integration of dual tolerance varieties further enhances the options available to growers, enabling more tailored approaches to balancing yield potential, profitability, and herbicide management. Strategic varietal selection based on seasonal conditions and long-term goals is essential for maximising returns and managing risk.

Table 3. Summary of varieties represented by herbicide, hybrid/OP status, maturity group and blackleg resistance rating, GRDC 2025 sowing guide.

Variety	Herbicide group	Hybrid/open pollinating	Maturity group	Blackleg rating
Hyola Solstice CL	IMI	H	E-M	R
Nuseed Ceres IMI	IMI	H	E	RMR
Pioneer 43Y92 (CL)	IMI	H	E	RMR
Pioneer 44Y94 CL	IMI	H	E-M	RMR
Pioneer 45Y95 (CL)	IMI	H	M	RMR
Pioneer PY327C (NEW)	IMI	H	E	na
Pioneer PY421C	IMI	H	E-M	RMR
Victory V75-03CL	IMI	H	M	RMR
InVigor LT 4530P	LL+TT	H	E-M	RMR
DG Buller G (NEW)	Optimum GLY®	H	E-M	na
Pioneer PY323G	Optimum GLY®	H	E	MRMS
Pioneer PY422G	Optimum GLY®	H	E-M	MR
Pioneer PY525G	Optimum GLY®	H	M	MR

Continued next page.

Variety	Herbicide group	Hybrid/open pollinating	Maturity group	Blackleg rating
Pioneer PY424GC (NEW)	Optimum GLY® + IMI	H	E-M	na
Pioneer 44Y27 (RR)	Roundup Ready	H	E-M	RMR
Pioneer PY428R (NEW)	Roundup Ready	H	E-M	na
DG Hotham TF	TruFlex®	H	M	R
InVigor R 4520P	TruFlex®	H	E-M	MRMS
Nuseed Eagle TF	TruFlex®	H	M	R
Nuseed Emu TF	TruFlex®	H	E	MR
Nuseed Hunter TF	TruFlex®	H	E-M	R
Nuseed Raptor TF	TruFlex®	H	E-M	R
Victory V55-04TF	TruFlex®	H	M	R
InVigor LR 3540P (NEW)	TruFlex® + LL	H	E	R
InVigor LR 4540P	TruFlex® + LL	H	E-M	RMR
InVigor LR 5040P (NEW)	TruFlex® + LL	H	M	MR
Hyola Regiment XC	TruFlex® +IMI	H	E-M	R
ATR Bluefin	TT	OP	E	RMR
ATR Bonito	TT	OP	E-M	MS
ATR Swordfish	TT	OP	E-M	MRMS
Bandit TT	TT	OP	E	R
DG Avon TT	TT	OP	E	MR
DG Bidgee TT	TT	OP	E-M	R
DG Torrens TT	TT	OP	E-M	RMR
Hyola Blazer TT	TT	H	E-M	RMR
HyTTec Trident	TT	H	E	R
HyTTec Trifecta	TT	H	M	R
HyTTec Trophy	TT	H	E-M	R
HyTTec Velocity	TT	H	E	MR
InVigor T 4511	TT	H	E-M	RMR
Monola 422TT	TT	OP	E-M	MRMS
Monola H524TT (NEW)	TT	H	E	RMR
Pioneer PY429T (NEW)	TT	H	E-M	R
Renegade TT	TT	OP	E-M	MR
RGT Baseline TT	TT	H	M	MRMS
RGT Capacity TT	TT	H	E-M	MRMS
SF Dynatron TT	TT	H	M	MRMS
SF Spark TT	TT	H	M	MR
Hyola Defender CT	TT+IMI	H	M-E	R
Nuseed Griffon TTI (NEW)	TT+IMI	H	E-M	RMR
Pioneer PY520TC	TT+IMI	H	M	MR

Grain quality data was not available at the time of compiling this report.

NVT sites compromised by bird damage, pod shattering, chemical damage, or poor establishment are not released publicly. These results may become available in the 'Quarantined trials report' section of the website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

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WHEAT VARIETIES IN THE MALLEE, NORTH CENTRAL AND WIMMERA

Ashlee Tierney (BCG)

TAKE HOME MESSAGES

- The top wheat varieties in the Mallee for 2024 were Calibre, Brumby, and Shotgun.
- The highest yielding varieties in North Central for 2024 were Calibre, Shotgun, Ballista, and LRPB Matador.
- The top varieties in the Wimmera in 2024 were Tomahawk CL Plus, Shotgun, and Calibre.

BACKGROUND

The 2024 season began with high January rainfall across much of the Mallee, North Central and Wimmera. This weather pattern did not continue through the year, and by April and May many farmers were deliberating the best approach to their sowing program: whether to sow dry, or wait for the break to come. Like many growers across the regions, some National Variety Trials (NVTs) were dry sown (Table 1).

Variety choice remains a popular topic of discussion amongst growers. With breeders constantly bringing new varieties onto the market there is plenty to consider. Options available to growers include higher yields, improved disease resistance, herbicide tolerances, and variations in plant types and maturity timings, ensuring there is a fit for every farming system.

In 2024, BCG established two early season wheat trials, one in the Mallee and one in the Wimmera, as well as 13 main season wheat trials: eight in the Mallee, two in the North Central and three in the Wimmera (Table 1). These trials were about one-third breeding lines, and the rest released varieties.

The combination of NVT data, individual site reports. and multi-environmental trial analysis (MET) long-term data provides a useful tool for growers to determine which varieties are performing well and may be suitable for their farming system.

AIM

To compare the performance of new and existing wheat varieties in the Mallee, North Central and Wimmera NVT.

TRIAL DETAILS

Crop type/s:	Wheat, refer to Figures 1–3 for varieties
Target plant density:	130 plants/m^2 (Mallee), 160 plants/m^2 (North Central and Wimmera)
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Replicates:	Three

Nutrition, weeds, insects and disease were managed as per best practice. For individual trial details see <https://nvt.grdc.com.au>.

The early season trial at Birchip was dry sown and received 10mm of supplementary water on 22 April.

The early season trial at Wonwondah was dry sown and received 10mm of supplementary water on 24 April.

METHOD

This research was conducted through the NVT program delivered by GRDC. The program involves a series of replicated field trials that test varieties from different crop types in different locations. These trials aim to maximise genetic potential yield, rather than profitability. The sites receive multiple fungicide applications and are managed to ensure they are not nitrogen limited to avoid confounding factors when assessing the genetic potential of varieties. The data displayed in this article are a combination of NVT results, individual site reports, and multi-environmental trial analysis (MET) long-term summaries. Variety performance is presented as the grain yield percentage of the site average, with MET data indicating performance in 2024, relative to the previous five years (2019–2023).

Table 1. Sowing date, paddock details, rainfall, and harvest date of 2024 wheat NVT trials in the Mallee, North Central and Wimmera regions.

Location	Sowing date	Germinating rainfall date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Mallee							
Balranald	20 May	20 May	Clay	Medic	342 (7)	198 (6)	6 Dec
Birchip (Nullawil)	12 May	12 May	Loamy clay	Vetch	361 (7)	178 (1)	13 Nov
Birchip (Nullawil) early season	22 Apr	22 Apr (irrigation)	Loamy clay	Vetch	361+10 (7)	178+10 (1)	11 Nov
Hopetoun	9 May	30 May	Clay	**	266 (3)	100 (1)	*
Manangatang	16 May	16 May	Sand (0–10cm) Clay (10–100cm)	Chickpeas	296 (5)	100 (1)	18 Nov
Merrinee	16 May	30 May	Sand (0–10cm) Clay (10–100cm)	Vetch	224 (2)	115 (1)	20 Nov
Quambatook	13 May	14 May	Clay	**	425 (6)	185 (1)	21 Nov
Ultima	14 May	14 May	Clay	Lentils	356 (6)	143 (2)	14 Nov
Walpeup	14 May	30 May	Sandy loam	**	266 (3)	137 (2)	*
North Central							
Charlton	29 May	30 May	Clay	**	311 (2)	208 (3)	*
Diggora	9 May	9 May	Clay	Peas	456 (6)	228 (3)	11 Dec
Wimmera							
Horsham	28 May	30 May	Clay	Lentils	401 (5)	262 (5)	*
Kaniva	8 May	30 May	Clay	Lentils	427 (5)	184 (1)	13 Dec
Warracknabeal	14 May	15 May	Clay	**	314 (3)	168 (2)	11 Dec
Wonwondah (early season)	24 Apr	24 Apr (irrigation)	Clay	Lentils	401 (5)	262+10 (5)	*

*Trial was not harvested. **Information not available. Number in brackets () denotes decile.

RESULTS AND INTERPRETATION

New varieties released in 2024

Shotgun bred by Australian Grain Technologies (AGT) is an AH variety derived from Scepter. Agronomically, it is very similar to Scepter, with the same maturity and plant type, but with an increase in yield. Shotgun offers a similar disease package to Scepter, but with slight improvements for powdery mildew and stripe rust, with provisional ratings of S and MS respectively (Table 3).

RGT Ponsford is a new, mid-maturing wheat from RAGT Australia. This variety has a good disease package for rust, with ratings of MRMS for stripe rust, RMR for stem rust and MR for leaf rust, and a rating of MSS for Septoria (Table 3).

Boa is a new, quick-to-mid-maturing AH variety from LongReach Plant Breeders for high production and irrigation areas. It has two reduced height genes, which produce a plant with an erect growth habit, short canopy, and increased tillering to suit high production and irrigation systems.

Ironbark from AGT is a new variety derived from Beckom. It has a similar maturity, plant height, and canopy to Beckom, with improved yield and grain size. Ironbark carries the same aluminium and boron tolerance gene as Beckom and offers a step up in its stripe rust resistance with a provisional rating of MR compared to MRMS in Beckom.

Wallaroo is a new quick-maturing dual-purpose winter wheat from Trigall Australia. This maturity allows the opportunity to take advantage of an early break without the risk of frost damage, and make the most of available moisture. Wallaroo has good resistance to all three rusts, with ratings of R for leaf rust, a provisional rating of RMR for stem rust, and RMR for stripe rust (Table 3).

Brighton is an AH dual-purpose winter wheat from AGT, suitable for grazing and grain production. Derived from Beckom, it offers the same short plant height and acid soil tolerant genes. It has a quick-to-mid winter maturity, slightly quicker than Illabo.

Lancelin from AGT is similar to Scepter in terms of maturity, yield, and its disease package, but is an Australian Soft (ASFT) classified wheat intended for export customers in the south-east Asian market. It requires a lower protein level making it suitable for those who have trouble achieving the higher protein required for hard bread wheat varieties.

Yield results

Table 2. 2024 wheat yield results of the 2024 NVT sites across the Mallee, North Central and Wimmera regions.

Region	Location	Average trial yield (t/ha)
Mallee	Balranald	1.9
	Birchip (Nullawil)	4.2
	Birchip (Nullawil) early season	5.0
	Hopetoun	Data not released
	Manangatang	1.6
	Merrinee	2.1
	Quambatook	5.4
	Ultima	Data not released
	Walpeup	Trial was abandoned
North Central	Charlton	Trial was abandoned
	Diggora	4.4
Wimmera	Horsham	Trial was abandoned
	Kaniva	6.5
	Warracknabeal	Data not released
	Wonwondah (early season)	Trial was abandoned

Table 3. Disease ratings of selected wheat varieties.

Variety	Maturity	Quality	Stripe rust	Stem rust	YLS	CCN resistance	Septoria
Ballista	Q-M	AH	MSS	MR	MS	MRMS	SVS
Boa	Q-M	AH	MRMS (P)	MS (P)	MS (P)	-	S (P)
Calibre	Q-M	AH	S	MR	MRMS	MRMS	S
RGT Ponsford	M	AH*	MRMS	RMR	MS	MS	MSS
RockStar	M-S	AH	S	MRMS	MRMS	MSS	S
Scepter	M	AH	MSS	MRMS	MRMS	MSS	S
Shotgun	M	AH	MS (P)	MRMS (P)	MRMS (P)	-	S (P)
Vixen	Q	AH	SVS	MRMS	MRMS	MSS	S
Wallaroo	Q	APW/AH*	RMR	RMR (P)	MRMS	R (P)	MSS
Dozer CL Plus	Q-M	APW	S	MS	MS	MS (P)	S (P)
Sunblade CL Plus	M	AH	MRMS	MS	MSS	MSS	S
Tomahawk CL Plus	Q-M	APW	MSS	MR	MRMS	MRMS (P)	S (P)

R= Resistant, RMR= Resistant to Moderately Resistant, MR= Moderately Resistant, MRMS= Moderately Resistant to Moderately Susceptible, MS= Moderately Susceptible, MSS= Moderately Susceptible to Susceptible, S= Susceptible, SVS= Susceptible to Very Susceptible. (P)= Provisional rating. *= Quality grade pending. - = No rating available. Disease ratings for all varieties and diseases can be found at <https://nvt.grdc.com.au/nvt-disease-ratings>.

Main season wheat

In the Mallee, the top yielding varieties over the past five years have been Shotgun, Ballista, Calibre, Vixen, RockStar and Tomahawk CL Plus (Figure 1), noting that the top variety in the Mallee trial, Shotgun, only has two years of NVT data. In 2024, the top varieties across the Mallee region as a percentage of the region mean were Calibre (110 per cent), Brumby (108 per cent), Shotgun (106 per cent), and LRPB Matador, Tomahawk CL Plus and Ballista (all 104 per cent). On an individual site basis, the top yielding variety was Calibre at Balranald (114 per cent) and Quambatook (111 per cent), Shotgun at Birchip (114 per cent), RockStar at Manangatang (114 per cent) and Brumby at Merrinee (111 per cent).

For the North Central trials, the only 2024 data is from Diggora (Figure 2). The top yielding wheat varieties in the North Central region over the past five years have been Shotgun, RockStar, Ballista, Boa, Ironbark, and Sunmaster (Figure 2). In that list are three new varieties (Shotgun, Boa, and Ironbark) which were released in 2024 and have only had two years in the NVT trials. The other varieties (RockStar, Ballista, and Sunmaster) all have five or more years of NVT data showing they are consistently high yielding varieties over numerous seasons. In 2024, Calibre was the top variety at Diggora, yielding 114 per cent of the site mean, followed by Shotgun at 112 per cent, Ballista at 109 per cent, and Boa, Ironbark and Sunmaster all yielding 108 per cent of the site mean. Of the Clearfield varieties, Sunblade CL Plus, Tomahawk CL Plus, and Dozer CL Plus averaged above the site mean at Diggora for 2024 and the region mean for the long-term 2019–2023 data.

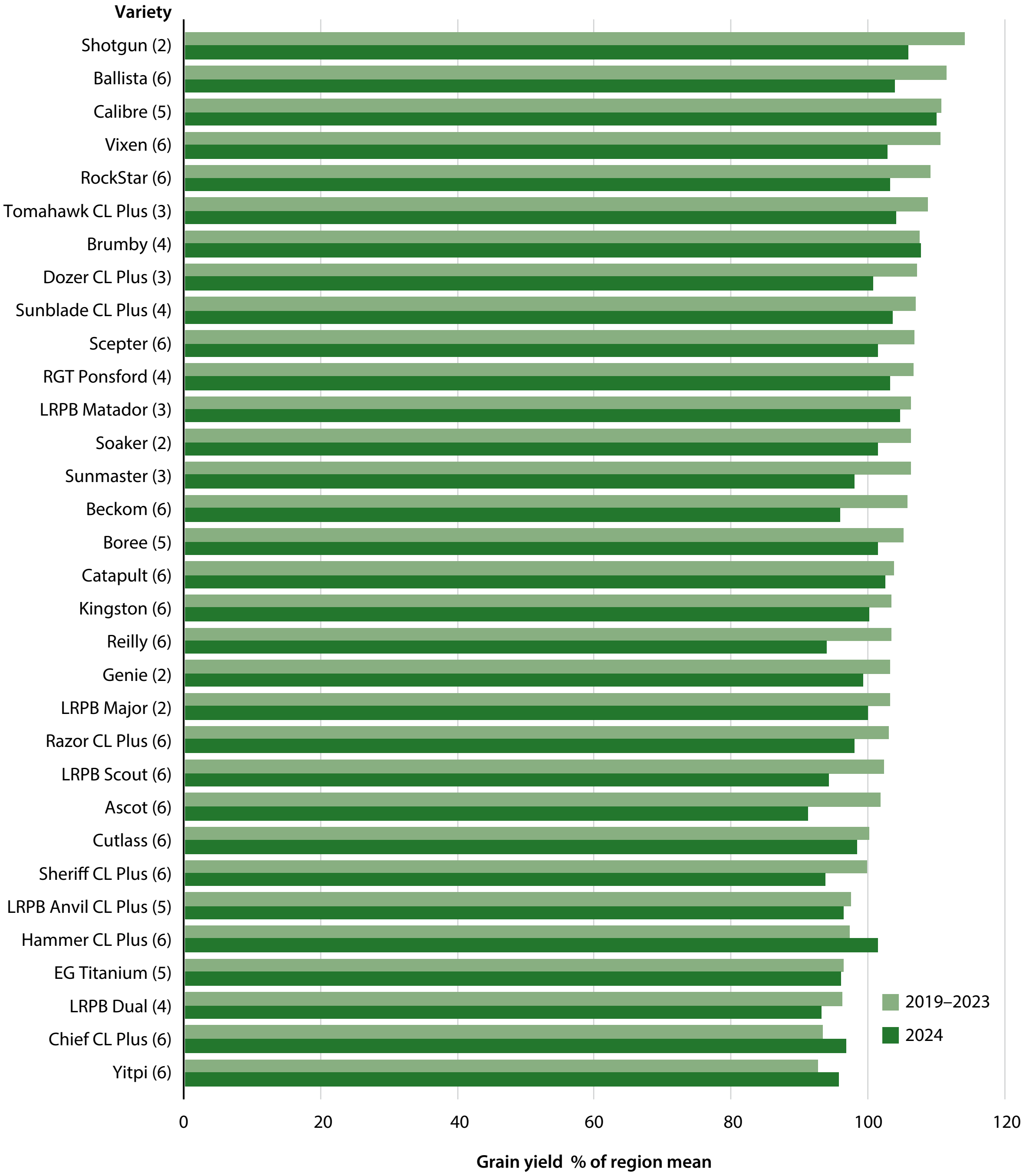

Figure 1. Mallee wheat NVT average yield as a percentage of region mean, 2019–23 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data include Balranald, Birchip, Manangatang, Merrinee, and Quambatook.

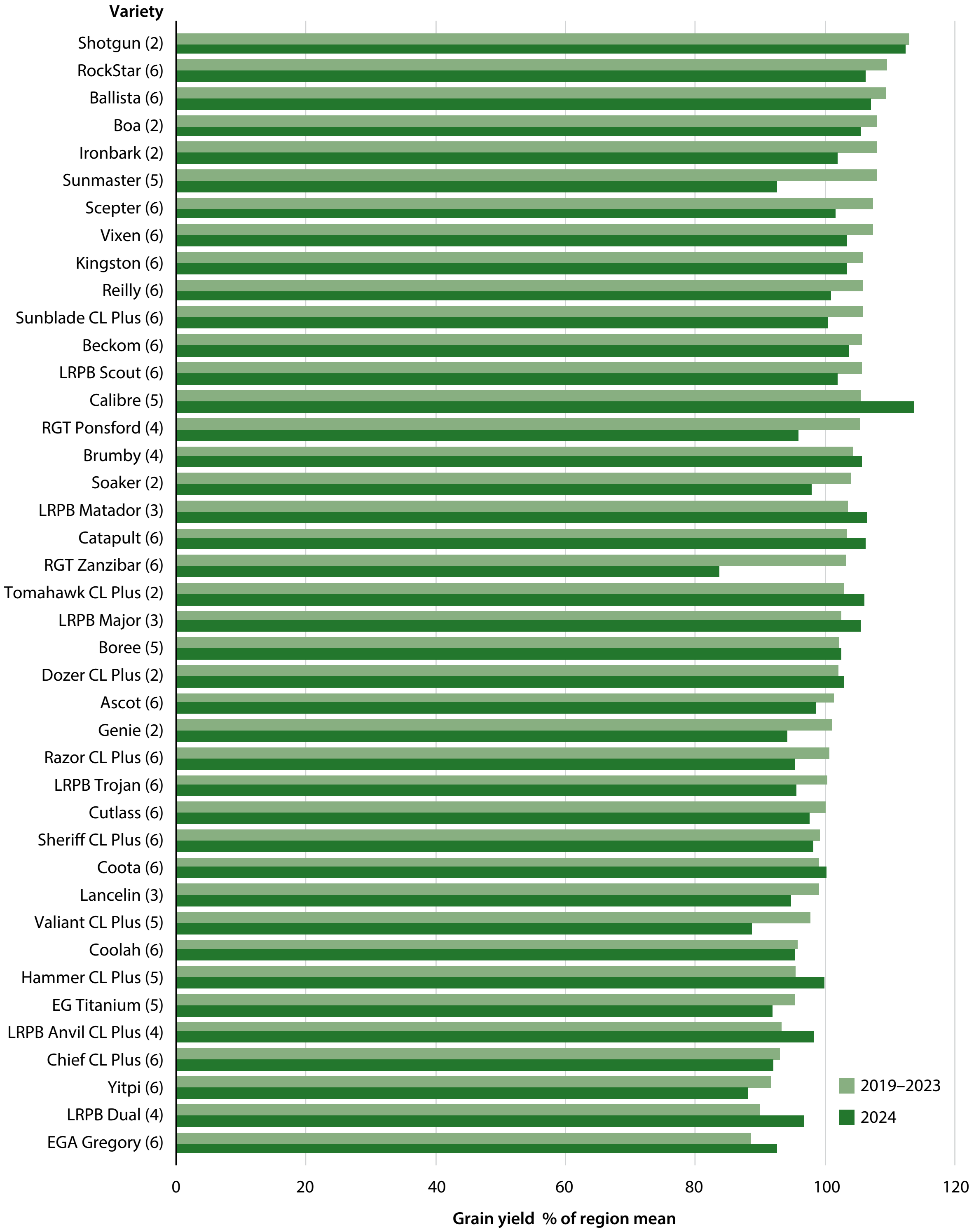

Figure 2. North Central wheat NVT average yield as a percentage of region mean, 2019–23 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data only include Diggora.

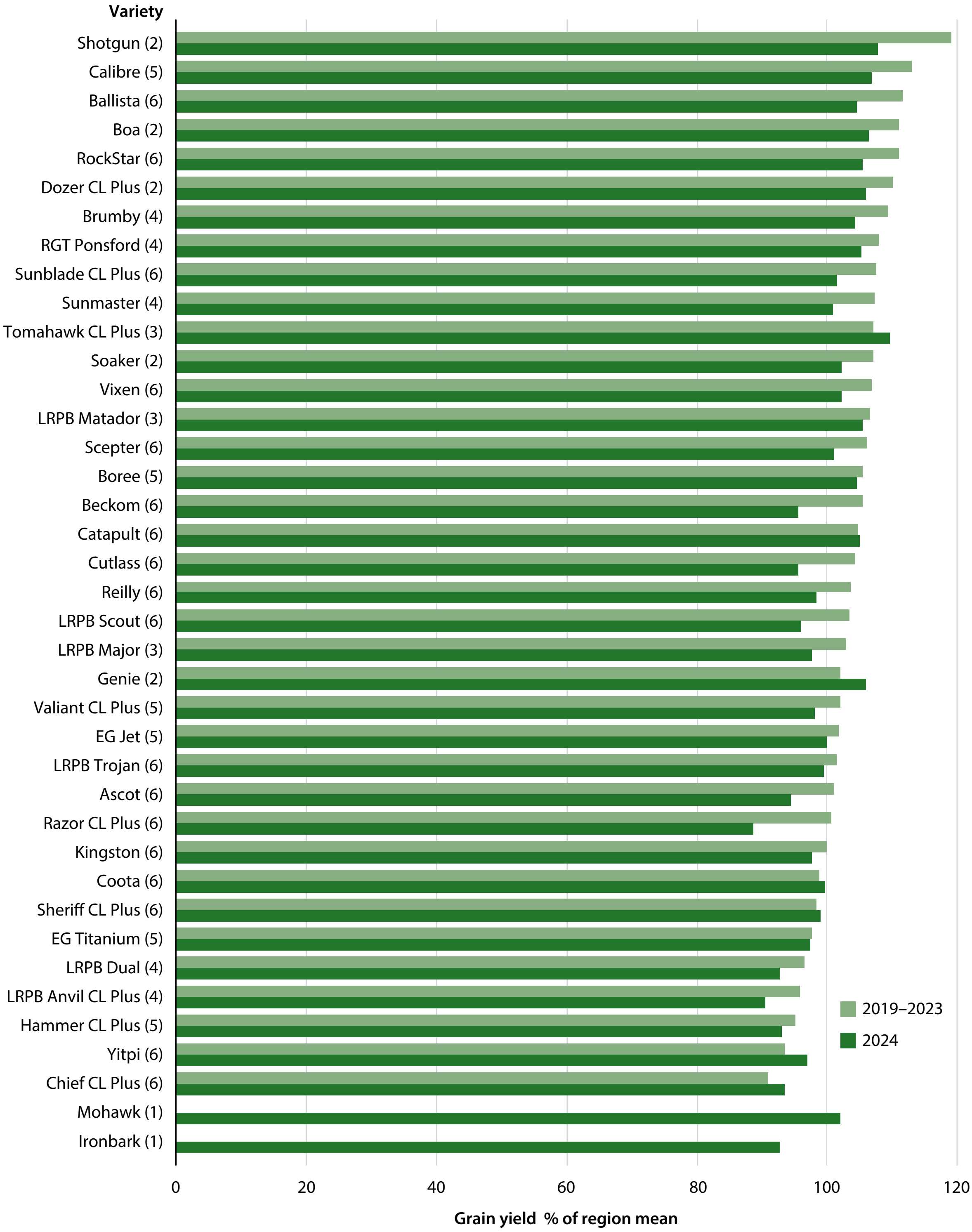

Figure 3. Wimmera wheat NVT average yield as a percentage of region mean, 2019–23 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data only include Kaniva.

The only 2024 data for the Wimmera region included in Figure 3 is from Kaniva. The long-term data from 2019 to 2023 have Shotgun, Calibre, Ballista, Boa, and RockStar as the highest yielding varieties in the Wimmera region. In that list are some new varieties (Shotgun and Boa) which were released this year and have only had two years in the NVT trials. The other varieties (Calibre, Ballista, and RockStar) all have five or more years of NVT data showing they are consistently high yielding varieties over numerous seasons. In the 2024 season for Kaniva, Tomahawk CL Plus was the highest yielding at 110 per cent of the site mean, followed by Shotgun (108 per cent), Calibre (107 per cent), and Boa, Genie, and Dozer CL Plus at 106 per cent of the site mean. The Clearfield varieties Tomahawk CL Plus and Dozer CL Plus yielded well in 2024 and, along with Sunblade CL Plus, are among the top performing varieties from 2019 to 2023.

Early break wheat

From 2019 to 2023, the top yielding wheat varieties in the early break wheat trial at Birchip have been Sheriff CL Plus, followed by Genie, Mohawk, LRPB Major, and Wallaroo, which have been in the NVT trials for two years. In 2024, the top varieties in terms of percentage of site mean were Brumby (112 per cent), Catapult (111 per cent), Denison (110 per cent) and Mohawk (108 per cent). The new dual-purpose variety Wallaroo was one of the top performers in 2023, yielding at 107 per cent of the site mean, however it did not perform as well in 2024, yielding 98 per cent of the site mean. This variety is worth monitoring in the coming years to better understand its potential across different seasons.

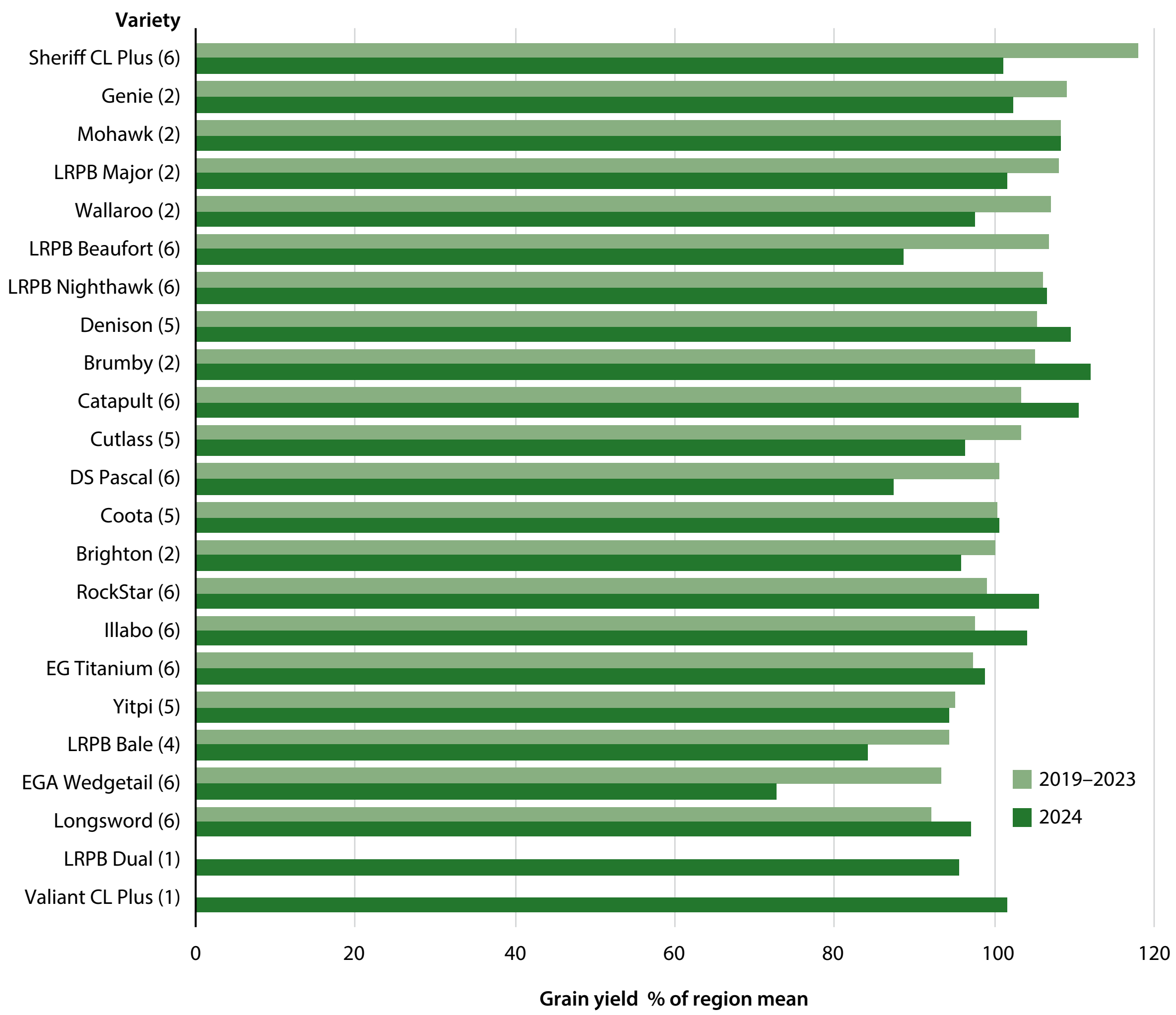

Figure 4. Birchip early break wheat NVT average yield as a percentage of site mean, 2019–23 and 2024. The number in brackets denotes how many seasons the variety has been in NVT.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

While Clearfield varieties are an important tool in weed management and have a place in rotations, they can often come with a yield penalty. The NVT program aims to manage trials in a best-practice situation which is not reality for growers. When looking at the yield data presented, consider the additional benefits of the herbicide tolerant varieties, and use them where they will have the biggest impact on weed control options. The top yielding Clearfield varieties across all regions are Tomahawk CL Plus, Sunblade CL Plus and Dozer CL Plus. Of these, Sunblade CL Plus is the only one with AH classification; both Tomahawk CL Plus and Dozer CL Plus carry an APW classification. These varieties are all yielding above the long-term region average, with the top Clearfield variety 5–9 per cent below the highest yielding variety in the main season wheat trials.

In years with numerous and severe frost events it is difficult to avoid frost damage, however frost avoidance strategies can be implemented, including variety choice. Targeting the optimal flowering period by sowing varieties within their optimal sowing window to decrease the risk of flowering during high-risk frost periods is important (DPIRD, 2024). This, combined with choosing varieties with different maturity timings to widen the flowering window, will help to reduce risk and minimise losses (GRDC, 2024).

Grain quality data from NVT was not available at the time of compiling this report.

NVT results compromised by frost and drought are not released publicly. They will be made available in the 'Quarantined trials report' section of the website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

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CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

DURUM WHEAT – VARIETIES AND NITROGEN MANAGEMENT

Dr Yolanda Plowman, Pip Lees, and Kate Finger (BCG)

TAKE HOME MESSAGES

- Patron was the highest yielding durum variety in the 2024 Kaniva NVT, continuing its long-term dominance over other varieties.
- Additional nitrogen application correlated with higher grain protein, however none of the nitrogen treatments tested, differentiated by timing and application rate, resulted in a protein content of 13 per cent (DR1 standard) for Patron.
- The most profitable nitrogen treatment was achieved by Nil nitrogen treated Patron.

BACKGROUND

Durum wheat is an important crop for human diets. It stands out from bread wheat due to its firm grain texture and high protein content (Sissons, 2008) and is grown for its excellent cooking qualities and suitability for pasta production (GRDC, 2017). In recent years advances have been made in improving the suitability of varieties for more marginal rainfall environments, with improved disease resistance helping to make it a competitive crop option.

Two key agronomic factors are important for the management of durum wheat: nitrogen (N) input and disease. It's important that durum growers manage these factors effectively to meet quality standards and attract price premiums, alongside achieving high yields to make it a more profitable option than bread wheat.

The main driver of durum quality is grain protein, meaning it's critical to get in-season application of N right. Applying N at the time of late flag emergence is shown to positively influence grain protein, however determining the optimal rate of urea to achieve 13 per cent protein for the DR1 standard can be challenging (McDonald and Hooper, 2013).

To support growers in maximising the profitability and quality of durum wheat production, a variety trial and N management trial were conducted. These trials aimed to provide practical guidance on selecting suitable varieties for marginal rainfall environments and determining optimal N application rates for achieving target protein levels.

AIM

To compare the performance of new and existing durum wheat varieties in the Wimmera NVT, and to identify the best nitrogen management strategy to achieve 13 per cent protein in durum wheat in 2024.

TRIAL DETAILS

Crop type/s:	Durum wheat
Paddock details:	Refer to Table 1
Treatments:	Refer to Table 2
Target plant density:	130 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Replicates:	Three (NVT), Six (N Management)

METHOD

Both the NVT and N management field trials were sown using a replicated random block trial design. Assessments included emergence scores, leaf tissue tests, head counts, grain yield, and quality parameters for the N management trial. Emergence scores, growth staging at flowering, as well as grain yield and quality parameters data, were collected in the NVT durum variety trial.

Table 1. Sowing date, paddock details, rainfall, and harvest date of 2024 durum trials in Kaniva.

Region	Location	Sowing date	Germinating rainfall date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Wimmera	Kaniva	8 May	30 May	Clay	Lentils	427 (5)	184 (1)	12 Dec

Table 2. Summary of durum wheat variety, nitrogen treatments, application splits, products, timings, rates, and total nitrogen applied (kg N/ha).

Variety	Treatment and application split	Product	Timing	Rate	Total N applied (kg N/ha)
Scepter	District practice* 50:50	Urea	GS25–29 GS39	170kg/ha 170kg/ha	156
	Decile 9–10# 50:50	Urea	GS25–29 GS39	290kg/ha 290kg/ha	267
Patron	Nil	n/a	n/a	0	0
	Early 50:50	Urea	GS13–21 GS25–29	170kg/ha 170kg/ha	156
	District practice* 100	Urea	GS25–29	340kg/ha	156
	Decile 1–2# 50:50	Urea	GS25–29 GS39	70kg/ha 70kg/ha	64
	Decile 5# 50:50	Urea	GS25–29 GS39	145kg/ha 145kg/ha	133
	Decile 9–10# 50:50	Urea	GS25–29 GS39	290kg/ha 290kg/ha	267
	Early 33:33:33	Urea	GS13–21 GS25–29 GS39	113kg/ha 113kg/ha 113kg/ha	156
	Granular N 43:43:13	Urea Urea Urea	GS25–29 GS39 GS49	170kg/ha 170kg/ha 13kg/ha	162
	Liquid N 43:43:13	Urea Urea Maximum N-Pact	GS25–29 GS39 GS49	170kg/ha 170kg/ha 10L/ha	162
	Granular N + S 43:43:13	Urea Urea SOA	GS25–29 GS31–39 GS49	170kg/ha 170kg/ha 29kg/ha	162

*District practice is based on the rule of thumb of 45kg N/ha required to produce 1t/ha of durum wheat, and 40kg N/ha to produce 1t/ha bread wheat. #Yield Prophet® Lite was used to calculate the N rates for the different decile treatments at the end of June.

Table 3. Maturity, quality and disease resistance ratings[1] for durum wheat varieties used in this trial.

	Maturity*	Quality*	Crown rot	Yellow leaf spot	Septoria tritici blotch	Stripe rust
Patron	M	ADR	SVS	MRMS	MRMS	MRMS
DBA-Aurora	M	ADR	SVS	MRMS	MRMS/S	MRMS
Hyperno	M	ADR	SVS	MRMS	MSS	MR
Westcourt	M	ADR	VS	MRMS	S	MR
Caparoi	M	ADR	VS	MR	MRMS/S	MS
DBA Mataroi	E-M	ADR	SVS	MRMS	MSS	MS
DBA Bindaroi	E-M	ADR	SVS	MS	MS	MS
Saintly	E	ADR	VS (P)	MRMS	MRMS/S	MRMS

MR= Moderately Resistant, MRMS= Moderately Resistant to Moderately Susceptible, MS= Moderately Susceptible, MSS= Moderately Susceptible to Susceptible, S= Susceptible, SVS= Susceptible to Very Susceptible, VS= Very Susceptible. (P) = Provisional rating / = Pathotype differences [1]Disease ratings were sourced from the GRDC'S National Variety Trials.
*Maturity and quality information was sourced from NSW DPI Winter Crop Variety Sowing Guide 2024.

TRIAL INPUTS

Fertiliser: Granulock Supreme Z + Flutriafol (400mL/100 kg) @ 60kg/ha at sowing for both trials.

In the durum NVT trial 220kg/ha of urea was applied as a split application (100kg/ha on 28 July (GS14), 60kg/ha on 31 July (GS21) and 60kg/ha on 14 August (GS31)).

See Table 2 for N rate information for the N Management trial.

The different rates were applied on 17 July (GS13–21), 19 August (GS25–29), 6 September (GS39), 1 October (GS49).

Nutrition, weeds, insects and disease were managed as per best practice. For individual trial details see: <https://nvt.grdc.com.au/>.

RESULTS AND INTERPRETATION

NVT durum varieties

Rainfall in November and December 2023 was significantly higher than the long-term average, while subsequent months generally experienced below-average rainfall, particularly from February to July 2024 (Figure 1). Across both 2024 and the longer term, most varieties performed consistently close to the regional mean, suggesting stability of most varieties over time (Figure 2). Patron was the highest yielding durum variety at Kaniva for the 2024 season, yielding 5.7t/ha and 111 per cent of the site mean. It remains the highest yielding on average between 2019 and 2023. The largest drop in 2024 compared to longer-term data was for DBA Mataroi, which decreased by an average of 7 per cent compared to past years. In contrast, Caparoi increased an average of 5 per cent compared to previous years.

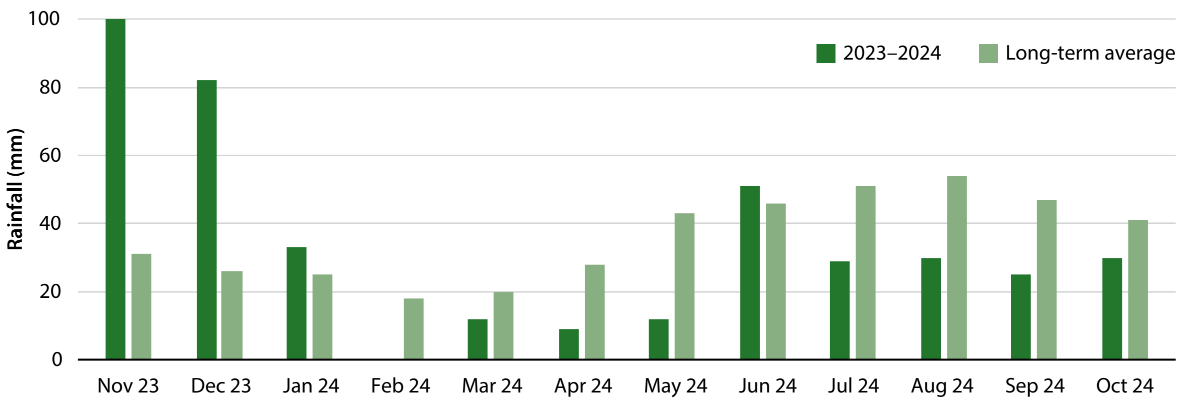

Figure 1. Monthly rainfall (mm) in Kaniva for the 2023–2024 period (■ dark-green bars) compared with the long-term average rainfall (■ light-green bars).

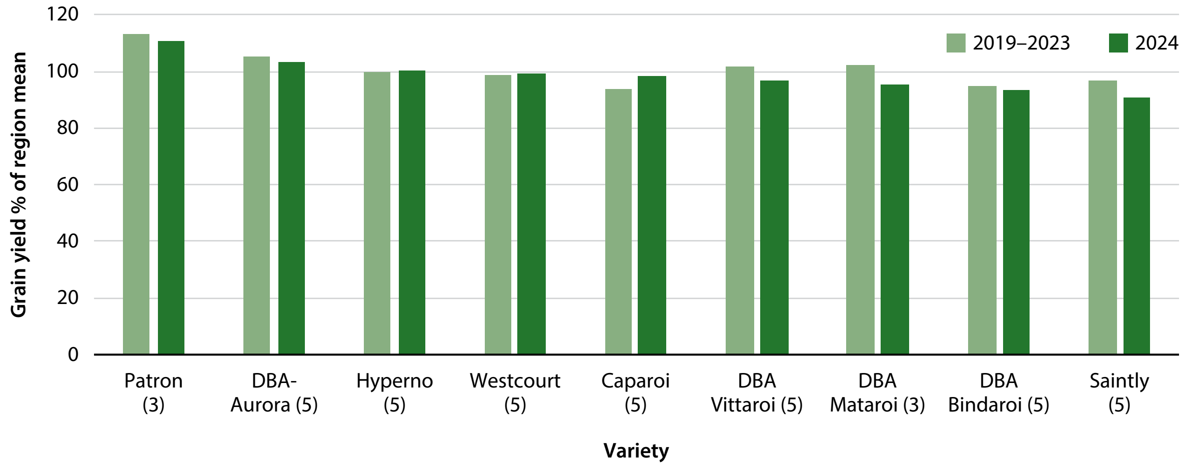

Figure 2. Kanvia NVT yields as a percentage of site mean (%) 2024 and the average of 2019–23. The number in brackets denotes how many seasons the variety has been in NVT.

Grain quality (protein) data was not available for the 2024 season at the time of writing this report, however long-term data for each variety is shown in Figure 3. DBA Bindaroi and Caparoi exhibited the highest mean protein percentages over the longer-term, suggesting superior suitability for achieving grain quality standards. On the other hand, Patron showed the lowest protein percentage among the varieties.

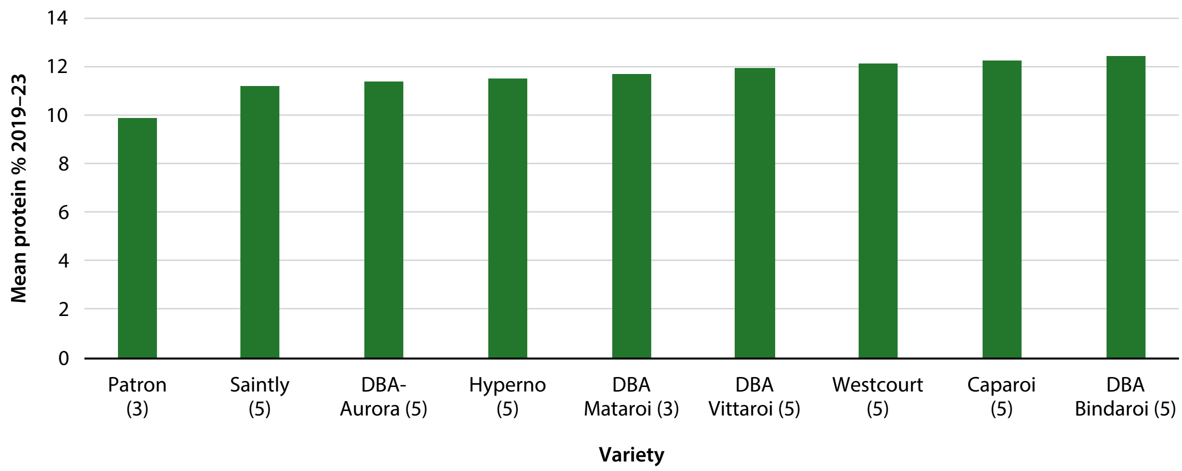

Figure 3. Kanvia NVT protein % 2019–23. The number in brackets denotes how many seasons the variety has been in NVT.

Nitrogen management

The starting soil nitrogen (N) at the site was 69kg N/ha to a depth of 100cm. The trial established well, with all treatments achieving an establishment score of 95 per cent. N treatment did not significantly influence the number of heads produced, however there was a significant difference between varieties, as shown in Figure 4, with the trial control Scepter producing 8 heads/m^2 more than Patron (data not shown).

There were no significant differences in mean yield between varieties, however there was for N treatment (p = 0.009, LSD = 0.4452) (Figure 3). Yields were generally consistent across most N treatments, ranging from 5.3t/ha to 5.5t/ha, indicating little variation in the effect of treatments. The Patron 33:33:33 N early treatment produced the highest yield, whereas Patron 50:50 N D9–10 produced significantly lower yield than most other treatments, suggesting a negative effect of 267 units of N on grain yields. The high yields produced by the Patron 33:33:33 N early treatment suggest timing played a role in the early development of tillers and grain development.

Figure 5 illustrates the relationship between N application rates (N units/ha) and grain protein percentage across various treatments. As expected, grain protein percentage generally increased with the application of additional N. For example, Patron 50:50 N D9–10, which received 267 units of N, achieved the highest protein percentage (11.6 per cent), while the Patron Nil N treatment, receiving no N, showed the lowest protein percentage (9.8 per cent). These findings emphasise the important role of N management in optimising durum protein content. Despite these findings, however, treatments fell short of producing a level of protein that would meet the DR1 quality standard, which requires a protein content of at least 13 per cent (GrainCorp, 2024). Reasons for this are unclear; longer-term NVT data shows Patron has typically produced lower levels of protein compared to other varieties over time, hence this variety may have a limited response to N input. Considering rainfall throughout most of the 2024 growing season was lower than average, it is also possible that lower rainfall conditions led to lower recovery of N. Research on the link between water deficiency and grain protein in durum is inconsistent and requires further investigation (Flagella et al., 2010).

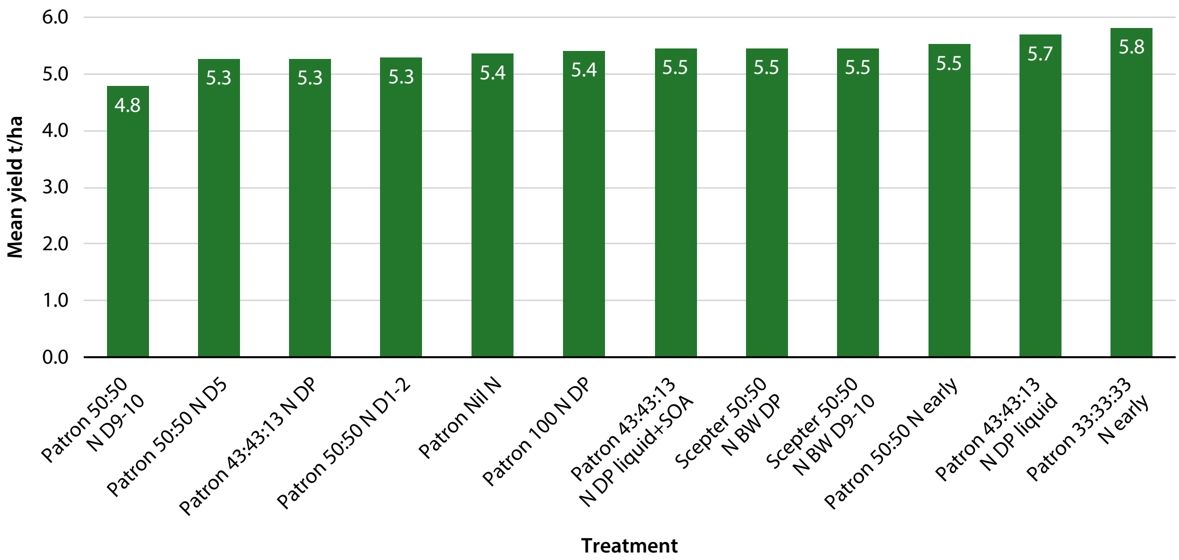

Figure 4. The effect of N treatment on mean yield for durum varieties at Kaniva, 2024. Means are reported above bars. P value and LSD reported for N treatment only, p = 0.009, LSD = 0.45t/ha.

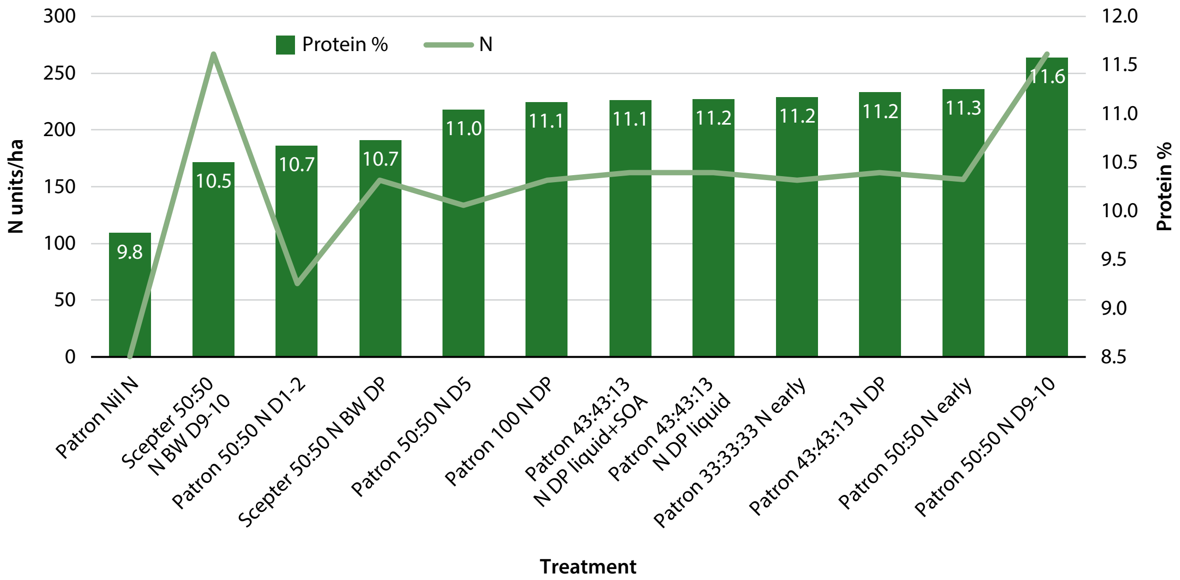

Figure 5. N application rates (— light-green line, left axis) and corresponding protein percentage (■ dark-green bars, right axis) across various treatments. The treatments include different N formulations, timings, and application methods. P value and LSD reported for N treatment only, p = <0.001, LSD = 0.1837.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Durum varieties

NVT results provide growers with an opportunity to compare the yield, grain quality, and rating of different varieties over the current year, as well as the previous five years. Growers can use this information as a guide to determine which varieties are performing well for their region.

Despite the higher rainfall in November and December 2023, below-average rainfall from February onwards likely had a substantial influence on crop performance. Patron was the highest-yielding durum variety at Kaniva in 2024, while DBA Mataroi recorded a 7 per cent decline in yield compared to its longer-term average. Although Patron was dominant for yield, it produced the lowest grain protein of all varieties in the trial; instead, the highest grain protein percentages were achieved by DBA Bindaroi and Caparoi.

Nitrogen management

An economic breakdown for each trial treatment is presented in Table 3. The highest partial gross margin (PGM) and gross income were achieved by the Patron Nil N treatment due to the absence of variable costs ($2227/ha for both). Among N application treatments, Patron 50:50 N D1–2 achieved a relatively high PGM ($1218/ha) with moderate N input (64 units), demonstrating a cost-effective balance between yield and input expenses. In contrast, treatments with higher N rates (for example, Patron 50:50 N D9–10 and Scepter 50:50 N BW D9–10) generated significant negative PGMs due to high variable costs, despite producing comparable or slightly higher yields. The highest yield (5.8t/ha) was achieved with Patron 33:33:33 N early treatment, but its PGM was only $44/ha due to high input costs. Data indicates the risk of diminishing financial returns with higher N inputs, suggesting lower to moderate N rates may optimise profitability while maintaining yields in this environment under conditions similar to the 2024 growing season.

Table 3. Summary of partial gross margin by treatment.

Treatment	Average yield (t/ha)	Gross income ($/ha)	Total variable costs ($/ha)*	Partial gross margin $/ha	Grade	N units
Control	5.4	2227	0	2227	DR3	0
Patron 50:50 N D1–2	5.3	2192	973	1218	DR3	64
Patron 50:50 N D5	5.3	2186	2023	162	DR3	133
Patron 33:33:33 N early	5.8	2418	2373	44	DR3	156
Patron 50:50 N early	5.5	2292	2373	-81	DR3	156
Patron 43:43:13 N DP liquid	5.7	2363	2465	-101	DR3	162
Patron 100 N DP	5.4	2249	2373	-124	DR3	156
Patron 43:43:13 N DP liquid + S	5.5	2263	2465	-202	DR3	162
Patron 43:43:13 N DP	5.3	2189	2465	-276	DR3	162
Scepter 50:50 N_BW DP	5.5	1804	2373	-568	APW1	156
Patron 50:50 N D9–10	4.8	2177	4063	-1885	DR2	267
Scepter 50:50 N BW D9–10	5.8	1800	4060	-2259	APW1	267

*Variable cost only included the variation in N rate applied.

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CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

COMMON VETCH TRIAL RESULTS IN THE VICTORIAN MALLEE IN 2023 AND 2024

Stuart Nagel, Melissa McCallum, Angus Kennedy, and Francisco Jimenez (SARDI)

TAKE HOME MESSAGES

- Current commercial common vetch varieties offer good variation in maturity types.
- Variation in biomass accumulation between commercial varieties demonstrates the need to match end use target with variety selection.

BACKGROUND

The National Vetch Breeding Program (NVBP) at SARDI (South Australian Research and Development Institute) has been conducting advanced breeding trials (S4) with BCG for many years. Advanced breeding trials provide essential data on variety and breeding line performance across a range of environments and allow assessment of variety adaptability and end use performance.

The Victorian Mallee trial enables the NVBP to ensure advance breeding material is both relevant to local farming systems and provides advantages over current variety options. This report includes results from the 2023 and 2024 seasons and aims to demonstrate the yield potential of current varieties, as well as highlighting some of the advanced material progressing through the breeding program.

Common vetch has become an integral component of many modern farming systems in Mallee areas. These trials demonstrate the influence of flowering and maturity on dry matter and grain yields across different seasons and environments as well as how variety influences target end use performance.

AIM

To demonstrate vetch varietal performance across seasons and end uses to provide local results and yield potentials.

To assess advanced breeding lines in regional areas where vetch is an important option in cropping rotations.

CONTENTS

VARIETIES AND THEIR MANAGEMENT

FARMING SYSTEMS

CROP AGRONOMY

WEED MANAGEMENT

PESTS AND DISEASE MANAGEMENT

LIVESTOCK

SOILS

SOWING CONSIDERATIONS

CROP END USE

APPENDICES

PADDOCK DETAILS

Paddock details as per Table 1.

Table 1. Paddock details of trials 2023–2024.

Year	2023	2024
Location	Kinnabulla	Nullawil
Crop year rainfall (Nov–Oct) (mm)	273	305
GSR (Apr–Oct) (mm)	139	178
Soil type	Sandy clay loam	Loamy clay
Sowing date	19 April	16 April
Hay cut date	28 August – 22 September	23 August – 10 September
Grain harvest date	18 November	11 November

TRIAL DETAILS

Crop type: Common vetch (varieties detailed in Table 2)

Target plant density: 60 plants/m^2 (40–45 kg/ha)

Seeding equipment: Knife points, press wheels, 30cm row spacing

Replicates: Four

Table 2. Commercial varieties include in BCG-SARDI vetch trials in 2023 and 2024.

Variety	Commercial variety notes
Morava	Late maturing (latest common vetch commercially available). High dry matter and grain yield potential, with a purple flower.
Studenica	Very early maturing. High dry matter and grain yield potential, with a white flower.
Volga*	Early maturing variety. High dry matter and very high grain yield potential, with a purple flower.
Timok*	Mid maturing variety. Very high dry matter and high grain yield potential, with a purple flower.
SA37107	Mid maturing variety. high dry matter and high grain yield potential, with a purple flower. Also demonstrates improved tolerance to acid soils. Limited seed should be available for 2026 season. To be commercialised as Pek.

*Only included in 2023.

TRIAL INPUTS

Trials were sown, maintained, and results measured as per best practice.

METHOD

These trials included 12 common vetch advanced breeding lines and commercial varieties. In 2023, there were four commercial varieties, while in 2024 there were two. The aim was to demonstrate varietal performance and assess the potential of advanced lines in specific regions across multiple seasons. The trials were individually designed as randomised complete block designs. All trials were assessed for emergence, vigour, time to flowering, dry matter production in spring, and grain yield. All analysis was completed using GenStat 21st edition.

RESULTS AND INTERPRETATION

Results for 2023 and 2024 show the effect of seasonal conditions on biomass production and grain yield, irrespective of variety (Table 3). Grazing biomass (early July) was much greater in 2023 than 2024. As such there was a significant difference between breeding lines in 2023, but no difference in commercial variety performance. In 2024, the average dry matter in early July was low at 610 kg/ha, with no differences in breeding lines or commercial varieties. Hay yields (measured at early flat pod development) showed no significant difference in either year. There were differences in performance between commercial varieties and the breeding lines, but the trial variation was too large for results to be significant. Grain yields for the vetch trial averaged 1.98 t/ha in 2023 and 0.84 t/ha in 2024. There was no significant difference in 2023 between commercial varieties and breeding lines. In 2024, there was a significant difference, with SA37107 and Morava yielding better than some of the breeding lines, but there was no significant difference between the commercial varieties.

Table 3. Yield results from commercial varieties and near commercial lines included in the vetch breeding trials in 2023 and 2024.

	Grazing biomass (t/ha)		Hay biomass (t/ha)		Grain yield (t/ha)	
Variety	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**
SA37107	1.25	0.55	4.39	3.84	1.85	1.00
Morava	1.29	0.54	5.14	4.10	1.76	0.96
Studenica	1.12	0.57	4.50	3.65	1.33	0.85
Timok	1.42		4.78		1.92	
Volga	1.01		3.92		2.10	
Sig. diff.	**0.029**	**0.541**	**0.265**	**0.452**	**0.280**	**0.004**
LSD (P=0.05)	**0.43**	**NS**	**NS**	**NS**	**NS**	**0.18**
CV%	**10**	**37.5**	**13.7**	**15**	**7.8**	**9.4**

In 2024, there were four different hay cutting dates to correspond with commercial varieties and breeding lines reached early pod development. When using hay cutting date to explain hay biomass, the earlier the cutting date the lower the biomass yields (Figure 1). The three commercial varieties included in the 2024 breeding trial are labelled in Figure 1. Studenica had one of the lowest hay biomass yields and was the earliest to be cut. Hay biomass yields increased as hay cutting date progressed through the season. Morava had a greater hay biomass than SA37107 and Studenica, and was the last variety to reach early flat pod development stage. While there was no significant difference between hay biomass yields, the results in Figure 1 suggest that Morava was slower to reach early flat pod development allowing it to capitalise on the longer growing season and accumulate more biomass, compared to earlier varieties. Some promising breeding lines cut on 5 September had greater hay biomass than Morava.

While hay biomass increases with later cutting dates, the rate of biomass accumulation for the different varieties tells a different story in 2024 (Figure 2). Biomass accumulation was measured as the amount of biomass increase from grazing in early July to hay cutting, divided by the number of days. Studenica had the fastest accumulation over that period, whereas Morava had the slowest, and SA37107 was in the middle. These results were as expected. Studenica is characterised by good winter growth and early biomass accumulation combined with a very early maturity. Morava is slower to accumulate biomass but takes advantage of longer growing seasons to accumulate more biomass.

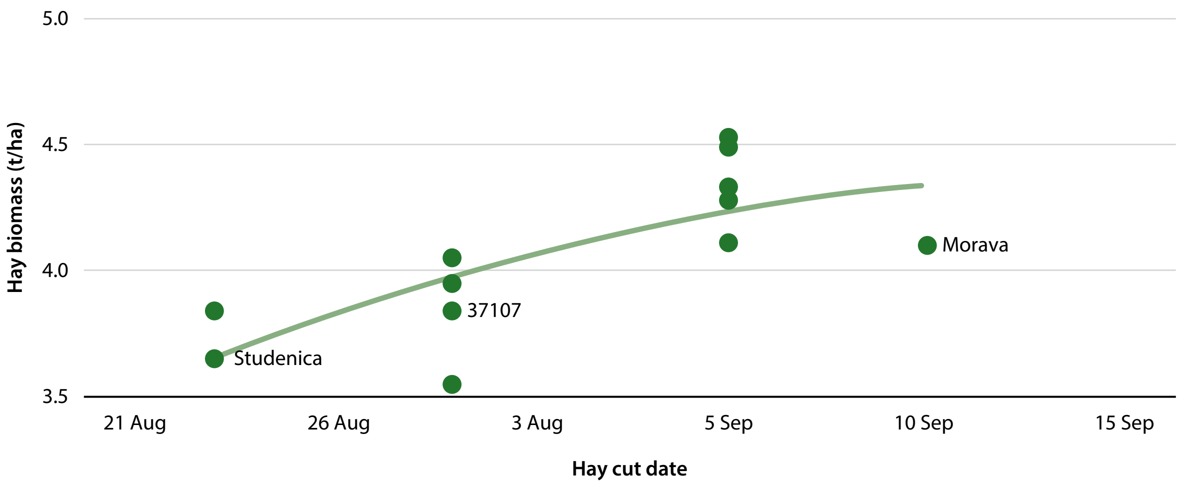

Figure 1. Mean hay biomass in 2024 described by hay cutting date for the commercial varieties and breeding lines included in the National Vetch Breeding Program. Stats: P = 0.452, LSD= NS, CV 15%.

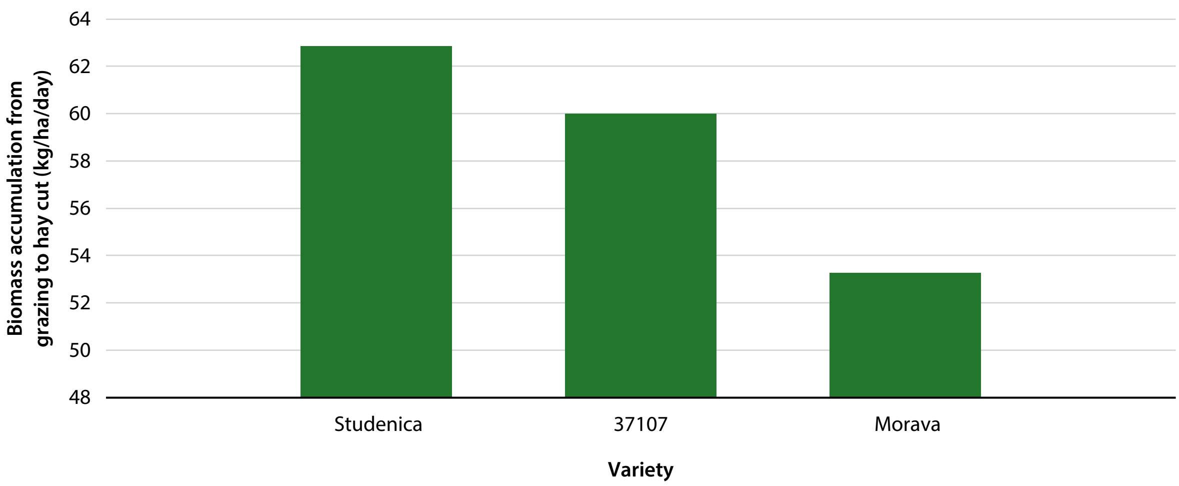

Figure 2. Mean biomass accumulation in kg/ha/day between grazing biomass in early July and hay biomass for Studenica, SA37107, and Morava in 2024. Stats: P = 0.248, LSD= NS, CV 22.5%.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Results across the last two seasons indicate limited differences in the final yields of commercial varieties. However, the timing of yield and biomass accumulation rates differ, so the end use target is the primary driver when selecting suitable vetch varieties.

In-season changes to end use can still be made based on environmental conditions and economics, but targeted management for a specific end use will maximise results.

As demonstrated in Figure 2, if the target is early grazing or a green/brown manure option, Studenica offers the best option, SA37107 is better for early hay or desiccation for brown manure to target ryegrass prior to seed set, and Morava is a better fit for later hay cutting due to a later drying window with good biomass.

FURTHER READING

2025 Victorian and Tasmanian Crop Sowing Guide, 'Vetch' <https://grdc.com.au/resources-and-publications/all-publications/nvt-crop-sowing-guides/vic-tas-crop-sowing-guide>.

Factsheet: Gibberellic Acid use in Vetch <https://sagit.com.au/gibberellic-acid-use-in-vetch-sardi-fact-sheet/>.

ACKNOWLEDGEMENTS

This research was funded by GRDC as part of the National Vetch Breeding Program (UOA2104-011RTX 9178755).

LENTIL, FABA BEAN AND FIELD PEA VARIETIES IN THE MALLEE AND WIMMERA

Matt Lade (BCG)

TAKE HOME MESSAGES

- In the Mallee, GIA Lightning, ALB Terrier and GIA Thunder were the highest-yielding lentil varieties.
- In the Wimmera, GIA Lightning, GIA Thunder and PBA Hurricane XT were the highest-yielding lentil varieties.
- PBA Samira, PBA Rana and PBA Zahra were the highest-yielding varieties of faba bean in the Wimmera.
- PBA Noosa, PBA Taylor and PBA Wharton had the highest field pea yields in the Mallee.
- In the Wimmera, PBA Pearl, PBA Taylor, and PBA Wharton were the best performing varieties of field pea.

BACKGROUND

Lentils, faba beans, and field peas are important pulse options used in rotations by Wimmera and Mallee farmers. Long-term regional comparison of varieties is important for helping growers assess the most suitable option for cropping systems.

The 2024 season began with much of the Wimmera and Mallee receiving high summer rainfall resulting in reasonable levels of subsoil moisture.

This led to growers starting off with an optimistic outlook for the year. However, the high rainfall did not continue and 2024 ended up providing many challenges for growers.

The first challenge started with a later than ideal break in late May, which was variable and came in small amounts, causing patchy germination.

Throughout the season there were long periods of insufficient rainfall, as well as severe frost events at critical periods of grain formation.

It should also be noted that October rainfall was generally ineffective at many of the sites as it occurred late in the month after crops had matured. Several trials were abandoned or quarantined in the 2024 NVT program because of these challenges.

This report presents results from the lentil, faba bean, and field pea National Variety Trials (NVT) in the Mallee and Wimmera for the 2024 season. NVT data provides a snapshot of the performance of different varieties in different years/seasons. Growers can then use this information to guide cropping decisions. It is important to consider these results in the context of the season experienced, as results are presented from a single year.

AIM

To compare the performance of lentil, faba bean, and field pea varieties in the Wimmera and Mallee regions.

TRIAL DETAILS

Crop type/s:	Lentil, faba bean and field pea varieties
Target plant density:	Lentils 120 plants/m^2, faba Beans 28 plants/m^2, field Peas 55 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Replicates:	Three

PADDOCK DETAILS

Table 1. Paddock details for lentil, faba bean and field pea variety trial sites.

Location	Sowing date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Mallee						
Birchip (Nullawil) (lentil and field pea)	21 May	Clay	Barley	361	178	Lentils: 11 Nov Field peas: 12 Nov
Ouyen (lentil only)	14 May	Sand 0–10cm Clay 10–60cm	Wheat	333	215	19 Nov
Rainbow (lentil and faba bean)	27 May	Clay	Wheat	317	134	*
Ultima	14 May	Clay	Oats	356	143	*
Wimmera						
Horsham	28 May	Clay	Barley	401	262	Lentils: 25 Nov Field peas and faba beans: 10 Dec
Donald (lentil only)	28 May	Clay	Wheat	334	132	13 November
Kaniva	27 May	Clay	Wheat	427	184	*
Minimay (faba bean only)	3 June	Clay	Wheat	561	385	4 Dec

*Indicates abandoned or quarantined trial.

TRIAL INPUTS

Nutrition, weeds, insects and disease were managed as per best practice.

METHOD

This research was conducted through the NVT program delivered by the Grains Research and Development Corporation (GRDC). A series of replicated field trials was established in the Wimmera and Mallee to compare varieties of lentils, faba beans and field peas. Grain yield and quality were assessed. The data displayed in this article is a combination of NVT results and multi-environment trial analysis (MET) long-term summaries; quality data was not available at the time of writing this report. Grain yield data is presented as a percentage of the site mean for the 2024 yield results and long-term averages.

Growers should use the MET analysis when comparing varieties as this encompasses more data over multiple seasons and is therefore more reliable. MET analyses and single site summaries can be found at <https://nvt.grdc.com.au/trials/results>.

RESULTS AND INTERPRETATION

As a result of the season experienced, and some trials being abandoned or quarantined, yield data was only obtained from certain sites in each region. Yield data for lentils was only obtained from two sites in the Mallee and one in the Wimmera. Data for faba beans in the Mallee was not available, and in the Wimmera, it was taken from two sites. Yield data for field peas was taken from one site in the Mallee and one in the Wimmera. Caution should be taken when comparing region averages in 2024 as rainfall and trial conditions varied between sites, and in some regions only include data from a single site. Tables 2, 3, and 4 display this information.

Lentils

A region average of 1.15t/ha was recorded across the two Mallee sites for which yield data was obtained (Table 2). The region average in the Wimmera (Donald) was 1.52t/ha. Rainbow, Ultima, and Kaniva were quarantined, and Horsham lentil results were not available at the time of writing.

Table 2. Site and region yield averages for lentils, 2024.

Region	Location	Site average	Region average
Mallee	Birchip	1.22t/ha	
	Ouyen	1.08t/ha	1.15t/ha
	Rainbow	NA	
	Ultima	NA	
Wimmera	Horsham	UN	
	Donald	1.52t/ha	1.52t/ha
	Kaniva	NA	

NA indicates an abandoned or quarantined trial. UN indicates unreleased at time of writing report.

In the Mallee, GIA Lightning (122 per cent of the region mean), ALB Terrier (121 per cent), and GIA Thunder (119 per cent) were the highest yielding varieties in 2024 (Figure 1). Over the long-term GIA Thunder, ALB Terrier and GIA Lightning seem to be the best performers, however, these varieties have been in Mallee trials for less than six years, so the remaining years are predicted yields. PBA Jumbo2 is also a consistent high performer in the long-term data but has fewer broadleaf weed control options than GIA Thunder, ALB Terrier, and GIA Lightning, which have imidazolinone tolerance.

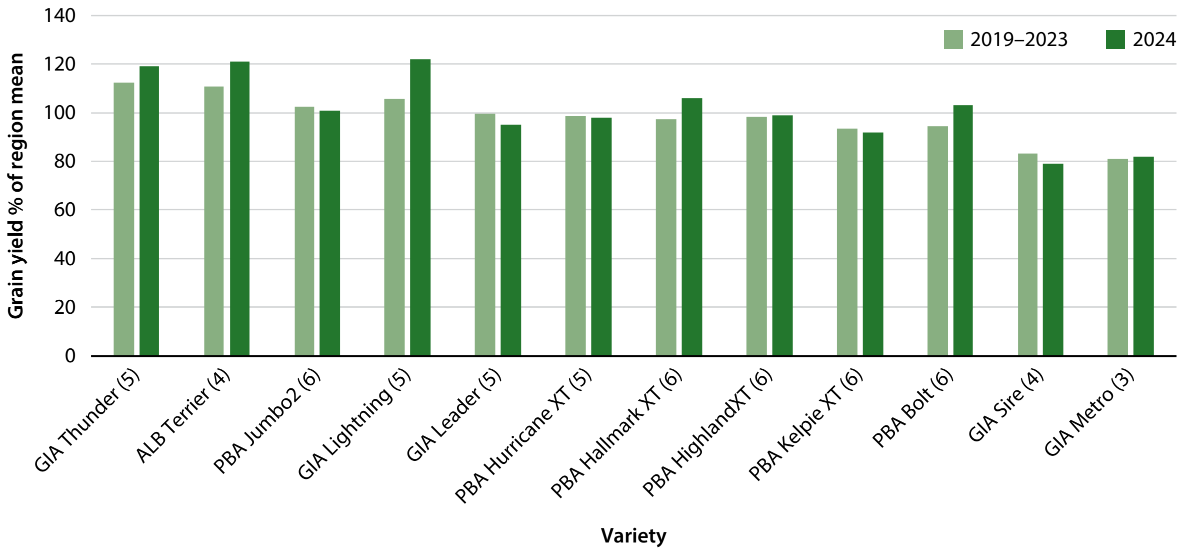

Figure 1. Mallee Lentil NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

Lentils – individual Mallee sites

Birchip: 1.22t/ha site average

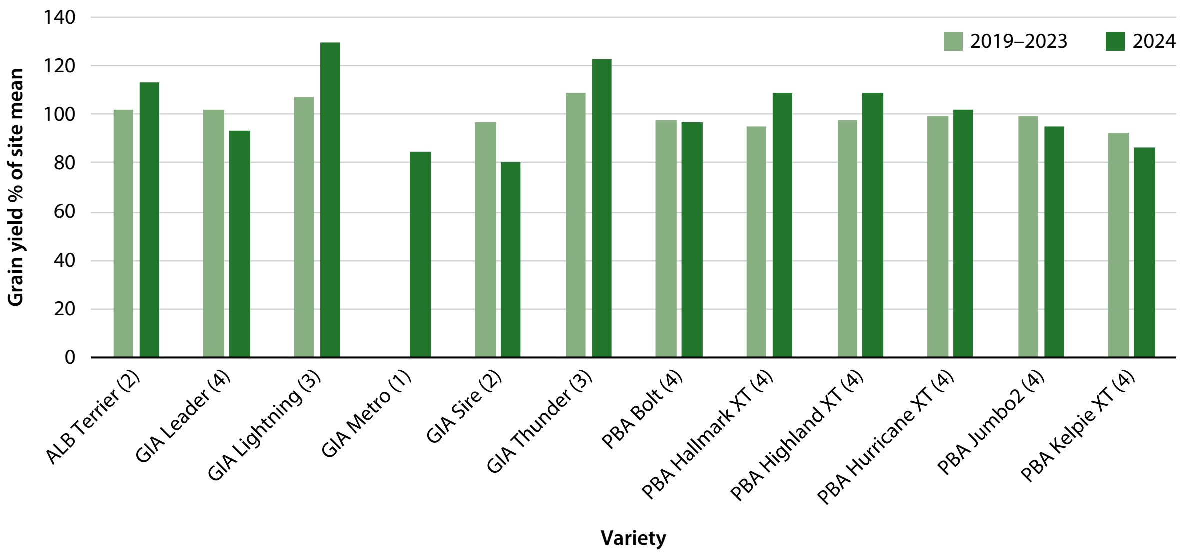

Figure 2. Birchip Lentil NVT average yields as a percentage (%) of the mean for Birchip sites, 2019–2023 and 2024. Brackets denote how many seasons yield data has been obtained for the variety in the Birchip NVT (if less than six then the remainder of the years' data is predicted).

Ouyen: 1.08t/ha site average

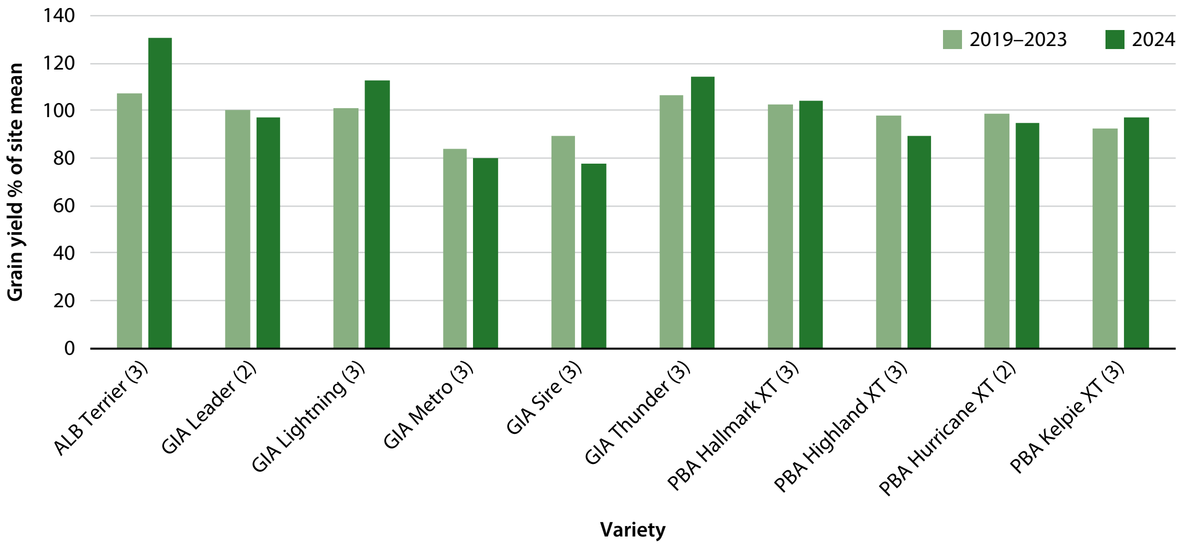

Figure 3. Ouyen lentil NVT average yields as a percentage (%) of the mean for Ouyen sites, 2022–2023 and 2024. Brackets denote how many seasons yield data has been obtained for the variety in the Ouyen NVT (data is only available for lentil sites in Ouyen from 2022 onwards).

At both Mallee sites, GIA Lightning, GIA Thunder and ALB Terrier were the highest yielding varieties. Contrary to longer-term data, ALB Terrier was the highest yielding variety at Ouyen, (131 per cent) compared to Birchip, where it was the third highest yielding (113 per cent). Yields were similar for GIA Thunder and GIA Lightning at both Birchip and Ouyen. However, GIA Lightning yielded slightly higher at Birchip, whereas the inverse was true at the Ouyen trial.

In the Wimmera (Donald), GIA Lightning, GIA Thunder and PBA Hurricane XT were the highest yielding varieties in 2024 at 112, and 104 per cent of the region mean, respectively (Figure 4). GIA Thunder, ALB Terrier, and PBA Highlander XT have been the best performers over the longer-term, however, these varieties have been in Wimmera trials for less than 6 years, so the remaining years are predicted yields.

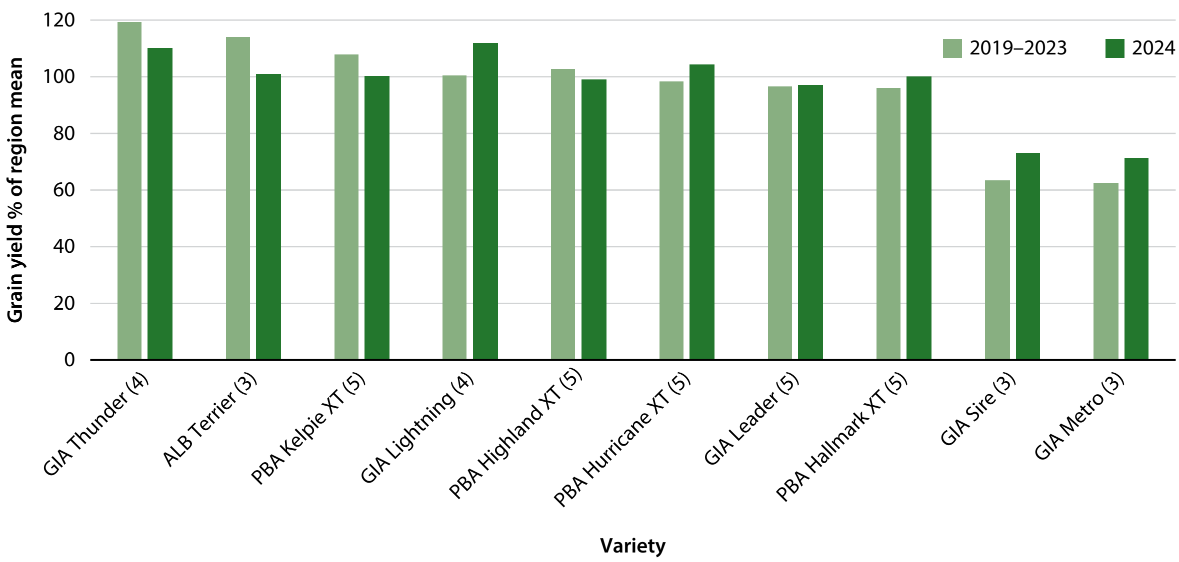

Figure 4. Wimmera (Donald) lentil NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

Faba beans

A region average of 1.68t/ha was recorded across the two Wimmera sites for which yield data was obtained (Table 3). There was only one trial site in the Mallee for faba beans at Rainbow, however this trial was abandoned. The site at Kaniva was also quarantined. PBA Samira, PBA Rana, and PBA Zahra were the highest yielding varieties at 111 per cent or more of the Wimmera region mean in 2024 (Figure 5). PBA Samira and PBA Zahra have been consistently high yielding varieties since 2019. PBA Bendoc is close behind and has the added benefit of imidazolinone tolerance, providing an attractive choice if additional weed control is needed.

Table 3. Site and region yield averages for faba beans, 2024.

Region	Location	Site average	Region average
Wimmera	Wonwondah (Horsham)	1.52t/ha	
	Minimay	1.84t/ha	1.68t/ha
	Kaniva	NA	

NA indicates an abandoned or quarantined trial.

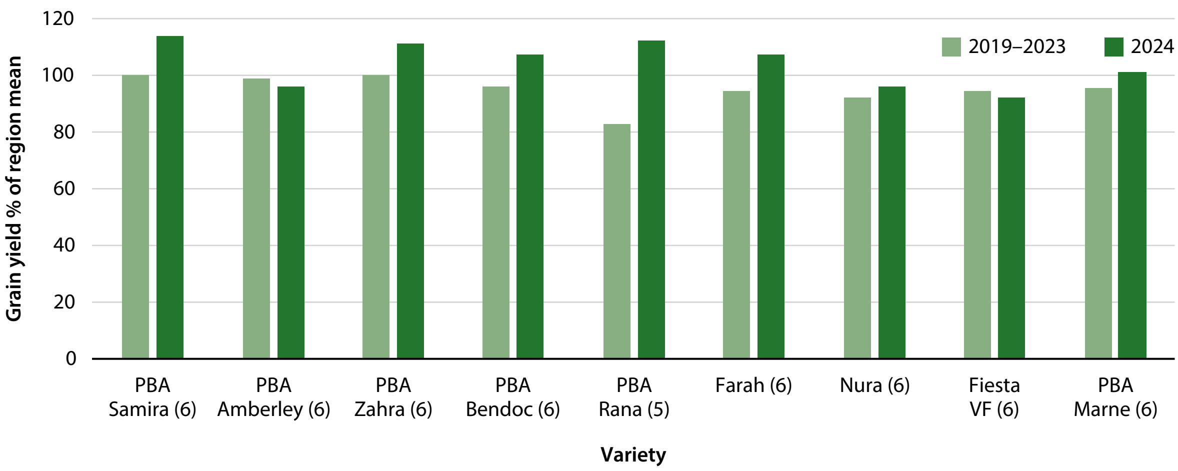

Figure 5. Wimmera faba bean NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

Faba beans – individual Wimmera sites

Wonwondah (Horsham): 1.53t/ha site average

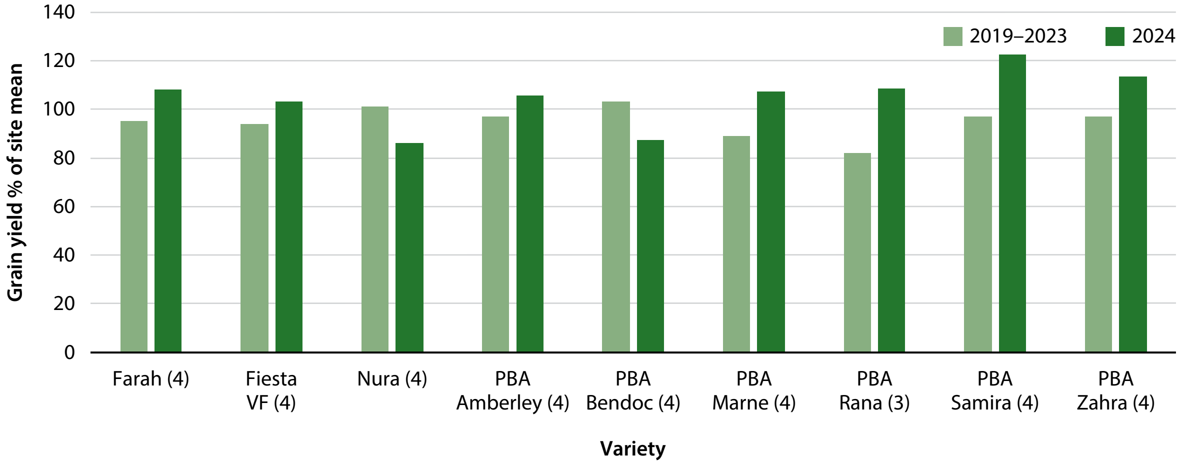

Figure 6. Wonwondah (Horsham) NVT average yields as a percentage (%) of the mean for Wonwondah sites, 2019–2023 and 2024. Brackets denote how many seasons yield data has been obtained for the variety in the Wonwondah NVT (if less than six the remainder of the years' data is predicted).

Minimay: 1.84t/ha site average

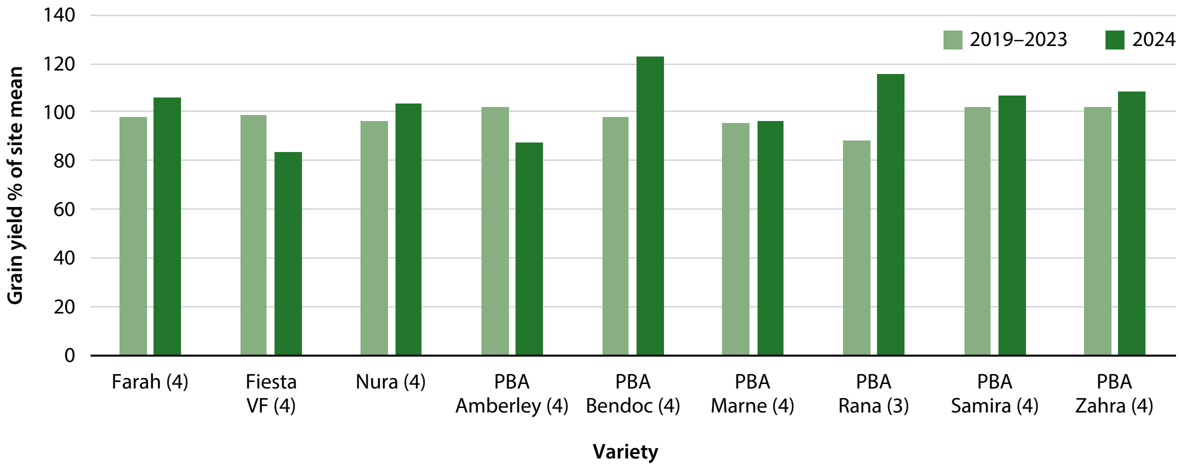

Figure 7. Minimay NVT average yields as a percentage (%) of the mean for Minimay sites, 2019–2023 and 2024. Brackets denote how many seasons yield data has been obtained for the variety in the Minimay NVT (if less than six the remainder of the years' data is predicted).

Field peas

The average yield in the Mallee was 1.72t/ha, obtained from the average yield at the Birchip trial site. The average yield for field peas in the Wimmera was 1.63t/ha, obtained from one site at Horsham (Table 4).

In the Mallee, PBA Noosa had the highest yields in 2024 with 119 per cent of the region mean, followed by PBA Taylor (115 per cent), and PBA Wharton (113 per cent) (Figure 8). APB Bondi, while not one of the highest in 2024, still performed well and has been consistently high yielding over the longer-term. Data for this variety is only available for five years, so remaining data is predicted yield. PBA Butler and PBA Pearl have been higher yielding varieties in the past, but their performance was well below average in 2024. Caution should be taken when looking at the results for these two varieties as these results are unexpected, and the reason for lower yields has not been determined.

Table 4. Site and region yield averages for field peas, 2024.

Region	Location	Site average	Region average
Mallee	Birchip	1.72t/ha	1.72t/ha
	Ultima	NA	
Wimmera	Horsham	1.63t/ha	1.63t/ha
	Kaniva	NA	

NA indicates an abandoned or quarantined trial.

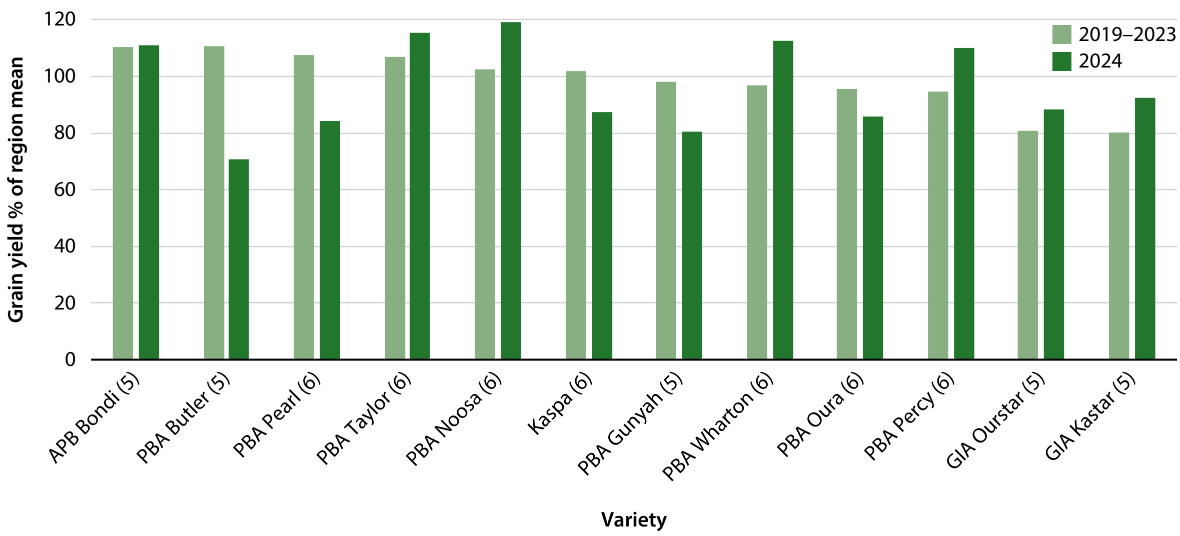

Figure 8. Mallee (Birchip) field pea NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

In the Wimmera, PBA Pearl was the best performer at 125 per cent of the region mean, followed by PBA Taylor (109 per cent), and PBA Wharton (106 per cent) (Figure 9). PBA Pearl has been a consistent high yielding variety for the past six years. PBA Butler has shown high yields over the past four previous years, however, it performed well below the region average in 2024, coming in as the second lowest-yielding variety in the trials. The low yields for PBA Butler in both the Wimmera and Mallee were unexpected and contrary to results from previous years. Growers should be cautious when evaluating these results.

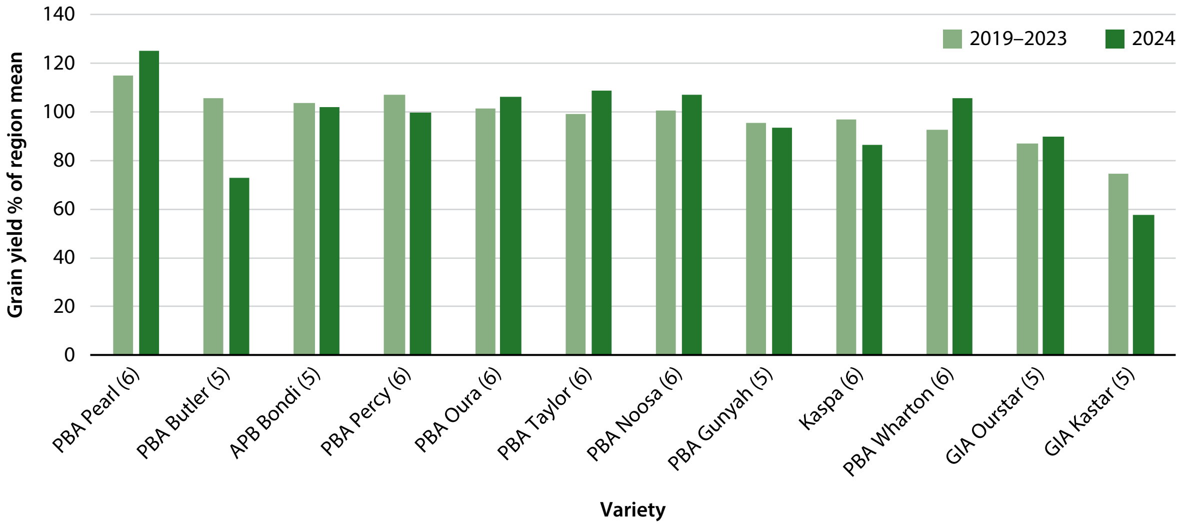

Figure 9. Wimmera (Horsham) field pea NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six then the remainder of the years' data is predicted).

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The NVT is conducted primarily to compare variety performance in terms of yield potential under the same regional growing conditions, and this needs to be repeated over several seasons to ensure findings are robust. As such, growers should consider how many years of data is available when considering a variety.

Furthermore, growers should assess the variables of their own farming systems, such as rainfall, nutrition, disease, and soil constraints, and consider this information in conjunction with NVT data.

All three pulse types are good break crops for cereal-based farming systems. Deciding which break crop to grow will depend on each grower's individual circumstances. For example, faba beans will be a better option for paddocks prone to waterlogging, but not be the best option on sandy soils (Hawthorne, Pritchard, and Knights, 2011). Deciding what crop type to grow and which variety should be discussed with an experienced advisor.

Several factors should be considered when choosing a lentil, faba bean or field pea variety. Aside from yield, the main attributes to consider are flowering time, maturing time, seed size, herbicide tolerance, and disease resistance ratings. It is important to match the characteristics of a variety to the environment in which it is to be grown for mitigating risk, whilst maximising the benefits.

Lentils

Herbicide tolerance options in lentils can be very useful tools depending on circumstances. For example, if there is known high weed pressure in a paddock, growers should consider if it would be beneficial to select a lower yielding dual-herbicide tolerant variety such as GIA Metro or GIA Sire. Rather than focusing on higher yielding varieties, this would help get weeds under control, as a wider range of herbicide options can be used. However, this should be discussed with an experienced advisor. Another scenario might be if a paddock has herbicide residue from the previous year; GIA Thunder has imidazolinone tolerance.

Faba beans

Imidazolinone tolerant varieties of faba bean are available and can be a useful tool for managing weeds in farming systems. However, the tolerance is not always necessary, and variety decisions will depend on the state of the paddock they are intended for.

Field peas

As well as the regular characteristics listed above, field peas have other attributes to consider such as grain type (kaspa, dun, white pea, or blue pea), whether they are conventional height or a semi-dwarf, and whether they are semi-leafless or not. The right variety will differ between individual circumstances and should be discussed with an experienced advisor.

Site results unavailable at the time of writing this report will be published within the 'Quarantined trials reports' section of the NVT website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

Table 5. NVT Disease ratings of lentils.

Variety	Ascochyta blight (Hurricane virulent) resistance	Ascochyta blight (Nipper virulent) resistance	Botrytis grey mould resistance	Pratylenchus neglectus resistance	Pratylenchus thornei resistance
ALB Terrier	MR (P)	R	MRMS (P)	MR	MR
GIA Leader	MR (P)	MR (P)	MRMS (P)	MRMS (P)	MR (P)
GIA Lightning	MRMS (P)	R (P)	MS (P)	MRMS (P)	MR (P)
GIA Metro	RMR (P)	MR (P)	MRMS (P)	MR (P)	MRMS (P)
GIA Sire	MRMS (P)	R (P)	MS (P)	MRMS (P)	MRMS (P)
GIA Thunder	MRMS (P)	R (P)	MRMS (P)	MR (P)	MR (P)
Nipper	MR	MRMS	MRMS	RMR	MR
PBA Ace	MR	R	MS	MR	MRMS
PBA Bolt	MRMS	MR	S	MR	MR
PBA Hallmark XT	MRMS	RMR	MRMS	MR	MRMS
PBA Highland XT	MR (P)	MR	MS	MR	MRMS
PBA Hurricane XT	MRMS (P)	RMR	MS	MRMS	MRMS
PBA Jumbo2	RMR	R	MR (P)	MR	MRMS
PBA Kelpie XT	MRMS	MRMS	MS	MRMS	MRMS

(P) is a provisional rating. S = susceptible, M = moderately, R = resistant.

Table 6. NVT disease ratings of faba beans.

Variety	Ascochyta blight resistance	Cercospora leaf spot resistance	Chocolate spot resistance	Pratylenchus thornei resistance	Rust (faba bean) resistance
Farah	MS	S	S	MS	VS
Fiesta VF	S	S	S	MS	VS
Nura	MR (P)	S	MS	MS	VS
PBA Amberley	MR	S	MRMS	MRMS	VS
PBA Bendoc	MR	S	S	MRMS	VS
PBA Marne	MS	S	MS (P)	MS	MRMS
PBA Rana	MRMS (P)	S	MS	MS	VS
PBA Samira	MR (P)	S	MS	MRMS	S
PBA Zahra	MRMS	S	MS	MRMS	S

(P) is a provisional rating. S = susceptible, M = moderately, R = resistant

Table 7. NVT disease ratings of field peas.

Variety	Bacterial blight resistance	Downy mildew Resistance	Powdery mildew resistance	Pratylenchus neglectus resistance	Pratylenchus thornei resistance
APB Bondi	S	RMR	RMR	RMR	MSS
GIA Kastar	S	S	RMR	MR	MS
GIA Ourstar	S (P)	S	S	MRMS	MS
Kaspa	S	S	S	RMR	MRMS
PBA Butler	MS	S	S	RMR	MRMS
PBA Gunyah	S	S	S	RMR	MRMS
PBA Noosa	S	MS	S	RMR	MRMS
PBA Oura	MS	S	S	MR	MRMS
PBA Pearl	MS	S	S	MR	MRMS
PBA Percy	MRMS	S	S	RMR	RMR
PBA Taylor	S	S	S	RMR	MRMS
PBA Wharton	S	S	RMR	MR	MRMS

(P) is a provisional rating. S = susceptible, M = moderately, R = resistant.

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BCG sincerely thanks the Watts family (Nullawil), Brett Fisher (Rainbow), Tim Weir (Ouyen), Baden and Warrick Grey (Ultima), Jason Pymer (Horsham), Ben Crouch (Kaniva), Warakirri Cropping farm manager Jono Robinson (Donald), and Ollie Gabbe (Minimay) for generously hosting the trial sites and for their support throughout the project.

CHICKPEA AND LUPIN VARIETIES IN THE MALLEE AND WIMMERA

Matt Lade (BCG)

TAKE HOME MESSAGES

- CBA Captain was the highest yielding desi chickpea variety in both the Mallee and Wimmera.
- PBA Royal was the highest yielding kabuli chickpea variety in both the Mallee and Wimmera.
- PBA Jurien was the highest yielding variety of lupin.

BACKGROUND

Chickpeas are a high value pulse crop well suited to medium rainfall areas of south-eastern Australia, they are used mainly for human consumption (Pulse Australia, 2015). Chickpeas generally leave less fixed nitrogen (N) behind for the following year's crop compared to other legumes such as lentils and field peas (GRDC, 2018), however, they are still an important break crop in the Mallee and the Wimmera, particularly for the management of disease.

Lupins are a high protein legume often grown for on-farm livestock feed or sold to livestock feed manufacturers (Agriculture Victoria, 2024). Although lupin consumer markets are relatively small in comparison to other grains, Australia is the world's largest producer of lupins and there is interest in growing this legume as an additional protein source for consumption in the future (CSIRO, 2024). Long-term regional comparison of varieties is therefore important for enabling growers to assess the most suitable option for their cropping systems.

The 2024 season began with much of the Wimmera and Mallee receiving high summer rainfall resulting in reasonable levels of available subsoil moisture. This led to growers starting off with an optimistic outlook for the year. However, the high rainfall did not continue, creating a challenging season for growers. The first challenge occurred with a later than ideal break in late May, which was variable and came in small amounts, causing patchy germination.

Throughout the season there were long periods of insufficient rainfall, as well as severe frost events at critical periods of grain formation. It should also be noted that October rainfall was generally ineffective at many of the sites as it occurred late in the month after crops had matured. Several trials were abandoned or quarantined in the 2024 NVT program because of these challenges.

This report presents results from the chickpea and lupin National Variety Trials (NVT) in the Mallee and Wimmera for the 2024 season. NVT data provides a snapshot of the performance of different varieties in different years/seasons. Growers can then use this information to guide cropping decisions. It is important to consider these results in the context of the season experienced, as results are presented from a single year.

AIM

To compare the performance of chickpea and lupin varieties in the Mallee and Wimmera regions.

TRIAL DETAILS

Crop type/s:	Desi and kabuli chickpea varieties; narrow leaf lupin varieties.
Target plant density:	Desi chickpea 35 plants/m^2, kabuli chickpea 30 plants/m^2, lupins 45 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing.
Sowing date:	Refer to Table 1
Replicates:	Three

PADDOCK DETAIL

Table 1. Paddock details for chickpea and lupin variety trial sites.

Location	Sowing date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm) Apr–Oct	Harvest date
Mallee						
Birchip (Nullawil)	21 May	Clay	Barley	361	178	Lentils: 11 Nov Fields peas: 12 Nov
Hopetoun (lupin)	8 May	Sandy loam	Barley	266	100	21 Nov
Rainbow (chickpeas)	27 May	Clay	Wheat	317	134	*
Walpeup (lupin)	16 May	Loam 0–10cm Clay 10–60cm	Barley	266	137	*
Wimmera						
Horsham (chickpea)	28 May	Clay	Barley	401	262	Lentils: 25 Nov Field peas and faba beans: 10 Dec
Telopea Downs (lupin)	7 May	Sand	Barley	361	179	*
Kaniva (chickpea)	27 May	Clay	Wheat	427	184	*

*Indicates abandoned or quarantined trial.

TRIAL INPUTS

Nutrition, weeds, insects, and disease were managed as per best practice.

METHOD

This research was conducted through the NVT program funded by the Grains Research and Development Corporation (GRDC). A series of replicated field trials was established in the Wimmera and Mallee to compare varieties of desi and kabuli chickpeas, as well as narrow leafed lupins. Grain yield and quality were assessed. The data displayed in this article is a combination of NVT results and multi-environment trial analysis (MET) long-term summaries; quality data was not available at the time of writing this report. Grain yield data is presented as a percentage of the site mean for the 2024 yield results and long-term averages.

Growers should use the MET analysis when comparing varieties as this encompasses more data over multiple seasons and is therefore more reliable. MET analyses and single site summaries can be found at <https://nvt.grdc.com.au/trials/results>.

RESULTS AND INTERPRETATION

As a result of the season experienced, and some trials being abandoned or quarantined, yield data was only obtained from one site in each region for both desi and kabuli chickpeas. Yield data for lupins was only obtained from one site in the Mallee and was not available for the Wimmera. Caution should be taken when comparing the region averages of these crop types in 2024 as they are only from one trial site. Tables 2, 3, and 4 display this information.

Desi chickpeas

A region average of 1.32t/ha was recorded in the Mallee (Birchip) (Table 2). An average yield of 0.99t/ha was recorded in the Wimmera (Horsham). The Rainbow and Kaniva trials were abandoned.

Table 2. Site and region yield averages for desi chickpeas, 2024.

Region	Location	Site average	Region average
Mallee	Birchip	1.32t/ha	1.32t/ha
	Rainbow	NA	
Wimmera	Horsham	0.99t/ha	0.99t/ha
	Kaniva	NA	

NA indicates an abandoned or quarantined trial.

In the Mallee, CBA Captain was the highest yielding variety at 110 per cent of the region mean in 2024 (Figure 1), possibly due to its more erect plant type and good-height-to-lowest-pod (SARDI, 2024). These traits provide easier harvesting, which has an impact because low biomass growth which was experienced this season inhibits grain collection by headers. This hypothesis should be supported with further data in the future. All other varieties produced relatively similar yields, which were lower than the site mean. Long-term data indicate PBA Striker has been a higher yielding variety for the past five years, however, this was not the case in 2024.

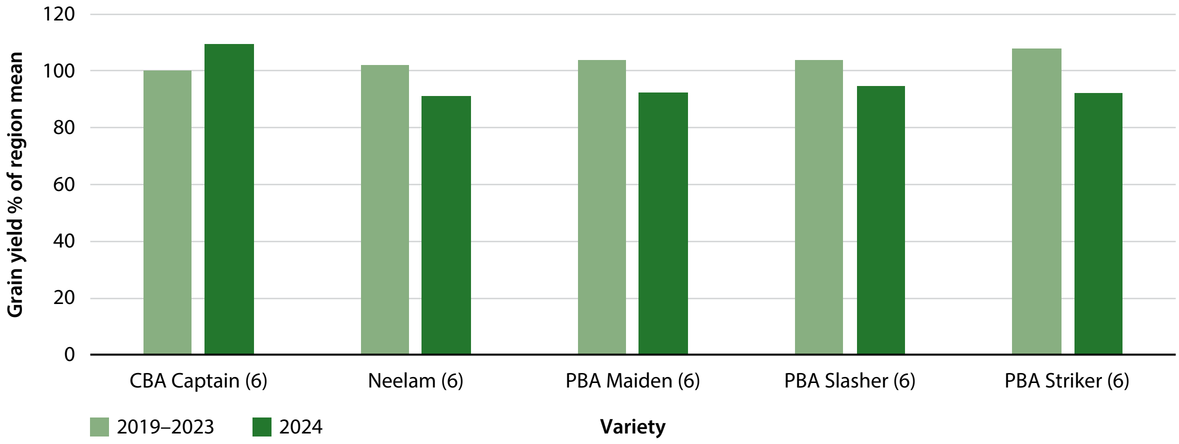

Figure 1. Mallee (Birchip) desi chickpea NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

CBA Captain was also the highest yielding variety in the Wimmera, at 110 per cent of the region mean in 2024 (Figure 2). Neelam was the lowest yielding variety at 85 per cent of the region mean. Long-term data shows Neelam's yield has typically been more comparable to other varieties, unlike in 2024 when it lagged significantly. Conversely, the CBA Captain variety, which usually ranks at the lower end of yields, outperformed others and recorded the highest yield in 2024. As proposed in the Mallee findings, CBA Captain's advantage this year might have been due to its more erect plant type, easing harvest operations.

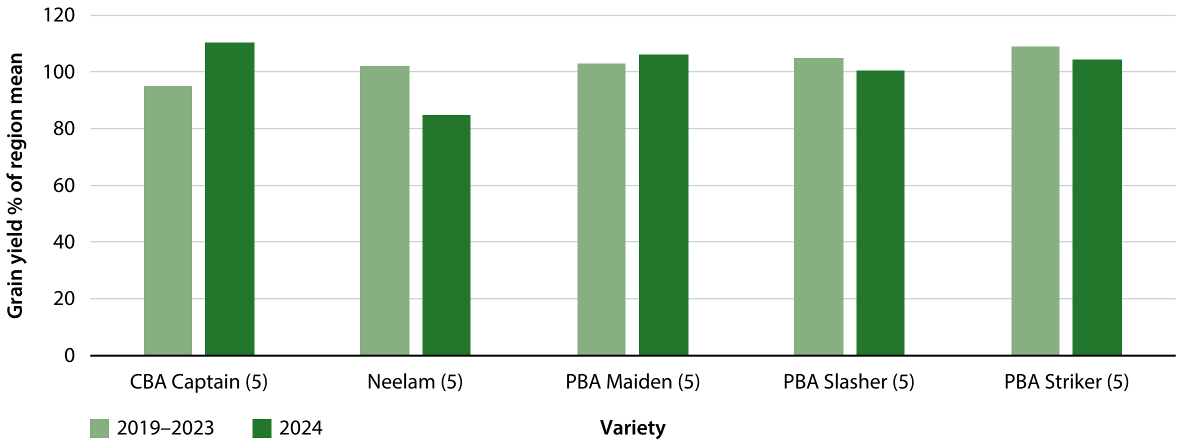

Figure 2. Wimmera (Horsham) desi chickpea NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

Kabuli chickpeas

A region average of 1.18t/ha was recorded in the Mallee (Birchip) for kabuli chickpeas in 2024 (Table 3). In the Wimmera (Horsham), the region average was 0.91t/ha. Rainbow and Kaniva trials were abandoned.

Table 3. Site and region yield averages for Kabuli chickpeas, 2024.

Region	Location	Site average	Region average
Mallee	Birchip	1.18t/ha	1.18t/ha
	Rainbow	NA	
Wimmera	Horsham	0.91	0.91t/ha
	Kaniva	NA	

NA indicates an abandoned or quarantined trial.

Almaz and PBA Royal were the highest yielding varieties in the Mallee in 2024 at 107 and 109 per cent of the region mean, respectively (Figure 3), contrary to long-term data which shows Almaz as a lower yielding variety. However, Almaz has only been in the NVT for five seasons, so the remainder of the years' data is predicted. PBA Monarch was the worst performer, achieving only 89 per cent of the region mean. PBA Royal has been a consistently high yield performer over the longer-term, and this continued in 2024. PBA Magnus has also been a high performer in past years and yielded close to the region mean this year. Like Almaz, PBA Magnus has only been in the trials for five years so remaining years' data is predicted.

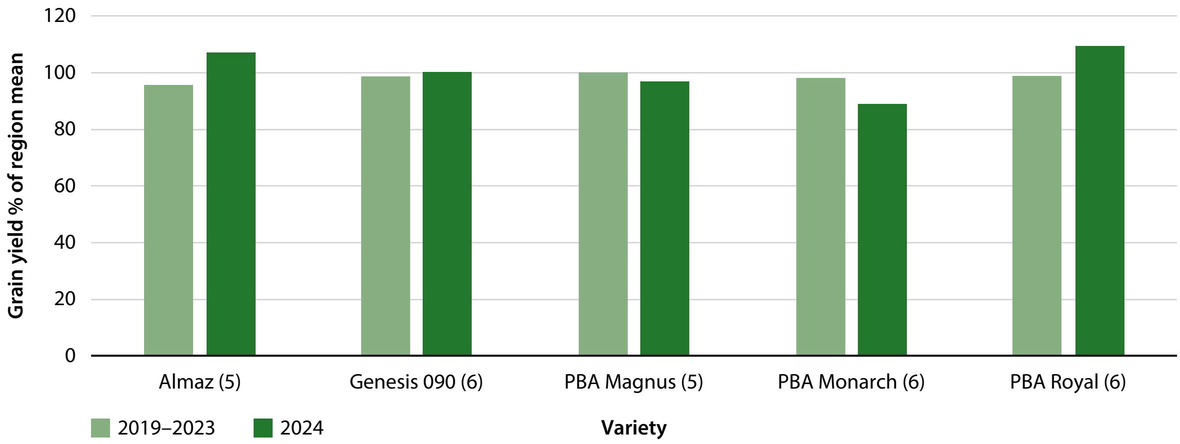

Figure 3. Mallee (Birchip) kabuli chickpea NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

In the Wimmera, the highest yielding variety of kabuli chickpea was PBA Royal at 115 per cent of the region mean (Figure 4). PBA Magnus and Genesis 090 were the next two highest yielding varieties, while PBA Monarch yielded the lowest at 84 per cent of the region mean. Both PBA Royal and Genesis 090 have been strong performers against the other varieties over the longer-term and continued that performance in 2024. Comparing 2024 data to the long-term data, PBA Magnus performed better than it has in past years.

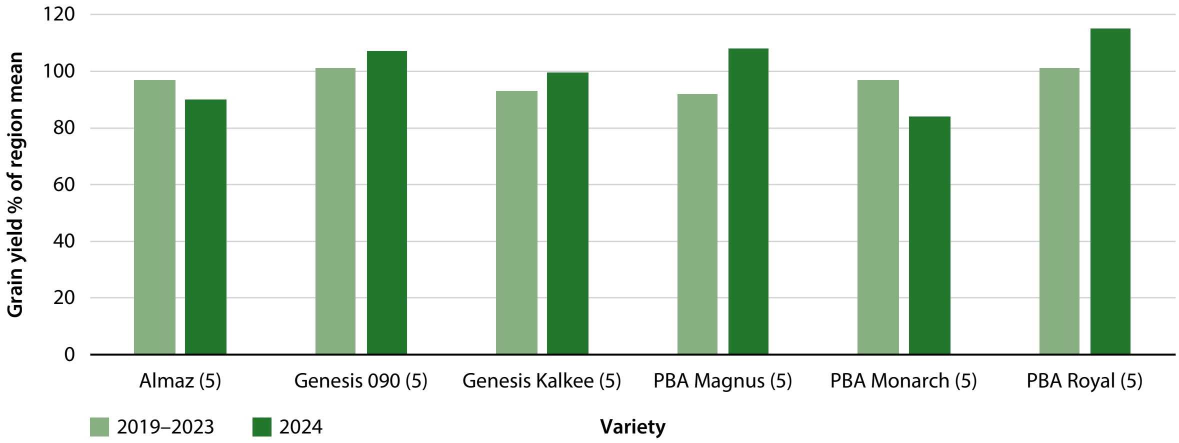

Figure 4. Wimmera kabuli chickpea NVT average yields as a percentage (%) of region mean 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

Narrow leafed lupins

A region average yield of 1.18t/ha was recorded in the Mallee (Hopetoun) for lupins in 2024 (Table 4). Yield data was obtained from one site, as the sites at Walpeup and Telopea Downs were quarantined.

Table 4. Site and region yield averages for lupins, 2024.

Region	Location	Site average	Region average
Mallee	Hopetoun	1.18t/ha	1.18t/ha
	Walpeup	NA	
Wimmera	Telopea Downs	NA	NA

NA indicates an abandoned or quarantined trial.

PBA Jurien was the highest yielding variety of lupin in the Mallee, achieving 126 per cent of the region mean (Figure 5), and has been a high performer since 2019. The lowest yielding varieties were Rosemont (82 per cent of the region mean) and PBA Bateman (87 per cent). PBA Bateman has been a high performing variety since 2019, however, this season it was well below the average for the region.

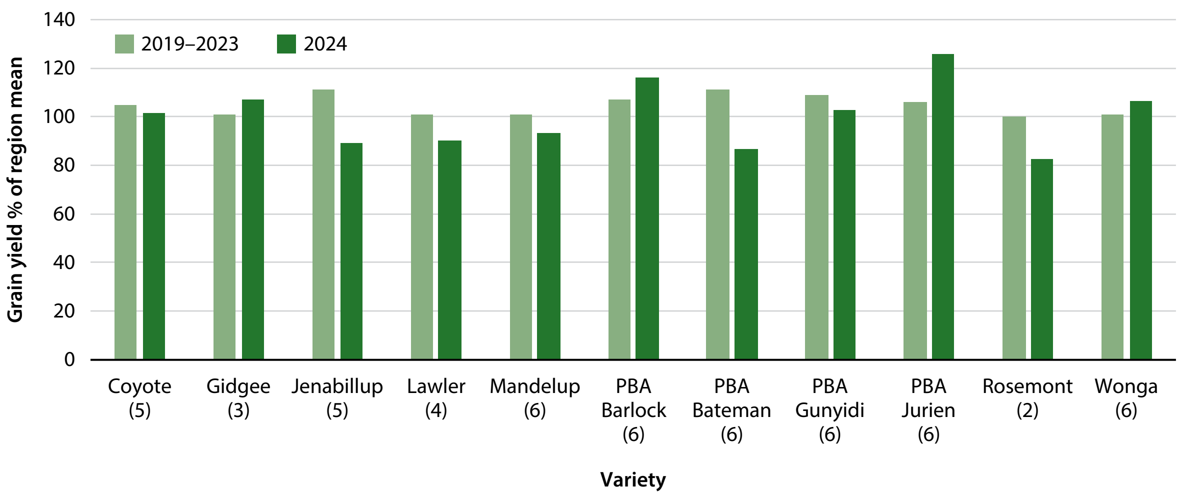

Figure 5. Mallee (Hopetoun) lupin NVT average yields as a percentage (%) of region mean, 2019–2023 and 2024. Brackets denote how many seasons the variety has been in the NVT (if less than six the remainder of the years' data is predicted).

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

NVT is conducted primarily to compare variety performance in terms of yield potential under the same regional growing conditions, and this needs to be repeated over several seasons to ensure findings are robust. As such, growers should consider how many years of data is available when considering a variety.

Furthermore, growers should assess the variables of their own farming systems, such as rainfall, nutrition, disease, and soil constraints, and consider this information in conjunction with NVT data.

Several factors should be considered when choosing a chickpea or lupin variety. Aside from yield, the main factors to examine are flowering time, maturing time, seed size, herbicide tolerance, and disease resistance ratings. It is important to match the characteristics of a variety to the environment in which it is to be grown for mitigating risk, whilst maximising the benefits. For example, an early flowering and early maturing variety will be better suited to short growing season environments and will likely perform better than later flowering and maturing varieties grown under the same conditions.

Chickpeas

Chickpeas are a high value crop and can be profitable under the right seasonal conditions. Chickpeas are also an effective break crop for cereal-based farming systems.

Ascochyta blight is one of the key diseases affecting this crop. According to NVT data, chickpeas are moderately susceptible to this disease (GRDC, 2024). Growers should consider whether it is more beneficial to select a higher yielding variety rather than focus on marginal increases in disease resistance, however this should be discussed with an experienced advisor.

Lupins

Lupins are grown as break crops and mainly used as stock feed. They offer growers the opportunity to diversify crop rotations, whilst controlling disease and fixing soil nitrogen. Many of the higher yielding varieties also show higher resistance ratings to diseases such as anthracnose, cucumber mosaic virus and phomopsis (GRDC, 2024). Lupins have poor crop competition compared to other legumes, and limited options for post-emergence broad leaf control. Several varieties in the NVT trials are tolerant to metribuzin, which is an important consideration for agronomic management. For example, selecting PBA Bateman over Jenabillup provides the benefit of metribuzin tolerance, whilst maintaining yield potential.

Site results unavailable at the time of writing this report will be published within the 'Quarantined trial reports' section of the NVT website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

Table 5. NVT disease ratings of chickpeas.

Variety	2022/23 Phytophthora Root Rot resistance	Ascochyta Blight (Pathogen Group 1: South) Resistance	Ascochyta Blight (Pathogen Group 2: North) Resistance	Prat.* neglectus resistance	Prat.* neglectus tolerance	Prat.* thornei resistance	Prat.* thornei tolerance
Almaz	-	S	MS	MRMS	MII	S	IVI
CBA Captain	S	S	MS	MR	MT	MS	MT
Genesis 090	-	MS	MS	MRMS	IVI	MS	MII
Neelam	-	S	S	MRMS	MI	MS	MTMI
PBA Magnus	-	S	MS	MR	MII	MSS	I
PBA Maiden	-	S	S	MRMS	MI	MRMS	MII
PBA Monarch	-	S	MS	MRMS	I	MS	MII
PBA Royal	-	MS	MS	MR	VI	MS	MII
PBA Slasher	-	S	S	MRMS	MI	MRMS	MT
PBA Striker	-	S	S	MRMS	MI	MRMS	TMT

*Pratylenchus. (P) is a provisional rating. S = susceptible, M = moderately, R = resistant, T = tolerant, I = intolerant.

Table 6. NVT disease ratings of lupins.

Variety	Anthracnose resistance	Cucumber mosaic virus resistance	Phomopsis (pod infection) resistance	Phomopsis (stem infection) resistance	Sclerotiniastem rot resistance
Coyote	MRMS	MRMS	MRMS	S	S (P)
Gidgee	RMR	MRMS	S (P)	MR	S (P)
Jenabillup	MS	MRMS	MR	MS	S (P)
Lawler	MR	MRMS	MS	MR	S (P)
Mandelup	MRMS	MRMS	S	MR	S (P)
PBA Barlock	RMR	MRMS	MR	MR	S (P)
PBA Batemen	MRMS	MR	MS	RMR	S (P)
PBA Gunyidi	MRMS	MRMS	MRMS	RMR	S (P)
PBA Jurien	RMR	MS	MRMS	RMR	S (P)
Rosemont	MRMS	MR	MRMS (P)	MR	S (P)
Wonga	MR	MR	MR	MR	S (P)

(P) is a provisional rating. S = susceptible, M = moderately, R = resistant, T = tolerant, I = intolerant

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

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BCG sincerely thanks the Watts family (Nullawil), Brett Fisher (Rainbow), Devon Mill (Hopetoun), Ross Stone (Walpeup), Jason Pymer (Horsham), Ben Crouch (Kaniva), and Michael Norton (Telopea Downs) for generously hosting the trial sites and for their support throughout the project.

OAT VARIETIES IN THE NORTH CENTRAL AND WIMMERA

Ashlee Tierney (BCG)

TAKE HOME MESSAGES

- Goldie was the top yielding oat variety in the North Central region in 2024.
- The top yielding varieties in the Wimmera in 2024 were Bannister and Echidna.
- The top yielding varieties long-term in the North Central have been Koala, Bannister, and Goldie, which only includes four years of data.

BACKGROUND

The 2024 season began with high January rainfall across much of the North Central and Wimmera. This weather pattern did not continue, and by April and May, many farmers were deliberating the best approach to their sowing program: whether to sow dry, or wait for the break to come. Many growers across the regions started dry sowing in April and some National Variety Trials (NVT) were also sown dry.

Oats have a variety of end-uses, including grain for human consumption (milling) and as animal feed, or oaten hay. Oats with a range of end-uses are included in the NVT trials however no hay quality assessments were undertaken. The results presented below include only grain yield.

In 2024, BCG established three oat variety trials: two in the North Central and one in the Wimmera. These trials were about 15 per cent breeding lines and the rest released varieties.

The combination of NVT data, individual site reports, and multi-environmental trial analysis (MET) long-term data provides a useful tool for growers to determine which varieties are performing well and may be suitable for their farming system.

AIM

To compare the performance of new and existing oat varieties in North Central and Wimmera NVT.

TRIAL DETAILS

Crop type: Oat, refer to Figures 1–2 for varieties.

Target plant density: 160 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Replicates: Three

Nutrition, weeds, insects and disease were managed as per best practice. For individual trial details see <https://nvt.grdc.com.au/>.

METHOD

This research was conducted through the NVT program delivered by GRDC. The program involves a series of replicated field trials designed to test varieties from different crop types in different locations. These trials aim to maximise genetic potential yield, rather than profitability. The sites receive multiple fungicide applications and are managed to ensure they are not nitrogen limited, to avoid confounding factors when assessing the genetic potential of varieties. The data displayed in this article are a combination of NVT results, individual site reports and multi-environmental trial analysis (MET) long-term summaries. Variety performance is presented as the grain yield percentage of the site average, with MET data indicating performance in 2024, relative to the previous five years (2019–2023).

Table 1. Sowing dates, paddock details, rainfall, and harvest of 2024 oat NVT trials in the North Central and Wimmera regions.

Region	Location	Sowing date	Germinating rainfall date	Soil type	Paddock history (2023)	Crop year rainfall (mm) Nov–Oct	GSR (mm)	Harvest date
North Central	Charlton	29 May	30 May	Clay	**	311 (2)	208 (3)	*
	Diggora	8 May	9 May	Clay	Peas	456 (6)	228 (3)	10 Dec
Wimmera	Dimboola	28 May	30 May	Clay	Vetch	317 (3)	162 (1)	11 Dec

Number in brackets () denotes decile. *Trial was not harvested. **Information not available.

RESULTS AND INTERPRETATION

New varieties released in 2024

Minnie is a high yielding grain oat from Intergrain. It has a mid-to-slow maturity, similar to Bannister. Its short-to-medium plant height improves lodging tolerance and harvestability, but may make it unsuitable as a dual-purpose variety. This variety has been released in Western Australia, but will not be available in the eastern states until 2026.

Yield results

Table 2. 2024 oat yield results of the 2024 NVT sites across the North Central and Wimmera regions.

Region	Location	Average trial yield (t/ha)
North Central	Charlton	Trial was abandoned
	Diggora	3.9
Wimmera	Dimboola	3.2

Table 3. Disease ratings of selected oat varieties.

Variety	Maturity	End-use	Bacterial blight	Stem rust	Leaf rust	CCN	BYDV	*Septoria avenae*
Archer	M	Hay	MSS (P)	MSS	R/S (P)	-	MSS (P)	MRMS (P)
Kingbale	M-S	Hay	MSS (P)	MSS	S	R	MS	MSS
Wallaby	M-S	Hay	MSS (P)	SVS (P)	MR (P)	-	MS (P)	MS (P)
Echidna	Q-M	Milling/ feed grain	S	S	SVS	MS	MSS	SVS
Yallara	Q	Milling/hay	S	S	S	R	S	MSS
Bannister	M	Milling/hay	S	S	MSS	MR	MS	MSS
Goldie	M	Milling/hay	S	SVS	SVS	MR	MS	MS
Koala	M-S	Milling/hay	S	MS	MSS	R	MSS	MSS
Williams	Q	Milling	MSS	S	MRMS	S	MSS	MSS
Bilby	Q-M	Milling	SVS	S	MSS	S	S	S
Minnie	M-S	Milling	S	S	S	R	S	MSS

R= Resistant, RMR= Resistant to Moderately Resistant, MR= Moderately Resistant, MRMS= Moderately Resistant to Moderately Susceptible, MS= Moderately Susceptible, MSS= Moderately Susceptible to Susceptible, S= Susceptible, SVS= Susceptible to Very Susceptible. (P)= Provisional rating. - = no rating available. / = indicates pathotype differences. Disease ratings for all varieties and diseases can be found at <https://nvt.grdc.com.au/nvt-disease-ratings>.

For the North Central trials, the only data available for 2024 are from the Diggora site (Figure 1). The top yielding varieties from 2019 to 2023 are three milling/hay varieties: Koala, which yielded 109 per cent of the region mean, followed by Bannister and Goldie, at 107 per cent. Milling varieties Bilby, Minnie, and Williams, and the hay variety Archer, all yielded 102 per cent of the region mean in the long-term data. Echidna, the milling/feed grain variety, also yielded well at 103 per cent of the region mean. In 2024, Goldie was the standout variety, yielding 124 per cent of the site mean for Diggora. Other milling/hay varieties, Bannister and Koala performed well, at 112 per cent of the site mean. Milling variety Minnie was the other top yielding variety at Diggora in 2024, yielding 114 per cent of the site mean.

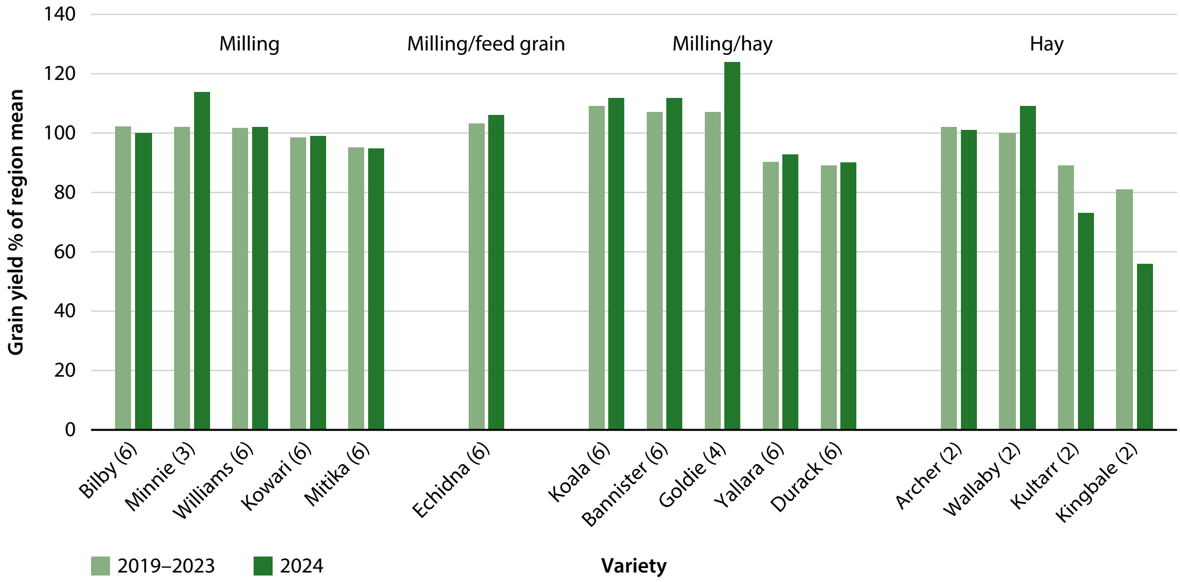

Figure 1. North Central oat NVT average yield as a percentage of region mean, 2019–2023 and 2024. The number in brackets denotes how many seasons the variety has been in NVT. Note: 2024 data only include Diggora.

As the first year of oat trials in the Wimmera region, there is no long-term data to compare with 2024 results, so interpret these results with caution because they do not represent a variety's performance over different seasonal conditions. Of the 15 varieties, five are milling varieties, one is milling/feed grain, five are milling/hay and four are hay varieties (Figure 2). For this range of end-uses, grain yield is the data being collected in this trial. Two of the milling varieties yielded above the site mean: Minnie (107 per cent) and Williams (101 per cent). The only milling/feed grain included in the trial was Echidna, which was the second highest yielding in the trial at 113 per cent of the site mean. The top yielding dual-purpose varieties as a percentage of the site mean were Bannister (114 per cent), Goldie (109 per cent), and Koala (105 per cent). Archer, a hay oat, was among the top yielding varieties at 107 per cent of the site mean for grain yield.

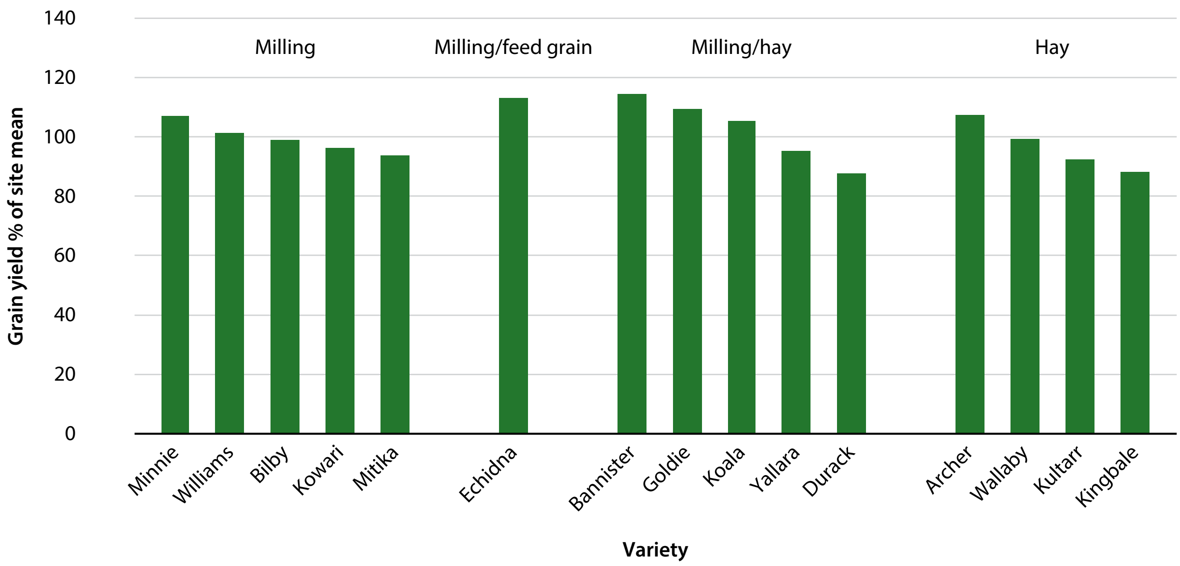

Figure 2. Dimboola oat NVT average yield as a percentage of the site mean in 2024.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Global demand for milling oats continues to grow as the population becomes more health conscious and seeks alternative grains with added nutritional benefits. The markets for oat milk, oat noodles, and oat healthcare products are also on the rise, helping to increase the export oat market. Compared with feed oats, milling oats have a $60/t advantage across all regions (*The Weekly Times*, 2024).

Oats can be a lower risk crop when compared with other options. Selecting a dual-purpose oat variety can be a good way to spread risk on the farm. It can support decision making during the year based on seasonal conditions, and provide an alternative market for hay, if necessary. This allows growers to evaluate which is more profitable: cutting for hay or harvesting the grain. Oats also have a lower frost risk when compared with wheat and barley. If frost is a concern, consider zoning property based on frost risk, and choosing a lower risk crop such as oats for zones identified as high risk.

Grain quality data from NVT was not available at the time of compiling this report.

NVT results were compromised by frost and drought are not released publicly. They will be made available within the 'Quarantined trials report' section of the website <https://nvt.grdc.com.au/trials/quarantined-trial-reports>.

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CASE STUDY

AN INTERNATIONAL PARTNERSHIP BRINGING DIVERSITY TO AUSTRALIAN WHEAT AND BARLEY GENETICS

Anna Marcus (BCG) and Dr Julie M Nicol (CAIGE)

Trial:	Demonstration of promising international cereal lines (bread wheat, durum wheat, and barley)
Location:	Nullawil
Crop year rainfall (Nov–Oct):	361mm
GSR (Apr–Oct):	178mm
Soil type:	Loamy clay
Paddock History:	Vetch brown manure

WHAT IS THE CAIGE PROJECT?

The CAIGE (CIMMYT and ICARDA Germplasm Evaluation) project assesses the yield performance and disease resistance of diverse genetics from the two International CGIARs (Consultative Group of International Agricultural Research). This includes CIMMYT International (the International Maize and Wheat Improvement Centre) and ICARDA (the International Centre for Agricultural Research in Dry Areas). BCG collaborated with the University of Sydney GRDC-led project, CAIGE, to establish a demonstration trial at the 2024 BCG Main Research Site of some of the promising high-yielding adapted germplasm from both international centres using Australian commercial check varieties as a comparison.

Funded by GRDC, the International CAIGE project was established in 2006 by The University of Sydney. Initially, the project only considered bread and durum wheat. Barley, led by the University of Queensland, was added in 2012.

At the same time the yield data is collected in Australia, complementary pathology testing for disease occurs with Australian partners. Once the trials are harvested, field yield data and genomic data is assembled and analysed by the University of Queensland in multi-environmental trials over three years. The CAIGE core team then pulls all the data together, along with data from the consultative group and CAIGE partners. The most promising international lines are used by private breeding companies for developing new commercial varieties, or straight releases, such as the bread wheat Borlaug 100.

Figure 1. ICARDA barley in October at the Nullawil trial site.

A paper published in the July 2024 edition of Frontiers in Plant Science by the CAIGE core team (https://doi.org/10.3389/fpls.2024.1435837) provided a benefit-cost analysis indicating the economic value of the project was 20:1, and the contribution of the CAIGE genetics in commercial varieties has been significantly increasing over time.

CAIGE is a complex project with many moving parts and multiple partners, which makes it unique. Partners include the private breeding sector, and they work together to share data collected on these international materials for the benefit of their breeding companies and the broader Australian grains industry. The international genetics provides adapted cereal lines for a wide range of diverse environments, which are high-yielding and have valuable disease resistances. The lines come from diverse genetic backgrounds that are providing new genetics to the Australian gene pool. Many of the lines have been identified to perform well across a range of environments – exhibiting a degree of resilience – and some are better suited to specific regions such as the Victorian Mallee. The way the project shares the data enables plant breeders to select the materials most appropriate for their need and purpose.

WHO ARE CIMMYT AND ICARDA?

Both CIMMYT International and ICARDA belong to the Consultative Group on International Agricultural Research and have a mandate to improve agricultural systems in the developing world, working in collaboration with key stakeholders and advanced research institutions. Their key mission is to improve food security in their mandated regions and promote sustainable agricultural systems.

ICARDA (icarda.org) has headquarters in Morocco and regional offices throughout North Africa and West Asia. It has a regional focus working in dryland agricultural systems. ICARDA is a key partner with CAIGE and shares bread wheat, durum wheat, and barley genetic materials in the project.

CIMMYT International (cimmyt.org) has a global mandate to work on wheat and maize improvement in developing countries with national project partners and advanced research institutions. It is headquartered in Mexico and has regional offices across the developing world where wheat and maize are staple foods. Its contribution to the project includes developing high-yielding, sustainable bread and durum wheat lines.

TRIAL DETAILS

The demonstration trial involved nine lines – three each of bread wheat, durum wheat, and barley. For each crop, there was a representative check Australian variety (Calibre for bread wheat, Bitalli for durum wheat and Cyclops for barley). Two diverse ICARDA barley lines were selected, and one bread and durum wheat from ICARDA and CIMMYT (Figure 2). The trial was dry sown on 2 May into vetch hay stubble; at sowing 60kg/ha of Granulock SZ was applied and treated with Flutriafol. All varieties established evenly throughout the plot. The trial was managed as per best practice; 70kg/ha of urea was spread and necessary broadleaf, fungicide and insecticide sprays applied.

Figure 2. Aerial view of the trial showing (from left) durum wheat, bread wheat and barley varieties.

AUSTRALIAN CHECKS AND CIMMYT AND ICARDA LINES USED

Durum wheat

AGT Bitalli: this wheat has established itself as one of the most reliable and highest-yielding varieties available for the southern cropping region. It is a 'low risk' durum variety, combining adaptation to a range of environments and growing conditions, with excellent grain quality and low screening risk. It also has good resistance to foliar diseases.

CIMMYT – 37:ZDG21: is a high-yielding durum wheat with genetic diversity from North Africa and Mexico. It brings genetic diversity along with foliar disease resistance and has been found to perform well in dryland environments.

ICARDA – 61:ZDL22: is high-yielding, being a landrace (wild relative) crossed with Spanish durum wheat. This wheat has foliar disease resistance and brings genetic diversity.

Bread wheat

AGT Calibre: a higher yielding and longer coleoptile variety than Scepter, its most obvious comparison. Calibre adapts well in medium yielding environments and is AH quality.

CIMMYT – 290:ZWB21: a high-yielding competitive bread wheat from Mexico. It brings genetic diversity from Mexico and Spain. 290:ZWB21 also has good-to-moderate disease resistance to several foliar diseases, such as rusts and Septoria nodorum (leaf spot).

ICARDA – 1:ZIZ22: a competitive bread wheat from Morocco which is high yielding. Genetics are diverse, from North Africa and the cross includes the Australian variety Excalibur. It has good-to-moderate disease resistance to several diseases.

Barley

AGT Cyclops: Cyclops has an erect semi-dwarf growth habit, derived from the Hindmarsh and La Trobe family of lines. It has the potential to yield well. This was demonstrated in the CAIGE trials and in the 2023 NVT trials at Birchip, when Cyclops yielded 24 per cent above the trial mean. It is very susceptible to both powdery mildew and barley leaf rust but has useful levels of resistance to spot form of net blotch and net form of net blotch.

ICARDA Nursery – 122:ZBS19 and 8:MMB21: both 8:MMB21 and 122:ZBS19 are lines derived from parents identified when the CGIAR barley program was being run in Mexico. This program focused on breeding for high-input environments and malt quality. These two lines share a common parent in the Mexican variety Conchita. 122:ZBS19 is crossed with European variety Henley, and 8:8MMB21 is crossed with Keops in Syria in 2012. The progeny of Keops has demonstrated heat tolerance in ICARDA trials. Both lines have shown consistently high yield potential in the CAIGE trials as well as an excellent package of resistance to multiple foliar pathogens. They are both moderately resistant (MR) or better for barley leaf rust, powdery mildew, and net form of net blotch.

All the international lines tested by BCG in 2024 were competitive for yield with the Australian check varieties, in addition to providing useful resistance to several economically important diseases in Australia.

Figure 3. BCG Main Field Day 2024.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

IMPORTANCE TO AUSTRALIAN FARMING SYSTEMS

CIMMYT and ICARDA focus their projects on dry and lower-income areas, selecting germplasm specifically for developing countries. However, through the CAIGE project, this initiative also offers significant benefits for Australian agriculture. The program is diverse and aims to produce both high-yielding and disease-resistant varieties. Plant breeders in Australia are able to access CAIGE genetic diversity to develop new and improved varieties that are desirable for their stress tolerance, disease resistance, and high yields.

Many Australian varieties have been developed from CIMMYT or ICARDA lineage, as well as direct releases from CIMMYT. This emphasises the value of international partnerships in improving crop yields and disease resistance as Australian farming systems change.

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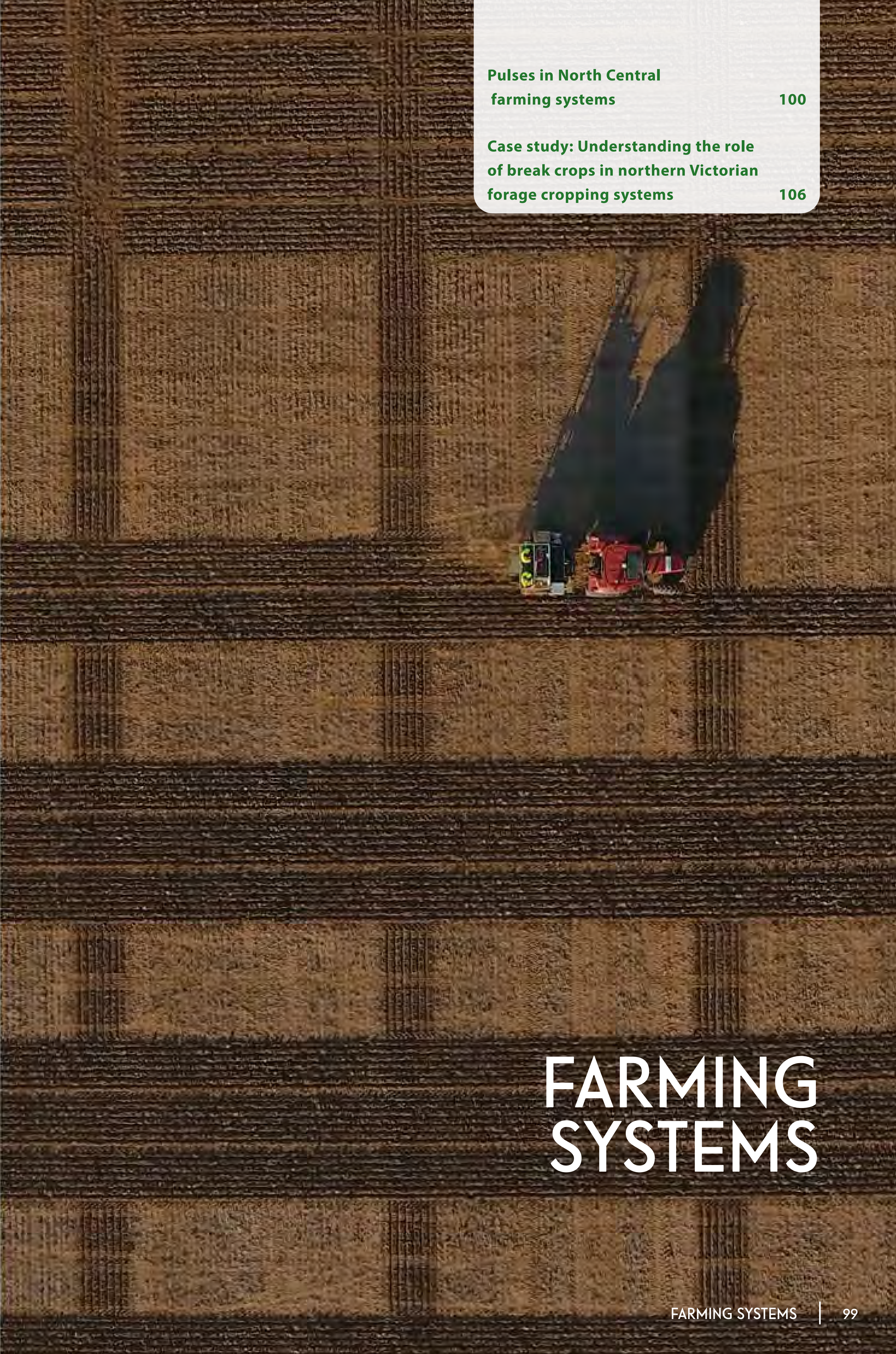

FARMING SYSTEMS

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

PULSES IN NORTH CENTRAL FARMING SYSTEMS

Casey Sim, Angus Butterfield, and Kate Finger (BCG)

TAKE HOME MESSAGES

- Vetch hay was the most profitable break crop by $411/ha in 2024.
- Field peas and faba beans were the best performing grain legumes in 2024 growing conditions.
- The addition of lime, gypsum and granular manure soil amendments to a saline soil resulted in no yield response.

BACKGROUND

Growers in the North Central region have typically used canola and vetch as a break crop. In general, other pulses have not been widely adopted in this area due to their sensitivity to soil constraints including waterlogging, acidity, and salinity. However, improvements to genetic tolerance, in combination with the use of soil amendments, could increase the viability of faba beans, lentils, field peas and chickpeas as a break crop in these systems. Whilst vetch is a common break crop in the area, primarily grown for hay or brown manure, it can be often considered a weed that can be challenging to control. Vetch hay is also heavily reliant on dry conditions for cutting, and hay operations can often overlap with harvest, creating more logistical issues for growers.

This highlights the need for another pulse crop in the North Central, so growers still gain the system benefits of a pulse in the rotation, without taking on the additional costs and risks associated with processing vetch hay. Another pulse option could also allow growers to spread risk across a wider range of crops.

Pulse crop types have varying levels of tolerance to the aforementioned constraints, however there is a range of varietal tolerance within each species. New varieties with improved tolerance to salinity and boron have been developed. Lentils and chickpeas are more sensitive to waterlogging, soil salinity, and boron toxicity than field peas, faba beans, and vetch. In contrast, canola, another typical break crop for a region, has a much higher salinity and acidity tolerance, and adequate tolerance to waterlogging and boron toxicity (Christopher et al. 2021). Whilst many of the soil constraints (sodicity, salinity, and waterlogging) common in the North Central can be ameliorated to some degree, boron toxicity can only be managed by variety selection.

This is the first of a two-year systems trial. In Year 1, various amendments were applied to different pulse species. Amendments were chosen based on common soil constraints in the area. Gypsum for salinity and sodicity, lime for pH and pelletised manure to improve soil condition. An additional brown manure treatment (no soil amendment applied) where the crop was desiccated at 50 per cent flowering was also added as an alternative to growing pulses for grain. In Year 2, the entire trial will be sown to a cereal to evaluate the legacy effect.

If constraints can be managed through amelioration and variety selection, the addition of pulses to a farming system may provide benefits of nitrogen (N) fixing, weed control and disease breaks, along with being a profitable grain crop in their own right.

AIM

To compare the profitability and legacy effect of different pulses on a saline soil type in the North Central region.

PADDOCK DETAILS

Location:	Mitiamo
Crop year rainfall (Nov–Oct):	470mm
GSR (Apr–Oct):	182mm
Soil type:	See table 1 below
Paddock history:	Oaten hay (2023)

TRIAL DETAILS

Crop type/s:	Refer to Table 2
Treatments:	Refer to Table 3
Target plant density:	Refer to Table 2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	TOS1 – 26 April 2024, TOS2 – 7 May 2024
Replicates:	Four
Harvest date:	5 December 2024

TRIAL INPUTS

Trial managed as per best practice, aside from soil amendment treatments (see Table 2).

METHOD

The trial was sown in a split plot design by crop type, with soil amendment treatments randomised within each crop type block. All vetch, canola and brown manure treatments were sown 26 April, and all remaining treatments were sown 7 May. Assessments included establishment scores, crop biomass at termination timings or 50 per cent flowering (at vetch termination and 50 per cent flowering for other pulses and canola) as well as yield and grain quality parameters. Gross margins were estimated using the 2024 Farm Gross Margin and Enterprise Planning Guide for South Australia (SAGIT, 2024), with prices taken from *The Weekly Times* 11 December 2024 for Charlton (grain prices) and Elmore (hay prices). This trial will be resown in 2025 with a cereal to determine how certain pulses and management practices affect the following crop.

Table 1. Soil characteristics for Mitiamo trial site pre-sowing.

Depth (cm)	Texture	Soil water (Grav %)	pH (water)	pH ($CaCl_2$)	EC (dS/m)	Chloride (mg/kg)	Boron (mg/kg)
0–10	Clay	3.9	6.6	6.0	0.28	180	1.9
10–30	Clay	20.2	8.0	6.9	0.34	150	6.3
30–70	Clay	26.7	8.2	8.0	2.69	730	16
70–100	Silty clay loam	26.1	8.2	8.1	3.89	1200	13

Table 2. Crop types.

Crop types	Variety	Sowing rate (plants/m²)
Common vetch	Morava	60
Purple vetch	Popany	60
Field pea	PBA Butler	50
Faba beans	PBA Samira	30
Canola	TT Trophy	50
Chickpea	Genesis 090	35
Lentil	GIA Thunder	120

Table 3. Soil amendment treatments.

Treatment	Product/description	Timing	Rate
Gypsum	Gypsum Purity – 55%	12 April 2024	5t/ha
Lime	Lime Effective Neutralising Value – 60%	12 April 2024	2.5t/ha
Manure	Terrus Pro granulated, carbon-based fertiliser N:P:K:S 3:1:4:2	With seed at sowing	60kg/ha
Control	-	-	-

RESULTS AND INTERPRETATION

Seasonal conditions

The site received a germinating rainfall of 27mm on 11 May, which resulted in both time of sowing (TOS) establishing at the same time. Below average rainfall and several frost events made it a challenging year for pulses. Five frost events occurred between 10 of September and 18 September. During this period most pulses were either flowering or at early podding, at a growth stage where they can be prone to grain loss. These events could have had a detrimental effect on yield, particularly on lentils, chickpeas and field peas which have a low tolerance to frost (Hawthorne, 2007).

The site received 60.8mm rainfall between 24 November and 30 November, when all crops were at or near maturity. The trial was visually assessed for pod loss before harvest. Despite the large rain events, chickpeas, faba beans and field peas experienced minor pod losses (between zero and 5 per cent), demonstrating their ability to withstand harvest rain. However, lentils experienced 20 per cent pod loss and canola 26.5 per cent.

Pulse performance

Despite the frost events, field peas and faba beans were significantly higher yielding than other pulses at Mitiamo in 2024, averaging 1.7t/ha and 1.6t/ha respectively (Table 3). Field peas and faba beans were also by far the most profitable pulse in the trial with gross margins of $507/ha to $512/ha. They also substantially outperformed canola which delivered $268/ha. This disparity is likely a combination of canola's relatively high gross margins and pod loss prior to harvest, which potentially reduced yield by up to 26.5 per cent.

Compared to other pulses in the trial, field peas and faba beans may have achieved higher yields due to earlier flowering time which would have led to earlier grain-fill before frost events. Faba beans also have the best frost tolerance of pulses (White, 2000). Field peas and faba beans also have greater tolerance to salinity than lentils and chickpeas.

Lentils and chickpeas w ere both the lowest yielding at 0.7t/ha, and the least economical options, with gross margins of $104/ha to $150/ha. Chickpeas flower later than other pulses and generally avoid yield losses from frost in an average year. However, critical frost events in 2024 occurred later in the season when chickpeas were at the late flower/early pod development stage, resulting in empty pods and shriveled grain in the sample (about 5 per cent). Lentils were podding during the frost event and might have been subject to yield loss; however, no empty pods were observed at harvest and very few grains were small or shriveled. Pod loss of about 20 per cent in lentils was also observed at harvest and heavily impacted final yield. Salinity and boron toxicity were the two main soil constraints at the site. Both lentils and chickpeas have lower tolerances to these constraints relative to field peas and faba beans. These factors likely resulted in chickpeas and lentils producing a relatively lower yield and gross margin as input costs were similar for all pulses (Table 4).

Vetch hay averaged 3.7t/ ha and was the most profitable crop in the trial, with a gross margin of $923/ha to $1110/ha. The earlier maturing common vetch Morava and a longer season variety, purple vetch Popany, showed no significant differences in hay yield when cut at flat pod (common vetch – 25 September, purple vetch – 8 October), despite having visual differences. Popany has a more erect plant structure which gave the illusion of more biomass whereas Morava was shorter but denser (Figure 1).

Table 4. Yield and gross margin of grain pulses and vetch hay at Mitiamo 2024.

Crop type	Yield (t/ha)	Price[1] ($/t)	Income ($/ha)	Production costs[2] ($/ha)	Gross margin ($/ha)	Break even yield (t/ha)
Field pea	1.7[a]	541	920	408	512	0.75
Faba bean	1.6[a]	616	986	479	507	0.84
Canola	1.2[c]	770	894	656	268	0.88
Chickpea	0.7[d]	876	613	509	104	0.58
Lentil	0.7[d]	866	605	456	150	0.50
P				<0.001		
LSD				0.23		
CV%				12.2		
Purple v etch hay	3.9	375	1462	352	1110	0.90
Common vetch hay	3.4	375	1275	35 2	923	0.90
P				NS		
LSD				NS		
CV%				11		

[1]Price ($/t) are from the Weekly Times 11th Dec 2024. [2]These production costs are based of the 2024 Farm Gross Margin and Enterprise Planning Guide for South Australia (SAGIT, 2024).

Figure 1a. The purple vetch variety Popany, with an erect growth habit 2 October 2024.

Figure 1b. Common vetch variety Morava, with a short but dense growth habit 2 October 2024.

Soil amendments

For each crop type there was no difference in grain or hay yield with the addition of a soil amendment (data not shown). Liming is often slow acting when surface applied and should be incorporated for a more rapid response (Miller, 2024). Soil pH (water) at the site was also adequate for pulses at 6.6 so a rise in pH would not necessarily have improved yields. Gypsum responses in previous research has found that a response is inconsistent and that predicting a soil type response economically is poor (Hall. D, 2019). The greatest impact on soil sodicity from gypsum applications is generally observed over the long-term, as gypsum is not particularly mobile or as responsive as lime. As such, the addition of the gypsum treatment would have little effect on soil sodicity, particularly considering gypsum had historically been applied to the paddock. These inputs significantly increased production costs in 2024 but provided no yield or economic benefit. Their potential impact on crop production will continue to be monitored in 2025.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Vetch was still the most favourable break crop for the region in 2024, with significantly greater profitability than all other break crops. This was due to its ability to produce biomass despite below average rainfall. Hay cutting conditions were ideal in 2024, however, if a wet spring occurred, vetch hay may have been logistically challenging. Some of the high value break crops – including canola, chickpeas, and lentils – were not highly profitable with yield limited by frosts and harvest rain.

These higher value crops are often considered risky in unfavourable conditions, especially with the tough soil constraints in some areas of the North Central region.

Field peas could be a good fit for the area due to their flexibility in end-use and ability to be a profitable grain, hay, or brown manure option (see article *'North Central lentil and field pea varieties by time of sowing',* page 212, for variety suitability to constrained soils). However, bacterial blight and frost can often cause significant yield loss in field peas. Planting disease-free seed, crop rotation, variety selection and avoiding early sowing can help reduce the risk of bacterial blight (Fanning, 2022) in field peas.

Including diversity in the farming system allows growers to spread risk across the program which can minimise the high losses caused by unpredictable weather as seen in 2024. This trial will be resown with a cereal in 2025, to show the legacy effect of different pulses – both brown manured and harvested for grain – compared to canola.

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CASE STUDY

UNDERSTANDING THE ROLE OF BREAK CROPS IN NORTHERN VICTORIAN FORAGE CROPPING SYSTEMS

Anna Marcus and Angus Butterfield (BCG)

Trial:	C4Milk dryland break crop strategies
Location:	Mitiamo
Crop year rainfall (Nov–Oct):	413mm
GSR (Apr-Oct):	202mm
Soil type:	Clay (0–70cm) and silty clay loam (70–100cm)
Paddock history:	Oaten Hay

STUDY AIM

The C4Milk project aims to develop an understanding of the collective impact intense cropping rotations have on the sustainability and profitability of dairy farms. The project, which began in 2024, aims to do this by evaluating crop-on-crop effects in forage production systems over a multi-year trial. The project was developed based on the findings of previous Murray Dairy projects, which tracked changes for inland dairy farm systems and the increased use of grain crops for fodder. C4Milk is a three-year partnership between Murray Dairy, Queensland Department of Agriculture and Fisheries Dairy Group, Dairy Australia, and the Gardiner Foundation.

Figure 1. Flowering Morava vetch at Mitiamo trial site.

Forage cropping systems are essential in inland dairy regions, and agronomic decisions are often overlooked to prioritise cow nutrition. Over time, concerns have been raised due to the lack of break crops and rotations potentially being detrimental to farming system sustainability. There also has been minimal research on the importance of break crops in managing environmental and production risks overall in forage cropping systems. This research aims to explore the effects of break crops in forage production systems and assess whether break crops enhance forage cropping by improving the productivity, profitability, and sustainability of dairy farms.

FUTURE OF THE TRIAL

The BCG trial site at Mitiamo, Victoria, will determine crop-to-crop effects in a dryland forage production system. This trial aims to provide valuable information relating to the impact of crop rotations and different management strategies on quality and yield. This includes aspects such as plant health, nutrient management, weed control, yields, and harvest times.

2024 has been a set-up year for the project, and as such there have been no recorded effects from using break crops. BCG will gather valuable information after the break crop strategies have been applied in 2025. The trial itself has single and double-break crop strategies (Table 1). Break crops include barley, vetch, canola, and oats.

Table 1. Break crop strategies and rotations across seasons (winter 2024 to summer 2025/26).

Break crop strategy	Treatment	Winter 24	Summer 24/25	Winter 25 break crop	Summer 25/26
Single	S1	Barley	Fallow	Barley	Fallow
	S2	Barley	Fallow	Vetch	Fallow
	S3	Barley	Fallow	Canola	Fallow
	S4	Barley	Fallow	Oats	Fallow
Double	D1	Vetch	Fallow	Barley	Fallow
	D2	Vetch	Fallow	Vetch	Fallow
	D3	Vetch	Fallow	Canola	Fallow
	D4	Vetch	Fallow	Oats	Fallow

Winter cereal crops have increased in popularity among dairy farmers due to the crop's resilience and versatility. They are a good silage option and can help clean up weeds in paddocks, and allow for earlier sowing of summer crops. Due to perennial grasses not always being as persistent in low rainfall areas, dairy farming systems have been forced to look elsewhere. Replacing perennial grasses with winter cereals has demonstrated significant potential. Crops such as barley can be grazed during the winter before being harvested for fodder. Additionally, winter cereals can provide feed earlier than some annual grasses such as ryegrass, which is typically used in pasture production, because they are more tolerant of dry conditions, making them more adaptable to early sowing.

D1 Vetch	S2 Barley	D1 Vetch	S3 Barley
D1 Vetch	S2 Barley	D1 Vetch	S3 Barley
D1 Vetch	S2 Barley	D1 Vetch	S3 Barley
D1 Vetch	S2 Barley	D1 Vetch	S3 Barley
D4 Vetch	S4 Barley	S1 Barley	D2 Vetch
D4 Vetch	S4 Barley	S1 Barley	D2 Vetch
D4 Vetch	S4 Barley	S1 Barley	D2 Vetch
D4 Vetch	S4 Barley	S1 Barley	D2 Vetch
D2 Vetch	S3 Barley	S2 Barley	D4 Vetch
D2 Vetch	S3 Barley	S2 Barley	D4 Vetch
D2 Vetch	S3 Barley	S2 Barley	D4 Vetch
D2 Vetch	S3 Barley	S2 Barley	D4 Vetch
S1 Barley	D3 Vetch	S4 Barley	D3 Vetch
S1 Barley	D3 Vetch	S4 Barley	D3 Vetch
S1 Barley	D3 Vetch	S4 Barley	D3 Vetch
S1 Barley	D3 Vetch	S4 Barley	D3 Vetch
S4 Barley	D1 Vetch	D3 Vetch	D2 Vetch
S4 Barley	D1 Vetch	D3 Vetch	D2 Vetch
S4 Barley	D1 Vetch	D3 Vetch	D2 Vetch
S4 Barley	D1 Vetch	D3 Vetch	D2 Vetch
D2 Vetch	S3 Barley	S3 Barley	S4 Barley
D2 Vetch	S3 Barley	S3 Barley	S4 Barley
D2 Vetch	S3 Barley	S3 Barley	S4 Barley
D2 Vetch	S3 Barley	S3 Barley	S4 Barley
D3 Vetch	D4 Vetch	D1 Vetch	D4 Vetch
D3 Vetch	D4 Vetch	D1 Vetch	D4 Vetch
D3 Vetch	D4 Vetch	D1 Vetch	D4 Vetch
D3 Vetch	D4 Vetch	D1 Vetch	D4 Vetch
S1 Barley	S2 Barley	S2 Barley	S1 Barley
S1 Barley	S2 Barley	S2 Barley	S1 Barley
S1 Barley	S2 Barley	S2 Barley	S1 Barley
S1 Barley	S2 Barley	S2 Barley	S1 Barley

Figure 2. Trial and treatment design of 2024 trial.

D1 Barley	S2 Vetch	D1 Barley	S3 Canola
D1 Barley	S2 Vetch	D1 Barley	S3 Canola
D1 Barley	S2 Vetch	D1 Barley	S3 Canola
D1 Barley	S2 Vetch	D1 Barley	S3 Canola
D4 Oats	S4 Oats	S1 Barley	D2 Vetch
D4 Oats	S4 Oats	S1 Barley	D2 Vetch
D4 Oats	S4 Oats	S1 Barley	D2 Vetch
D4 Oats	S4 Oats	S1 Barley	D2 Vetch
D2 Vetch	S3 Canola	S2 Vetch	D4 Oats
D2 Vetch	S3 Canola	S2 Vetch	D4 Oats
D2 Vetch	S3 Canola	S2 Vetch	D4 Oats
D2 Vetch	S3 Canola	S2 Vetch	D4 Oats
S1 Barley	D3 Canola	S4 Oats	D3 Canola
S1 Barley	D3 Canola	S4 Oats	D3 Canola
S1 Barley	D3 Canola	S4 Oats	D3 Canola
S1 Barley	D3 Canola	S4 Oats	D3 Canola
S4 Oats	D1 Barley	D3 Canola	D2 Vetch
S4 Oats	D1 Barley	D3 Canola	D2 Vetch
S4 Oats	D1 Barley	D3 Canola	D2 Vetch
S4 Oats	D1 Barley	D3 Canola	D2 Vetch
D2 Vetch	S3 Canola	S3 Canola	S4 Oats
D2 Vetch	S3 Canola	S3 Canola	S4 Oats
D2 Vetch	S3 Canola	S3 Canola	S4 Oats
D2 Vetch	S3 Canola	S3 Canola	S4 Oats
D3 Canola	D4 Oats	D1 Barley	D4 Oats
D3 Canola	D4 Oats	D1 Barley	D4 Oats
D3 Canola	D4 Oats	D1 Barley	D4 Oats
D3 Canola	D4 Oats	D1 Barley	D4 Oats
S1 Barley	S2 Vetch	S2 Vetch	S1 Barley
S1 Barley	S2 Vetch	S2 Vetch	S1 Barley
S1 Barley	S2 Vetch	S2 Vetch	S1 Barley
S1 Barley	S2 Vetch	S2 Vetch	S1 Barley

Figure 3. Trial and treatment design of 2025 trial.

IMPORTANCE OF THIS RESEARCH

The C4Milk project highlights the importance of local research in guiding on-farm decision-making. The goal is to determine whether break crops can be both sustainable and profitable in dairy production systems. The project's aim is to assess the potential benefits of break crops, such as providing a break from pests, disease, and weeds, conserving moisture, increasing soil organic matter, and nutrients, and reducing soil structural and physical issues. While the project specifically focuses on dairy production systems, the information generated will also be valuable for low rainfall broadacre farming and other livestock producers, helping to make informed decisions about break crops and rotations in forage production systems.

Figure 4. Planet barley plot at Mitiamo trial site.

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BCG sincerely thanks Adam Gould for generously hosting the trial site at Mitiamo and for support throughout the project.

CROP AGRONOMY

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

ACHIEVING WATER LIMITED YIELD FRONTIERS MORE PROFITABLY

Kenton Porker, James Manson (CSIRO), Dr Yolanda Plowman, Angus Butterfield, and Meg Conlan (BCG)

TAKE HOME MESSAGES

- This GRDC-funded project focuses on connecting crop agronomy practices to maximising yield potential.
- Modern genetics and advanced crop management are delivering higher water use efficiency, achieving transpiration efficiencies greater than 25kg/ha/mm and evaporation losses of less than 60mm.
- Current farming systems and genetics demonstrate robust performance and adaptability to in-season variations in yield potential.

BACKGROUND

A new GRDC project (CSP2404-020RTX – Profitable Yield Frontiers) is focused on supporting tactical agronomy decisions in low to medium rainfall zones to achieve water-limited yield potentials. In these rainfall zones, early-season decisions often account for most of the crop expenditure. While higher inputs or adjusted timings can influence yield under different seasonal scenarios, knowing when and how to react, and the likely return, is challenging. Agronomic interventions must address the fundamentals of crop growth to deliver a yield response. Beyond sowing date, genetics, and nitrogen (N), opportunities to influence yield potential in-season are limited. Our goal is to develop a responsive agronomic system that increases yields without significantly raising risk or costs. We conducted a series of experiments to:

- Link tactical agronomy to physiological changes in the critical period and yield.
- Identify key benchmarks (crop and soil traits) for actionable decisions during the season.
- Lift water-limited yield potential in low to medium rainfall zones.

In 2024 – a season defined by summer rainfall, a late break, low in-season rainfall, and September frost stress – our work focused on understanding the crop canopy and how this influenced grain yield formation during the critical period, and refining agronomic benchmarks. This will help better position crops for success and adapt to seasonal water supply fluctuations.

AIM

Factorial field experiments were conducted to evaluate differences in growth and canopy development by using tactical agronomy levers – sowing date, nitrogen, and variety – to modify crop growth conditions during the critical period for grain number and yield determination. The aim is to assess the effectiveness of tactical agronomy in improving yield profitability across diverse seasonal conditions.

PADDOCK DETAILS

Location:	Nullawil
Crop year rainfall (Nov–Oct):	361mm
GSR (Apr–Oct):	178mm
Soil type:	Loamy clay
Paddock history:	Vetch brown manure

TRIAL DETAILS

Crop type/s:	Winter barley (AGTB1007, AGTB1009, AGT1010), spring barley (Neo, Cyclops, Beast), wheat (Shotgun, Rockstar) and winter wheat (Mohawk)
Treatments:	Refer to Table 1
Target plant density:	150 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	2 May 2024 (time of sowing 1), 4 June 2024 (time of sowing 2)
Replicates:	Four
Harvest date:	22 November 2024

TRIAL INPUTS

Trial managed as per best practice with varying nitrogen treatments (Table 1).

METHOD

A factorial small plot experiment was carried out in 2024 to create different canopy structures, using sowing date, genetics and nitrogen (N).

Supplementary water (30mm) was applied to treatments at the start of the critical period (flag leaf emergence) to determine the value of extra water and the response of different agronomy strategies. The latest genetics – including Shotgun wheat, Neo barley, and varieties of differing phenology and architecture – were included in these experiments. Sowing date and emergence targets were aimed at 25 April to 10 May, and a later emergence of three weeks later (or with the break).

N was seasonally adjusted to achieve two levels of yield aspiration based on anticipated seasonal rainfall outlooks: a more conservative Decile 2–3, and a more aggressive Decile 7–8. These were applied as split applications before stem elongation. A third treatment was applied to Neo barley and Shotgun wheat only where low N levels were applied before stem elongation and then topped up to the higher N strategy (Table 1).

Table 1. Nitrogen timing and treatment descriptions.

	Timing 1	Timing 2	Timing 3	
N treatment	14 Jun	16 Jul	14 Aug TOS1 5 Sep TOS2	Total Applied N
Low N (Decile 2)	-	20	-	20
High N (Decile 8)	43	40	-	83
Delayed N	-	20	63	83

*Soil N at sowing was 97 kg N/ha at 0–60cm, and 103 kg N/ha at 0–100cm. ** Applied as urea.

Varieties

Winter barley – AGTB1007, AGTB1009, AGT1010
Spring barley – Neo, Cyclops, Beast
Wheat – Shotgun, Rockstar
Winter wheat – Mohawk

Sowing and emergence dates

Sow date 1: 2 May (15 May emergence)
Sow date 2: 4 June (17 June emergence)

Irrigation timing (flag leaf emergence)

Sow date 1: 15 August
Sow date 2: 5 September

RESULTS AND INTERPRETATION

Overall results

Time of sowing, species, and genotype were the main agronomic factors driving yield in 2024 at this site. The yield difference between wheat and barley was most pronounced at Early sowing with yield declining from 6.1t/ha to 4.7t/ha in Neo barley from delayed emergence, and from 4.9t/ha to 4.3t/ha in Shotgun wheat. The influence of nitrogen strategy was negligible in 2024 for grain yield, although there is evidence of smaller grain at higher N rates in Neo (data not shown), and N significantly influenced grain protein.

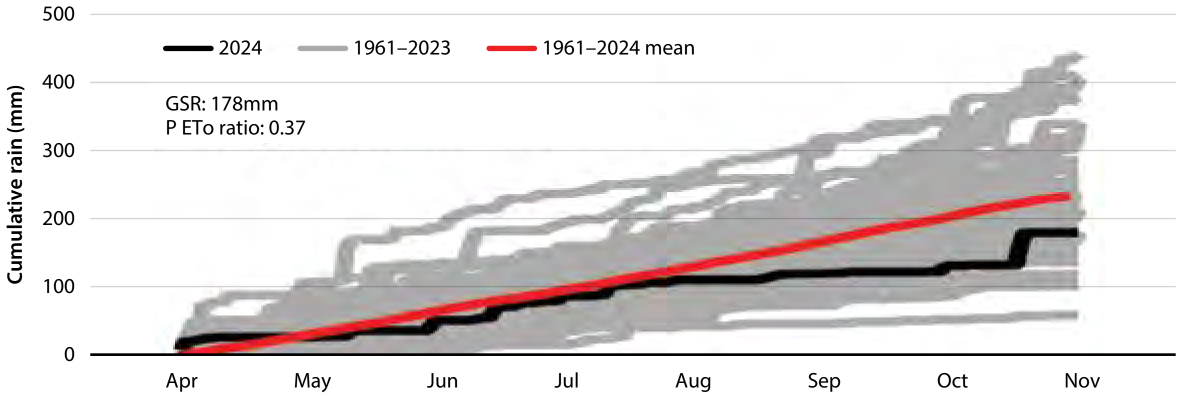

Figure 1. Cumulative rainfall at Nullawil, Victoria. GSR is growing season rainfall, P ETo is the ratio of precipitation (GSR) to reference evapotranspiration (FAO56 method).

Water use efficiency

Growing season rainfall in 2024 was close to average until August, which was followed by a dry finish (Figure 2). Rainfall supplied 37 per cent of the moisture estimated to have been lost by soil evaporation and crop transpiration (FAO56 method); we applied extra water at flag leaf emergence to evaluate the best agronomic system for converting rainfall into water. Soil and water data analysis for Plant Available Water (PAW) is currently under analysis, but farmers and agronomists will understand methods such as the 'French and Schultz' approach. We estimate water use as 25 per cent of November–April rainfall, plus growing season rainfall (April–October), subtracting 60mm for evaporation losses. Current benchmarks for transpiration efficiency are 26kg/ha/mm, which helped estimate a water-limited yield potential of 5.75t/ha in 2024. Early-sown spring barley consistently achieved 100 per cent of potential, while wheat reached about 85 per cent. Further analysis to calculate how much water was lost to evaporation and how much used for transpiration will help identify areas for improvement.

Applying extra water to wheat in the critical period

Applying 30mm of water at the start of the critical period increased yield by 0.7t/ha for early sowing and 1t/ha for later sowing, without reducing protein levels. This equates to 23kg/ha/mm for early sowing and 33kg/ha/mm for later sowing, indicating that transpiration efficiency during the critical period can exceed current benchmarks.

Table 2. Grain yield and quality of Neo, Shotgun and Shotgun with 30mm irrigation at flag leaf emergence. Predicted values are across all nitrogen treatments (n.s.), letters are groups determined by Tukey's Honestly Significant Difference (HSD).

Emerged	Variety	Grain yield (t/ha)		Protein (%)		Test weight (kg/hL)		Screenings (%)		Retention (%)*	
15 May	Neo	6.1	a	11.3	ab	70.7	c	4.1	b	73.5	-
	Shotgun+30mm	5.6	ab	10.1	cd	81.9	a	6.4	a		
	Shotgun	4.9	c	9.6	d	80.9	b	7.6	a		
17 Jun	Neo	4.7	cd	11.9	a	71.5	c	1.3	d	87.5	-
	Shotgun+30mm	5.3	b	10.8	bc	83.1	a	2.4	c		
	Shotgun	4.3	d	11.1	ab	83.0	a	2.6	c		

Predicted values are across all nitrogen treatments (n.s.), letters are groups determined by Tukey's Honestly Significant Difference (HSD). *Treatment means only, not analysed for this subset of treatments.

The observed treatment yield differences were primarily driven by variations in grain number, underscoring the project's focus on crop agronomy to target the growth stages most important for grain number determination. This critical period, occurring in the 30 days prior to flowering, will be a central focus of the project to optimise management practices and maximise yield potential.

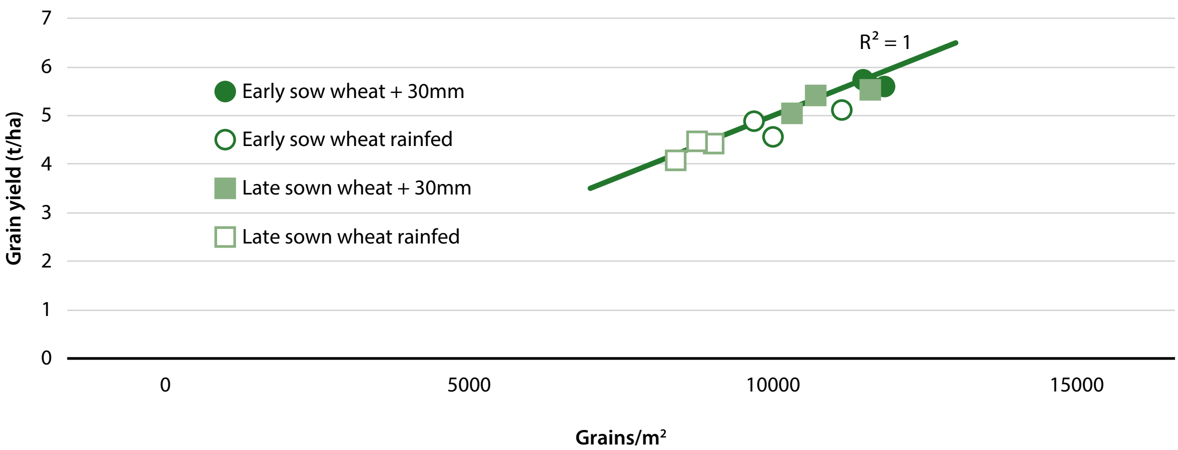

Figure 2. Relationship between grain yield and grain number from rainfed and irrigated Shotgun wheat at BCG, 2024.

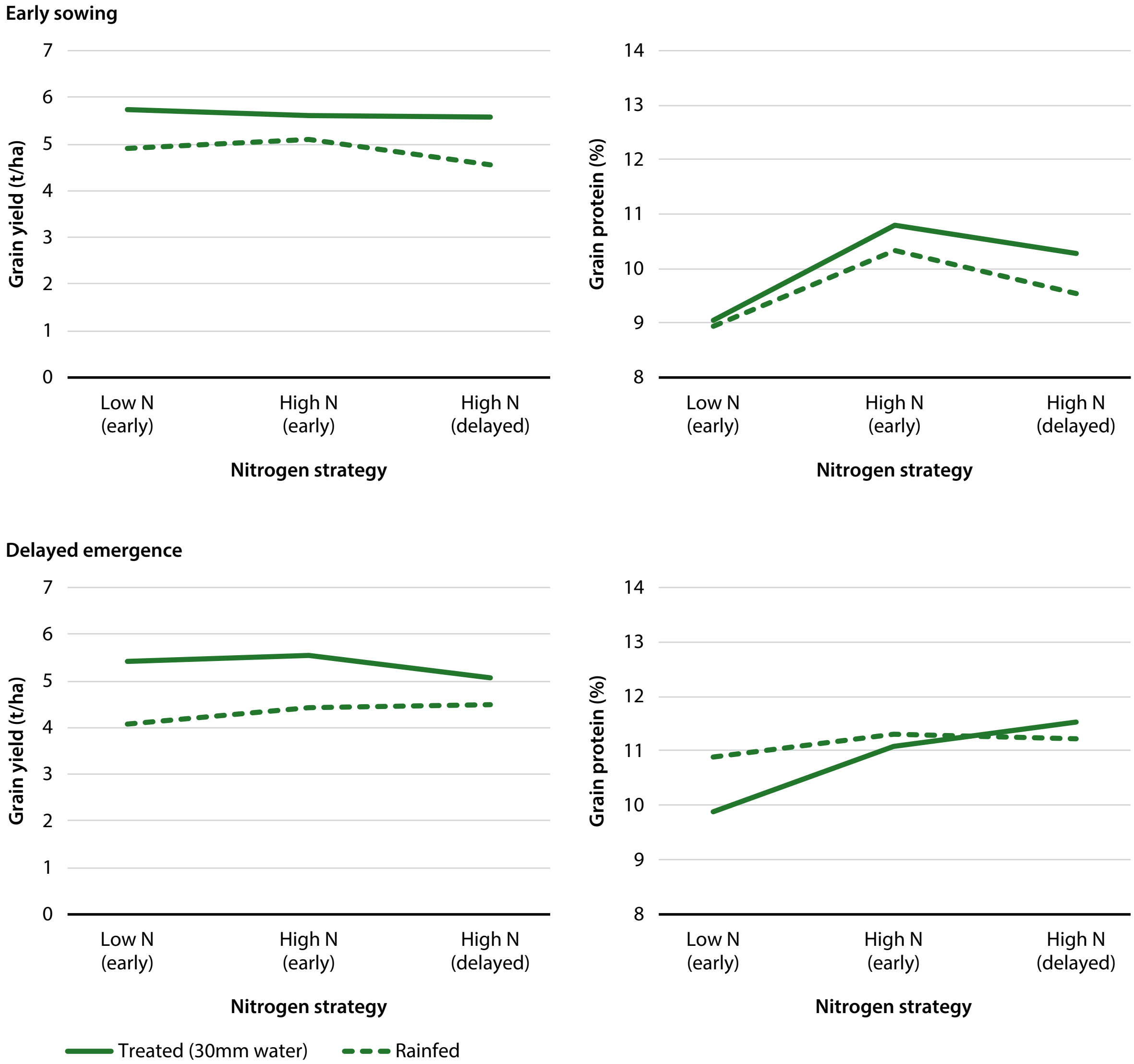

Figure 3. Influence of N strategy on grain yield and grain protein in Shotgun wheat under rainfed condition (dotted line) and when treated with 30mm of water (solid line) at flag leaf emergence, top panel is early sowing and bottom panel is delayed emergence.

Additional water did not alter the yield response to N at either early or delayed sowing. There was limited evidence of haying-off or negative effects from high N application. Interestingly, protein levels improved, with better N recovery and higher protein and yield when extra water was applied.

The lack of yield response to N suggests that N was not a major tactical lever at this site, likely due to the strong legume history meeting N demands. While applying high N rates was not economically justified in this scenario, growers can be reassured that high residual soil N and high N applications did not negatively impact yield or protein under dry spring conditions in the new cultivar.

Other insights: New early sowing options (winter wheat and barley performance)

Barley yields ranged from 5t/ha to 5.9 t/ha from earlier sowing at high N; importantly new winter barleys AGTB1009 and AGTB1010 achieved similar yield to the highest yielding commercially available spring barley varieties Neo, Cyclops, and Beast (Table 3). This is an exciting step forward in genetics for earlier planting and a more than 1t/ha improvement on Mohawk (winter wheat). Shotgun performed similarly to spring barley. Grain quality parameters of most relevance were screenings which were higher in all wheats, and Neo barley.

Table 3. Grain yield and grain quality of all varieties emerged on the early sowing date (15 May emergence) at high nitrogen inputs.

Variety	Grain yield (t/ha)		Protein (%)		Test weight (kg/hL)		Screenings (%)		Retention	
AGTB1009	5.6	ab	12.8	a	71.8	d	1.8	c	86.9	ab
AGTB1007	5.4	ab	12.6	a	70.2	d	1.6	c	89.1	a
AGTB1010	5.0	bc	13.0	a	70.6	d	1.9	c	82.7	bc
Neo	5.9	a	12.1	ab	70.4	d	6.7	a	59.8	d
Cyclops	5.5	ab	11.8	abc	72.0	d	3.2	b	80.3	c
Beast	5.4	ab	12.5	ab	70.9	d	1.8	c	91.4	a
Shotgun	5.1	abc	10.3	c	80.6	bc	7.3	a	-	-
Mohawk	4.4	cd	12.0	abc	83.8	a	5.7	a	-	-
Rockstar	4.0	d	11.4	abc	79.6	c	6.8	a	-	-

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The results emphasise the critical impact of sowing date, species, and genotype on yield outcomes, with minimal influence from nitrogen strategies under the conditions studied at this site on legume residue. Differences in grain number and the improved transpiration efficiency achieved with additional water, highlight opportunities for further yield gains. The absence of significant yield responses – or negative outcomes – to tactical agronomy and their interaction with additional water, suggests current farming systems and new genetics are robust. Growers can have confidence in the resilience of modern cultivars and their ability to adapt and perform across varying seasonal conditions.

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BCG sincerely thanks the Watts family for generously hosting the trial site at Nullawil and for their support throughout the project.

CLOSING THE YIELD GAP: PROFITABLE NITROGEN SOLUTIONS FOR EFFICIENT FARMING

Dr Yolanda Plowman (BCG), James Hunt (University of Melbourne), Kate Finger (BCG), Corinne Celestina (University of Melbourne), Arjun Pandey (University of Melbourne)

TAKE HOME MESSAGES

- Many growers struggle with making informed nitrogen decisions.
- Two decision support systems, Yield Prophet® and N banks, are consistently profitable, however the success of both approaches can vary year to year.
- In a multi-year nitrogen management trial (2018–2024), the YP50% strategy provided a high gross margin whilst mitigating the loss of soil organic N through a lower, but positive, partial N balance.

BACKGROUND

Two key factors affect wheat yield potential in Australia: rainfall and nitrogen (N). Outside of received rainfall (Hochman et al., 2017), which can't be controlled, wheat yields only reach half of their potential, mainly due to receiving insufficient N (Hochman and Horan, 2018). Grain yields for other non-legume crops (barley, canola and oats) are likely to demonstrate similar limitations. Under-fertilisation can also leave the soil with a negative N balance (exporting more N in grain than is returned with legumes and fertiliser (Norton and Elaina vanderMark, 2016). This can lead to the mining of soil organic N and associated soil organic matter causing N mineralisation decline, which is estimated to halve every 20 to 30 years in continuous cropping systems (Dalal and Mayer, 1986, Clarke and Russell, 1976, and Heenan et al., 2004). Remedying insufficient N supply to grain crops is possible and would have a substantial impact on the profitability of Australian farming enterprises; some data shows reducing N deficiency in wheat would increase Australian wheat yields by 40 per cent (Hochman and Horan, 2018, Hunt et al., 2021).

Legumes are commonly incorporated into cropping rotations either as pastures, brown manures, or for grain. However, grain legumes do not leave behind enough N to support the yield of subsequent crops, and not every cropping rotation will incorporate a legume pasture or brown manure. Yields of subsequent crops are therefore reliant on the input of additional N through fertiliser, yet growers can be hesitant to apply higher levels of N fertiliser due to concerns relating to risks to the crop ('haying off'), environment loss (leaching, volatilisation, denitrification), and economic factors (such as the cost of urea) (Hunt et al., 2021). Growers in southern Australia tend to under-fertilise because of these risks – and possibly the emphasis placed on them – as well as uncertainty of rainfall and yield which determines overall N demand.

Nitrogen management decisions are a key area of concern for Australian growers. More than 50 per cent of growers surveyed as part of the GRDC RiskWi$e project reported that making decisions relating to N management was challenging, with a subset of growers describing the decisions as 'very difficult' (Figure 1); this is where Decision Support Systems (DSS) can aid growers in identifying strategies for looming N decisions.

Growers have access to two key DSS that can help with N decisions: Yield Prophet® and N banks. Yield Prophet® helps match N input to the potential yield for a given season. This predictive management tool relies on APSIM modelling, and as such, the quality of output is reflective of the quality of input; the trade-off being that the cost (or time required) of collecting input data may be too high for some growers. Yield Prophet® might best be considered a DSS for growers who want to take a more 'active' approach to N management. On the other hand, some growers may prefer to employ a lower time and money-cost method by using N banks, a simpler, more 'passive' strategy that capitalises on year-to-year soil N carry-over to support crop growth.

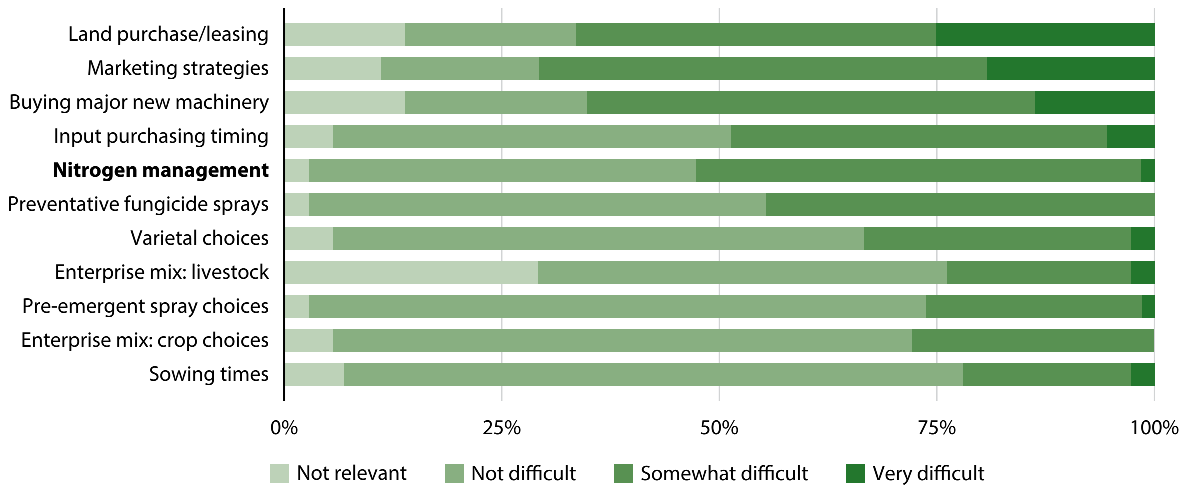

Figure 1. Survey results summarising grower perceptions of the difficulty associated with various decisions encountered in farming. Survey results provided by Brown et al., 2024, as part of reporting for the GRDC RiskWi$e project.

As part of the GRDC RiskWi$e project BCG is testing N banks and Yield Profit® in a network of N management trials to establish the risk and reward profiles of both systems. A multi-year trial was established in 2018 at Curyo, Victoria, to compare different N management strategies, including Yield Prophet® and N banks. Findings for several of the N management strategies from 2018 to 2024 are summarised here.

AIM

To assess various nitrogen management systems aimed at profitably reducing yield gaps caused by nitrogen deficiency, while mitigating the decline in soil organic matter.

PADDOCK DETAILS

Location: Curyo

Soil type: Sandy loam topsoil with clay content and calcium carbonate increasing with depth

TRIAL DETAILS

Treatments: Refer to Table 1

Seeding equipment: Knife points, press wheels, 30cm row spacing

Replicates: Four

Table 1. Crop type, sowing and harvest dates and rainfall for the five years of the trial.

	2018	2019	2020	2021	2022	2023	2024
Crop year rainfall (Nov–Oct) mm	200	368	358	241	558	276	273
GSR (Apr–Oct) mm	138	149	221	197	396	187	139
Crop type	Wheat	Canola	Wheat	Barley	Wheat	Lentil	Barley
Variety	Scepter	Hyola 350TT	Scepter	Spartacus CL	Razor CL	Thunder CL	Maximus CL
Sowing date	14 May	29 Apr	16 May	14 May	19 May	3 May	1 May
Harvest date	15 Nov	15 Nov	21 Nov	25 Nov	7 Dec	12 Nov	1 Nov

TRIAL INPUTS

N fertiliser:

Table 2. Nitrogen fertiliser (starter fertiliser + top-dressed urea) applied to different treatments in all years of the experiment.

		Total N fertiliser applied (kg N/ha)						
System	**Treatment**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Nil	Nil	16	7	7	7	7	0	7
Replacement	-	16	27	42	57	49	0	7
National average	-	44	38	52	52	52	0	58
Nitrogen banks (kg/ha N)	100	69	49	36	66	20	0	23
	125	94	32	64	68	69	0	54
	150	119	64	32	83	95	0	74
Yield Prophet® probability	100%	16	31	7	7	45	0	7
	75%	16	95	63	7	75	0	53
	50%	32	119	91	7	137	0	107
	25%	72	119	135	15	143	0	164

Starter fertiliser: 2018: Urea at 35kg/ha at sowing (host farmer management)
2019: Granulock Z at 60kg/ha at sowing
2020: Granulock Z at 60kg/ha at sowing
2021: Granulock Z at 60kg/ha + triple superphosphate at 35kg/ha at sowing
2022: Granulock Z at60kg/ha + triple superphosphate at 35kg/ha at sowing
2023: Granulock Z at 60kg/ha + triple superphosphate at 35kg/ha at sowing
2024: Granulock Z at 60kg/ha + triple superphosphate at 35kg/ha at sowing

The experiment was kept free of weeds and disease as per current best practice management.

METHOD

N management strategy set up

A multi-year experiment using a randomised complete block design was established in 2018 to evaluate the performance of different N management systems. Four different systems were tested:

1. Matching N fertiliser to seasonal yield potential (Yield Prophet® and Yield Prophet® Lite, YP)
2. Maintaining a base level of fertility using N fertiliser (N banks)
3. Replacing the amount of N removed in grain each year with fertiliser in the next season (replacement)
4. Applying national average N fertiliser rate (45kg/ha) each season (national average, NA)

All systems were compared to a nil control which received only starter fertiliser (7kg N/ha per year of MAP). Within the Yield Prophet® and N bank systems there were different treatments targeting different yield potentials (Table 3). In the Yield Prophet® treatment before 2021, water limited potential yield was determined at different levels of probability; the amount of N required to achieve these yields was applied, assuming a requirement of 40kg/ha N per t/ha of wheat yield and 80kg/ha N per t/ha of canola yield. From 2021 onward, Yield Prophet® Lite was used in a similar way. There were different target levels of N fertility (N bank targets) for the N bank treatments. N fertiliser rates in these treatments were calculated as the N bank target value minus soil mineral N (kg/ha) measured before sowing. Gross margins were calculated based on the 2024 SAGIT Gross Margin Guide (SAGIT, 2024). Average N fertiliser cost was based on calculations from historical SAGIT Gross Margin Guides over the seven-year period (2018–2024).

Table 3. Nitrogen management systems and treatments used in the experiments.

System	Treatment	Description
Nil	Nil	No nitrogen applied other than in starter fertiliser
Replacement	R	Amount of N removed in grain applied as fertiliser N
National average	NA	National average N fertiliser (45kg/ha N) applied each season
Nitrogen banks (kg/ha N)	NB100	Soil mineral N + fertiliser = 100kg/ha N
	NB125	Soil mineral N + fertiliser = 125kg/ha N
	NB150	Soil mineral N + fertiliser = 150kg/ha N
Yield Prophet® probabilities based on seasonal finish	YP100%	Lowest yielding finish on record (decile 1 in Yield Prophet® Lite)
	YP75%	Lower yielding quartile finish (decile 2–3 in Yield Prophet® Lite)
	YP50%	Median finish (decile 4–7 in Yield Prophet® Lite)
	YP25%	Higher yielding quartile finish (decile 8–9 in Yield Prophet® Lite)

RESULTS AND INTERPRETATION

2018–2022 results

Please see BCG Season Research Results from 2018–2022 growing seasons for previous results of the experiments. No article was published in 2023 as this trial was sown to lentils.

2024 results

Soil mineral N levels ranged from 63kg/ha to 71kg/ha, and no significant differences were detected between treatments (Table 4). The highest grain yield was achieved by YP25% (6.8t/ha), which was significantly higher than all other treatments, except YP50%, YP75%, and National average treatments (6.6, 6.07, and 6.1t/ha, respectively) ($p < 0.001$, LSD = 0.8). YP25%, also delivered the highest protein percentage (11.4%), significantly higher than all other treatments ($p < 0.001$, LSD = 0.5), and came in as second highest gross margin ($1247/ha), behind YP50% ($1284/ha). By comparison, the Nil and Replacement treatments had the lowest yields (4.48–4.71t/ha) and protein (7.6–8.1%), reflecting limited nitrogen availability. Performance of all three N bank treatments sat between the highest and lowest treatments across all yield, protein, and gross margins.

Table 4. Soil mineral N measured before sowing, top-dressed N, partial crop N supply (soil mineral N + fertiliser N), grain yield, protein and gross margin for different treatments in the experiment in 2024.

System	Treatment	Soil mineral N (kg/ha)	Top- dressed N (kg/ha)	Partial N supply (kg/ha)	Yield (t/ha)	Protein (%)	Gross margin ($/ha)
Nil	Nil	68	0	68	4.5	7.6	$798
Replacement	-	66	0	66	4.7	8.1	$884
National average	-	69	45	114	6.1	8.9	$1184
Nitrogen banks (kg/ha N)	100	65	14	79	5.5	8.3	$1052
	125	63	41	104	5.3	9.5	$1015
	150	71	58	129	5.7	9.6	$1100
Yield Prophet® probability	100%	63	0	63	4.6	7.9	$840
	75%	63	40	103	6.1	9.0	$1184
	50%	64	87	151	6.6	10.4	$1284
	25%	66	137	203	6.8	11.4	$1247
Sig. diff. LSD (P=0.05)		**NS**			**<0.001 0.8**	**<0.001 0.5**	

Seven-year averages

Grain yield data over the seven trial years for each N management treatment are shown in Figure 2. On average across the seven years, the YP25% and YP50% treatments were the most promising strategies in closing the yield gap (3.62t/ha and 3.64t/ha, respectively), and both treatments were significantly higher than all other treatments ($p < 0.001$, LSD = 0.29). YP25% showed a relatively high seven-year cumulative partial N balance of 114 kg/ha compared to YP50% (17kg/ha), indicating a higher chance of N loss under this treatment in this environment (Figure 5). Given the relatively minor difference in grain yield between YP25% and YP50%, and the substantial difference in partial N balance, YP50% is the optimal N strategy for this environment.

No significant differences were observed in mean grain yield between the three N bank treatments NB100, NB125, and NB150 (3.1t/ha, 3.2t/ha, 3.3t/ha, respectively), over the seven-year average. However, considering the partial N balance for all three treatments, NB125 showed an almost neutral balance (-2kg/ha) relative to NB100 and NB150 (-96kg/ha and 49kg/ha, respectively) over the seven years. This suggests the NB125 strategy is the best option of the N bank treatments for this environment.

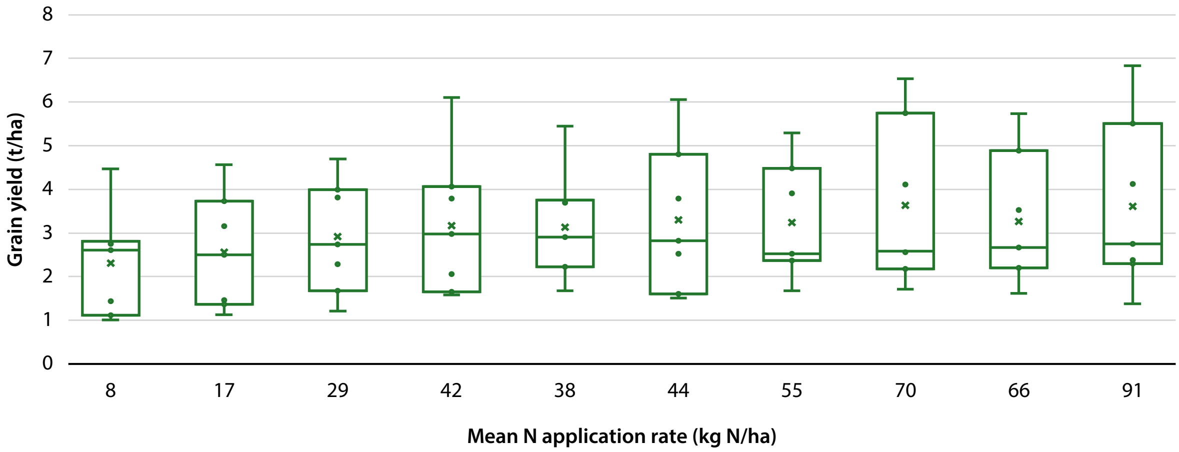

Figure 2. Grain yield (t/ha). Box-and-whisker plots of seven-year average grain yield (t/ha) data for each treatment. Lower and upper box thresholds are the 25th and 75th percentiles; the median is depicted by the horizontal line within each box, whereas the mean is depicted by an 'x'. Whiskers extending from the boxes represent the extreme percentiles.

The highest average gross margin across the seven years was achieved by YP50% ($903), closely followed by YP25% ($844), YP75% ($838), NB100 ($783), and NB125 ($776, p < 0.001, LSD $133) which were all statistically assessed as not different from each other (Figure 3). This is illustrated in Figure 4, where the relationship between mean N application and gross margin can be seen to be flattening out.

YP50%, YP75%, NB100, and NB125 all avoided a negative gross margin over the seven year period and consequently had lower down side risk in the longer term, contrary to YP25% which did record a negative gross margin (Figure 3). Lower gross margins were achieved with the National Average ($763), NB150 ($739), Replacement ($674), YP100% ($571), and Nil strategies (492).

Taking into consideration grain yield, cumulative partial N balance average across seven years, and the downside risk, YP50% has been shown to be the better all round N strategy in this environment. For decision-makers seeking a straightforward strategy with consistent results, NB125 stands out as the most reliable simplified nitrogen management option.

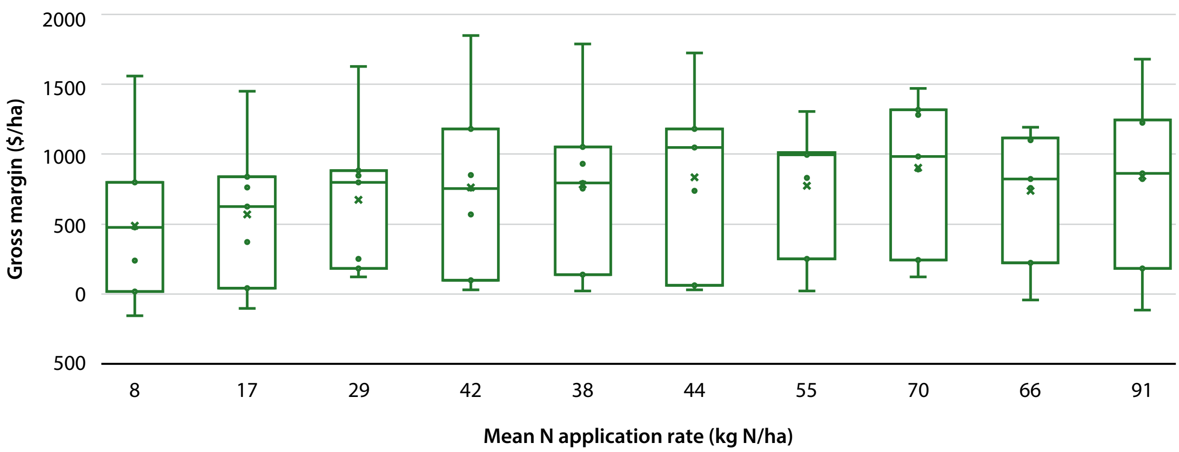

Figure 3. Box-and-whisker plots of seven-year average gross margin ($/ha) data for each treatment. Lower and upper box thresholds are the 25th and 75th percentiles; the median is depicted by the horizontal line within each box, whereas the mean is depicted by an 'x'. Whiskers extending from the boxes represent the extreme percentiles.

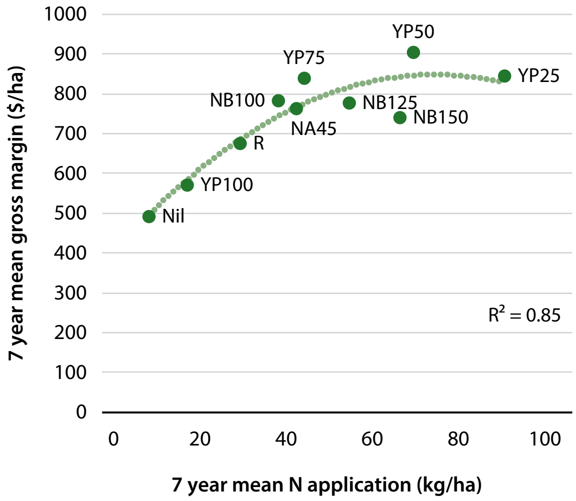

Figure 4. The relationship between mean seven-year fertiliser application and mean seven-year gross margin for the different treatments. The quadratic function fitted by least-squares regression is of the form $y = -0.08x^2 + 11.93x + 403.90$, $R^2 = 0.85$.

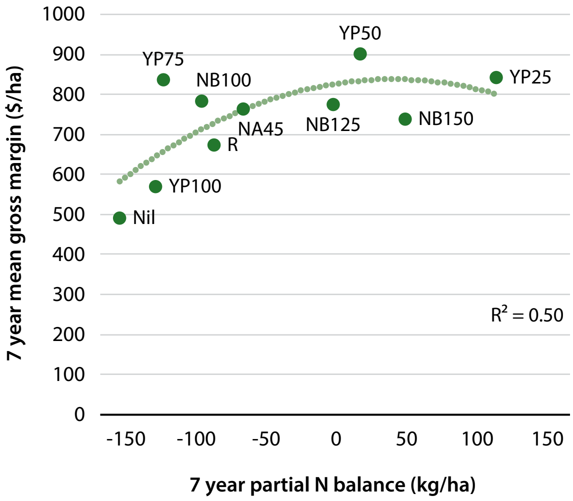

Figure 5. The relationship between seven-year N balance and seven-year mean gross margin for the different treatments. The quadratic function fitted by least-squares regression is of the form $y = -0.01x2 + 0.55x + 827.21$, $R^2 = 0.50$.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

In 2024, the YP25% treatment demonstrated outstanding performance, achieving the highest grain yield and protein percentage, and the second highest gross margin. Over the seven-year average, YP50% also dominated the highest yields and economic returns, whilst minimising seven-year cumulative partial N balance, indicating it is the optimal treatment for this environment. Alternatively, single-year and seven-year average results showed N bank treatments offered a balanced intermediate performance across all metrics, particularly NB125, which maintained a neutral cumulative partial N balance across the seven years. The advantage of this strategy is the simplified decision-making process which is likely to appeal to some grain growers. The Nil and Replacement treatments highlighted the limitations of restricted N availability, producing the lowest yields and protein levels in both 2024 and across the seven-year average.

Growers are encouraged to conduct soil testing and use environmentally appropriate N Decision Support Systems, such as Yield Prophet® or N Banks, to optimise profitability. These findings demonstrate that both approaches are effective decision-making tools for maximising returns in both the short and long-term. The choice between these strategies is likely influenced by growers' preference for simplicity or complexity in N management.

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Thank you to Professor James Hunt, the University of Melbourne, for providing a technical review of this article.

BCG sincerely thanks Paul Barclay for generously hosting the trial site at Curyo and for support throughout the project.

DEEP POTENTIAL: UNLOCKING THE POWER OF LONG COLEOPTILE WHEAT WITH SMART AGRONOMY

Dr Yolanda Plowman, Ashlee Tierney, and Brooke Bennett (BCG)

TAKE HOME MESSAGES

Deep sowing with long coleoptile varieties can improve crop establishment by accessing subsoil moisture at deeper depths, offering a valuable tool for managing late rainfall breaks and seasonal variability.

1. Optimised agronomic practices, including sowing depth and press wheel pressure, are essential for maximising the benefits of long coleoptile varieties.
2. This trial provides crucial insights to help growers effectively integrate these varieties into cropping programs in preparation for future high-yielding long coleoptile wheat options.

BACKGROUND

It is well understood that delaying sowing of a wheat crop can result in a grain yield penalty (Murray, 2015). However, in current farming systems the ability to sow early and on-time relies heavily on timely seasonal breaks. Shifting long-term climate patterns of increased summer rainfall and a late break will increase challenges relating to sowing decisions (Flohr et al., 2021). Optimising agronomic practices and sowing depth to capitalise on increased stored summer rainfall below the top 10cm could be a powerful tool for growers in managing these challenges.

Coleoptile length in wheat varieties is gaining attention due to the possibility of maximising farm output by strategically choosing varieties based on the trait. The coleoptile is a sheath that protects the shoot as it emerges, allowing longer coleoptile varieties to be sown deeper than conventional varieties (GRDC GroundCover, 2023). Because of breeding efforts, dwarfing genes of many current varieties have decreased the length of the coleoptile (Rebetzke et al., 2022), restricting the depth that varieties can be sown, and in turn, reducing the flexibility of sowing strategy for growers. Two wheat dwarfing genes, *Rht18* and *Rht13*, which result in a longer coleoptile length have been identified. These genes are being bred into new varieties (GRDC Groundcover, 2023).

Substantial work has been invested in identifying and sourcing the genetics to breed longer coleoptile varieties; the next challenge is to identify how best to use long coleoptile varieties under different elements of agronomic management, such as sowing depth and press wheel pressure. The work outlined in this study was designed to deliver information to growers relating to the performance of long coleoptile varieties under various agronomic management to guide their adoption in farming enterprises.

AIM

To investigate the integration of long coleoptile wheat varieties into Australian farming systems under varying agronomic practices.

PADDOCK DETAILS

Location:	Nullawil
Crop year rainfall (Nov–Oct):	361mm
GSR (Apr–Oct):	178mm
Soil type:	Loamy clay
Paddock history:	Vetch brown manure

TRIAL DETAILS

Crop type:	Wheat
Treatments:	Refer to Table 1
Target plant density:	100 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	13 May 2024
Replicates:	Four
Harvest date:	22 November 2024
Trial average yield:	3.42 t/ha

TRIAL INPUTS

Trial managed as per best practice.

METHOD

One field trial with four replicates was sown at Nullawil using a split plot trial design. The trial investigated the relationship between variety by sowing depth and by press wheel pressure. It incorporated six varieties, two sowing depths, and three press wheel pressures, combined creating a total of 36 treatments (Table 1).

Of the six varieties, four commercial lines were included: Scepter, which has a short coleoptile and is a popular variety in the region, Calibre, which has a mid-long coleoptile length, Magenta, which has a mid-long coleoptile, and Mace, which has a medium-length coleoptile. Two long coleoptile experimental varieties were also included: Mace18 which has been bred from Mace to contain the *Rth18* gene for increased coleoptile length, and Magenta13, which has been bred from Magenta and contains the *Rht13* gene (GRDC Groundcover, 2023). Two sowing depths were targeted: shallow which aimed for 30–40mm, and deep which aimed for 80–100mm. Three press wheel pressures were used: light, where press wheels were lifted all the way up so they just skimmed the surface, standard, where springs were released and gave 15kg of pressure, and heavy, where springs were fully tightened giving 27kg of pressure.

Assessments included soil temperature, soil moisture, soil matric potential, soil strength, emergence counts, NDVI, measurements of coleoptile length and sowing depth, emergence percentage, harvest index, grain yield, and grain quality.

Table 1. Treatments.

Variety (Coleoptile length)	Sowing depth (mm)	Press wheel pressure (kg)
Mace (Medium)	Shallow (30–40)	Light (0)
Scepter (Short)	Deep (80–100)	Standard (15)
Magenta (Mid-long)		Heavy (27)
Calibre (Mid-long)		
Mace18 (Long)		
Magenta13 (Long)		

RESULTS AND INTERPRETATION

Treatment effect on plant density

In this trial, plant density was influenced by variety, depth, and press wheel pressure, however there was significant variation in effect across treatments (Table 2). As standalone factors, variety and sowing depth had significant impacts on plant density (p = 0.019, LSD = 7.68, and p = 0.005, LSD = 7.44, respectively), and there were also significant interactions between variety and pressure, and variety and depth (p = 0.029, LSD = 14.73 and p = 0.012, LSD = 12.03, respectively).

Long coleoptile varieties, such as Mace18 and Magenta13, offer advantages for crop establishment under deep sowing conditions. However, these benefits diminish with shallow sowing (Figures 1 and 2). For instance, Mace18 achieves significantly higher plant density (69 plants/m^2) compared to shorter coleoptile varieties such as Mace (50 plants/m^2) and Scepter (55 plants/m^2) when sown deeply. A similar pattern was observed with Magenta13 (59 plants/m^2), outperforming the shorter coleoptile variety Magenta (42 plants/m^2). Essentially, under shallow sowing conditions, the data from this trial shows there is no added benefit from using a long coleoptile variety instead of a short coleoptile variety in terms of plant density.

Table 2. Statistical significance (p value) and least significant difference (LSD) for the effects of variety, sowing depth, press wheel pressure, and their interactions on the plant density.

Factor	*p* value	LSD
Variety	0.019	7.68
Pressure	NS	NS
Depth	0.005	7.44
Variety x Pressure	0.029	14.73
Variety x Depth	0.012	12.03
Pressure x Depth	NS	NS
Variety x Depth x Pressure	NS	NS

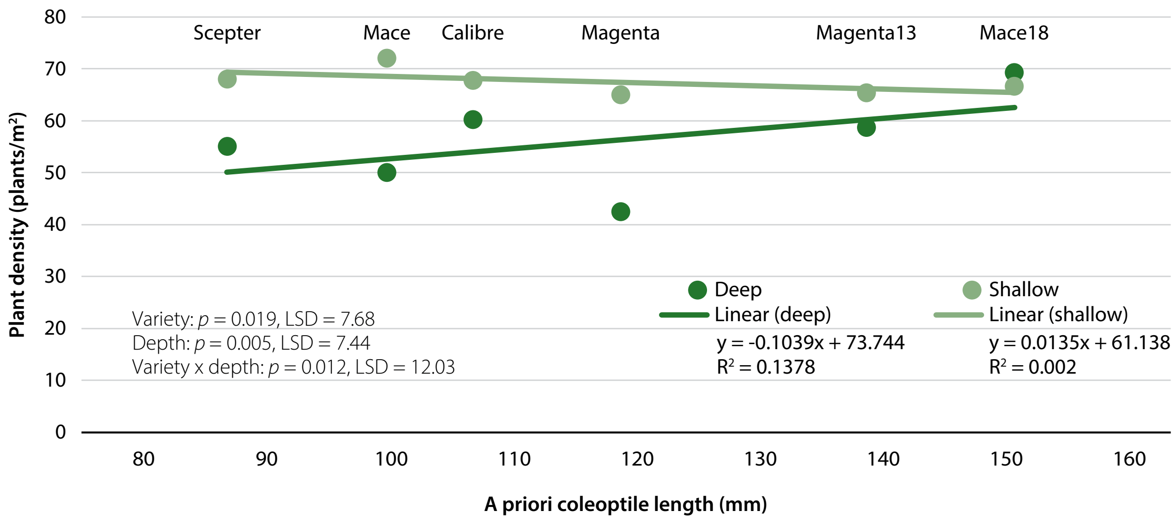

Figure 1. Relationship between plant density (plants/m^2) and a priori coleoptile length (mm) under deep and shallow sowing depths.

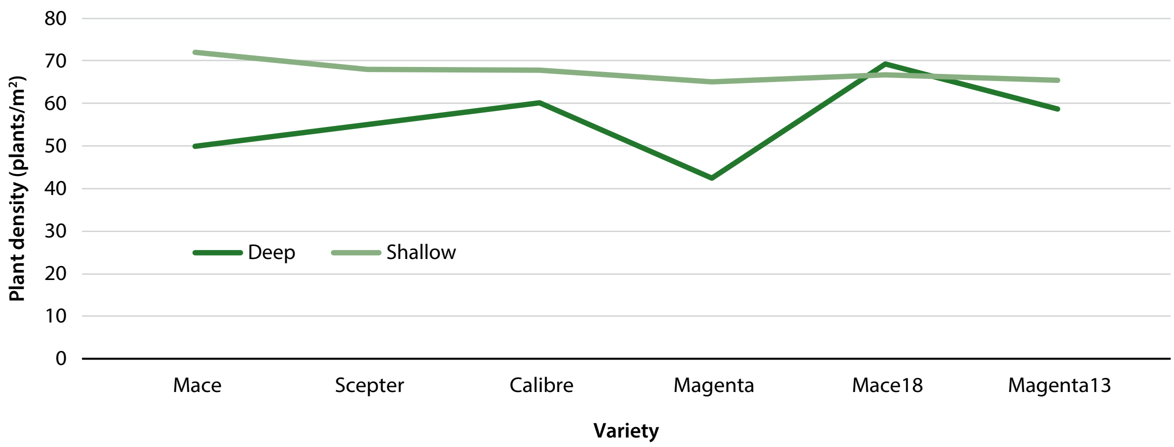

Figure 2. Plant density (plants/m^2) by wheat variety and sowing depth (deep versus shallow).

Plant density data also emphasised the increased importance of press wheel pressure when sowing deeper. In this trial, where subsoil moisture was adequate for good seed-moisture access, it was more important to have lighter press wheel pressure for longer coleoptile varieties; the benefits of the long coleoptile trait in these varieties were negated by heavier pressure. This is evident from the trends for Magenta13 and Mace18 (Figures 3 and 4) which show higher plant density under light press wheel pressure (68 plants/m^2 and 73 plants/m^2, respectively) compared to plant density achieved under heavy press wheel pressure (50 plants/m^2 and 65 plants/m^2, respectively).

This suggests that, if sowing deep, it's important to optimise the press wheel pressure for soil type and environment to gain the full benefits of the long coleoptile technology; growers might need to experiment with alternative sowing approaches when sowing longer coleoptile varieties.

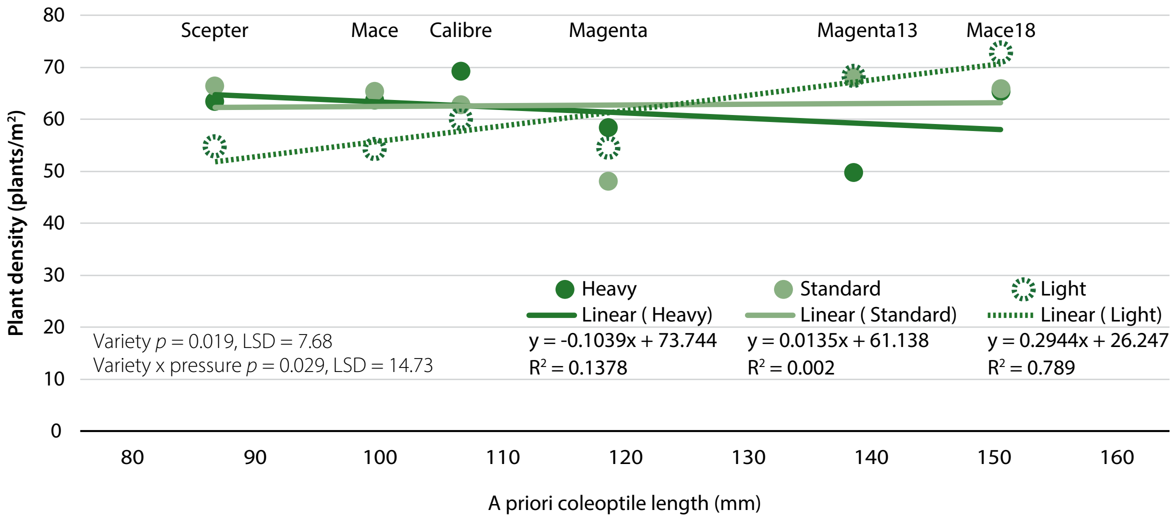

Figure 3. Relationship between plant density (plants/m^2) and a priori coleoptile length (mm) under heavy, standard, and light press wheel pressure.

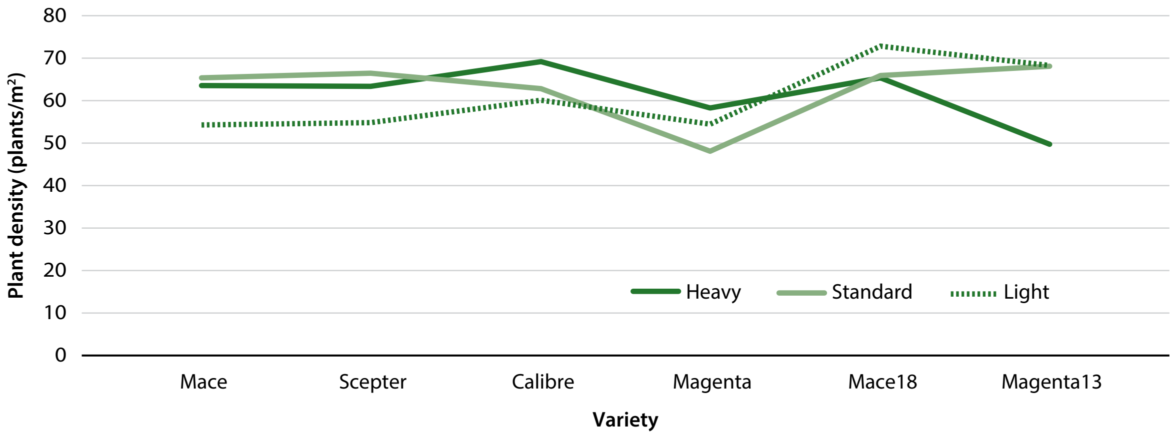

Figure 4. Plant density (plants/m^2) by wheat variety and press wheel pressure (heavy, standard, and light).

Grain yield

Yield was significantly influenced by variety and depth (p <0.001, LSD = 0.2563, p = 0.001, LSD = 0.1086 (Table 3). However, press wheel pressure did not yield significant results as either a standalone factor or an interaction.

Yield comparisons illustrate the importance of selecting the right variety and depth for yield optimisation (Figures 5 and 6). Among the long coleoptile varieties, yields for Mace18 and Magenta13 were generally significantly lower than most other varieties at both depths. Calibre produced significantly higher yields than many other varieties across most sowing depth and press wheel pressure treatments (Figure 3), achieving the highest yield of 4.6t/ha under heavy pressure and deep planting.

Table 3. Statistical significance (*p* value) and least significant difference (LSD) for the effects of variety, sowing depth, press wheel pressure, and their interactions on grain yield.

Factor	*p* value	LSD
Variety	<0.001	0.2563
Pressure	NS	NS
Depth	0.001	0.1086
Variety x Pressure	NS	NS
Variety x Depth	NS	NS
Pressure x Depth	NS	NS
Variety x Depth x Pressure	NS	NS

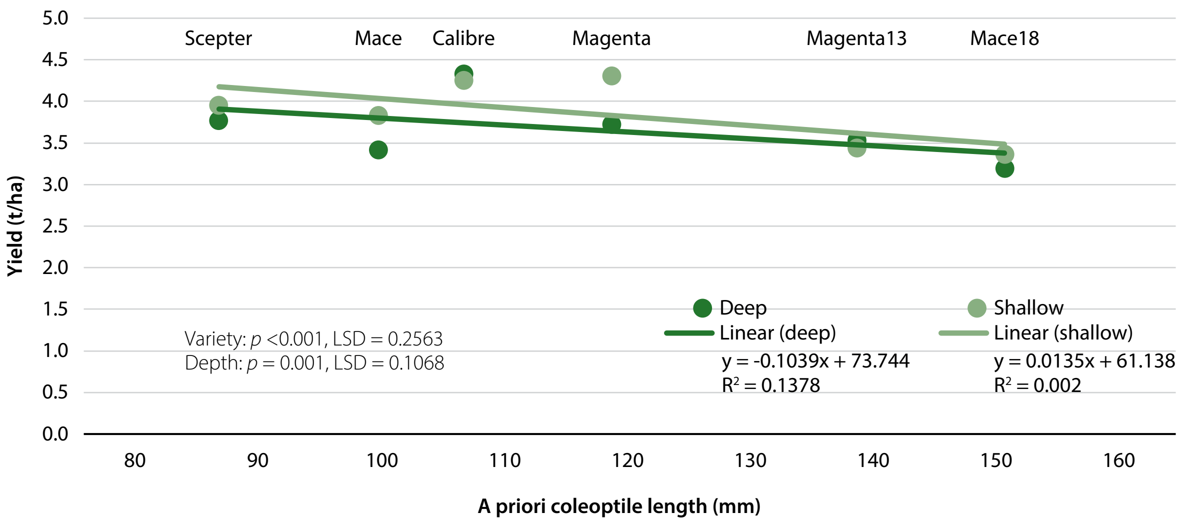

Figure 5. Relationship between yield (t/ha) and a priori coleoptile length (mm) under deep and shallow sowing depths.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

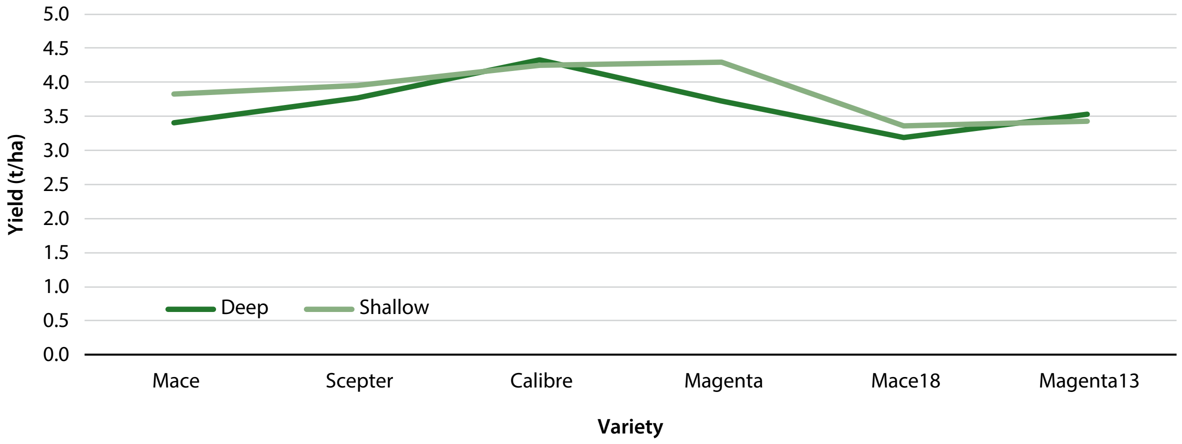

Figure 6. Yield (t/ha) by wheat variety and press wheel pressure (deep and shallow).

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Yield penalties can be incurred in wheat crops from delayed sowing, which is sometimes a consideration due to late rainfall breaks. However, early and timely sowing can impose an additional risk through seasonal variability and unpredictable climate patterns. As such, deep sowing to access soil moisture stored at lower depths is a tool that can help ease the stress of making these decisions. Sowing long coleoptile varieties that are capable of emerging from lower sowing depths, allows them to access soil moisture and secure early season vigour.

Understanding how long coleoptile varieties perform across a range of agronomic management elements, such as sowing depth and press wheel pressure, is critical for deploying these tools in a way that will help growers optimise sowing activities. Data from this trial showed varied responses for both plant density and yield, in the long coleoptile varieties, Mace18 and Magenta13, emphasising the importance of variety and environment-specific management.

Three key findings arose from this trial. First, plant density was significantly influenced by variety, sowing depth, and pressure wheel pressure. The long coleoptile varieties, Mace18 and Magenta13, performed best under deep sown conditions, outperforming region-dominating varieties such as Scepter and Calibre. Second, the benefits of the long coleoptile varieties were lessened under heavier press wheel pressure. Third, yield was strongly affected by variety and sowing depth. Despite superior plant density in the long coleoptile varieties under certain conditions, they yielded no more than shorter varieties, with most shorter coleoptile varieties reaching significantly higher yields than both long coleoptile varieties under both press wheel pressures. It is important to note that the two long coleoptile varieties used in this trial have been bred for long coleoptile traits, not yield. The purpose of this work is to equip growers with knowledge about how best to adapt agronomic practices to include long coleoptile varieties in their cropping programs, so they are ready to respond when future high-yielding long coleoptile varieties become available.

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BCG sincerely thanks the Watts family for generously hosting the trial site at Nullawil and for their support throughout the project.

WEED MANAGEMENT

THE EFFECT OF ADJUVANTS ON KNOCKDOWN AND GROUP 14 HERBICIDES

Matt Lade and Angus Butterfield (BCG)

TAKE HOME MESSAGES

- Choosing the correct adjuvant as per the product label when spraying is important to get the most out of herbicides being used.
- Certain herbicides, including Group 14, are ineffective without adjuvants.
- Adding Group 14 spikes to glyphosate and adjuvant mixes will speed up the rate of brownout.

BACKGROUND

Adjuvants are designed to enhance the activity and effectiveness of herbicides. It is important to note that not all adjuvants are the same and, while some might be able to be used interchangeably, others cannot as they are designed for specific purposes. There are different categories of adjuvant and each acts in a different way to enhance a herbicide's effectiveness. For a guide to the different categories of adjuvant, a reference point is the GRDC Adjuvants National Reference Manual found on the GRDC website.

Knockdown herbicides such as paraquat (Group 22) and glyphosate (Group 9), and a range of Group 14 herbicides (such as carfentrazone, pyraflufen, oxyfluorfen and butafenacil) are commonly used in farming systems, particularly during summer fallow or as knockdowns before sowing.

Adjuvants improve the effectiveness of some herbicides and are widely used in a variety of spray applications, as stated above, and can play an important role in how well herbicides perform. A spray-trial was established to demonstrate the different effects of adjuvants on knockdown and Group 14 herbicides to help growers better understand the importance of adjuvant use and selection. The Group 5 herbicide metribuzin was also included in the trial to demonstrate the effects of mixing this herbicide with glyphosate.

Some of the adjuvants and herbicides used in this trial are not registered for use with certain herbicides and were tested for experimental purposes only. Always read the label and adhere to directions when using herbicides and adjuvants.

This trial was for demonstration purposes only, and as such, was not replicated or statistically rigorous. Data presented is observational only. Results should be interpreted with caution and discussed with a trusted advisor.

AIM

To assess and demonstrate the effect of adjuvants on knockdown herbicides (glyphosate and paraquat) and Group 14 herbicides, and to demonstrate the outcomes of mixing the herbicides metribuzin (Group 5) and glyphosate.

PADDOCK DETAILS

Location: Nullawil and Murra Wurra

Crop year rainfall (Nov–Oct): Nullawil 361mm
Murra Warra 380mm

GSR (Apr–Oct): Nullawil 178mm
Murra Warra 225mm

TRIAL DETAILS

Treatments: Refer to Tables 2 and 3

Seeding equipment: Knife points, press wheels, 30cm row spacing

Table 1. Paddock and trial details for herbicide spray matrix trials.

Location	Nullawil (Mallee)	Murra Wurra (Wimmera)
Soil type	Loamy clay	Brown clay
Sowing date	30 May 2024	4 June 2024
Crop types	Canola, wheat, barley, vetch, lentil, field pea, faba bean.	Canola, wheat, barley, oats, lentils, vetch, field pea, chickpea, faba bean.
Treatment spray date	3 September 2024	10 September 2024
Nozzle type	Orange 01	Orange 01
Water rates	100L/ha	100L/ha
Bar pressure	250kpa	250kpa
Weather conditions	Temp 17.8°C Humidity 37% Cloud Cover 10% Wind Direction SSE Wind speed 1–2km/h	Temp 17.1°C Humidity 48% Cloud cover 20% Wind direction NW Wind speed 5km/h

TRIAL INPUTS

Fertiliser: Granulock Supreme Z + Flutriafol (400mL/100 kg) @ 60kg/ha at sowing

Herbicide: Refer to Tables 2 and 3

Insecticide: N/A

Fungicide: Wimmera demonstration: Aviator Xpro @ 500mL/ha on 26 July 2024

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

METHOD

Both sites were sown in strips for demonstration purposes, with crop types planted by row. The Nullawil trial contained six ranges by eight rows and the Murra Wurra trial contained three ranges by twelve rows. The treatment sprays were applied across the ranges with four treatments fitting per range. Treatments were applied using either a hand boom or a shielded sprayer behind a tractor. See Figures 1 and 2 for details of trial layouts. The treatments were not replicated across the same crop type as the main purpose of the trials was for demonstration purposes only. Treatments are displayed in Tables 2 and 3.

Assessments included burndown scores and control scores. Photographs of the different treatments were taken to support findings.

Table 2. Treatment sprays applied to the Mallee matrix at Nullawil.

Trt. no.	Herbicide 1	Rate (g or mL/ha)	Herbicide 2	Rate (g or mL/ha)	Adjuvant	Rate (%)
1	Glyphosate 450	1000				
2	Glyphosate 450	1000			AMS	1
3	Glyphosate 450	1000			Uptake	0.5
4	Glyphosate 450	1000			Hasten	1
5	Glyphosate 450	1000			LI700	0.25
6	Glyphosate 450	1000	Metribuzin	180		
7	Glyphosate 450	1000	Terrad'or	20	Hasten	1
8	Control					
9	Sharpen	17				
10	Sharpen	17			Hasten	1
11	Sharpen	17			CanDo	0.5
12	Sharpen	17			Uptake	0.5
13	Terrad'or	20				
14	Terrad'or	20			Hasten	1
15	Terrad'or	20			CanDo	0.5
16	Terrad'or	20			Uptake	0.5
17	Control					
18	Gramoxone 360	800	Terrad'or	20	Hasten	1
19	Gramoxone 360	800				
20	Gramoxone 360	800			BS1000	0.2
21	Gramoxone 360	800			Uptake	0.5
22	Gramoxone 360	800			Adigor	0.5
23	Gramoxone 360	800			LI700	0.25
24	Gramoxone 360	800			Hasten	1

Table 3. Treatment sprays applied to the Wimmera matrix at Murra Wurra.

Trt. no.	Product 1	Rate (g or mL/ha)	Product 2	Rate (g or mL/ha)	Product 3	Rate (%)
1	Terrad'or	20				
2	Terrad'or	20			Hasten	1
3	Terrad'or	20			CanDo	0.5
4	Control					
5	Gramoxone 360	800	Terrad'or	20	Hasten	1
6	Gramoxone 360	800				
7	Gramoxone 360	800			BS1000	0.2
8	Gramoxone 360	800			Uptake	0.5
9	Gramoxone 360	800			Adigor	0.5
10	Gramoxone 360	800			LI700	0.25
11	Gramoxone 360	800			Hasten	1
12	Control					

Range 6	Gramoxone 360 800ml/ha + Hasten 1%	Trt 24
	Gramoxone 360 800ml/ha + LI700	Trt 23
	Gramoxone 360 800ml/ha + Adigor 0.5%	Trt 22
	Gramoxone 360 800ml/ha + Uptake 0.5%	Trt 21
	Laneway	
Range 5	Gramoxone 360 800ml/ha + BS1000 0.2%	Trt 20
	Gramoxone 360 800ml/ha	Trt 19
	Gramoxone 360 800ml/ha + Terrad'or + Hasten 1%	Trt 18
	Control	Trt 17
	Laneway	
Range 4	Terrad'or 20g/ha + Uptake 0.5%	Trt 16
	Terrad'or 20g/ha + CanDo 0.5%	Trt 15
	Terrad'or 20g/ha + Hasten 1%	Trt 14
	Terrad'or 20g/ha	Trt 13
	Laneway	
Range 3	Sharpen 17g/ha + Uptake 0.5%	Trt 12
	Sharpen 17g/ha + CanDo 0.5%	Trt 11
	Sharpen 17g/ha + Hasten 1%	Trt 10
	Sharpen 17g/ha	Trt 9
	Laneway	
Range 2	Control	Trt 8
	Glyphosate 450 1L/ha + Terrad'or 20g/ha + Hasten 1%	Trt 7
	Glyphosate 450 1L/ha + Metribuzin 180g/ha	Trt 6
	Glyphosate 450 1L/ha + LI700	Trt 5
	Laneway	
Range 1	Glyphosate 450 1L/ha + Hasten 1%	Trt 4
	Glyphosate 450 1L/ha + Uptake 0.5%	Trt 3
	Glyphosate 450 1L/ha + AMS 1%	Trt 2
	Glyphosate 450 1L/ha	Trt 1

Row	1	2	3	4	5	6	7	8
	TT Canola	IMI Canola	Wheat	Barley	Vetch	Lentil	Field Pea	Faba Bean

Figure 1. Map of the layout at the Mallee matrix site at Nullawil.

Range 3	Terrad'or 20mL/ha	Trt 1
	Terrad'or 20mL/ha + Hasten 1%	Trt 2
	Terrad'or 20mL/ha + CanDo 0.5%	Trt 3
	Control	Trt 4
	Laneway	
Range 2	Gramoxone 360 800mL/ha + Terrad'or 20ml/ha + Hasten 1%	Trt 5
	Gramoxone 360 800mL/ha	Trt 6
	Gramoxone 360 800mL/ha + BS1000 0.2%	Trt 7
	Gramoxone 360 800mL/ha + Uptake 0.5%	Trt 8
	Laneway	
Range 1	Gramoxone 360 800mL/ha + Adigor 0.5%	Trt 9
	Gramoxone 360 800mL/ha + LI 700 0.25%	Trt 10
	Gramoxone 360 800mL/ha + Hasten 1%	Trt 11
	Control	Trt 12

Row	1	2	3	4	5	6	7	11	8	9	10
	IMI Canola	GT Canola	TT Canola	Wheat	Barley	Oats	Lentil	Vetch	Field Pea	Chickpea	Faba Bean

Figure 2. Map of the layout at the Wimmera matrix site at Murra Wurra.

RESULTS AND INTERPRETATION

Group 14 herbicides

Both Group 14 herbicides, Terrad'or® and Sharpen, were relatively ineffective at controlling weeds when used without adjuvants. Effectiveness improved notably when used with adjuvants (Figures 3a, 3b, 3c), however, the level of control was still unsatisfactory for several crop types as most had less than 85 per cent control after four weeks (Table 5 and 6). Therefore, full control may be better achieved with the addition of other knockdown herbicides.

Figure 3a. Control imidazolinone tolerant canola at the Murra Warra site, one week after treatments were sprayed.

Figure 3b. Imidazolinone tolerant canola treated with Terrad'or® at 20mL/ha at the Murra Warra site, one week after treatments were sprayed.

Figure 3c. Imidazolinone tolerant canola treated with Terrad'or® at 20mL/ha + Hasten 1% at the Murra Warra site, one week after treatments were sprayed.

Initial brownout

Gramoxone + BS1000 was the most effective treatment followed closely by the other adjuvant-incorporated gramoxone treatments. Gramoxone alone had a considerably lower impact in terms of initial brownout (Figures 4a, 4b, 4c). Glyphosate treatments did not show noteworthy initial brownout after one week, apart from glyphosate + Terrad'or® + Hasten (Treatment 7, Table 2) which demonstrated a higher rate of browning (Table 4).

Figure 4a. Control cereals at the Murra Warra site one week after treatment sprays. Oats shown closest to the camera followed by barley and wheat respectively.

Figure 4b. Cereals treated with Gramoxone 360 800mL/ha at the Murra Warra site one week after treatment sprays. Oats shown closest to the camera followed by barley and wheat respectively.

Figure 4c. Cereals treated with Gramoxone 360 800mL/ha + BS1000 0.2% at the Murra Warra site one week after treatment sprays. Oats shown closest to the camera followed by barley and wheat respectively.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Table 4. Initial brownout scores one week after spraying at Nullawil. Values are % browned out. 0 = no effect, 100 = 100% browned out.

Treatment	TT Canola	IMI Canola	Wheat	Barley	Vetch	Lentil	Field pea	Faba bean
Glyphosate 450	10	10	15	10	0	0	5	0
Glyphosate 450 + AMS	10	10	15	15	0	0	5	0
Glyphosate 450 + Uptake	10	10	10	5	0	0	5	0
Glyphosate 450 + Hasten	10	10	20	20	0	0	5	0
Glyphosate 450 + LI700	10	10	15	15	0	0	5	0
Glyphosate 450 + Metribuzin	5	5	0	0	0	0	5	5
Glyphosate 450 + Terrad'or + Hasten	60	30	25	50	60	40	30	60
Control	0	0	0	0	0	0	0	0
Sharpen	0	0	0	0	20	7	0	20
Sharpen + Hasten	60	50	5	5	50	50	25	20
Sharpen + CanDo	50	40	5	5	50	40	15	20
Sharpen + Uptake	40	20	5	5	35	40	15	20
Terrad'or	0	0	0	5	30	5	0	20
Terrad'or + Hasten	60	50	35	40	50	50	30	40
Terrad'or + CanDo	60	40	20	30	50	50	20	30
Terrad'or + Uptake	50	30	20	25	30	40	20	40
Control	0	0	0	0	0	0	0	0
Gramoxone + Terrad'or + Hasten	50	50	40	40	90	60	50	50
Gramoxone	15	10	15	20	80	30	10	30
Gramoxone + BS1000	70	60	70	70	90	90	90	30
Gramoxone + Uptake	40	40	60	50	80	60	15	30
Gramoxone + Adigor	60	60	75	40	90	80	70	30
Gramoxone + LI700	70	70	60	50	90	80	80	30
Gramoxone + Hasten	50	30	50	50	80	60	40	30

Knockdown herbicides

Gramoxone 360

While all Gramoxone treatments that included an adjuvant performed better than Gramoxone alone, there were clear differences between the effectiveness of the different adjuvants. For example, the Uptake and Hasten treatments were generally less effective than BS1000, LI700, and Adigor treatments.

Four weeks after application, the most effective treatment in pulses at the Murra Warra site was Gramoxone + Terrad'or® + Hasten, whereas in the cereal and canola it was Gramoxone + BS1000 (Table 5). At Nullawil, Gramoxone + LI700 had the best control for canola and pulses while Gramoxone + BS1000 was the most effective for cereals (Table 6). Treatments that included BS1000, LI700 and Adigor performed similarly in terms of level of control when compared across all crop types. Gramoxone alone exhibited unsatisfactory control.

Glyphosate 450

Glyphosate + Terrad'or® + Hasten outperformed glyphosate alone and all other glyphosate treatments in the Nullawil canola and pulses (Table 6). After four weeks, the treatment effect was unsatisfactory for canola and pulses, which was expected due to the application of a sub-lethal rate to highlight differences between adjuvants for demonstration purposes.

In the cereals, the glyphosate treatments all showed a higher level of control with no noticeable differences found between glyphosate alone or with adjuvants. Adding metribuzin to glyphosate reduced weed control in wheat, barley, and lentils, suggesting growers should take care when considering this practice. Higher on-label rates may overcome this effect. Growers are reminded that this trial was for demonstration purposes, and the findings should be interpreted with caution, given the lack of treatment replication. Vetch at Nullawil was sprayed out early – two weeks after applications – to prevent any seed set at the site, so control scores could not be completed for this crop type.

Table 5. Control scores four weeks after spraying at Murra Warra. Values indicate % control, 0 = no control, 100 = 100% control.

Treatment	IMI Canola	GT Canola	TT Canola	Wheat	Barley	Oats	Lentil	Vetch	Field pea	Chickpea	Faba bean
Terrad'or	0	0	0	0	0	0	0	0	0	0	5
Terrad'or + Hasten	50	60	40	20	20	10	90	5	70	5	5
Terrad'or + CanDo	30	20	20	20	10	10	60	5	70	5	5
Control	0	0	0	0	0	0	0	0	0	0	0
Gramoxone 360 + Terrad'or + Hasten	70	70	70	50	60	90	85	30	90	10	5
Gramoxone 360	0	0	0	30	20	30	0	0	50	5	0
Gramoxone 360 + BS1000	97	90	97	93	85	95	30	0	99	5	0
Gramoxone 360 + Uptake	60	30	20	60	50	60	0	5	20	0	0
Gramoxone 360 + Adigor	50	50	50	90	85	93	20	0	85	5	0
Gramoxone 360 + LI700	70	50	80	80	80	93	10	0	95	5	0
Gramoxone 360 + Hasten	60	40	50	60	75	90	10	5	70	5	5
Control	0	0	0	0	0	0	0	0	0	0	0

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Table 6. Control scores four weeks after spraying at Nullawil. Values are % control. 0 = no control, 100 = 100% control.

Treatment	TT Canola	IMI Canola	Wheat	Barley	Lentil	Field pea	Faba bean
Glyphosate 450	10	15	95	95	30	10	5
Glyphosate 450 + AMS	25	15	100	95	30	10	5
Glyphosate 450 + Uptake	20	10	100	80	30	10	10
Glyphosate 450 + Hasten	20	10	95	95	30	10	10
Glyphosate 450 + LI700	25	10	100	70	40	10	5
Glyphosate 450 + Metribuzin	10	5	60	30	5	10	10
Glyphosate 450 + Terrad'or + Hasten	70	65	95	45	25	70	80
Control	0	0	0	0	0	0	0
Sharpen	0	0	0	0	5	2	5
Sharpen + Hasten	50	40	0	10	15	30	10
Sharpen + CanDo	40	40	0	10	15	15	10
Sharpen + Uptake	40	30	0	0	25	15	10
Terrad'or	5	0	0	0	5	0	10
Terrad'or + Hasten	85	70	25	30	60	50	30
Terrad'or + CanDo	85	75	10	20	40	45	40
Terrad'or + Uptake	50	60	5	20	40	35	30
Control	0	0	0	0	0	0	0
Gramoxone + Terrad'or + Hasten	60	60	20	60	60	75	20
Gramoxone	60	20	10	30	15	30	15
Gramoxone + BS1000	85	85	70	75	90	95	15
Gramoxone + Uptake	70	50	50	50	40	60	20
Gramoxone + Adigor	90	85	80	60	50	75	25
Gramoxone + LI700	90	85	60	60	85	95	30
Gramoxone + Hasten	70	60	70	65	15	60	20

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The results of these trials were presented as demonstrations at the BCG Main Field Day (Nullawil) on 11 September 2024 and at the Wimmera crop walk (Murra Warra) on 18 September 2024.

The demonstration illustrated the significant impact of adjuvants on the success of herbicides. Adding Terrad'or® to glyphosate also accelerated initial brownout and increased overall control. However, glyphosate was sprayed at non-lethal rates for demonstration purposes, therefore at the standard higher rate of glyphosate, this advantage on overall control may be less clear. It is important to choose the right adjuvant for the intended herbicide as this will help growers maximise herbicide impact.

The addition of both Terrad'or® and Hasten to glyphosate seemed to improve control in certain crops, highlighting the importance of considering weed type before choosing whether to include a Group 14 spike. Although no additional benefit was observed from the use of adjuvants with glyphosate in this demonstration, this is contrary to other findings. Label instructions are clear on the use of this herbicide, and growers are encouraged to discuss their approach with an experienced advisor.

Adding metribuzin to glyphosate had a negative impact and reduced weed control on wheat, barley, and lentils. This was expected due to the known antagonistic effect between these chemicals under some conditions. However, this effect may be overcome at higher application rates. Sub-lethal rates were used in this demonstration; given the non-replicated nature of the demonstration, these findings are observations for interest only.

The demonstration showed an adjuvant must be added to Gramoxone 360 for the herbicide to work as expected. This makes sense as it is clearly stated on the label that an adjuvant is required. Using BS1000 over Uptake or Hasten may be a better choice for higher levels of control.

Group 14 herbicides are best used in conjunction with other herbicides to minimise resistance issues. The most effective way to use Group 14 herbicides is to mix them as a spike with a knockdown herbicide, along with the recommended adjuvant specified on the label.

In these demonstrations the use of Group 14 herbicides without adjuvants provided no benefit, nor did the addition of adjuvants to Group 14 herbicides alone. This indicates that – along with the above case for managing resistance – the best use for Group 14 herbicides seems to be as a spike mixed with a knockdown herbicide and appropriate adjuvant.

It is important to note that this trial was set up for demonstration purposes only and was not replicated. Some treatments included the use of off-label chemistry. Growers are advised to use their discretion when considering the findings outlined in this trial, and to discuss their weed control strategy with an experienced advisor.

REFERENCES

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HERBICIDE STRATEGIES FOR CONTROLLING FLAXLEAF FLEABANE

Angus Butterfield (BCG)

TAKE HOME MESSAGES

- Flaxleaf fleabane is a challenging weed to control, but failing to manage it can have significant economic consequences.
- First spray applications are critical for effective flaxleaf fleabane control – premium herbicide products often deliver better results in the first spray.
- The addition of Dropzone® to a standard summer spray significantly improved control of flaxleaf fleabane, while common mixes such as 24-D ester and triclopyr didn't offer additional control over a standard glyphosate mix.
- Glyphosate and Terrad'or® may not be required for the control of flaxleaf fleabane, and the exclusion of these products could significantly reduce costs.

BACKGROUND

The presence of flaxleaf fleabane (Conyza spp.) weed is steadily increasing across key agricultural regions in Australia. Since the adoption of no-till farming systems, the control of fleabane has been increasingly challenging across key cropping regions in Australia. There are seven different fleabane species in Australia, however flaxleaf fleabane is the most prevalent (Walker et al. 2012). Fleabane is a wind-borne surface germinating weed that has natural tolerance to glyphosate and thrives in low competition situations (Daniel, 2015). The weed has a high reproductive capacity, with each plant capable of producing up to 110,000 seeds (Wu, 2012).

Herbicide strategies often fail to control weeds effectively, which poses a threat to agricultural productivity. In the past, soil disturbance through tilling was a successful method of control. However, the shift to no- or low-till farming means that there is now a heavy reliance on knockdown herbicides. Residue herbicides such as clopyralid provide excellent control (Brill et al. 2012), however these herbicides are not ideal for rotations that incorporate pulses. Knockdown herbicides are most effective when applied when fleabane is at the rosette or seedling growth stage. However, emergence occurs between 10 °C and 30 °C, meaning the weed can emerge under an established crop in the spring and is unable to be targeted at early growth stages (Walker et al. 2012). Once the plant elongates, its hairy, narrow leaves and thick cuticle reduce herbicide penetration, complicating control further (Wu, 2012).

AIM

To identify optimal herbicide options for first and second sprays in a double knock strategy.

To investigate the efficacy of camera sprayer rates and evaluate the economic impact of these chemical mixes.

PADDOCK DETAILS

Location:	Jil Jil
Summer rainfall (Nov–Mar):	150mm
Paddock history:	Lentil stubble

TRIAL DETAILS

Target weed species:	Flaxleaf fleabane
Treatments:	Refer to Table 1 and Table 2
Spray dates:	First spray 9 February; Double knock 16 February
Replicates:	Three

METHOD

Two field trials were established to compare the efficacy of herbicide strategies, as outlined in Table 2. These strategies were imposed on a weed-infested site located at Jil Jil, in the Mallee (-35.869551, 142.982099). At the time of trial establishment, fleabane plants were pre-flowering and between 5–10 cm tall. Both field trial designs were randomised complete block with three replicates. The site contained a large population of fleabane at an advanced growth stage. First spray herbicide options compared various Group 4 herbicides to a glyphosate mix (outlined in Table 2), and all treatments were sprayed with a mixture of paraquat 250 2000mL, Terrad'or® 20g and Hasten 1% 7 days after first spray. Second spray herbicide options included different herbicide mixing partners with paraquat, as well as simulated camera sprayer treatments (outlined in Table 3). Treatments for the trial were determined by researchers and local agronomists.

First spray applications were applied on 9 February 2024, followed by a second spray application completed seven days after the initial spray. Both trials were scored using the European Weed Research Council (EWRC) scale (Dear et al. 2003) (Table 1) on days 4, 7, 14, 21 and 28 after the last herbicide application. A lower EWRC score indicates higher efficacy of herbicide control (i.e., weed death). Scores were taken in-field and based on whole-plot assessments. Data from the two trials were analysed separately using one-way ANOVA in Genstat 22nd edition.

Table 1. The European Weed Research Council (EWRC) rating scale for weed control[1].

EWRC score	Efficacy (weed kill)	Weed control (%)
1	Complete kill	100
2	Excellent	99.9–98
3	Very good	97.9–95
4	Good-acceptable	94.9–90
5	Moderate but not generally acceptable	89.9–82
6	Fair	81.9–70
7	Poor	69.9–55
8	Very poor	54.9–30
9	None	29.9–0

[1]This table is recreated from Dear et al. (2003).

RESULTS AND INTERPRETATION

First spray herbicide options: Trial 1

Glyphosate alone (Table 2, Treatment 8) provided poor control of fleabane (68.3% control at 28 days).

The addition of Group 4 herbicides to a glyphosate mix, which are commonly used over summer fallow, displayed mixed results: 24-D ester, Starane® and triclopyr (Treatments 4, 5, 6, and 7) were not significantly different to glyphosate alone, whereas the addition of 2,4-D amine, dicamba and a 2,4-D ester/dicamba mix (Treatments 1, 2, 3) significantly improved control of fleabane.

Dropzone®, a 2,4-D amine formulation, provided the highest control (98.3%).

Cost per hectare for the optimal options (Treatments 1 to 3) were in the mid- to high-cost range, relative to the less effective options, reinforcing the importance of proactive weed management.

Table 2. Herbicide efficacy results showing EWRC, Weed Control % and Cost of first spray treatments 28 days after application.

Treatment no.	Treatment	Rate (g or mL/ha)	EWRC[1]	Weed Control (%)	Cost ($/ha)[2]
1	AMS Triclopyr 600 Dropzone® Glyphosate VC-700	1% 1000 1100 2000 0.25%	1.6[a]	98.3	55.9
2	AMS Dicamba 2,4-D Ester 680 Glyphosate VC-700	1% 500 350 2000 0.25%	5b	85	55.3
3	AMS Triclopyr 600 2,4-D Amine 450 Glyphosate VC-700	1% 100 1200 2000 0.25%	5b	83.3	52.5
4	AMS Triclopyr 600 Dicamba Glyphosate VC-700	1% 100 150 2000 0.25%	5.3[bc]	80	49.7
5	AMS Triclopyr 600 2,4-D Ester 680 Glyphosate VC-700	1% 100 500 2000 0.25%	5.6[bc]	76.7	51.1
6	AMS Triclopyr 600 Starane® Glyphosate Uptake	1% 100 500 2000 0.5%	5.6[bc]	76.7	61.6
7	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	6[bc]	70	47.1
8	AMS Glyphosate VC-700	1% 2000 0.25%	6.6[bc]	68.3	43.6

[1]Data is shown as the mean of three replicates. Superscript letters indicate significant differences. P<0.001, LSD = 1.154, CV = 12.9 %. LSD = Least Significant Difference (P = 0.05), CV = Coefficient of Variation. [2]Costs are based on product information at the time of application. Double knock spray is included in cost.

Second spray herbicide options: Trial 2

High paraquat rates (camera sprayer rates) combined with Terrad'or® and amitrole T at 500 mL, achieved 93% control (Table 3, Treatments 1 and 3). However, high rates of amitrole T (Treatment 7) decreased efficacy, resulting in significantly lower control.

Including effective Group 4 herbicides in the paraquat and Terrad'or® mix (2,4-D amine and Starane®) enabled strong results (90% control) even without glyphosate in the second spray.

This highlights two key points; the importance of Group 4 herbicides in the first spray, and that glyphosate may not be essential for fleabane control. Given the high price of glyphosate ($15.7/ha including AMS and VC-700), adopting this strategy could significantly reduce costs. This, however, may not be the case for other summer weeds, so growers must consider the whole weed spectrum before considering this approach. The addition of Group 14 herbicides with standard paraquat rates did not result in increased control when compared to a paraquat stand-alone double knock. This suggests growers are receiving less value when using 20 g/ha of Terrad'or® on fleabane, given the cost of Terrad'or® at $14.7/ha.

Table 3. Herbicide efficacy showing EWRC, Weed Control % and cost of second spray treatments 28 days after application.

	First spray		Second spray				
Trt no.	**Product**	**Rate (g or mL/ha)**	**Product**	**Rate (g or mL/ha)**	**EWRC[1]**	**Weed Control %**	**Cost ($/ha)[2]**
1	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Triclopyr 600 Paraquat 250 Amitrole T Terrad'or® Hasten	150 4000* 500 40* 1%	3a	93	72.6
2	24-D Amine 450 Starane® Uptake	2000 500 0.5%	Paraquat 250 Terrad'or® Hasten	2000 20 1%	4ab	90	53
3	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250 Amitrole T Terrad'or® Hasten	4000* 500 40* 1%	4.6bc	83	69.1
4	AMS Triclopyr 600 Amitrole T Glyphosate VC-700	1% 100 5000* 2000 0.25%	Paraquat 250 Terrad'or® Hasten	2000 20 1%	5.6 cd	78.3	135
5	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250 Voraxor® Hasten	2000 100 1%	6 cd	72.8	58.2

Continued next page.

	First spray		Second spray				
Trt no.	**Product**	**Rate (g or mL/ha)**	**Product**	**Rate (g or mL/ha)**	**EWRC[1]**	**Weed Control %**	**Cost ($/ha)[2]**
6	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250	2000	6.6 d	66.7	32.5
7	AMS Tricopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250 Amitrole T VC-700	4000* 5000* 0.25%	6.6 d	66.7	135.3
8	AMS Glyphosate VC-700	1% 2000 0.25%	Paraquat 250	2000	6.6 d	66.7	28.9
9	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250 Terrad'or® Hasten	2000 20 1%	6.6 d	66.7	47
10	AMS Triclopyr 600 Glyphosate VC-700	1% 100 2000 0.25%	Paraquat 250 Triclopyr 600	2000 100	6.6 d	66.7	36
11	AMS Glyphosate VC-700	1% 2000 0.25%	Paraquat 250 Terrad'or® Hasten	2000 20 1%	7d	61.7	43.6

[1]Data is shown as the mean of three replicates. Superscript letters indicate significant differences. P<0.001, LSD = 1.492, CV = 15.2 %. LSD = Least Significant Difference (P = 0.05), CV = Coefficient of Variation. [2]Costs are based at time of application. Double knock spray is included in cost. *Results with an asterisk show simulated camera sprayer rates.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

It is crucial for growers to continue efforts to control fleabane and reduce weed seed banks, particularly because the weed populations can increase rapidly due to their prolific seed reproduction.

Findings from these trials indicate that the first sprays were more critical for controlling fleabane than the second. Farmers should consider using premium products in their first spray rather than the second spray.

Premium options like Dropzone® in the first spray phase, combined with effective knockdown strategies, deliver the most effective results, whereas many common mixes such as 24-D ester and triclopyr didn't enhance control over a standard glyphosate mix. In addition, the control provided by paraquat was only improved with increased camera sprayer rates.

Reducing reliance on costly products like glyphosate and Terrad'or® is possible under specific conditions, providing significant cost savings for growers.

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ACKNOWLEDGEMENTS

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PESTS AND DISEASE MANAGEMENT

SLUG MONITORING AND MANAGEMENT 2024

Casey Sim (BCG)

TAKE HOME MESSAGES

- Slugs were active around the Wimmera region, even in a decile 1 growing season.
- Carpet mats are a good, inexpensive way to monitor slug activity.

BACKGROUND

The widespread adoption of no/low till farming and stubble retention management practices on farm, whilst benefiting soil moisture retention, has also inadvertently favoured slug populations. These changes to management practices, in combination with recent wet seasons in the Wimmera, have created ideal conditions for slug activity and breeding. Ultimately, this has led to increased seedling damage and yield losses from these pests, as well as higher operational costs for controlling them. Slugs are establishment pests and reduce yields primarily by cutting seedling numbers. Canola is particularly susceptible to yield losses, with previous trials finding losses of up to 60–80 per cent (GRDC, 2024).

A major challenge for growers dealing with slugs is managing bait applications to best avoid seedling damage and yield losses. Baiting is not only expensive, typically costing Victorian growers $30/ha–$120/ha (GRDC, 2024) but can also be inefficient when applied reactively. Slugs are tricky targets, and baiting is only effective if conditions are adequate for surface activity and slugs are feeding. Baits do not attract slugs, so they must encounter them to be effective. If baits are applied too early in the season, slugs may not yet be active and the baits may need to be reapplied, wasting resources. If applied too late, once seedling loss has already occurred and establishment is slower, slugs may be breeding and require higher rates of bait over a longer period to protect seedlings. Previous research has established thresholds for *Deroceras reticulatum* (grey field slug) populations and crop damage, with populations as low as 1 slug per refuge trap causing seedling losses (Nash et al, 2024). Economic thresholds are yet to be developed for other key pest slug species under Australian conditions.

BCG is in the first of a three-year project funded by GRDC, and managed by SARDI and the University of Adelaide. This project seeks to gain a better understanding of slug population dynamics, improve in-field monitoring and evaluate spring baiting as a population control strategy. The goal is to provide growers with well-informed strategies for monitoring and managing slug populations.

METHOD

This project has two components: monitoring, and a bait trial to be conducted in 2025. Six monitoring paddocks with known slug populations were set up in March 2024 for slug monitoring over the next three years (see Table 1 below). Twenty slug mats (250mm by 250mm) were set up in two transects of 10 mats spaced 10m apart. Locations within the paddock for monitoring were selected based on yield maps from previous years where significant yield losses attributed to slug damage were observed.

Monitoring was conducted monthly. Data on the number and species of slug under each mat were collected, and a subsample of slugs was sent to SARDI for dissection to identify slug development stage (adult or juvenile). At the time of monitoring, several environmental metrics were taken including temperature (ambient, bare soil, and under mat temperature), soil moisture (ranked by feel such as dry, moist, wet), weather conditions, wind, and time of day.

Growers managed paddocks as per usual, including current slug management practices. All sites were baited after sowing with the exception of Site 4.

Table 1. Slug Monitoring Paddocks 2024.

Site no.	Region	Crop type 2024	Previous crop
Site 1	Kewell	Wheat	Lentil
Site 2	Vectis	Canola	Lentil
Site 3	McKenzie Creek	Canola	Faba bean
Site 4	Clear Lake	Faba bean	Wheat
Site 5	Laharum	Oat	Canola
Site 6	Bungalally	Faba bean	Barley

RESULTS AND INTERPRETATION

Seasonal overview

Coming into 2024, slug populations were likely elevated due to the relatively wet seasonal conditions experienced during 2022 and 2023. Slugs can live for up to two years and, being opportunistic breeders, they breed whenever conditions are suitable rather than seasonally. The decile 1 growing season rainfall experienced in the Horsham area in 2024 meant slug activity was relatively lower than previous years (Figure 1).

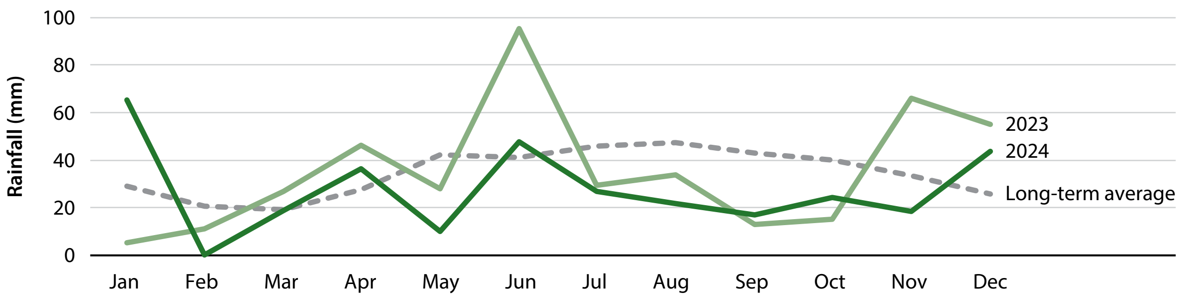

Figure 1. 2023, 2024, and long-term average rainfall for Horsham. Data sourced from the Bureau of Meteorology weather station number 79028 at Longerenong.

Over summer, slugs remain dormant in patches of moisture within the soil and typically only emerge to the soil surface when it reaches 96 per cent relative humidity, and soil gravimetric moisture is 20–45 per cent (GRDC, 2024). These conditions often occur after the autumn break. In 2024, the autumn break was not a distinctive rainfall event. However, 29mm of rainfall in the first week of April, in combination with higher-than-average stored soil moisture from a wet summer was thought to have been adequate for slugs to become surface-active. As such, slugs were observed at all monitoring sites after this 'false break'. Slug activity decreased after April and throughout winter, due to several factors. Firstly, all sites excluding site 4 were baited after sowing. Secondly, the soil surface at this time remained relatively dry, a product of low rainfall and slow growing crops reducing ground coverage and increasing evaporation area. However, as crops reached canopy closure, soil moisture was trapped at the surface and increased relative humidity. This along with accumulated rainfall and higher temperatures going into spring, likely created a more ideal environment for slug activity, which increased in late winter and early spring. Further temperature increases and a reduction in crop canopies as crops reached maturity resulted in less soil surface relative humidity and a decrease in slug activity in late spring.

While the above outlines the general trend observed at all sites, several different species were observed at certain sites. Not all slug species behave in the same way and have different temperature and moisture thresholds for surface activity; this is explored in further detail below in the section, 'Species Breakdown'.

Damage

The autumn break meant slug activity in 2024 was relatively lower than previous years during crop establishment. Significant damage to the crop was only observed on faba beans at Site 4 (Figure 3). Some feeding damage in the other faba bean paddock (Site 6) and both canola paddocks (sites 2 and 3) was observed early in the season, however damage was minor and often only observed on the crop when it had passed the growth stage when yield would be affected (4L canola) (Figure 3).

Figure 3a. Slug damage to canola at site 2 at the 8 leaf growth stage.

Figure 3b. Slug damage to faba bean seedling at site 4 at 2 node growth stage.

Figure 3c. Slug damage to faba bean at site 4 during flowering.

SPECIES BREAKDOWN

Black keeled slugs

Figure 4. Black keeled slugs observed at site 1.

Black keeled slugs were the most common species observed in 2024, distinguishable from other species by the keel (ridge) running along their tail (see Figure 4). During March, black keeled slugs (BKS) were only observed at site 1 but peaked the following month at multiple sites (Figure 5). Activity then decreased in early winter before increasing again in late winter to early spring. The soil moisture threshold for surface activity is generally higher for black keeled slugs relative to other species (50mm to 100mm rainfall), this means they are generally observed later in the season than other species. However, as the area received average summer rainfall and the soil profile held greater moisture, this threshold may have been reduced coming into the 2024 growing season and as such they were first observed at a similar time to other species.

Where other slug species are primarily surface-dwelling and seek refuge in cracks in the soil, BKS burrow down into the soil to seek moisture. The burrowing behaviour often leads to underestimated populations for this species, particularly in dry years. This may be why they were only observed in low numbers throughout winter, with a combination of baiting after sowing and dry conditions increasing their burrowing behaviour. BKS can be more damaging in lower numbers than other species because they can burrow into the seed bed and feed on seeds, reducing plant density. Canola is particularly susceptible (GRDC, 2024).

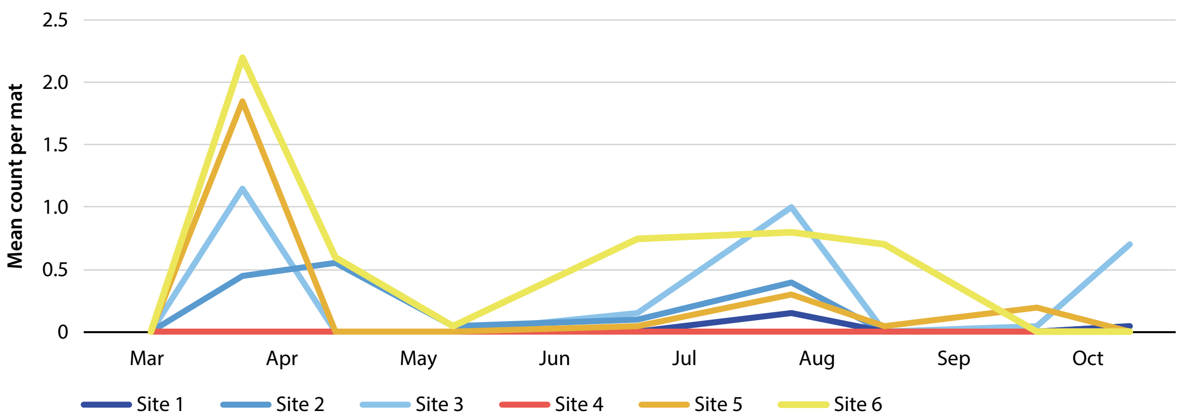

Figure 5. Average number of black keeled slugs per mat observed monthly throughout 2024.

Brown field slugs

Figure 6a. Brown Field Slugs (image source Micheal Nash).

Figure 6b. Brown Field Slug eggs observed at site 5.

Brown field slugs (BFS) are ambiguous in appearance but can be distinguished from other species by their brown/grey colour, clear mucus, and tail flicking behaviour when agitated (see Figure 6). Dissections determined the species was *Deroceras invadens*. BFS were only observed at one site at the beginning and towards the end of the growing season (see Figure 7). Brown field slugs are typically more active in warm conditions, which is why they became active later in spring than BKS, after temperatures had further increased. During the October count, eggs were also observed under one of the mats, suggesting despite low rainfall, the crop canopy and slug mats allowed for sufficient relative humidity for this species to breed (see Figure 7). This species is typically less damaging to crops than other species and mainly found in pastures. These slugs were only found in an oat paddock, and no damage to the emerging crop was observed.

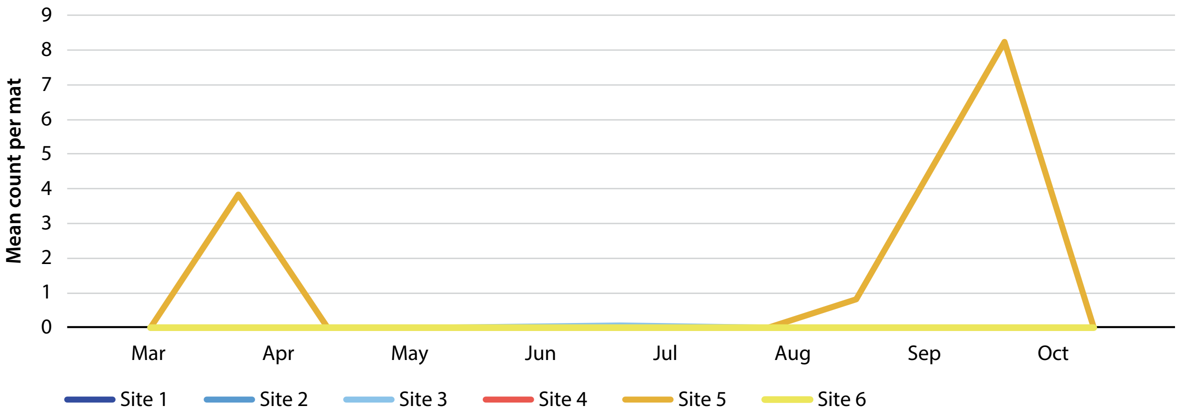

Figure 7. Average number of Brown field slugs per mat observed monthly throughout 2024.

Striped field slug

Figure 8. Striped field slugs observed at Site 4.

The Striped field slug (SFS) is easily distinguishable from other slugs by the dark brown tram tracks (two or three stripes) running down their body (see Figure 8). Limited dissections suggest this species was *Ambigolimax valentianus*. This species was continually observed at site 4 throughout the growing season but was also observed in April at site 3 in low numbers at the beginning of the season (see Figure 9). Compared to other slug species, SFS seemed to be more active in drier conditions. These ideal environmental conditions and the fact that the paddock was not baited or rolled may explain why this species was observed in greater numbers, with up to 82 slugs counted under a single mat. They are not known to cause economic damage. However, they were observed doing the greatest feeding damage of any species. This may have been a product of a high population density and relatively low food sources. Damage was also mostly to the lower canopy of faba beans after they were established, past a growth stage where yield would be affected.

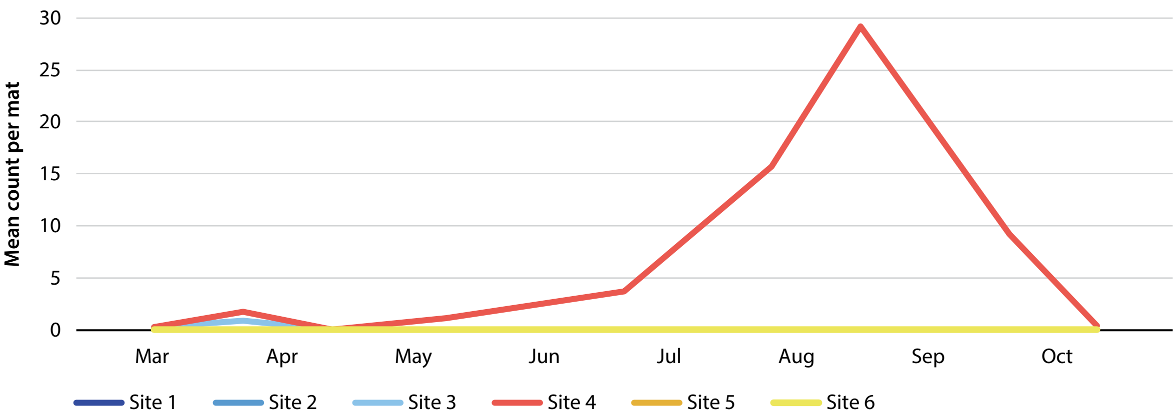

Figure 9. Average number of Striped field slugs per mat observed monthly throughout 2024.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

These initial results highlight that, even in years with decile 1 growing season rainfall, relative humidity at the soil surface can still be high enough for slug activity and reproduction.

One of the objectives of this project is to validate the efficacy of carpet slug mats for monitoring slug activity and their practicality for farmer use. Traditionally, ceramic tiles or bait lines have been used, however these methods have limitations that often lead to populations being underestimated. The slug mats used in this study presented some challenges in monitoring slug populations, particularly around maintaining an ideal environment for slugs. The mats are good insulators but due to seasonal conditions were put down wet, onto dry soil. The mats then dried out and protected the soil underneath from rain, meaning the environment underneath stayed dry. Moving the mats onto damp soil remedied this issue, as the area under the mats was then able to stay moister relative to bare soil. Temperature data collected at the time of monitoring also showed soil temperature was often cooler under the mat than at the bare soil, creating a more ideal environment for slug activity. Overall, these mats present a good, inexpensive option for growers who want to monitor slug populations, as long as they are placed onto moist soil. Baits can be placed under the mat for ease of monitoring. The mats also provided a refuge for other pest and beneficial species, such as slaters, millipedes, carabids and spiders. Highlighting they could be useful for monitoring other soil surface dwelling pests and beneficials of interest.

Further years of monitoring by BCG and other groups in the medium rainfall zone will be used to produce a model that assesses management options and takes an integrated approach to slug control, with the aim of providing growers with more efficient and economic options for slug control.

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INTEGRATED MANAGEMENT STRATEGIES FOR MANAGING SEPTORIA TRITICI BLOTCH (STB) IN WHEAT IN THE MEDIUM AND LOW RAINFALL REGIONS OF VICTORIA

Hari Dadu (Agriculture Victoria), Grant Hollaway (Astute Ag),
Yolanda Plowman and Ashlee Tierney (BCG)

TAKE HOME MESSAGES

- Proactive disease management, which combines variety selection, paddock selection and appropriate fungicide use, provides proven sustainable and economic disease control.
- Septoria tritici blotch (STB) reduced grain yield in highly susceptible wheat varieties by 21 per cent in the MRZ (Wimmera) during 2024. However, yield losses may be reduced if sowing time can be adjusted as part of integrated control of STB.
- Monitoring symptoms is critical for STB control. To maximise efficacy, apply fungicides after the appearance of first symptoms on the lower canopy.

BACKGROUND

Septoria tritici blotch (*Zymoseptoria tritici,* STB), is a stubble-borne fungal disease of wheat, that is now widespread and damaging in many parts of Victoria. In recent years, it has become the most prevalent disease across Victoria's medium (MRZ) and low (LRZ) rainfall zones with grain yield losses of greater than 20 per cent in susceptible crops during seasons conducive for the disease. The increased incidence and distribution of the disease is largely due to current intensive farming practices, including no-till and stubble retention, which have led to inoculum build-up. During 2022, Agriculture Victoria (AgVic) and Birchip Cropping Group (BCG) trials showed up to ~43 per cent yield loss and quality reductions in susceptible varieties, demonstrating that losses can be greater during wet seasons (Dadu et al., 2022).

To determine the best management practices suited to LRZ and MRZ for STB control, Agriculture Victoria in partnership with the South Australia Research and Development Institute (SARDI) – with supporting investment from GRDC – conducted 48 field experiments over four seasons during 2021–24. This research revealed yield losses can be significantly reduced by avoiding susceptible varieties, adjusting sowing time, managing stubble loads, rotating wheat with other crops, and using foliar fungicides. This article summarises the results from two experiments conducted during 2024 in the MRZ, Victoria, to optimise sowing time and fungicide timing for STB management.

AIM

- To determine optimal sowing time for management of STB in wheat.
- To optimise fungicide application timing for better efficacy of STB control.

PADDOCK DETAILS

Location:	Longerenong (MRZ)
Crop year rainfall (Nov–Oct):	338mm
GSR (Apr – Oct):	149mm
Soil type:	Clay
Paddock history:	Faba bean

TRIAL DETAILS

Crop type/s:	Wheat
Treatments:	Refer to Tables 1 and 2
Target plant density:	150 plants/m^2
Seeding equipment:	Knife points, press wheels, 30 cm row spacing
Sowing date:	Early sown: 24 April 2024; Late sown: 21 May 2024; Fungicide timing: 24 April 2024
Replicates:	Six
Harvest date:	5 December 2024
Trial average yield:	5.5t/ha

TRIAL INPUTS

Fertiliser:	Trials managed as per best practice reflecting the region and to ensure nutrients are not limiting.
Herbicide/Insecticide:	Trials kept weed and pest free.
Fungicide:	Refer to Tables 1 and 2
Seed treatment/inoculant:	Refer to Tables 1 and 2

METHOD

1. Experiment 1: Sowing time as a strategy for STB management

During 2024, two field experiments with two times of sowing – one sown on 24 April (early) and one sown on 21 May (late) – were compared in the MRZ at Longerenong, Victoria. Each experiment included three wheat varieties (Hammer CL Plus (MSS), Scepter (S) and Razor CL Plus (SVS)) in six replicates and two treatments (inoculated with +/- disease) sown in a randomised block design (Table 1). Both experiments were assessed for disease severity, grain yield and quality.

2. Experiment 2: Optimise fungicide timing for better efficacy

During 2024, one field experiment was conducted in the MRZ at Longerenong, Victoria.
The experiment was sown to a susceptible variety, Scepter, and inoculated with infected stubble. The experiment was visually monitored for disease, and fungicide treatments applied at incremental disease levels with effects compared to a minimum disease control (Table 2). All the treatments were replicated six times and assessed for disease severity, grain yield, and quality.

Table 1. Sowing time experiment treatment outline for both early and late sown experiments*

Treatment	Product	Active ingredient (gai/L)	Rate
Minimum disease	Jockey Stayer® + Elatus™ Ace® at Z31 + Maxentis® at Z39 and Soprano® at Z55	Fluquinconazole 167g/L + Benzovindiflupyr 40g/L + Propiconazole 250g/L + Azoxystrobin 133g/L + Prothioconazole 100g/L and Epoxiconazole 125g/L	300mL/100kg seed + 500 + 600 and 125mL/ha
Maximum disease	No disease control with STB infected wheat stubble and nil fungicide in season		

*Triadimefon applied at 300mL/ha to all plots to selectively control stripe rust.

Table 2. Fungicide timing experiment treatment outline*

Treatments/Fungicide application timing	Product	Active ingredient (gai/L)	Rate
Symptomless	Elatus™ Ace®	Benzovindiflupyr 40g/L + Propiconazole 250g/L	500mL/ha
First symptoms	Maxentis®	Azoxystrobin 133g/L + Prothioconazole 100g/L	600mL/ha
Secondary symptoms	Maxentis®	Azoxystrobin 133g/L + Prothioconazole 100g/L	600mL/ha
Symptomless + Secondary symptoms	Elatus™ Ace® + Maxentis®	Benzovindiflupyr 40g/L + Propiconazole 250g/L + Azoxystrobin 133g/L + Prothioconazole 100g/L	500 + 600mL/ha
Minimum disease	Jockey Stayer® + Elatus Ace™® at Z31 + Maxentis® at Z39 and Soprano® at Z55	Fluquinconazole 167g/L + Benzovindiflupyr 40g/L + Propiconazole 250g/L + Azoxystrobin 133g/L + Prothioconazole 100g/L and Epoxiconazole 125g/L	300mL/100kg seed + 500 + 600 and 125mL/ha
Maximum disease	No disease control with STB infected wheat stubble and nil fungicide in season		

RESULTS AND INTERPRETATION

1. Sowing time as a strategy for STB management (Experiment 1)

Septoria tritici blotch (STB) severity significantly varied with sowing time, variety, and fungicide application. Early sowing in April demonstrated losses of up to 21 per cent (~1.2t/ha) in susceptible varieties because of higher STB infection levels of up to 33 per cent at late flowering stage (Table 3). However, when sowing was delayed by about a month and still within the optimal sowing window, the risk from disease significantly reduced and no yield was lost. Equally, by avoiding susceptible varieties yield loss was minimised even when sown early. Early sowing allows for more disease infection cycles causing significant yield loss, while delayed sowing would avoid early release of spores from stubble, delay primary infection, and reduce risk of yield loss.

Higher STB severity in early sown experiment also affected grain quality of Scepter (S) and Hammer CL Plus (MSS), with a small increase in screenings and reduction in 1000 grain weight, but did not affect protein (data not shown). Late sowing did not affect the grain quality of any of the three wheat varieties.

These experiments clearly highlighted the benefit of integrating different management strategies to avoid disease impacts which may even mitigate the need for fungicide intervention. The finding of reduced impacts of STB from avoiding susceptible varieties and delayed sowing is consistent with the findings of Murray et al. (1990). With increasing occurrences of fungicide resistance in diseases in Victoria, it is beneficial to have strategies that can suppress disease severity.

Table 3. Septoria tritici blotch severity and grain yield of wheat varieties with (Max) and without (Min) disease, sown in separate experiments on 24 April (early) and 20 May (late) at Longerenong (MRZ), Victoria, 2024.

Variety	Rating[E]	Disease severity[A] (% leaf area affected) in Max. treatment		Grain yield (t/ha)					
		Early sown	Late sown	Early sown			Late sown		
		22 Sep Z65[B]	14 Oct Z65	Max.[C]	Min.	Loss (%)[D]	Max.	Min.	Loss (%)
Hammer CL Plus	MSS	12[a]	1[a]	5.50	5.93[ns]	0	6.01	6.03[ns]	0
Scepter	S	31[b]	5[c]	5.21	6.30*	17	6.09	6.57[ns]	0
Razor CL Plus	SVS	33[b]	3[b]	4.51	5.69**	21	5.69	5.72[ns]	0
	P	0.001	<0.001						
	LSD (0.05)	10.4	1.1						

[A]Within column means with one letter in common are not significantly different (0.05). ** = statistically significant at 1% and * = 5%; ns = not statistically significant when the Max and Min treatments were compared. [B]Date of assessment made and Zadoks growth stage. [C]Max. = Maximum disease treatment (No disease control with 1kg STB infected wheat stubble); Min. = Minimum disease treatment (No stubble, seed (Fluquinconazole 167g/L @ 300mL/ha), Foliar applied fungicide at Z31 (Benzovindiflupyr 40g/L + Propiconazole 250g/L @ 500mL/ha) + Z39 (Azoxystrobin 133g/L + Prothioconazole 100g/L @ 600mL/ha) + Z55 (Epoxiconazole 500g/L @ 125mL/ha). [D]Yield loss % for each variety was presented as % yield decrease vs the minimum disease treatment. EDadu (2024) Cereal Disease Guide 2024.

2. Optimising fungicide time and efficacy (Experiment 2)

Fungicides effectively suppressed STB infection in Scepter (S) and increased grain yield by 13 per cent when compared to the untreated treatment (Table 4). In addition, grain retention and thousand grain weight were also improved (Table 5). Fungicides were more effective when applied after STB symptoms were detected in the crop. This finding contradicts the general consensus that preventative applications are more effective for STB control. However, a pre-emptive foliar application alone did not provide complete control and an additional application was needed, increasing the economic cost of the management. The long latent period (~30 days), which is the time between infection and appearance of first symptoms, poses challenges for timely fungicide application. Delaying application could lead to underestimation of the disease risk and lead to yield loss, while applying too early may result in suboptimal control.

Therefore, monitoring symptoms in wheat crops for STB is critical to improve the efficacy of applied fungicides. Early season STB infections typically affect lower leaves in the canopy. As the canopy develops, disease progresses upwards to the yield-contributing flag leaves when there is sufficient rain to support epidemic progression. Application of fungicides upon detection of the first symptoms in the lower canopy can intercept latent infections early in the upper canopy, offering better control.

In this experiment, the first symptoms of STB were detected on the lower canopy at stem elongation stage (Z37), much later than the traditional stage (Z31) routinely used for fungicide application. The secondary symptoms were marked as symptom appearance on the flag leaves, which were detected around the early booting stage (Z41). Given the below average seasonal conditions during 2024, single fungicide applications at either of the growth stages provided levels of protection from STB equal to a dual or a triple application strategy. This supported previous season results that use of multiple fungicide applications would not be economical in seasons with dry weather.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Table 4. STB severity (%) in the wheat variety Scepter (S) in response to different fungicide treatments at Longerenong, Victoria during 2024.

Treatments	Disease severity (% leaf area affected)		
	19 Aug Z39[A]	13 Sep Z55[B]	22 Sep Z65
Maximum disease	9^{d}	19^{c}	45^{e}
Symptomless	4^{a}	10^{b}	25^{d}
First symptoms	5^{b}	5^{a}	8^{bc}
Secondary symptoms	7^{c}	8^{b}	12^{c}
Symptomless + Secondary symptoms	4^{a}	4^{a}	3^{ab}
Minimum disease	6^{b}	4^{a}	2^{a}
P	<0.001	<0.001	<0.001
LSD (0.05)	1.2	2.9	5.8

[A]Within column means with one letter in common are not significantly different (0.05).
[B]Date of assessment made and Zadoks growth stage.

Table 5. Grain yield and quality of wheat variety Scepter (S) infected with STB in response to different fungicide treatments at Longerenong, Victoria, 2024.

Treatments	Grain yield (t/ha)	Yield gain %[B]	Protein (%)	Screenings <2.2mm	Retention >2.5mm[A]	1000gw
Maximum disease	5.2	-	10.3	4.4	87.7^{a}	44.3^{ab}
Symptomless	5.7		10.3	4.7	87.3^{a}	44.1^{a}
First symptoms	5.8		10.2	4.4	88.6^{abc}	44.9^{ab}
Secondary symptoms	5.9		10.5	4.2	89.7^{bc}	46.2^{b}
Symptomless + Secondary symptoms	5.8		10.4	3.9	90.5^{c}	46.3^{b}
Minimum disease	5.9	13	10.5	3.4	93.5^{d}	49.4^{c}
P	0.109		0.716	0.147	<0.001	<0.001
LSD (0.05)	*ns*		*ns*	*ns*	2.41	2.02

[A]Within a column, means with one letter in common are not significantly different (0.05).
[B]Yield gain % is the percentage yield increase vs the untreated control.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Septoria tritici blotch (STB) is now the most common foliar disease of wheat in Victoria's medium-rainfall (Wimmera) and low-rainfall (Mallee) zones. In 2022, grain yield losses in the Wimmera exceeded 40 per cent, while in 2023 losses in the Mallee reached up to 10 per cent (Dadu et al., 2022, 2023). These findings underscore the critical need for effective management strategies to control STB.

From 2021 to 2024, Agriculture Victoria (AgVic), in collaboration with BCG, conducted many field experiments in the Wimmera and Mallee (Dadu et al., 2021, 2022, 2023). These studies highlighted that the economic outcomes of disease management strategies vary depending on factors such as grain yield potential, variety selection, seasonal conditions, fungicide use, stubble loads, and crop rotation practices.

In summary, losses were minimised by implementing the following integrated disease management (IDM) strategies:

Variety selection: Planting resistant varieties is strongly recommended where possible. In the Wimmera and Mallee regions, yield losses can be substantially reduced by selecting varieties with at least a MS and MSS rating, respectively, without relying on fungicides. In contrast, continuous cultivation of susceptible varieties significantly elevates the risk of yield loss from STB (Murray et al., 1990; Dadu et al., 2022).

Paddock selection: Avoid planting wheat-on-wheat as STB is a stubble-borne disease. A break of at least a year has proven effective in reducing inoculum carryover. However, wheat sown following a break crop remained vulnerable to wind-blown spores from wheat stubble in surrounding paddocks, emphasising the importance of implementing further measures for effective disease management.

Stubble management strategies: Manipulating stubble loads through methods such as burning or baling has been shown to reduce inoculum levels and decrease early in-crop disease risk.

Seasonal conditions: Wet, cool conditions (15°C–20°C) with frequent rain or dew create an environment conducive to high levels of STB infection. In wet years with frequent rain events, STB pressure is generally higher, leading to more severe disease outbreaks (Murray et al., 1990; Dadu et al., 2022). Alternatively, in drier seasons, disease pressure is typically lower due to reduced moisture and fewer opportunities for infection. However, localised outbreaks can still occur if specific rainfall events create favourable conditions.

Sowing time: Avoid early sowing, especially when using susceptible varieties. STB spores are typically released from stubble early in the season, and delaying planting allows crops to avoid this initial spore release. Sowing later can limit crop exposure to multiple infection cycles, effectively reducing the overall risk of disease.

Use of fungicides and timing of application: Fungicides have proven effective in suppressing STB infection, but their application can generally be avoided in seasons with below-average rainfall and where grain yield potential is less than 3t/ha. For example, in 2021, fungicide use in both the MRZ and LRZ was not economical (Dadu et al., 2021). However, when susceptible varieties are sown in wet seasons, fungicide strategies should include applications at both growth stages 31 and 39 (Dadu et al., 2022). To maximise efficacy, the timing of fungicide applications should align with disease progression. Applications made after symptoms appear in the lower canopy have been shown to provide better control than pre-emptive applications made before symptoms are detected.

This study did not focus specifically on fungicide choices, but it is important to note that STB populations have the potential to develop resistance to fungicides, so their unnecessary use should be avoided. Based on historic studies by NSW DPI, it is known that reduced sensitivity to the triazole (DMI, Group 3) fungicides is well established in Victoria. Furthermore, a sample tested in 2024 revealed the presence of a resistance mutation to strobilurin fungicides (QoI, Group 11) which is concerning. It is recommended to consult the Australian Fungicide Resistance Extension Network (AFREN) and follow their fungicide resistance management strategies to help mitigate the risk of resistance development in STB populations. For more information on fungicide resistance, go to the website <www.afren.com.au>.

CONTENTS

VARIETIES AND THEIR MANAGEMENT

FARMING SYSTEMS

CROP AGRONOMY

WEED MANAGEMENT

PESTS AND DISEASE MANAGEMENT

LIVESTOCK

SOILS

SOWING CONSIDERATIONS

CROP END USE

APPENDICES

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OPTIMISING DISEASE CONTROL IN SOUTHERN VICTORIAN MALLEE CEREAL CROPS

Meg Conlan, Dr Yolanda Plowman, Casey Sim (BCG), and Grant Hollaway (Astute Ag)

TAKE HOME MESSAGES

- Effective disease management requires tailoring strategies to crop variety, seasonal conditions and disease levels.
- Minimising fungicide use in low-disease years can improve profitability without compromising yield.
- Fungicide timing at key growth stages is essential for maximising yield and profitability in disease-prone seasons.

BACKGROUND

The variable nature of disease, which is driven largely by rainfall, complicates in-crop disease management in the southern Mallee. In disease-prone seasons, poor fungicide management can result in significant yield losses, highlighting the need for effective control strategies. Conversely, in low-disease years, fungicide applications often provide no yield benefit, instead increasing costs and reducing profit. Wheat in the region is commonly affected by Septoria tritici blotch and stripe rust, while barley is impacted by spot form of net blotch (SFNB) and net form of net blotch (NFNB).

This report details the second year of a GRDC project. Results from 2023 emphasised the importance of avoiding highly susceptible cereal varieties to mitigate disease risk and demonstrated premium fungicide treatments do not always yield better economic returns (Jones and Plowman, 2023). Previous research by Agriculture Victoria and BCG in the southern Mallee found SFNB reduced yields of susceptible barley varieties by 17 per cent in 2016 and 10 per cent in 2017 (McLean et al., 2022). Another study in 2022 showed foliar diseases could reduce wheat yields by up to 50 per cent, underscoring the significant threat these diseases pose during a conducive season (Dadu et al., 2022). These yield losses were mitigated by using integrated disease management strategies, including variety selection and timely fungicide application (Dadu et al., 2022).

To support growers facing challenges with disease management amid seasonal variability, field trials focused on variety selection, optimising fungicide timing, and evaluating fungicide options. These trials aim to provide practical recommendations for enhanced disease control and improved profitability for growers in the southern Mallee.

AIM

This study aimed to enhance cereal disease management in the southern Mallee region by:

- Assessing how various wheat and barley varieties with differing disease resistance ratings performed during the 2024 season.
- Identifying the most effective timings for fungicide application to control disease.
- Evaluating the effectiveness and economic viability of different fungicide options for disease control.

PADDOCK DETAILS

Location:	Nullawil
Crop year rainfall (Nov–Oct):	361mm
GSR (Apr–Oct):	178mm
Soil type:	Loamy clay
Paddock history:	Vetch brown manure

TRIAL DETAILS

Crop type/s:	Wheat and barley
Treatments:	Refer to Tables 2, 3 and 4
Target plant density:	130 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	22–24 May 2024
Replicates:	Three or four
Harvest date:	12 November 2024 (barley), 9 December 2024 (wheat)

TRIAL INPUTS

Nutrition, weeds and insects were managed as per best practice.

METHOD

Six trials were set up at Nullawil, in the Victorian southern Mallee, with three trials each dedicated to wheat and barley. The trials aimed to investigate different varieties, fungicide timings, and fungicide product selection for foliar disease management. Wheat and barley varieties with varying resistance ratings were sown (Table 1) and subjected to either a high (nil control) or low (full control) disease treatment (Table 2, Trials 1 and 4). Additional trials focused on wheat varieties Scepter and LRPB Matador, as well as barley varieties Maximus CL and RGT Planet, to examine various fungicide timing applications (Table 3, Trials 2 and 5) and fungicide product selection (Table 4, Trials 3 and 6).

All trials were set up using randomised complete block designs with three or four replicates. Assessments included disease severity, establishment counts, and yield parameters. Disease severity was visually assessed by estimating the percentage of leaf area affected with disease on eight occasions during the season, from GS15 to GS55. These severity estimates were used to calculate the Area Under the Disease Progression Curve (AUDPC), providing a cumulative measure of disease severity over time (Brown and Keane, 1997).

Table 1. Disease resistance ratings[1] for wheat and barley varieties used in the southern Mallee disease management trials (1 and 4) during 2024.

Disease	Variety					
	Wheat					
	Scepter	Ballista	Vixen	Valiant	Matador	Sunblade
Septoria tritici blotch	S	SVS	S	MSS	S (P)	S
Stripe rust	MSS	MSS	SVS	S	MS	MRMS
Leaf rust	MSS	S	SVS	S	MSS	MSS
	Barley					
	Combat	Maximus	Commodus	Planet	Titan	Neo
Spot form of net blotch	RMR	MS	MSS	SVS	MS	MR (P)
Net form of net blotch	MRMS	MRMS	MSS	SVS	MS	MS (P)
Scald	S	SVS	SVS	SVS	VS	S (P)

MR=moderately resistant, MRMS=moderately resistant to moderately susceptible, MS=moderately susceptible, MSS=moderately susceptible to susceptible, S=susceptible, SVS=susceptible to very susceptible, VS=very susceptible, P=provisional.

[1]Disease ratings were sourced from GRDC National Variety Trials.

Table 2. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'variety' trials (Trials 1 and 4) in the southern Mallee during 2024.

Treatment		Product	Active ingredient	Timing	Rate
Wheat					
i)	High disease	No fungicide	-	-	-
ii)	Low disease	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
		Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300mL/ha
Barley					
i)	High disease	No fungicide	-	-	-
ii)	Low disease	Systiva	333g/L Fluxapyroxad	Sowing	150mL/100kg seed
		Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300mL/ha

Growth stage according to Zadoks scale, GS15=seedling growth, GS31=stem elongation, GS39=flag leaf emergence, GS55=head emergence (Zadoks, et al., 1974).

Table 3. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'fungicide application timing' trials (Trials 2 and 5) in the southern Mallee during 2024.

Treatment/product		Active ingredient	Timing	Rate
Wheat				
i)	Nil control	-	-	-
ii)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
iii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
iv)	Aviator Xpro	15g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
v)	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
vi)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
vii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
viii)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
ix)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
Barley				
i)	Nil control	-	-	-
ii)	Systiva	333g/L Fluxapyroxad	Sowing	150mL/100kg seed
iii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
iv)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
v)	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vi)	Systiva	333m/L Fluxapyroxad	Sowing	150mL/100kg seed
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
viii)	Aviator Xpro	150g/L Prothioconazole, 75 g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
ix)	Systiva	333ml/ha Fluxapyroxad	Sowing	150mL/100kg seed
	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha

Table 4. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'fungicide strategy' trials (Trials 3 and 6) in the southern Mallee during 2024.

Treatment		Product	Active ingredient	Timing	Rate (mL/ha)
Wheat					
i)	Nil control	No fungicide	-	-	-
ii)	Triazole only	Epoxyconazole 125	125g/L Epoxyconazole	GS31	500
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS39	300
iii)	Mid-range 1	Epoxyconazole 125	125g/L Epoxyconazole	GS31	500
		Maxentis	210g/L Prothioconazole, 210g/L Tebuconazole	GS39	400
iv)	Mid-range 2	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS31	600
		Epoxyconazole 125	125g/L Epoxyconazole	GS39	500
v)	Expensive	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
vi)	Full control	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300
Barley					
i)	Nil control	No fungicide	-	-	-
ii)	Triazole only	Propiconazole 250	250g/L Propiconazole	GS31	500
		Proviso	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	250
iii)	Mid-range 1	Propiconazole 250	250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
iv)	Mid-range 2	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS31	600
		Proviso	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	250
v)	Expensive	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
vi)	Full control	Elatus Ace	40 g/LBenzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300

RESULTS AND INTERPRETATION

Seasonal conditions and diseases present

Nullawil received 178mm (Decile 1) of rainfall during the growing season, leading to dry seasonal conditions and low overall disease pressure. Despite the dry conditions, Septoria, rust, and yellow leaf spot (YLS) were observed in wheat, while barley was affected by spot form of net blotch (SFNB), net form of net blotch (NFNB), and scald. Stored soil water resulted in higher yield than would have been expected based solely on in-crop rainfall.

Trial 1: Wheat varieties with and without disease

Disease presence and resistance rating alignment

Disease progression was monitored throughout the season, with Septoria detected in all plots during the early growth stages (GS31 to GS39). By mid-season (GS39), additional diseases, including stripe rust, became evident. Late-season assessments (GS55 and two weeks post-GS55) revealed the presence of stripe rust, Septoria, and YLS across all varieties.

In the high disease treatments, a clear relationship was observed between disease severity and variety susceptibility to stripe rust. The lowest disease severity was recorded in the Sunblade CL Plus low disease treatment (MRMS, AUDPC 111), while the highest was in the Vixen high disease treatment (SVS, AUDPC 435) (Table 5). Even under low disease treatments, susceptible varieties such as Vixen exhibited substantial disease loads (AUDPC 231) (Table 5). Although low disease treatments significantly reduced disease severity (p<.001), complete suppression was not achieved (Table 5). Susceptible varieties consistently retained higher residual disease loads compared to those with moderate resistance, underscoring the importance of avoiding highly susceptible varieties as part of an effective disease management strategy.

Disease effects and yield

Despite differences in disease levels between varieties and high and low disease treatments, the disease did not significantly affect grain yield in this trial (Table 5). This indicates that while disease was present, levels were not sufficient to limit yield. Despite the lack of yield impact, high disease levels did affect protein content, with reduced protein in treatments with greater disease severity (p=0.001) (Table 5). However, the differences in protein levels were not enough to alter grain quality ratings. Partial gross margin (PGM) analysis suggests small impacts of disease on PGM in all varieties, except for LRPB Matador, which recorded the highest PGM under the high disease treatment ($944). In contrast, the Valiant CL Plus high disease treatment recorded the lowest PGM ($576), reflecting the significant cost of uncontrolled disease for highly susceptible varieties (Table 5).

Table 5. Effect of foliar disease levels (Table 2) on disease severity, grain yield, and partial gross margins of wheat varieties with contrasting resistance/susceptibility to disease (Table 1) at Nullawil during 2024 (Trial 1).

Variety	Treatment	AUDPC^	Grain yield (t/ha)	Protein (%)	PGM ($/ha)*	Cost of disease ($/ha)
Ballista	Low disease	154	3.06	10.10	874	-
	High disease	373	2.90	***10.03***	829	45
LRPB Matador	Low disease	164	3.09	10.93	883	-
	High disease	313	***3.30***	10.07	***944***	-61
Scepter	Low disease	162	2.89	11.10	827	-
	High disease	430	2.56	10.50	733	94
Sunblade CL Plus	Low disease	***111***	2.22	11.63	635	-
	High disease	170	2.11	11.37	603	31
Valiant CL Plus	Low disease	151	2.82	***12.37***	805	-
	High disease	410	***2.01***	11.67	***576***	230
Vixen	Low disease	231	2.94	10.47	840	-
	High disease	***435***	2.49	10.30	712	128
	Sig. diff.					
	Variety	**<.001**	**0.004**	**<.001**		
	Treatment	**<.001**	**NS**	**0.001**		
	Variety x treatment	**NS**	**NS**	**NS**		
	LSD (P=0.05)					
	Variety	**54.9**	**0.475**	**0.430**		
	Treatment	**31.7**	**NS**	**0.248**		
	Variety x treatment	**NS**	**NS**	**NS**		

Values that are bold and italicised represent the lowest and highest values for that trait. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, calculated using wheat AGP cash prices ($286/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation does not include fungicide and application costs and is based on the yields presented in this table.

Trial 2: Wheat under various fungicide applications and timings

This trial involved two wheat varieties, Scepter and LRPB Matador, treated with various fungicide application timings (Table 3). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease presence across treatments

Septoria was the predominant disease throughout the growing season, with occasional occurrences of stripe rust and dead leaf symptoms (senescence), particularly during the later stages of crop maturity. Treatments incorporating flutriafol, either alone or in combination with additional fungicide applications, significantly reduced disease severity (p=0.047) and AUDPC (p<.001); however, complete suppression was not achieved (Table 6). GS31+GS39 (Treatment viii) and Flutriafol+GS31+GS39 (Treatment ix) exhibited the most effective disease suppression, with AUDPC values of 224 and 228, whilst the Nil control (Treatment i) experienced the highest disease pressure (AUDPC 459) (Table 6). These results highlight the importance of well-timed, dual fungicide applications for achieving optimal disease control.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Yield and fungicide timing

Fungicide treatments significantly affected yield (*p*=0.003), with the dual application at GS31 and GS39 (Treatment viii) achieving the highest yield (4.93t/ha) and PGM ($1331/ha) compared to other treatments (Table 6). Among single applications, GS39 (Treatment v) was the most effective timing for disease control; however, it did not result in increased yield or PGM (Table 6). These findings underscore the importance of applying fungicides at both GS31 and GS39 to maximise yield and economic returns, aligning with the results of Dadu et al., (2023), who reported similar outcomes in a more disease-conducive year.

Table 6. Effect of fungicide treatments (Table 3) on foliar disease severity, grain yield and partial gross margins of wheat (mean of two wheat varieties) in Nullawil during 2024 (Trial 2).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	48	***459***	***3.61***	***1032***	0
ii)	Flutriafol	43	378	3.72	1044	12
iii)	GS15	***57***	443	3.78	1065	33
iv)	GS31	48	397	3.96	1089	57
v)	GS39	33	267	3.82	1057	25
vi)	Flutriafol+GS39	41	275	4.02	1094	62
vii)	GS15+GS39	25	255	4.15	1136	104
viii)	GS31+GS39	31	***224***	***4.93***	***1331***	299
ix)	Flutriafol+GS31+GS39	***24***	228	4.05	1059	27
	Sig. diff.	**0.047**	**<.001**	**0.003**		
	LSD (P=0.05)	**21.7**	**65.7**	**0.579**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, calculated using wheat AGP cash prices ($286/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

Trial 3: Wheat fungicide strategy

This trial involved two wheat varieties, Scepter and LRPB Matador, treated with various fungicide strategies (Table 4). As statistical analysis showed no significant difference between varieties, data from both was combined for analysis.

Disease severity

Disease severity two weeks after the GS55 spray ranged from 28 per cent for the Mid-range 1 strategy (Treatment iii) to 43 per cent for the Nil control (Treatment i) (Table 7). Fungicide treatments significantly reduced disease severity (*p*<.001), with all strategies outperforming the Nil control (Treatment i). Similarly, AUDPC values, which indicate disease progression over time, ranged from 276 under the Full control (Treatment v) to 363 for the Nil control (Treatment i), demonstrating a significant reduction in disease progression with fungicide applications (*p*=0.003) (Table 7).

Grain yield and economic outcomes

Despite reductions in disease severity and AUDPC, fungicide treatments did not result in a significant increase in grain yield, with no strategy delivering a statistically higher yield compared to the Nil treatment (Treatment i) (Table 7). However, PGM analysis highlighted the importance of cost considerations. The Triazole only strategy (Treatment ii) achieved the highest PGM at $970/ha, while the Expensive strategy (Treatment ix) recorded the lowest PGM at $917/ha. Moderate approaches, such as the Mid-range 1 strategy (Treatment iii) and Mid-range 2 strategy (Treatment iv), balanced effective disease control with economic return. In contrast, the Expensive (Treatment ix) and Full Control (Treatment v) strategies incurred higher costs without corresponding yield or financial benefits. These findings suggest that targeted, cost-effective fungicide strategies are optimal under the low to moderate disease pressure conditions observed in 2024.

Table 7. Effect of fungicide treatment (Table 4) on disease severity, grain yield and partial gross margins of wheat (mean of two wheat varieties) at Nullawil during 2024 (Trial 3).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	***43***	***363***	***3.22***	921	0
ii)	Triazole only	33	322	3.52	***970***	49
iii)	Mid-range 1	***28***	301	3.48	949	28
iv)	Mid-range 2	34	304	***3.54***	967	46
ix)	Expensive	33	296	3.41	***917***	-4
v)	Full control	33	***276***	3.53	934	13
	Sig. diff.	**<.001**	**0.003**	**NS**		
	LSD (P=0.05)	**5.5**	**38.6**	**NS**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that variable. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, this is based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, this was calculated using wheat AGP cash prices ($286/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

Trial 4: Barley varieties with and without disease

Disease presence

Barley exhibited lower overall disease levels compared to wheat. Disease progression was consistent across trials, with SFNB appearing early in the season (GS31 to GS39). By mid-season (GS39), both SFNB and NFNB were detected in most treatments. Late-season assessments (GS55 and two weeks post-GS55) revealed the presence of SFNB, NFNB, and scald across all plots. Despite the presence of multiple diseases, overall disease pressure remained low throughout the growing period.

Disease effects and yield

Fungicide treatments significantly reduced disease severity (p<.001) and AUDPC (p=0.023). However, no significant yield differences were observed, due to limited disease development in this experiment (Table 8).

Table 8. Effect of foliar disease level (Table 2) on disease severity, grain yield and partial gross margins of barley varieties with different resistance/susceptibility to disease (Table 1) at Nullawil during 2024 (Trial 4).

Variety	Treatment	Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Disease cost ($/ha)
Combat	Low disease	***2***	***77***	***5.05***	***1506***	-
	High disease	4	96	4.65	1385	121
Commodus CL	Low disease	***2***	101	***4.20***	***1252***	-
	High disease	6	133	4.37	1302	-50
Maximus CL	Low disease	3	134	4.64	1382	-
	High disease	6	132	4.89	1456	-74
Neo CL	Low disease	***2***	131	4.75	1414	-
	High disease	5	147	5.05	1504	-90
RGT Planet	Low disease	9	228	4.65	1385	-
	High disease	***21***	***269***	4.45	1325	60
Titan AX	Low disease	***2***	115	4.40	1312	-
	High disease	4	134	4.52	1346	-34
	Sig. diff.					
	Variety	**<.001**	**<.001**	**0.002**		
	Treatment	**<.001**	**0.023**	**NS**		
	Variety x treatment	**0.009**	**NS**	**NS**		
	LSD (P=0.05)					
	Variety	**2.8**	**30.9**	**0.299**		
	Treatment	**1.6**	**17.8**	**NS**		
	Variety x treatment	**4.0**	**NS**	**NS**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that variable. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, this is based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, this was calculated using barley MALT 1 cash prices ($298/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation does not include fungicide and application costs and is based on the yields presented in this table.

Trial 5: Barley under various fungicide applications and timings

This trial involved two barley varieties, Maximus CL and RGT Planet, treated with various fungicide application timings (Table 3). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease presence across treatments

Throughout the trial, SFNB appeared early in the season (GS31–GS39), while NFNB became more prominent by mid-season. Late-season assessments (GS55 and two weeks post-GS55) revealed a combination of SFNB, NFNB, and scald across most plots. Fungicide treatments significantly reduced disease progression (p<.001) (Table 9). The Nil control (Treatment i) recorded the highest AUDPC (273), while dual fungicide combinations, GS15+GS39 (Treatment vii) and GS31+GS39 (Treatment viii), achieved significantly lower AUDPC values of 176 and 170 respectively, indicating enhanced disease control (Table 9). Despite this, complete suppression of disease was not achieved.

Yield and fungicide timing

Due to low rainfall during the growing season, disease pressure was minimal and did not significantly affect yield (Table 9). In years where disease does not limit yield, the cost of production can be increased by unnecessary fungicide applications, as reflected in several negative profit margins shown in Table 9.

Table 9. Effect of fungicide treatment (Table 3) on foliar disease severity, grain yield and partial gross margins of barley (mean of two barley varieties) at Nullawil during 2024 (Trial 5).

Treatments		AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil control	***273***	4.14	1234	0
ii)	Systiva	243	4.30	1254	20
iii)	GS15	204	***4.11***	1209	-25
iv)	GS31	188	4.24	1220	-14
v)	GS39	229	***4.38***	***1278***	44
vi)	Systiva+GS39	217	4.22	1204	-30
vii)	GS15+GS39	176	4.33	1248	14
viii)	GS31+GS39	***170***	4.21	1184	-50
ix)	Systiva+GS31+GS39	192	4.22	***1160***	-74
	Sig. diff.	**<.001**	**NS**		
	LSD (P=0.05)	**44.8**	**NS**		

Values that are bold and italicised represent the lowest and highest values for that variable. ^AUDPC = Area Under Disease Progress Curve, this is based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, this was calculated using barley MALT 1 cash prices ($298/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

Trial 6: Barley fungicide strategy

This trial involved two barley varieties, Maximus CL and RGT Planet, treated with various fungicide strategies (Table 4). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease severity

Low disease pressure was observed throughout the trial, and no significant differences in disease severity and AUDPC were detected between treatments (Table 10). This outcome reflects the dry seasonal conditions, indicating that in a low-pressure disease environment, disease impacts were minimal across all treatments.

Grain yield and economic outcomes

Grain yield did not vary significantly between treatments (Table 10). The Nil control (Treatment i) achieved the highest PGM at $1424/ha, suggesting the economic benefit of applying fungicides was limited (Table 10) under the dry conditions experienced in 2024. These results indicate that reducing fungicide inputs during seasons with low disease pressure may optimise profitability without compromising yield.

Table 10. Effect of fungicide treatment (Table 4) on disease severity, grain yield and partial gross margins of barley (mean of two barley varieties) at Nullawil during 2024 (Trial 6).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	11	191	4.78	***1424***	0
ii)	Triazole only	***21***	179	4.76	1397	-27
iii)	Mid-range 1	10	***159***	4.84	1412	-12
iv)	Mid-range 2	10	***248***	***4.54***	***1314***	-110
ix)	Expensive	***9***	163	4.85	1398	-26
v)	Full control	10	166	***4.89***	1392	-32
	Sig. diff.	**NS**	**NS**	**NS**		
	LSD (P=0.05)	**NS**	**NS**	**NS**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that variable. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, this is based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial gross margin, this was calculated using barley MALT 1 cash prices ($298/t) from *The Weekly Times*, 11 December 2024, Wycheproof. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Research into disease management remains critical, even during dry seasons like 2024, as it highlights the economic risks of unnecessary fungicide applications and reinforces the importance of tailoring fungicide decisions to crop variety and seasonal conditions. Consistent with the findings from BCG's 2023 disease trials, variety selection and timely fungicide applications are key to effective disease control, with wheat exhibiting greater sensitivity to fungicide timing than barley (Jones and Plowman, 2023). Protecting the critical money leaves, flag-3, flag-2, flag-1, and the flag leaf, during GS31 to GS39 proved pivotal in wheat. These leaves play a crucial role in grain fill, and fungicide applications at these stages had the most significant impact on yield and partial gross margins.

The dry conditions of 2024 reduced disease pressure, highlighting that fungicide applications may not always be necessary, particularly for less susceptible varieties. In low-disease years, minimising or avoiding fungicide use can enhance profitability. Conversely, during wetter seasons with higher disease risk, such as 2022, well-timed fungicide applications are essential for protecting yield (Dadu et al., 2022). Research by Agriculture Victoria and BCG in the southern Mallee demonstrated that foliar diseases could reduce wheat yields by up to 50 per cent under conducive conditions. However, these losses were mitigated through varietal selection and timely fungicide applications (Dadu et al., 2022). Similarly, Agriculture Victoria and BCG studies from 2016 and 2017 revealed barley yield losses due to SFNB of 17 per cent and 10 per cent, respectively, emphasising the importance of effective disease management during conducive seasons (McLean et al., 2022).

Avoiding unnecessary fungicide use during dry seasons also helps preserve the longevity of available fungicide options. Fungicide resistance is an increasing concern nationally, and the Australian Fungicide Resistance Extension Network (AFREN) emphasises the importance of reducing fungicide use when possible. For more information on fungicide resistance, go to the website <www.afren.com.au>.

Overall, strategic and adaptable disease management is essential for optimising profitability. While intensive fungicide regimes offered little economic benefit in 2024, continued research across diverse seasonal conditions will further refine best-practice guidelines for wheat and barley growers in the southern Mallee.

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CONTENTS

VARIETIES AND THEIR MANAGEMENT

FARMING SYSTEMS

CROP AGRONOMY

WEED MANAGEMENT

PESTS AND DISEASE MANAGEMENT

LIVESTOCK

SOILS

SOWING CONSIDERATIONS

CROP END USE

APPENDICES

OPTIMISING DISEASE CONTROL IN NORTH CENTRAL CEREAL CROPS

Meg Conlan, Dr Yolanda Plowman, Casey Sim (BCG), and Grant Hollaway (Astute Ag)

TAKE HOME MESSAGES

- Avoiding highly susceptible varieties is a valuable component of an integrated disease management strategy.
- Making in-crop fungicide decisions that factor in seasonal conditions, variety susceptibility and disease levels in a paddock can reduce fungicide inputs in low-risk situations.
- In low disease pressure seasons, minimal fungicide use, combined with resistant varieties, can reduce costs without compromising profitability and reduce risks associated with fungicide resistance.

BACKGROUND

In the North Central region, the need for in-crop disease management in cereal crops is influenced by seasonal conditions, crop variety, and paddock history. Effective disease management strategies are essential for minimising yield losses during seasons with high disease pressure, while avoiding unnecessary fungicide applications in low-pressure years to reduce costs, without compromising profitability. Poorly timed or excessive fungicide applications can lead to significant yield penalties in high-risk seasons or unnecessary expenses when disease pressure is low.

Cereal crops in the North Central region are commonly affected by multiple foliar diseases. Septoria tritici blotch and stripe rust are prevalent in wheat, while barley is frequently impacted by spot form of net blotch (SFNB) and net form of net blotch (NFNB).

Trials conducted during 2023, the first year of this two-year GRDC project, were disrupted by kangaroo grazing. Incorporating feedback from local growers, the 2024 trials aimed to assess disease impacts and yield losses in cereal varieties with different resistance levels. These trials also evaluated various fungicide timings and product options, offering practical insights to enhance disease management strategies for growers in the North Central.

AIM

This study aimed to enhance cereal disease management in the North Central region by:

- Assessing how various wheat and barley varieties with differing disease resistance ratings performed during the 2024 season.
- Identifying the most effective timings for fungicide application to control disease.
- Evaluating the effectiveness and economic viability of different fungicide options for disease control.

PADDOCK DETAILS

Location:	Mitiamo
Crop year rainfall (Nov–Oct):	467mm
GSR (Apr–Oct):	202mm
Soil type:	0–70cm clay, 70–100cm silty clay loam
Paddock history:	Oats

TRIAL DETAILS

Crop type/s:	Wheat and barley
Treatments:	Refer to Tables 2, 3, and 4
Target plant density:	130 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	23 May 2024
Replicates:	Four
Harvest date:	5 December 2024

TRIAL INPUTS

Nutrition, weeds and insects were managed as per best practice.

METHOD

Six trials were set up at Mitiamo, in the North Central region, with three each dedicated to wheat and barley. The trials investigated different varieties, fungicide timings, and fungicide options. Varieties of wheat and barley with varying resistance ratings were sown (Table 1, Trials 1 and 4) and treated with either a high (nil control) or low (full control) disease treatment (Table 2). Trials with wheat varieties Scepter and LRPB Matador (Trials 2 and 3) and barley varieties Maximus CL and RGT Planet (Trials 5 and 6), examined different fungicide timing applications (Table 3) and fungicide options (Table 4).

All trials were set up using randomised complete block designs with four replicates. Assessments included disease severity, establishment counts, and yield parameters. Disease severity was visually assessed by estimating the percentage of leaf area affected by disease on eight occasions during the season, from GS15 to GS55. These severity estimates were then used to calculate the Area Under the Disease Progression Curve (AUDPC), providing a cumulative measure of disease severity over time (Brown and Keane, 1997).

Table 1. Disease resistance ratings[1] for wheat and barley varieties used in the North Central region disease management trials (1 and 4) during 2024.

Disease	Variety					
	Wheat					
	Scepter	Ballista	Vixen	Valiant	Matador	Sunblade
Septoria tritici blotch	S	SVS	S	MSS	S (P)	S
Leaf rust	MSS	S	SVS	S	MSS	MSS
Stripe rust	MSS	MSS	SVS	S	MS	MRMS
	Barley					
	Combat	Maximus	Commodus	Planet	Titan	Neo
Spot form of net blotch	RMR	MS	MSS	SVS	MS	MR (P)
Net form of net blotch	MRMS	MRMS	MSS	SVS	MS	MS (P)
Leaf scald	S	SVS	SVS	SVS	VS	S (P)

MR=moderately resistant, MRMS=moderately resistant to moderately susceptible, MS=moderately susceptible, MSS=moderately susceptible to susceptible, S=susceptible, SVS=susceptible to very susceptible, VS=very susceptible, P=provisional. [1]Disease ratings were sourced from the GRDC's National Variety Trials.

Table 2. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'variety' trials (Trials 1 and 4) in the North Central region during 2024.

Treatment		Product	Active ingredient	Timing	Rate
Wheat					
i)	High disease	No fungicide	-	-	-
ii)	Low disease	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
		Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300mL/ha
Barley					
i)	High disease	No fungicide	-	-	-
ii)	Low disease	Systiva	333g/L Fluxapyroxad	Sowing	150mL/100kg seed
		Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300mL/ha

Growth stage according to Zadoks scale, GS15=seedling growth, GS31=stem elongation, GS39=flag leaf emergence, GS55=head emergence (Zadoks, et al. 1974).

Table 3. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'fungicide application timing' trials (Trials 2 and 5) in the North Central region, during 2024.

Treatment/product		Active ingredient	Timing	Rate
Wheat				
i)	Nil control	-	-	-
ii)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
iii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
iv)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
v)	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vi)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
viii)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
ix)	Flutriafol	Flutriafol	Sowing	400mL/100kg fertiliser
	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	600mL/ha
Barley				
i)	Nil control	-	-	-
ii)	Systiva	333m/L Fluxapyroxad	Sowing	150mL/100kg seed
iii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
iv)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
v)	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vi)	Systiva	333m/L Fluxapyroxad	Sowing	150mL/100kg seed
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
vii)	Proviso	250g/L Prothioconazole	GS15	190mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
viii)	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha
ix)	Systiva	333m/L Fluxapyroxad	Sowing	150mL/100kg seed
	Aviator Xpro	150g/L Prothioconazole, 75g/L Bixafen	GS31	500mL/ha
	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400mL/ha

Growth stage according to Zadoks scale, GS15=seedling growth, GS31=stem elongation, GS39=flag leaf emergence, GS55=head emergence.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Table 4. Fungicide treatments, active ingredients, application timings and rates for wheat and barley 'fungicide strategy' trials (Trials 3 and 6) in the North Central region during 2024.

Treatment		Product	Active ingredient	Timing	Rate (mL/ha)
Wheat					
i)	Nil control	No fungicide	-	-	-
ii)	Triazole only	Epoxyconazole 125	125g/L Epoxyconazole	GS31	500
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS39	300
iii)	Mid-range 1	Epoxyconazole 125	125g/L Epoxyconazole	GS31	500
		Maxentis	210g/L Prothioconazole, 210g/L Tebuconazole	GS39	400
iv)	Mid-range 2	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS31	600
		Epoxyconazole 125	125g/L Epoxyconazole	GS39	500
v)	Expensive	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
vi)	Full control	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300
Barley					
i)	Nil control	No fungicide	-	-	-
ii)	Triazole only	Propiconazole 250	250g/L Propiconazole	GS31	500
		Proviso	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	250
iii)	Mid-range 1	Propiconazole 250	250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
iv)	Mid-range 2	Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS31	600
		Proviso	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	250
v)	Expensive	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
vi)	Full control	Elatus Ace	40g/L Benzovindiflupyr, 250g/L Propiconazole	GS31	500
		Maxentis	133g/L Azoxystrobin, 100g/L Prothioconazole	GS39	400
		Prosaro	210g/L Prothioconazole, 210g/L Tebuconazole	GS55	300

Growth stage according to Zadoks scale, GS15=seedling growth, GS31=stem elongation, GS39=flag leaf emergence, GS55=head emergence.

RESULTS AND INTERPRETATION

Seasonal conditions and diseases present

Mitiamo received 202mm (Decile 4) of rainfall during the growing season, leading to dry seasonal conditions and overall low disease pressure. Despite the dry conditions, Septoria and stripe rust were observed in wheat, while barley was mostly affected by spot form of net blotch (SFNB) and some net form of net blotch (NFNB).

Trial 1: Wheat varieties with and without disease

Disease presence and resistance rating alignment

Significant variation was observed in disease severity (both post GS55 and AUDPC) between varieties and treatments (Table 5). Low disease treatments consistently had lower disease ($p<.001$) and AUDPC ($p<.001$) compared to high disease treatments, with the largest differences observed in highly susceptible varieties such as Valiant CL Plus and Vixen. Valiant CL Plus exhibited a high AUDPC (86) and disease severity (25 per cent) under high disease treatments, resulting in a substantial cost of disease ($104/ha) (Table 5). In contrast, Sunblade CL Plus, which is less commonly grown in this region and has a moderate resistance rating (MRMS), showed low AUDPC and minimal cost of disease, indicating strong alignment with its resistance profile. These findings reinforce the importance of variety choice in building strategies for disease suppression, even in dry seasons.

Disease effects and yield

Statistically significant differences in yield were observed between low and high disease treatments across varieties ($p<.001$), indicating that disease negatively impacted grain yield (Table 5). The extent of yield loss varied by variety, with the highest losses recorded in Valiant CL Plus (18 per cent) and Ballista (16 per cent), with the lowest in Sunblade CL Plus (2 per cent) and LRPB Matador (6 per cent) (Table 5). A clear relationship emerged between the disease ratings of varieties and their yield response to disease, with more resistant varieties, such as Sunblade CL Plus and LRPB Matador, showing smaller yield losses. In contrast, highly susceptible varieties like Valiant CL Plus experienced the greatest yield penalties due to disease.

Table 5. Effect of foliar disease level (Table 2) on disease severity, grain yield, and partial gross margins of wheat varieties with contrasting resistance/susceptibility to disease (Table 1) at Mitiamo during 2024 (Trial 1).

Variety	Treatment	Disease severity (%LAA) 2 weeks post GS55 spray[#]	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Cost of disease ($/ha)
Ballista	Low disease	3	19	2.11	634	-
	High disease	9	42	1.78	537	97
LRPB Matador	Low disease	***2***	***18***	***2.44***	***736***	-
	High disease	6	36	2.30	691	45
Scepter	Low disease	3	21	2.19	658	-
	High disease	11	57	2.01	604	54
Sunblade CL Plus	Low disease	***2***	18	1.85	556	-
	High disease	6	28	1.82	547	9
Valiant CL Plus	Low disease	5	29	1.91	576	-
	High disease	***25***	86	***1.57***	***472***	104
Vixen	Low disease	3	27	2.28	686	-
	High disease	11	***111***	2.02	609	77
	Sig. diff.					
	Variety	**<.001**	**<.001**	**<.001**		
	Treatment	**<.001**	**<.001**	**<.001**		
	Variety x treatment	**0.007**	**0.005**	**0.025**		
	LSD (P=0.05)					
	Variety	**4.5**	**19.7**	**0.097**		
	Treatment	**2.6**	**11.4**	**0.057**		
	Variety x treatment	**6.4**	**27.8**	**0.139**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. [#]Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial Gross Margin, calculated using wheat AGP cash prices ($301/t) from *The Weekly Times*, 11 December 2024, Elmore. This calculation does not include fungicide and application costs and is based on the yields presented in this table.

Trial 2: Wheat under various fungicide applications and timings

This trial involved two wheat varieties, Scepter and LRPB Matador, treated with various fungicide application timings (Table 3). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease presence across treatments

Fungicide application treatments significantly reduced disease severity, with the most intensive treatment, Flutriafol+GS31+GS39 (Treatment ix), achieving the lowest disease severity at 4 per cent (p=0.004) and an AUDPC of 28 (p=0.013) (Table 6). Both stripe rust and Septoria were observed across all treatments. Early signs of Septoria appeared two weeks after the GS31 spray, with both stripe rust and Septoria becoming more prominent two weeks post-GS39. By GS55 and beyond, stripe rust was present in all plots, underscoring its widespread nature. Treatments involving multiple fungicide applications, particularly those including GS39, demonstrated greater efficacy in suppressing disease compared to single-application treatments or the Nil control (Treatment i).

Yield and fungicide timing

Fungicide treatments significantly impacted grain yield (*p*=0.001) (Table 6). The highest yield, 2.38t/ha, was achieved with Flutriafol+GS31+GS39 (Treatment ix), representing an 11 per cent yield increase compared to the Nil control (Treatment i) (2.15t/ha). Other multiple-application treatments, such as GS15+GS39 (Treatment vii) at 2.34t/ha and GS31+GS39 (Treatment viii) at 2.27t/ha, also resulted in notable yield improvements. However, despite these yield gains, many fungicide treatments led to reduced PGMs due to higher input costs. For instance, while Flutriafol+GS31+GS39 (Treatment ix) produced the highest yield, its PGM was $617/ha, $30/ha lower than the Nil control (Treatment i) ($647/ha) (Table 6). These findings highlight that in years of low disease pressure, intensive fungicide strategies may not deliver positive economic returns, emphasising the importance of balancing yield gains with the associated costs of fungicide applications.

Table 6. Effect of fungicide treatments (Table 3) on foliar disease severity, grain yield and partial gross margins of wheat (mean of two wheat varieties) at Mitiamo during 2024 (Trial 2).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	***11***	***62***	***2.15***	647	0
ii)	Flutriafol	6	39	2.24	654	7
iii)	GS15	10	59	2.26	***665***	18
iv)	GS31	6	38	2.18	613	-34
v)	GS39	6	38	2.18	621	-26
vi)	Flutriafol+GS39	5	33	2.23	616	-31
vii)	GS15+GS39	8	42	2.34	654	7
viii)	GS31+GS39	6	36	2.27	***605***	-42
ix)	Flutriafol+GS31+GS39	***4***	***28***	***2.38***	617	-30
	Sig. diff.	**0.004**	**0.013**	**0.001**		
	LSD (P=0.05)	**3.6**	**19.7**	**0.108**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial Gross Margin, calculated using wheat AGP cash prices ($301/t) from *The Weekly Times*, 11 December 2024, Elmore. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

Trial 3: Wheat fungicide strategy

This trial involved two wheat varieties, Scepter and LRPB Matador, treated with various fungicide strategies (Table 4). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease severity

Fungicide treatments significantly reduced disease severity (*p*<.001), with all fungicide strategies outperforming the Nil control (Treatment i) (Table 7). The Nil control also had the highest AUDPC value, however this was not significant.

Grain yield and economic outcomes

Fungicide treatments significantly impacted yield (*p*=0.013), with the highest yield observed in the Triazole-only (Treatment ii) and Mid-range 1 (Treatment iii) strategies, both producing 2.33t/ha, compared to the Nil (Treatment i), which yielded 2.13t/ha (Table 7). Regarding economic performance, Triazole-only (Treatment ii) provided the highest PGM of $665/ha, followed by Mid-range 1 (Treatment iii) ($656/ha). Conversely, the Expensive (Treatment ix) and Full-control (Treatment v) strategies had the lowest PGMs, at $607/ha and $614/ha (Table 7). These findings emphasise that in seasons with low disease pressure, expensive fungicide regimens do not necessarily result in positive economic outcomes. Targeted and cost-effective fungicide applications, such as Triazole only (Treatment ii) and Mid-range (Treatments iii and iv) strategies, may be more beneficial under such conditions.

Table 7. Effect of fungicide treatment (Table 4) on disease severity, grain yield and partial gross margins of wheat (mean of two wheat varieties) at Mitiamo during 2024 (Trial 3).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	***11***	***85***	***2.13***	641	0
ii)	Triazole only	7	67	***2.33***	***665***	24
iii)	Mid-range 1	6	62	***2.33***	656	14
iv)	Mid-range 2	5	***52***	2.32	644	3
ix)	Expensive	***4***	55	2.21	***607***	-34
v)	Full control	***4***	66	2.29	614	-27
	Sig. diff.	**<.001**	**NS**	**0.013**		
	LSD (P=0.05)	**3.2**	**NS**	**0.124**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial Gross Margin, calculated using wheat AGP cash prices ($301/t) from *The Weekly Times*, 11 December 2024, Elmore. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

Trial 4: Barley varieties with and without disease

Disease presence

SFNB was the predominant disease observed in the trial, however, disease severity and AUDPC values remained low across treatments due to the dry conditions, which restricted disease progression. For instance, Titan AX recorded an AUDPC of 90 under the low disease treatment, compared to 108 under the high disease treatment, with similarly minor differences observed for other varieties (Table 8). These findings indicate limited rainfall had a greater influence on disease progression than varietal resistance.

Disease effects and yield

Barley exhibited lower overall disease severity than wheat, and there were no significant disease impacts on yield in any variety (Table 8). As a result, disease control measures were not warranted in a season like 2024. Although significant treatment effects were observed for disease severity (*p*=0.002) in all varieties except Combat, these differences did not affect yield, indicating the low disease levels were not yield-limiting. While resistance ratings generally aligned with observed disease levels, their influence was less pronounced under the dry conditions of 2024. These findings reinforce the idea that in low-pressure seasons, growers can prioritise variety selection and reduce fungicide applications, thereby minimising costs without compromising yields.

Table 8. Effect of foliar disease level (Table 2) on disease severity, grain yield and partial gross margins of barley varieties with different resistance/susceptibility to disease (Table 1) at Mitiamo during 2024 (Trial 4).

Variety	Treatment	Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Cost of disease ($/ha)
Combat	Low disease	***1***	112	***4.23***	***1274***	-
	High disease	***1***	101	3.89	1170	104
Commodus CL	Low disease	2	92	***3.49***	***1051***	-
	High disease	3	115	3.52	1059	-8
Maximus CL	Low disease	2	117	3.59	1081	-
	High disease	3	137	3.57	1074	7
Neo CL	Low disease	***1***	115	4.00	1205	-
	High disease	4	121	3.85	1157	48
RGT Planet	Low disease	3	159	3.79	1142	-
	High disease	***6***	***169***	3.77	1135	7
Titan AX	Low disease	***1***	***90***	3.91	1176	-
	High disease	3	108	3.84	1157	19
	Sig. diff.					
	Variety	**0.005**	**0.005**	**0.036**		
	Treatment	**0.002**	**NS**	**NS**		
	Variety x treatment	**NS**	**NS**	**NS**		
	LSD (P=0.05)					
	Variety	**1.6**	**33.8**	**0.369**		
	Treatment	**0.9**	**NS**	**NS**		
	Variety x treatment	**NS**	**NS**	**NS**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial Gross Margin, calculated using barley BAR2 cash prices ($301/t) from *The Weekly Times*, 11 December 2024, Elmore. This calculation does not include fungicide and applications costs and is based on the yields presented in this table.

Trial 5: Barley under various fungicide application timings

This trial involved two barley varieties, Maximus CL and RGT Planet, treated with various fungicide application timings (Table 3). These varieties were selected for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Yield and fungicide timing

Disease development in this trial was limited, with no significant treatment effects observed on disease severity (AUDPC) or grain yield (Table 9). These findings suggest that during dry seasons with low disease pressure, in-crop fungicide applications are not warranted.

Table 9. Effect of fungicide treatment (Table 3) on foliar disease severity and grain yield of barley (mean of two barley varieties) at Mitiamo during 2024 (Trial 5).

Treatments		AUDPC^	Grain yield (t/ha)
i)	Nil Control	***122***	***3.43***
ii)	Systiva	143	3.51
iii)	GS15	130	3.51
iv)	GS31	134	***3.84***
v)	GS39	141	3.74
vi)	Systiva+GS39	126	3.50
vii)	GS15+GS39	124	3.45
viii)	GS31+GS39	135	3.56
ix)	Systiva+GS31+GS39	***154***	3.56
	Sig. diff.	**NS**	**NS**
	LSD (P=0.05)	**NS**	**NS**

Values that are bold and italicised represent the lowest and highest values for that trait. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55.

Trial 6: Barley fungicide strategy

This trial involved two barley varieties, Maximus CL and RGT Planet, treated with various fungicide strategies (Table 4). These varieties were chosen for their resistance ratings. Since statistical analysis showed no significant variety effect, the data from both varieties was combined for analysis.

Disease severity

No significant differences were observed in disease severity and AUDPC in the fungicide treatments, with all strategies maintaining a consistently low disease severity of 2 per cent at two weeks post-GS55 spray (Table 10).

Grain yield and economic outcomes

Grain yield differences were also not significant, ranging from 3.42t/ha in the Nil control (Treatment i) to 3.64t/ha in the Triazole-only (Treatment ii) strategy (Table 10). These results suggest that in a low disease pressure season, intensive fungicide regimes offer limited economic benefit. Instead, minimal fungicide strategies, such as Triazole-only (Treatment ii), were more cost-effective, highlighting the importance of tailoring fungicide use to seasonal conditions.

Table 10. Effect of fungicide treatment (Table 4) on disease severity, grain yield and partial gross margins of barley (mean of two barley varieties) at Mitiamo during 2024 (Trial 6).

Treatment		Disease severity (%LAA) 2 weeks post GS55 spray#	AUDPC^	Grain yield (t/ha)	PGM ($/ha)*	Profit difference ($/ha)†
i)	Nil	2	116	***3.42***	1029	0
ii)	Triazole only	2	***129***	***3.64***	1099	***70***
iii)	Mid-range 1	2	118	3.62	1059	30
iv)	Mid-range 2	2	***114***	3.49	1012	-17
v)	Expensive	2	115	3.54	1018	-11
vi)	Full control	2	120	3.60	1018	-11
	Sig. diff.	**NS**	**NS**	**NS**		
	LSD (P=0.05)	**NS**	**NS**	**NS**		

Growth stage according to Zadoks scale, GS55=head emergence. Values that are bold and italicised represent the lowest and highest values for that trait. #Disease severity refers to the percentage of leaf area affected (%LAA) by disease. ^AUDPC = Area Under Disease Progress Curve, based on 8 observations of foliar disease severity (% leaf area affected) between GS15 and GS55. *PGM = Partial Gross Margin, calculated using barley BAR2 cash prices ($301/t) from *The Weekly Times*, 11 December 2024, Elmore. This calculation includes fungicide and application costs and is based on the yields presented in this table. †Profit difference refers to the difference between the treatment and nil control.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Effective disease management remains crucial, even in dry seasons like 2024, as it highlights the economic risks of unnecessary fungicide applications. These trials demonstrated that under low disease pressure, intensive fungicide strategies are often unwarranted as they add to production costs without improving profitability. A strategic, minimal fungicide approach, tailored to disease levels as determined through crop monitoring, can effectively maintain yields while reducing input costs. Avoiding highly susceptible varieties also emerged as a key strategy, significantly reducing disease risk even under dry conditions.

Fungicide applications improved wheat yields, however the additional input costs often outweighed the financial benefits, emphasising the need to balance fungicide expenditure against potential gains. Barley trials showed even less justification for intensive fungicide use, with negligible disease and yield differences across treatments.

Variety selection was shown to play a pivotal role in disease suppression and economic performance. Resistant varieties consistently exhibited lower disease severity and smaller yield losses, reinforcing the value of selecting less susceptible cultivars as part of an integrated disease management strategy. Studies on disease management have consistently demonstrated the advantages of avoiding highly susceptible cultivars to reduce disease severity and prevent yield losses (McLean and Hollaway, 2018; Cook et al., 2024).

Reducing fungicide reliance is also vital for managing resistance in key diseases, such as Septoria and net blotches. Overuse of fungicides accelerates resistance development, threatening the long-term effectiveness of these tools. The Australian Fungicide Resistance Extension Network (AFREN) emphasises the importance of reducing fungicide use where possible. For more information, go to the website <www.afren.com.au>.

Overall, strategic and adaptable disease management is essential for optimising profitability. While intensive fungicide regimes provided little economic benefit in 2024, ongoing research across varying seasonal conditions will help further refine best-practice guidelines for wheat and barley growers in the North Central region.

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LIVESTOCK

CHOOSING GRAZING CEREALS TO FILL FEED GAPS

Alison Frischke and Angus Butterfield (BCG)

TAKE HOME MESSAGES

- New forage cereal varieties are emerging with higher biomass potential for grazing by livestock.
- Choose forage cereal varieties to plant as a stand-alone crop or in a multispecies mix with traits that can fill feed gaps such as plant growth patterns, forage quality, disease resistance, and suitability for grazing, hay or silage, and grain.

BACKGROUND

Managing feed for livestock across a season can be a challenge. Feed gaps occur in summer and autumn when stubbles are exhausted and the new season is yet to break, or rains have come but pastures need to regenerate and establish. Another key feed gap period, particularly in lower rainfall dryland areas, is in late spring before harvest begins when pastures have reached peak biomass, are grazed and then turn off (Frischke and Jolly, 2020).

Having a blend of pasture species is useful to spread grazing windows for livestock across the season. A mix can offer more quality feed with high digestibility at different times, that encourages feed intake and supports livestock nutrition (Lifetimewool, 2006). Cereal crops can be a valuable part of the diet, providing quick early feed for stock in winter, particularly when the crop can establish early. Over the past decade, seed companies have expanded their range of forage cereal varieties beyond the traditional grain types for this reason.

AIM

To demonstrate biomass production of a selection of new and existing forage cereal varieties at different times of the year.

PADDOCK DETAILS

Location:	Mitiamo
Crop year rainfall (Nov–Oct):	470mm (decile 7)
GSR (Apr–Oct):	182mm (decile 4)
Soil type:	0–70cm clay, 70–100cm silty clay loam
Paddock history:	Oaten hay (2023)

TRIAL DETAILS

Treatments:	Barley, wheat and oat varieties, see Table 1
Target plant density:	180 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	24 May 2024
Trial average dry matter yield:	2.44t DM/ha

TRIAL INPUTS

Fertiliser: Granulock® Supreme Z + Flutriafol (400mL/100kg) @ 60kg/ha at sowing

Trial managed as per best practice for herbicides, insecticides and fungicides.

METHOD

A field demonstration was sown using a completely randomised design, replicated four times. Biomass cuts of crop were sampled on 23 July (data not shown), and one replication sampled at peak biomass on 25 September. Normalised Difference Vegetative Index (NDVI) data was collected using a drone to estimate relative biomass on the same dates.

RESULTS AND INTERPRETATION

The site received 27mm on 11 May which enabled crops to establish well. However, below-average rainfall and several frost events during flowering, coupled with heavy soil texture, limited crop growth and grass control, and as a result crops were terminated at the point of flowering.

Biomass was low across all varieties, averaging 0.25t dry matter (DM)/ha at eight weeks on 23 July and 2.44t DM/ha on 25 September.

Table 1. Biomass production of grazing cereal varieties, Mitiamo 2024

Crop	Variety	Type	GS 31, 23 July		GS 55, 25 September		Peak biomass (t/ha)
			NDVI	% of average NDVI	NDVI	% of average NDVI	
Barley	Newton	Mid-slow winter forage	0.5442	106^{ab}	0.4298	101	2.47
	Planet	Mid (but elastic maturity*) malt grain	0.5367	105^{ab}	0.4021	95	2.32
	Kracken	Quick spring forage	0.5220	102^{abc}	0.4032	95	2.33
Oats	Kingbale	Mid-slow hay	0.4714	92^{d}	0.4164	99	2.40
	Mulgara	Quick hay/forage	0.4906	96^{cd}	0.3858	91	2.23
	Koala	Mid-slow milling/hay	0.5143	100^{bc}	0.4022	104	2.53
	Forester	Very slow hay	0.4999	97^{cd}	0.4407	104	2.54
	Marleigh	Mid-slow forage	0.4916	96^{cd}	0.4781	113	2.76
Wheat	Alfresco	Mid-slow spring forage	0.5509	107^{a}	0.4073	96	2.35
		Sig. diff. LSD (P=0.05) CV%	**<0.001 0.03 (6.5**) 4.4**		**0.07 NS -**		Not replicated

*Makes Planet suited to low to high rainfall regions. **LSD for % of average NDVI

Early season biomass was greatest for barley varieties Newton and Planet, and Alfresco wheat, followed closely by Kracken barley and Koala oats (Table 1).

The season limited plant growth, particularly of longer maturity varieties, such that production differences had waned by September, although production for Marleigh oats was slightly higher (but not significantly) (Table 1).

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Hand feeding of stock was required during 2024, extending through the winter when pasture feed was limited through much of Victoria and South Australia. Although the trial and farm biomass production were lower than average, it continued to accumulate later in the season making crops still useful for stock. In instances where the season compromised grain production crops were cut for hay where there was sufficient biomass or grazed.

When choosing cereal crops to grow for fodder, talk with other growers and seed sellers to understand growth and production traits, such as what time of year they produce biomass for grazing, their ability to recover from grazing, their potential to make quality hay, and the amount and quality of grain production. Also consider the disease and pest resistance profile to minimise management costs and maximise utility for cropping rotations. This will help decide which varieties to grow to fill feed gaps, and what should be included in a multispecies pasture mix.

Nutrition provided by cereal crops

Use feed tests to measure exactly what a crop is providing as it matures or be guided by data from previous trials (Frischke, 2023) and adjust for the season.

In general:

- Young cereal crops at GS30 have approximately 1.5t/ha biomass, and high protein (20–30 per cent), energy (12–14MJ/kg), lower NDF (35–45 per cent) and high digestibility (>80 per cent)
- By flowering, GS65 and early grain fill, crop biomass can range from 4t/ha to 12t/ha, but quality falls to maintenance levels (hay quality) with lower protein (8–9.5 per cent) and energy (8–9.5MJ/kg), higher NDF (55–70 per cent) and lower digestibility (50–60 per cent).
- Declining quality and palatability limits how much livestock can consume. There will be enough crop nutrition to support dry ewes and wethers, but it won't support the needs of growing lambs; supplementing with another source of protein and energy may be needed to meet any nutritional shortfalls during this time. An undersown legume pasture, a legume grain feeder, or access to an adjacent paddock with legume content can top up their high protein and energy needs.
- Once cereal grain has set, feed value rises again. The best feed value is the grain component, and to a lesser extent leaves and fine chaff. Grain has very good protein (11–15 per cent) and energy (12–14MJ/kg), low NDF (10–30 per cent) and high digestibility (70–95 per cent). As sheep eat the standing crop, they will consume enough fibre in chaff and leaves to meet fibre requirements.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Livestock nutrition and health on cereal crops

To manage health of livestock grazing cereal crops:

- Cereals contain low calcium (Ca), sodium and magnesium (Mg) and high potassium (K). Supplement young cereal crops with a loose mix of limestone:salt:Causmag at 2:2:1.
  Note: Legumes increase Ca and Mg content of a mixed species forage, but not enough to counteract the effects of high K from cereal (Newell et. al., 2020), therefore cereal/legume pasture mixes should also be supplemented.
- Crops grazed from late booting to maturity don't need magnesium. Instead use a loose mix of limestone:salt at 1:1.
- Stay up to date with vaccinations to prevent pulpy kidney resulting from high water-soluble carbohydrates.
- Although nitrate poisoning is rare, avoid it by introducing stock slowly, later in the day when they have full bellies (can be filled with hay), and delay grazing after nitrogen applications.

Other considerations are outlined in 'Value of standing crops for lamb production and soil protection' (Frischke and Jolly, 2020).

New forage cereal variety notes

New forage cereal varieties included in this demonstration (C. Altmann, pers. comm., March 2024 and AGF Seeds, 2024):

- *Newton barley*: a two-row, medium winter (between EGA Wedgetail and DS Bennett) feed-quality barley with awns that requires winter vernalisation (cold-period) to move from a vegetative to reproductive state. Its auricles and awns often have strong anthocyanin (purple colour) expression that persists through the seed coat of grain. Newton does not have high grain yield and is unlikely to develop grain in regions with warm winter temperatures. Early growth is prostrate, but it has very high tillering ability, meaning it's a highly competitive plant type against weeds. Newton has improved disease resistance over Urambie. Newton will hang on for a long time during winter, then bulk-up quickly in favourable springs or with access to irrigation, resulting in high total biomass production.
- *Alfresco wheat*: a two-row awnless spring forage wheat with slow maturity, suitable for grazing, hay, or silage, and has purple grain. Alfresco is densely tillered, has excellent grazing recovery and improved lodging resistance over tall straw oats, and useful rust resistance, making it an alternative to forage oats.
- *Marleigh oats*: a mid-late spring forage oat, with excellent early vigour, fast biomass production, and sound recovery post grazing. Marleigh fills the autumn/ winter feed gap ahead of other winter cereals, can be sown in a mix, and should be grazed early. Marleigh stems bend, therefore, it is not suitable for hay.
- *Kracken barley*: a two-row awnless spring forage barley. Kracken is fast establishing autumn-winter fodder crop, superseding Moby with better disease resistance and biomass, and a slightly longer maturity. Sown from autumn to late winter for quick production, this variety can be grazed several times in a season and is suitable for hay. Can be used to provide weed control and soil preparation before renovating with perennial pasture. Note that early plantings are susceptible to heat stress which can lead to early grain development, so avoid sowing when soil temperature is greater than 22°C.

Growing and managing the grazing of high-quality forage, and providing supplements (grain or other quality feeds) to meet the protein and energy needs of reproducing and growing livestock, improves rumen efficiency and livestock production and can help to reduce methane emissions (Agriculture Victoria, 2024).

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SOILS

EVALUATING THE IMPACT OF A WETTING AGENT ON SOIL EROSION IN THE MALLEE

Meg Conlan (BCG)

TAKE HOME MESSAGES

- The application of a wetting agent did not enhance soil moisture retention under the trial conditions.
- No measurable improvement in groundcover was observed post-application.
- The risk of wind erosion remained unchanged, indicating limited efficacy of the treatment in reducing soil degradation.

BACKGROUND

Drought continues to present a significant challenge in the Victorian Mallee. During dry periods, inadequate groundcover leaves soil vulnerable to wind erosion, negatively impacting soil health and crop potential. With climate change expected to exacerbate these issues, it is crucial to develop practical solutions that enhance soil resilience and integrate effectively into current farming practices.

Given the region's reliance on variable rainfall and lack of irrigation infrastructure, effective water management is essential for successful crop establishment. To address these challenges, agronomic strategies such as the application of wetting agents in furrows are being explored. Wetting agents have the potential to enhance soil moisture retention, promote plant vigour, and increase crop biomass, which could enhance groundcover and reduce soil erosion.

Through plot trials, this project assessed the effectiveness of a commercially available wetting agent in enhancing crop biomass and groundcover. This evaluation seeks to identify practical solutions for mitigating soil erosion and improving soil health amidst frequent drought conditions in the Mallee.

AIM

To assess the effectiveness of a wetting agent in improving crop emergence and establishment, thereby mitigating soil erosion in the Mallee.

PADDOCK DETAILS

Location:	Walpeup
Crop year rainfall (Nov–Oct):	266mm
GSR (Apr–Oct):	137mm
Soil type:	Sandy loam

TRIAL DETAILS

Crop type/s:	Lentils (Hallmark)
Treatments:	Commercially available wetting agent or nil control
Target plant density:	120 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	17 May 2024
Replicates:	Four
Harvest date:	7 November 2024
Trial average yield:	0.82t/ha

TRIAL INPUTS

Nutrition, weeds, insects, and disease were managed as per best practice.

METHOD

A plot trial replicated four times was conducted at Walpeup using a randomised complete block design. Lentils were sown with a wetting agent applied in-furrow at 4L/ha per the product label, with an untreated control included for comparison. Soil sampling was conducted before sowing and at harvest to assess soil moisture. Establishment counts and biomass cuts at flowering were taken to examine crop establishment and groundcover. Yield data was also collected at harvest. A paired two-sided t-test was used to analyse statistical differences between treatments.

RESULTS AND INTERPRETATION

Soil moisture

Rainfall leading up to sowing was minimal: Walpeup received 11mm in April and 12.8mm in May. Pre-sowing soil sampling revealed no significant differences between the treated and untreated plots across all measured depths, establishing a consistent baseline for comparison (Table 1). Soil sampling was repeated at harvest to assess the potential impact of the wetting agent on water retention. The post-harvest results showed no significant differences in soil moisture between the treated and untreated plots at any depth (Table 1). This suggests that under the low rainfall conditions of the trial, the wetting agent did not improve soil water retention.

Table 1. Gravimetric soil moisture percentages at varying depths pre-sowing and at harvest.

	Gravimetric soil moisture (%)				
	Pre-sowing	Harvest			
Treatment	**0–100cm**	**0–10cm**	**10–30cm**	**30–50cm**	**50–100cm**
Wetting agent	17.63	7.83	19.84	16.57	16.80
Nil	17.31	7.69	18.16	19.95	16.04
Sig. diff.	NS	NS	NS	NS	NS

Plant establishment and biomass

The wetting agent had no significant effect on plant establishment, with treated plots averaging 91.8 plants/m^2 compared to 95.5 plants/m^2 in untreated plots (Table 2). Biomass production at flowering was also similar across treatments, with both averaging 1.2t/ha. These results suggest the wetting agent did not enhance early crop development or groundcover, and consequently did not make the soil less vulnerable to the risk of wind erosion.

Grain yield

Grain yield followed a similar pattern, with no significant differences detected between treatments. Treated plots produced an average yield of 0.85t/ha, compared to 0.88t/ha in untreated plots (Table 2). These results demonstrate that the wetting agent did not enhance crop productivity, underscoring its limited effectiveness under the conditions of this trial.

Table 2. Plant establishment, biomass and grain yield for treated and untreated plots.

Treatment	Plant establishment (plants/m^2)	Biomass (t/ha)	Grain yield (t/ha)
Wetting agent	91.8	1.2	0.85
Nil	95.5	1.2	0.88
Sig. diff.	NS	NS	NS

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

This trial demonstrated that the wetting agent did not improve soil moisture retention, groundcover, or yield, limiting its practical value for Mallee farmers during this season's dry conditions. The absence of increased groundcover left soils exposed to wind erosion, underscoring the ongoing challenge of mitigating soil degradation in drought-prone environments.

Research into wetting agents has produced mixed results, with their effectiveness often influenced by environmental and agronomic factors. For instance, South Australian studies reported significant improvements in crop establishment for cereals grown in forest gravel soils when a commercially available wetting agent was applied (Davies et al., 2019). However, variables such as soil texture, crop type, and rainfall patterns likely contributed to the lack of measurable benefits observed in this trial.

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ACKNOWLEDGEMENTS

This project is supported by the Mallee Catchment Management Authority, through funding from the Australian Government's Future Drought Fund. BCG sincerely thanks Ross Stone for generously hosting the trial site at Walpeup and for support throughout the project.

SOWING CONSIDERATIONS

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

NORTH CENTRAL LENTIL AND FIELD PEA VARIETIES BY TIME OF SOWING

Claire Pickles, Kate Finger, Angus Butterfield, and Casey Sim (BCG)

TAKE HOME MESSAGES

- GIA Lightning, PBA Hallmark, GIA Thunder and ALB2321 were the best performing lentil varieties in the North Central region for 2024.
- PBA Coogee, PBA Taylor, PBA Wharton, and PBA Twilight were the best performing field pea varieties in terms of grain yield in the North Central region for 2024.
- The earlier time of sowing for field peas resulted in an extra 0.4t/ha of grain yield in comparison to the second time of sowing.
- Harvest timing is crucial in lentils to prevent yield loss from weather events.

BACKGROUND

The need for profitable break crops in the crop rotation is increasing as farming systems in North Central Victoria continue to evolve. Traditionally, options have included vetch and canola, however global demand for pulses for human consumption combined with economic value have resulted in an increase in local production. This has led to a trend of sowing these crops in areas that are not as well suited. Newer lentil and field pea varieties are showing better adaptability to non-traditional areas with soil constraints such as acidity and salinity. It remains important to understand where various crops fit into the sowing program and overall farming system to maximise economic benefits.

Two trials established in the North Central region in 2024 are demonstrating pulse variety performance in areas where pulses are not widely grown. This work helps assess the possibility of including pulses such as lentils and field peas into more non-traditional areas and as a profitable crop option.

AIM

To compare the performance of field pea and lentil varieties by time of sowing (TOS) in the North Central region.

PADDOCK DETAILS

Location:	Mitiamo
Crop year rainfall (Nov–Oct):	467mm
GSR (Apr–Oct):	202mm
Soil type:	Clay
Paddock history:	Oaten hay (2023)

TRIAL DETAILS

Crop type/s:	Lentil and field pea varieties and breeding lines
Target plant density:	Lentils: 120 plants/m^2; Field peas: 40 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	TOS 1: 26 April 2024, TOS 2: 24 May 2024
Replicates:	Three
Harvest date:	5 December 2024
Trial average yield:	Lentils: 0.5t/ha; Field peas: 1.6t/ha

TRIAL INPUTS

Fertiliser:	Granulock Supreme Z + Flutriafol (400mL/100kg) @ 60kg/ha at sowing

Seed was inoculated with Group EF rhizobia at sowing. Weeds, diseases, and pests managed as per best management practice.

METHOD

Two replicated field trials were sown using a complete randomised block trial design. Assessments included establishment counts, crop biomass (field peas only) at flowering (peak biomass 9 September), grain yield, and quality parameters. Plots were scored for percentage of pod loss/shattering before harvest.

RESULTS AND INTERPRETATION

Both times of sowing established well. TOS 1 was dry sown after 20mm of rain earlier in the month and 2mm two days before sowing. The second time of sowing received 27mm of rain 14 days before sowing and follow up rain of 20mm seven days after sowing.

Lentils

During flowering, the site experienced five frost events from 10 to 18 September. The site was harvested on 5 December following 49mm of rain in the final week of November and 15mm in the first four days of December. Strong winds were also experienced during these rain events, resulting in significant pod shatter and yield loss.

The best performing lentil varieties were GIA Thunder, GIA Lightning and PBA Hallmark at both times of sowing (Table 1).

The average grain yield was 0.5t/ha, with both times of sowing yielding similarly (0.04t/ha difference). The yield measured in this trial is lower compared to local grower yields, which were on average 1t/ha to 1.5t/ha, and included GIA Thunder. The lower yields in this trial are likely due to significant pod loss (dropping and shattering) before harvest, which highlights the impact of weather events and challenges around desiccation and timely harvest of lentil crops. Shattering scores were done six days before harvest and on the morning of harvest. Differences between the scores were minimal, highlighting most of the losses occurred in the first rain event. PBA Kelpie had 50 per cent shattering loss when scored before harvest which was the highest grain loss. PBA Ace, PBA Bolt, GIA Leader, GIA Lightning and ALB Terrier also had substantial pod shattering translating to approximately 30 per cent grain loss (data not shown).

Table 1. Lentil varieties x time of sowing (TOS) grain yield (t/ha). Varieties are ordered from highest yielding to lower yielding for TOS1.

Variety	TOS1	TOS2
GIA Thunder	0.8	0.7
GIA Lightning	0.8	0.8
PBA Hallmark	0.7	0.7
ALB2421	0.7	0.5
ALB2321	0.7	0.7
PBA Jumbo 2	0.7	0.7
PBA Hurricane XT	0.6	0.6
ALB2422	0.4	0.5
GIA Leader	0.4	0.5
PBA Bolt	0.4	0.5
PBA Highland XT	0.4	0.7
ALB Terrier	0.3	0.4
GIA Sire	0.3	0.3
GIA Metro	0.3	0.3
PBA Ace	0.3	0.6
PBA Kelpie XT	0.2	0.2
P Variety	<0.01	
TOS	0.046	
Variety x TOS	0.08	
LSD		
Variety	0.13	
TOS	0.04	
Variety x TOS	0.19	
CV (%)	22	

Field peas

Hay yield results from the field peas resulted in differences between varieties and between the two times of sowing, with TOS1 yielding 0.5t DM/ha more in hay yield (TOS data not presented). PBA Coogee, PBA Butler, PBA Twilight, PBA Bondi, and PBA Taylor were the highest yielding varieties (for hay) when averaged out for both times of sowing (Figure 1).

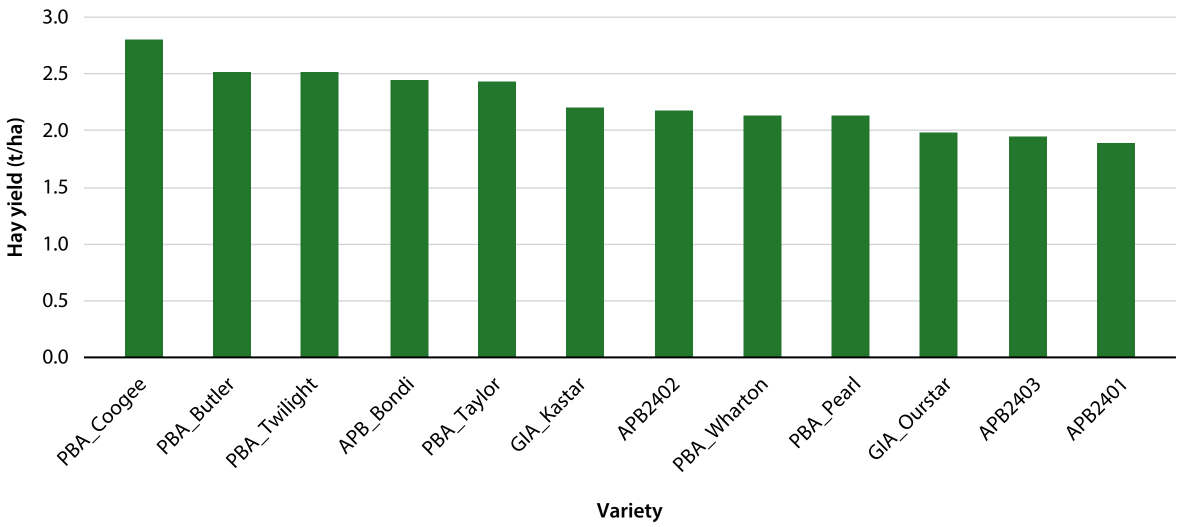

Figure 1. Mean field pea hay yield for each variety (t DM/ha) (P=0.002, LSD 0.42t/ha, CV16.1%)

The field pea trial had an average grain yield of 1.6t/ha. TOS1 (1.8t/ha) yielded 0.4t/ha more than TOS2 (1.4t/ha).

The best performing field pea varieties for grain yield were two breeding lines, APB2401, APB2402 and commercial varieties PBA Coogee, PBA Taylor, PBA Wharton and PBA Twilight TOS1 only). There was a significant interaction between TOS and variety. PBA Coogee and PBA Taylor yielded the same when sown early and late. However, this was not the case for some varieties, such as PBA Pearl, GIA Ourstar and APB2403, which nearly doubled in yield when sown earlier compared to later. This indicates variety selection is an important consideration when sowing later.

PBA Pearl experienced high grain loss due to pod loss before harvest with shattering scores of 70 per cent when scored after the late November rain. This indicates PBA Pearl should be prioritised for harvesting before other field pea varieties.

Table 2. Grain yield for field pea varieties x time of sowing (TOS) (t/ha).

Variety	TOS1	TOS2
APB2401	2.1	1.7
APB2402	2.1	1.4
PBA Coogee	2.0	1.8
PBA Taylor	1.9	1.7
PBA Wharton	1.9	1.4
PBA Twilight	1.9	1.5
APB Bondi	1.8	1.7
PBA Butler	1.8	1.5
APB2403	1.8	0.9
GIA Kastar	1.7	1.2
PBA Pearl	1.3	0.8
GIA Ourstar	1.2	0.8
P		
TOS	0.004	
Variety	<0.01	
TOS x Variety	<0.01	
LSD		
TOS	0.12	
Variety	0.15	
TOS x Variety	0.2	
CV (%)	8.5	

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Final lentil yields were significantly affected by weather events before harvest, highlighting the importance of harvest timing for lentils. When growing multiple varieties of lentils, it would pay to harvest lentils more susceptible to pod loss, such as PBA Kelpie, before varieties which had less pod drop, such as GIA Thunder.

New varieties' performance

ALB Terrier has a strong disease package (RMR to ASB) and typically has a high yield potential. It performed well in 2024, in NVT and in the Wimmera and Mallee, however this was not observed in this trial. ALB Terrier was highly sensitive to wet and windy conditions which caused pod drop. Based on this, it would be recommended to make it a top priority at harvest time if there is rainfall forecast. The Imidazolinone tolerance of this variety makes it suitable for use where weed control is a priority.

GIA Thunder is a small red lentil with IMI tolerance to Group B herbicides, high yield potential and suitability across a range of environments. GIA Lightning is also a small red lentil with IMI tolerance, has Improved adaptability to sandy soils, and performed well in 2024 at both times of sowing.

APB Bondi is a 'kaspa type' field pea released in 2024. It is mid flowering, mid maturity, and has good adaption to a broad range of environments including having moderate tolerance to high salinity. It performed well at both times of sowing and was not far from the top yielding varieties.

Key agronomic lessons

A year such as 2024 highlighted the benefits of sowing early for both lentils and field peas, where we measured on average an x and y % increase in yield for TOS1. It was particularly important for lentils, with some varieties being adversely affected by the weather at harvest. Late sowing risks are less pronounced when there is a favourable spring to follow, however the risk of heat and moisture stress would often be a limiting factor in this environment. Harvestability is another factor to consider when growing pulses, especially lentils, to maximise profitability.

Variety selection is crucial for managing soil salinity constraints, unique to this region and maximising returns from pulse crops. This data highlights the need to harvest pulses in particular, lentils prior to rain events.

ACKNOWLEDGEMENTS

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MANAGING CANOLA ESTABLISHMENT IN THE WIMMERA AND MALLEE

Casey Sim and Thomas Jones (BCG)

TAKE HOME MESSAGES

- The impact of pressure wheel pressure on crop establishment depends on topsoil characteristics.
- Sowing shallow was most beneficial for crop establishment in 2024.
- High plant densities did not always translate to higher yield in 2024.

BACKGROUND

Canola establishment can be challenging for growers in the Wimmera and Mallee, with various management, environmental, and genetic factors causing only 50 per cent of viable sown seed to establish (Porker et al., 2024). Poor establishment often has negative consequences for yield and in some cases can require resowing of crops, costing Australian growers an estimated $100–$200 million annually (Porker et al., 2024). This highlights the need for research into genetic and management strategies that can assist growers in improving canola establishment.

This is the second year of a three-year project funded by GRDC and led by CSIRO which investigates management by environment interactions, and the effects on canola establishment. As part of this project, BCG managed two trials of locally relevant treatments, determined through discussions with local advisors and grower advisory committees. In 2023, trials investigated the impact of seed size and sowing depth on canola establishment. Results showed shallow sowing and seed graded to a larger size produced significantly higher establishment but did not significantly affect yields. In 2024, the focus of these trials shifted toward other agronomic management practices that influence establishment, investigating the impact of press-wheel pressure and sowing depth.

AIM

These trials aimed to evaluate the impact of sowing depth and press-wheel pressure on establishment and yield of canola sown on typical soils in the southern Mallee and northern Wimmera.

PADDOCK DETAILS

Location:	Nullawil (Mallee)	Murra Warra (Wimmera)
Crop year rainfall (Nov–Oct):	305mm	346mm
GSR (Apr–Oct):	178mm	146mm
Soil type:	Clay loam	Self-mulching clay
Paddock history:	Vetch brown manure	Lentil

TRIAL DETAILS

Crop type/s:	Canola: 44Y94 CL + Hyola Regiment XC
Treatments:	Refer to Table 1
Target plant density:	Nullawil 40plants/m^2; Murra Warra 50plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	Nullawil 13 May 2024; Murra Warra 3 May 2024
Replicates:	Three
Harvest date:	7 November
Trial average yield:	Nullawil 1.73t/ha; Murra Warra 1.46t/ha

TRIAL INPUTS

Trials were managed as per best practice.

METHOD

Two replicated field trials were sown in the Mallee (Nullawil) and Wimmera (Murra Warra) growing regions using a split-split plot design. Assessments included soil moisture at sowing, emergence rate, establishment counts, soil strength (using a handheld penetrometer), and yield.

Table1. Treatments applied to canola sown at Nullawil and Murra Warra in 2024.

Variety	Sowing depth	Press wheel pressure
44Y94CL	Shallow (Nullawil – 1cm, Murra Warra – 3cm)	Nil – press wheels lifted (P1)
Hyola Regiment XC	Deep (Nullawil – 3cm, Murra Warra – 5cm)	Standard – 5kg/cm^2 (P2)
		Heavy – 25kg/cm^2 (P3)

RESULTS AND INTERPRETATION

Soil moisture at sowing

The Nullawil trial was sown on 5 May into 20–21 per cent gravimetric soil moisture after a 7mm rainfall event the previous day (Figure 1). Follow-up rain (5mm) did not occur until 30 May (Figure 2). The Murra Warra trial was sown dry on 3 May as the site had not received any rainfall for more than a month, however soil moisture was higher at the time of sowing (Figure 1). This is likely due to the heavier texture of the soil and greater water holding capacity. Similar to Nullawil, the Murra Warra site did not receive rain until 30 May (5mm).

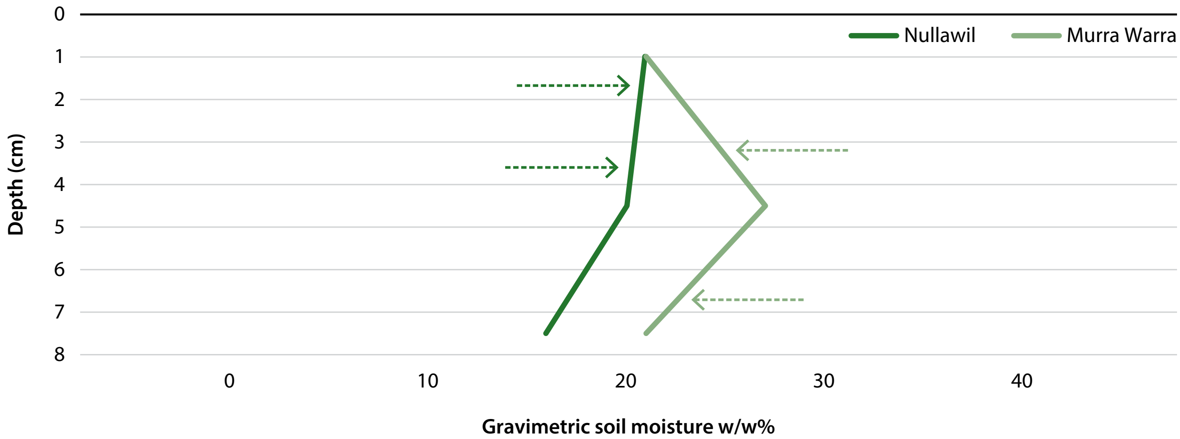

Figure 1. Gravimetric water content (w/w%) at Nullawil and Murra Warra at the time of sowing. Arrows illustrate the depths at which treatments were sown at both sites.

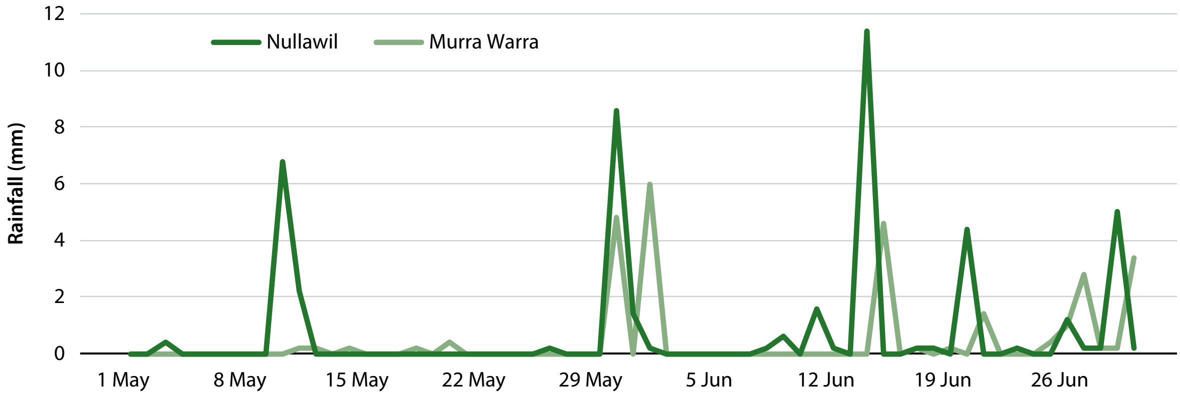

Figure 2. Rainfall (mm) at Nullawil and Murra Warra throughout crop establishment.

Target sowing depths were set at 1cm for the shallow treatment and 3–4cm for the deep treatment. Final sowing depth was validated by removing plants and measuring the length of the hypocotyl. At Nullawil, target depths were successfully achieved. At the Murra Warra site, precise sowing depths were harder to achieve due to the poorly structured, self-mulching topsoil, so the shallow treatment was sown at 3cm and the deep treatment at 5cm.

Soil strength at sowing

The impact of press-wheel pressure on soil strength varied between the two sites and soil types. At Nullawil, soil strength increased in the 14 days post-sowing as the sodic topsoil dried out, particularly for P2 and P3 treatments (Table 2). However, the soil strength decreased after 28 days post-sowing, following rainfall (Table 2). By this time, the effect of press-wheel pressure had also dissipated and all treatments had a similar soil strength (Table 2). At Murra Warra, differences in soil strength between treatments were less apparent. Soil strength gradually increased after sowing and did not appear to react in the same way to rainfall as the Nullawil soil. This may be due to the self-mulching clay topsoil at Murra Warra, where the soil continually breaks downs as it dries and cracks, before reforming when soil moisture increases.

Table 2. Average soil strength (kg/cm³) at the Nullawil and Murra Warra sites for the different press-wheel pressure treatments.

Site		Nullawil			Murra Warra	
Days after sowing	0 days	14 days	28 days	0 days	49 days[1]	63 days[2]
P1	0	1	0.9	1.55	2.3	3.7
P2	2.1	4.3	1.5	2.1	2.4	4.4
P3	2.7	6.9	2.2	2.7	2.6	4.7

[1]Initial crop emergence. [2]14 days after initial crop emergence.

Crop emergence

Differences in soil texture and soil moisture availability heavily influenced crop emergence, as neither site received rainfall for three weeks after sowing. The crop at Nullawil emerged immediately after the rain event in late May, likely due to the lighter soil texture which may have resulted in better access to soil moisture. Plant density two and three weeks post-sowing was significantly higher for nil and standard press-wheel pressure treatments, regardless of sowing depth ($p<0.05$) (Table 3).

In contrast, canola sown at Murra Warra did not emerge until late June, following several rainfall events, each delivering about 5mm of rain or less (Figure 2). This may be due to the heavier textured soil at the site, which can reduce soil moisture availability. Crop emergence at both six and seven weeks post-sowing (one and two weeks after initial emergence) was significantly affected by sowing depth ($p<0.05$) (Table 4). Shallow sown treatments were quicker to emerge. Six weeks following initial emergence, shallow sown treatments had a plant density similar to final establishment, whilst very few plants, if any, had emerged for deep sown treatments.

No significant differences were observed for emergence between varieties at both sites.

Table 3. Crop emergence two weeks post-sowing, final establishment and yield for the Nullawil trial in 2024.

Treatment		Emergence 2 weeks post-sowing (plants/m²)	Emergence 3 weeks post-sowing (plants/m²)	Establishment (plants/m²)
Depth	**Pressure**			
1cm	P1	25	32	57
	P2	25	27	40
	P3	15	25	33
3cm	P1	31	37	46
	P2	25	25	24
	P3	7	8	15
	Sig. diff.			
	Depth	NS	NS	<0.001
	Pressure	0.021	0.039	<0.001
	Depth x Pressure	NS	NS	NS
	LSD (p=0.05)			
	Depth	10.2	18	5.8
	Pressure	12.5	12	7.1
	Depth x Pressure	17.7	18	10.1
	CV %	67.8	60.3	23.2

Table 4. Rate of emergence and final establishment for canola sown at varying depths and press-wheel pressure at Murra Warra in 2024.

Treatment		Emergence 6 weeks post sowing[1] (plants/m²)	Emergence 7 weeks post sowing[2] (plants/m²)	Establishment (plants/m²)
Depth	**Pressure**			
3cm	P1	49	61	48
	P2	56	68	68
	P3	52	61	64
5cm	P1	0	7	34
	P2	1	7	27
	P3	6	18	38
	Sig. diff.			
	Depth	<0.001	<0.001	<0.001
	Pressure	NS	NS	NS
	Depth x Pressure	NS	NS	NS
	LSD (p=0.05)			
	Depth	11.2	12.1	7.8
	Pressure	13.8	14.8	9.56
	Depth x Pressure	19.5	20.9	13.52
	CV%	59.5	47.2	24.1

[1]1 week post initial emergence. [2]2 weeks post initial emergence.

Crop establishment

The crop was considered established at the four leaf growth stage, about four weeks after sowing for the Nullawil crops and eight weeks after sowing for the Murra Warra crops. At Nullawil, crop establishment was significantly affected by sowing depth and pressure ($p<0.05$), although interactions between the two were not significant (Table 3). Shallow sowing resulted in significantly higher plant establishment, regardless of press-wheel pressure. The shallow sown with nil press-wheel pressure treatment resulted in the highest plant density of 57 plants/m^2, equal to 91 per cent of sown seed emerged (Figure 3). For both sowing depths, nil press-wheel pressure resulted in significantly higher plant densities. Heavy press-wheel pressure resulted in the lowest plant densities, meaning that only 53 per cent of seed sown for shallow treatments and 24 per cent of seed sown for deep treatments emerged.

This may be a result of the sodic topsoil the crop was sown into at Nullawil. At sowing the tyne system broke up the sodic hardpan which was then reset by the standard and heavy press-wheel pressure treatments. The resetting of this hardpan in combination with an absence of rainfall increased soil strength, and subsequently increased resistance to crop emergence (Table 2).

At Murra Warra, crop establishment was only significantly affected by sowing depth ($p<0.05$) (Table 4). Sowing shallow resulted in a significantly higher plant density of 60 plants/m^2 averaged across press-wheel treatments, whilst sowing deep resulted in a plant density less than half that, 29 plants/m^2. The deep sowing treatment was sown deeper at Murra Warra than Nullawil. This may have caused the large disparity in plant establishment for both sowing depths, as canola is limited by its relatively short hypocotyl which can cause seedlings to fail to emerge if sown too deep. There were no consistent patterns across press-wheel pressure treatments. Press-wheel pressure may not have affected crop establishment in the same way it did at Nullawil because of differences in topsoil and the length of time the crop stayed in the ground due to inadequate soil moisture. The self-mulching quality of the topsoil may have buffered the effects of the press-wheels, by swelling in response to rain and then shrinking and breaking down into smaller aggregates as it dried, reducing the soil strength of the press-wheel treatments. This is reflected in the penetrometer readings, where soil strength was relatively consistent across press-wheel pressure treatments (Table 2).

No significant differences were observed between plant densities of varieties at both sites.

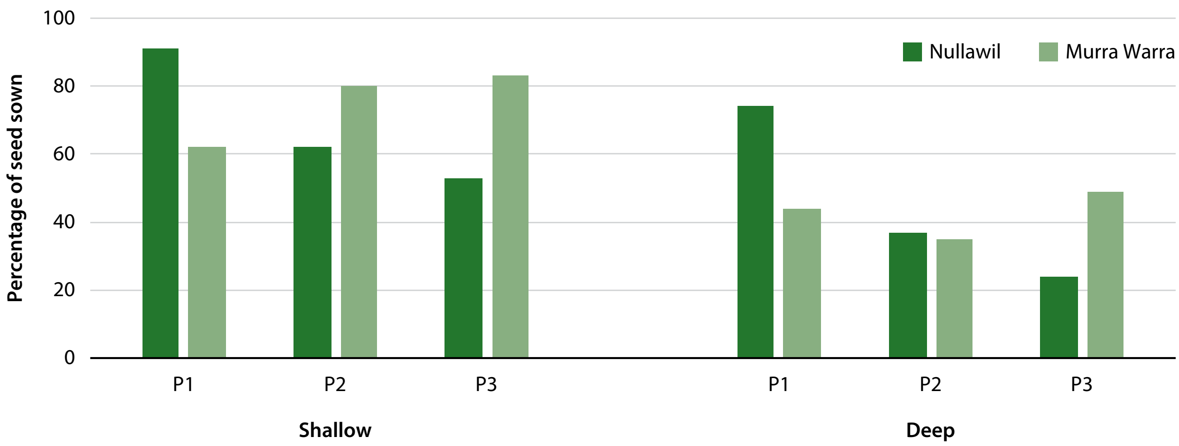

Figure 3. Percentage of seed sown that established at Nullawil and Murra Warra trials 2024.

Crop yield

At Murra Warra, shallow sown treatments produced a significantly higher yield, averaging 1.6t/ha ($p<0.05$), whilst deep sown treatments averaged 1.3t/ha (Table 5). Press-wheel pressure had no significant effect on yield.

Yields at the Nullawil site were significantly affected by pressure as well as depth pressure interactions (Table 5). Nil press-wheel pressure resulted in the highest yields of 1.93t/ha at shallow sowing depth and 2.01t/ha at deep sowing depth. Significance in depth by pressure interactions highlighted that canola may be best sown shallow if using a heavy press-wheel pressure, as sowing deep can result in a significantly lower yield.

Significant differences in yield may not have entirely been caused by significant differences in plant density. Canola can compensate for some yield loss when established at lower densities by putting out more branches and pods (GRDC, 2015). An example of this was seen for the shallow sown treatment at Nullawil, which resulted in significantly higher plant density but did not translate to significantly higher yields.

Other treatment effects, such as timing of emergence, may have also impacted yield. At Murra Warra, the emergence of deep sown treatments was delayed by one week, similar to the effect of sowing this treatment a week later. Previous studies have found that canola yield can decline with sowing date, ranging from 5 per cent to 12 per cent for each week sowing is delayed (Farre et al., 2002).

Yields were also significantly different by variety at both sites. At Nullawil, 44Y94 CL yielded higher, and at Murra Warra Regiment XC yielded higher (data not shown).

Table 5. Yield for canola sown and various depths and press-wheel pressure at Nullawil and Murra Warra 2024.

Treatment		Nullawil	Murra Warra
Depth	**Pressure**	**t/ha**	**t/ha**
Shallow	P1	1.93	1.56
	P2	1.87	1.63
	P3	1.56	1.63
Deep	P1	2.01	1.30
	P2	1.76	1.32
	P3	1.26	1.29
	Sig. diff.		
	Depth	NS	<0.001
	Pressure	<0.001	NS
	Depth x Pressure	<0.001	NS
	LSD (p=0.05)		
	Depth	0.12	0.08
	Pressure	0.14	0.10
	Depth x Pressure	0.20	0.144
	CV %	9.7	8.2

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Good crop establishment is essential to achieving good yields. Canola establishment can be sensitive to a range of soil and environmental factors, but there are several management decisions that enable growers to respond to expected conditions.

These trials have reinforced the importance of getting the basics right to successfully establish canola. Sow shallow (3cm or less) and into moisture where possible to ensure the crop is out of the ground quicker and at a vulnerable growth stage for a shorter period. Ensuring machinery is optimised to achieve target depth for the predominant soil types in the paddock is also important. Doing so can slow operations, but sowing deep seems to have the same effect as sowing later, reducing emergence rate and plant establishment, and potentially decreasing yield.

Whilst presswheel pressure had a significant impact on both plant density and yield at the Nullawil site, presswheel pressure by soil type interactions and effect on crop establishment needs to be studied further before more definitive guidelines can be created.

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BCG sincerely thanks David Jochinke and the Watts family for generously hosting the trials and for their support throughout the project.

SEEDER DEMONSTRATION DAY – PRELIMINARY FINDINGS

Kelly Angel (BCG)

TAKE HOME MESSAGES

- Seed depth uniformity increased with a disc seeder compared to a tyne seeder.
- There is evidence of fertiliser toxicity with some treatments, but without replication it is difficult to draw clear conclusions.
- Age of machinery is not a determinant of how accurately it can sow a crop. This is governed more by diligence to seeder setup and making sure other factors are accounted for, such as seed quality, potential for fertiliser toxicity and management of establishment pests.

BACKGROUND

Growers throughout the Wimmera have identified poor crop establishment as a key area of concern, particularly where disc seeding systems are used in high stubble loads. This is an issue across the southern region, with growers at Kaniva, Toolondo, Rupanyup and Goroke National Grower Network (NGN) forums in 2023 all identifying crop establishment as important for crop success, and reporting issues in replicating successful establishment year on year.

Poor establishment at the start of the season creates ongoing problems with crop vigour, competition and weed management, that can continue throughout the season, ultimately impacting yields and profitability. A key consideration for growers is how to ensure good establishment and crop density, especially with high stubble loads.

To address these concerns, BCG helped deliver a seeder demonstration day at Murra Warra, to allow growers to discuss the fundamental components of seeder setup including air carts, seeder bars, and crop agronomy. They also demonstrated or witnessed the performance of locally owned equipment with growers giving an account of their equipment, and associated successes and challenges.

This report discusses the demonstration strips that were created, as well as outlining some of the fundamental crop establishment factors growers should consider when sowing crops. It is a preliminary report as the crop was not yet harvested at the time of compilation.

AIM

To outline the fundamental aspects of seeder setup for successful crop establishment, and the associated agronomic techniques that can be used by growers.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

PADDOCK DETAILS

Location:	Murra Warra
Crop year rainfall (Nov–Oct):	345mm
GSR (Apr–Oct):	146mm
Soil type:	Grey vertosol
Paddock history:	2023 Lentils

TRIAL DETAILS

Crop type/s:	Canola 44Y94
Treatments:	Refer to table 1
Target plant density:	50 plants/m^2
Sowing date:	10 April 2024
Replicates:	Unreplicated demonstration
Harvest date:	Not included in this report

TRIAL INPUTS

Fertiliser:	MAP at sowing – 40kg/ha or 80kg/ha, all other inputs farmer managed
Herbicide:	Farmer managed
Insecticide:	Farmer managed
Fungicide:	Farmer managed

METHOD

A seeder demonstration site was established in the Wimmera at Murra Warra. For the demonstration, local growers were invited to bring along equipment of different ages and configurations for discussion of performance, and to establish a canola crop for monitoring through the season (Table 1). All equipment was calibrated to sow 3kg/ha of seed, which was the rate required to establish 50 plants/m^2 at the seed size provided (161,500 seeds/kg). Sowing depth was checked to ensure that seed from all equipment was placed at a similar depth.

On the day of the demonstration, each seeder conducted two passes, one with 40kg/ha of MAP fertiliser, the second with 80kg/ha MAP. All machines were single shoot only, so an assessment of fertiliser toxicity was possible. Treatments were not replicated.

During the season, assessments taken included: rate of plant establishment, final plant establishment counts, seed depth assessment, interplant spacing assessment, and grain yield as determined by grower equipment at harvest. Results for this final measure were not available at the time of reporting.

Performance of seeders in relation to crop establishment was compared, but could not be statistically analysed as lack of replication meant general trends were all that could be discussed.

Table 1. Seeder bars and air carts as part of the demonstration.

Seeder bar					
Make	John Deere	Simplicity	John Deere	Morris	Horsch
Model	1830	Territory	N540	Quantum	Sprinter 18NT
Year	2012	2021	2022	2017ish	2022
No. seed rows	48	80	40	60	72
No. ranks/ gangs	4	3	2	3	3
Row spacing	317mm	300mm	300mm	300mm	250mm
Overall width	15.24m	24m	12.19m	18m	18m
Seeding system	Tyne narrow point	Parallelogram Territory Tyne Openers Single shoot Dutch Opener Seeding Points. No residue managers fitted.	Single disc, single shoot with Aricks wheels fitted.	Parallelogram, single shoot, knife point. No residue managers.	Tyne, long shank pivoting on rubber torsion with depth determined by attached press wheel. Single shoot, knife point, hydraulic coulters out front.
Setting of seeding depth	Centralised whole bar	Adjusting of press wheel height so all 80 individually	Row by row	Row by row	Row by row
Liquid delivery	No	No	No	No	No
Practice	Inter-row sowing	Inter-row sowing – with Tru Trak GPS on the seeder bar.		Inter-row sowing	Inter-row sowing
Air cart					
Make	John Deere	2021 Simplicity	Bourgalt	Flexicoil	Horsch
Model	1910	30 series	6320	3850 – largest model	21000Lt
Capacity	270 bu	20500	12300L		21000L
Tow point	Behind	Behind	Behind	Behind	Behind
Number bins	2	3 seed/fert + small seeds box	3	3	3
Control system		Mechanical drive to clutches, electronic section control	Electronic	Electric over hydraulic	Electronic
Section control	No	8 sections, 10 openers per section	No	No section control – 8 distribution heads	Yes – 2 x 9m

RESULTS AND INTERPRETATION

Season review

After above average rainfall in January, February and March were dry. In the lead up to sowing in April, small rain events were insufficient to promote good crop establishment apart from the areas where narrow windrows had been present up until three days before sowing. This resulted in strips of early emerging crop occurring at the site, likely due to the increased moisture just below the surface in these areas. For most of the trial however, adequate rainfall to promote successful establishment did not occur until 30 May (7.4mm), meaning the seed was in the ground for nearly two months before successful establishment. In-season rainfall post emergence was patchy and low, with monthly rainfall depicted in Figure 1. The largest rainfall event for the growing season occurred on 14 June (22mm); all other events were less than 10mm which on this soil type (grey vertosol) is not generally considered significant.

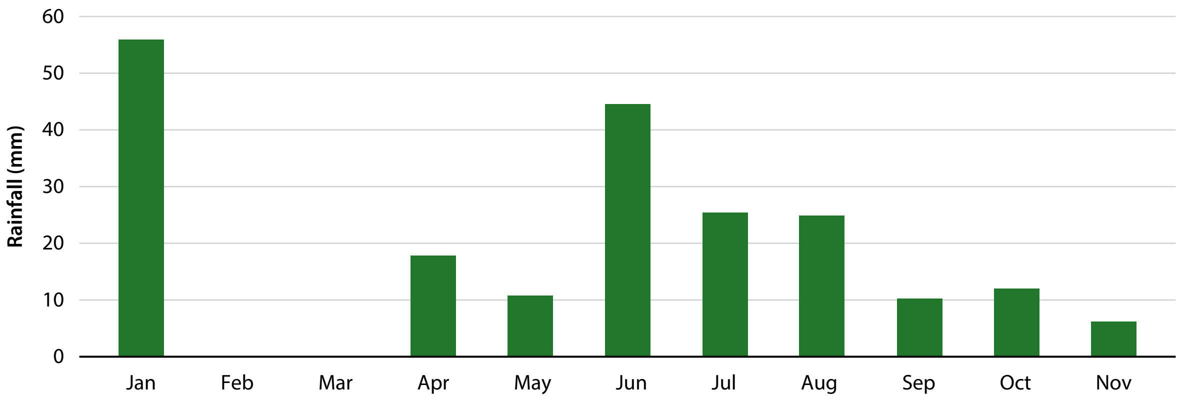

Figure 1. Rainfall (mm) received at the Murra Warra trial site.

Seeder type and seed placement – depth

Seed depth was intended to be set at about 2.5cm for all seeders in the demonstration. Figure 2 shows this was achieved for most seeders, with the exception of the older John Deere 1830 seeder bar which was slightly deeper than other treatments at about 3.5cm. The shallowest placement came from the JD N540 disc machine, at about 1.8cm.

The small variation in placement between machines did not dramatically affect crop establishment although anecdotally – from site visits – it was thought the slightly deeper sown seed of the JD 1830 bar established more plants at an earlier time. This was not detected in final plant number assessments, and any early establishment of plants was concentrated to regions where more moisture had been retained as a result of stubble cover from the previous lentil crop.

When looking at the variation of depth from each machine, as indicated by the vertical spread of data in the box plot, Figure 2 shows greater depth control from using a disc machine compared to a tyne machine. Tyne machines in dry soil can move soil aggregates or clods, allowing seeds to drop deeper into the seed bed. Conversely, in hard soil beds, tynes can flick back out of the soil, resulting in shallower seed placement. This is not to suggest that disc seeders are always more suitable, as harder set soils may present more challenges for penetrating to a suitable depth with a disc machine.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

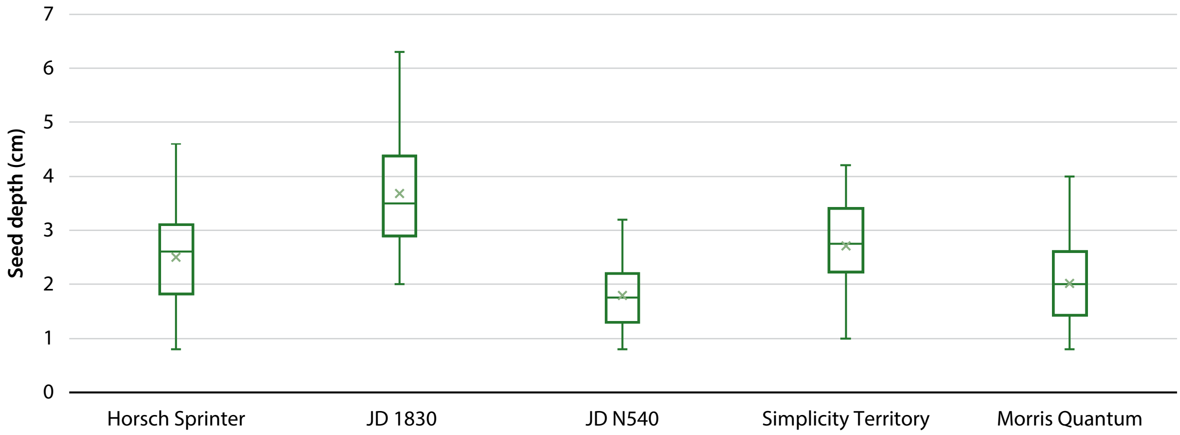

Figure 2. Seed depth (cm) measure and subsequent variability for each seeder involved in the demonstration day.

Seeder type and rate of establishment

Rate of establishment after the breaking rain showed some slight variations across the range of equipment used. This was closely linked to seed depth control, with equipment that had smaller variations in seed depth (the vertical range of each boxplot in Figure 2) generally establishing crops quicker. This resulted in both the JD N540 disc machine and the Simplicity Territory tyne machine achieving final crop establishment about seven days faster than some other machines, which is a critical consideration for getting crops off to a good start.

While the JD 1830 may have had some plants in favourable areas come up sooner due to the deeper seeding depth, this was counteracted by the delay in establishment of canola in areas where the soil was likely dry – as indicated by slower emergence due to being deeper, and lower final plant numbers compared to other treatments. This highlights the importance of seed placement when sowing small-seeded crops with small energy reserves. If they are sown too deep, they can run out of energy to emerge and establish their first leaves to allow photosynthesis, and oxygen and glucose production.

Only four treatments reached or exceeded the target plant population of 50 plants/m^2 within four weeks of establishment. All treatments achieved at least 30 plants/m^2. Generally speaking, canola has the ability to compensate for lower than ideal numbers, due to increased branching, however this is most effective when crops are established on time or early. The crop establishing in mid-June would be considered late, and would be relying heavily on a favourable spring to achieve any major compensation of low numbers, which did not occur in 2024.

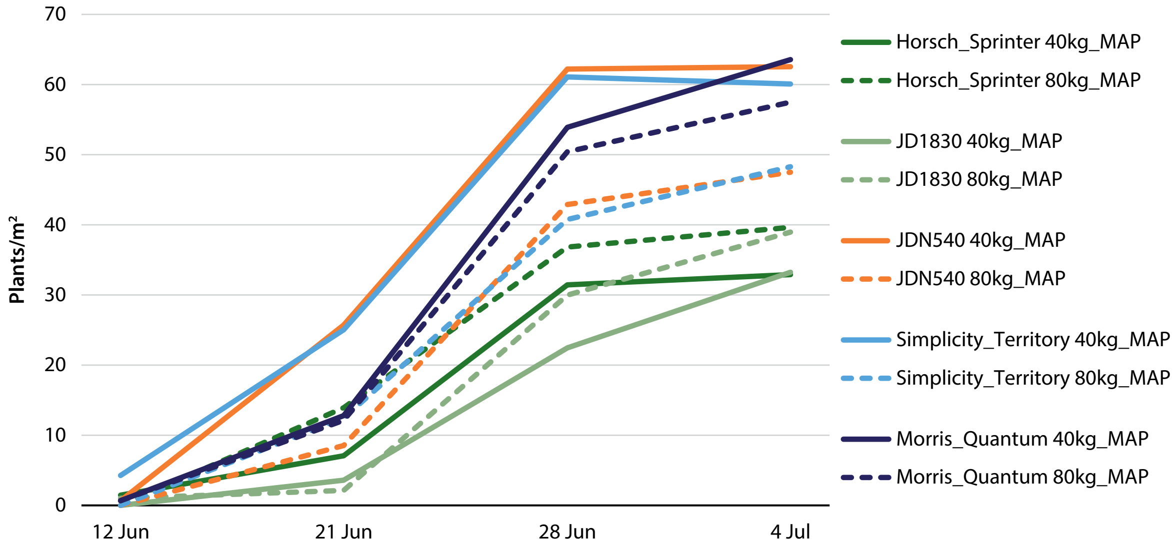

Figure 3. Rate of canola establishment after breaking rain on 30 May 2024.

Seeder type and fertiliser effect on crop establishment

Final crop establishment was greatest in the Morris Quantum, JD N540 and Simplicity Territory strips. However, there also appeared to be a fertiliser effect, as all three showed a 10–25 per cent reduction in plant numbers when sown with the 80kg/ha MAP fertiliser rate. Most notably, the disc seeder had the largest reduction in plant numbers due to higher fertiliser rates (Figure 4).

This aligns with the understood workings of this type of seeding equipment. It has a more concentrated placement of seed and fertiliser within the drill row, positioning more fertiliser close to the seed. This fertiliser may cause toxicity by two key mechanisms. Osmotic effect draws moisture away from the seed to the fertiliser, which causes desiccation or burning of the seed, or ammonia is released, causing toxicity in the seed. Both effects are considered more likely in drier conditions, and their significance is influenced by the fertiliser or blend of fertilisers used.

The Horsch Sprinter and JD1830 seeder setups had the lowest plant establishment, but also the least variation between fertiliser rates. This suggests the higher variability in seed placement may improve fertiliser safety when sown with the seed in the conditions that were experienced.

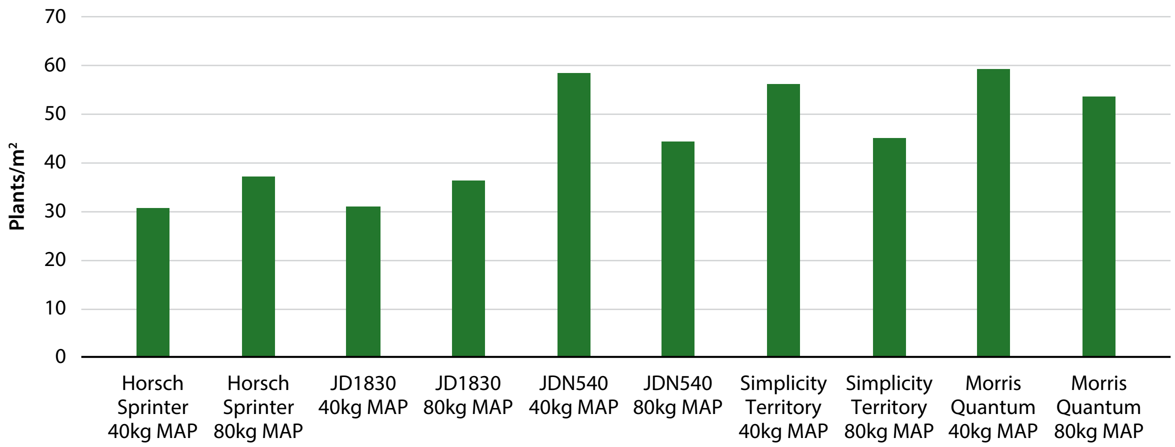

Figure 4. Crop establishment four weeks after germinating rain for the various seeders.

Seeder type interplant distance

Interplant distance from all demonstrated seeders was highly variable, as would be expected from equipment that is not a precision planter. Only small differences were noted between machines, with the greatest variation in plant spacing in the strips sown with the JD1830 machine (Figure 5).

Whether this is a reflection of better seed placement by the newer machines, or a random occurrence cannot be determined from this demonstration alone. It is interesting to note how variable seed placement can be, and the potential impacts this can have on other agronomic considerations such as access to water and nutrition, prevalence of weeds, and the ability of the crop to set the best possible yield outcomes.

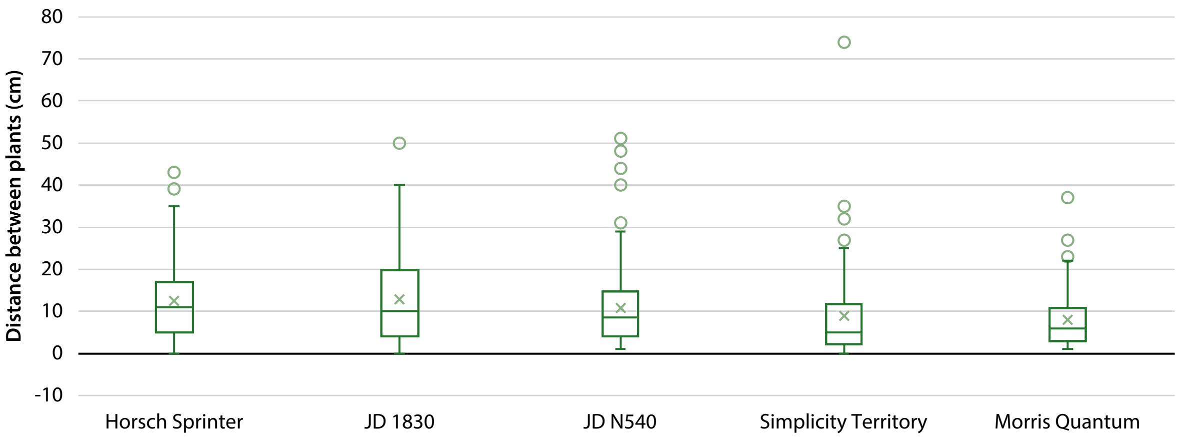

Figure 5. Interplant distances of the different seeders in the demonstration.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The work has highlighted that the performance of all seeders is impacted by the weather conditions when it comes to successful crop establishment across large areas of the paddock. If the time is taken to set them up well, by calibrating seeding rate and correctly setting the sowing depth, machines of all ages and models can successfully place seed to establish a crop. This highlights the importance of the operator and the time they take to understand the way their equipment works and how to optimise their machine. This demonstration was in the circumstances of limited stubble, which alleviated many issues. On the day of the demonstration, machinery expert Brett Asphar highlighted that there is no right or wrong machine, but a need to understand the issue growers are trying to rectify, and work out which tool, or collection of tools, does this best. It is also important to make sure growers are doing all they can to get the fundamentals of crop establishment right, as these are often within the operator's control.

The fundamentals of crop establishment

To set a crop up for success, apart from rainfall which is beyond our control, there are some key factors to consider. The 5R's of crop establishment are:

The **right** seed

Make sure seed is of good quality and free from effects of frost, heat, disease, and adverse harvest weather, as much as possible.

Conduct germination testing, and if concerned, vigour tests on seed, to know what the expected performance in the field should be. If lower than 90 per cent find an alternative seed source, if possible.

The **right** rate

Use seed germination percentage, expected field establishment, seed weight, and target population to work out the correct sowing rate. These can all affect the sowing rate required to achieve optimal plant populations and support crop yield.

Calibrate the air seeder to deliver the target seeding rate and check periodically to identify any issues with seeder performance.

The **right** placement

Check seeding equipment for sowing depth, and uniformity of sowing depth across the seeder bar. Inconsistent sowing depth can be an indication of tyre inflation issues, point wear and tear, or incorrect adjustments to tynes or press wheels that adjust the intended sowing depth.

The **right** timing

For the crop type being sown, where possible, target sowing windows that lead to the crop flowering at the optimal time.

Consideration of marginal soil moisture may be necessary where follow up rain is not forecast.

Dry sowing can offer logistical advantages but increases risks around whether the crop will get a breaking rain, pre-emergent herbicide performance, and wear and tear on equipment in abrasive soils. Consider your own business's attitude to risk in making decisions around the right timing.

The **right** management

Manage establishment pests and diseases in a timely fashion. Slugs, snails, and mice, as well as some insects, can seriously affect successful crop establishment and need diligent attention.

Harvest results are not yet available but will be collected and assessed to determine if any of the differences early in the season had any impact on outcomes at the end of the season. This information will be provided in an updated report.

ACKNOWLEDGEMENTS

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CROP END USE

GRAIN VS. BROWN MANURE VS. HAY: WHICH PULSE END-USE IS BEST?

Kate Finger, Angus Butterfield and Claire Pickles (BCG)

TAKE HOME MESSAGES

- Wheat yields in 2024 were not affected by lentil end-use treatments imposed in 2023.
- Brown manure field peas in 2023 and 150kg/ha urea treatments in 2024, resulted in a higher wheat yield in 2024.
- Best 2-year partial GM ($/ha) was lentil grain yr 1/wheat yr 2 and field pea grain yr 1/wheat yr 2, rather than brown manure/hay in year 1/wheat yr 2.

BACKGROUND

There are many recorded benefits from including a pulse phase in a cereal-based farming system, such as: (i) a weed and disease break, (ii) nitrogen (N) fixation, and (iii) conservation of soil moisture (Swan, 2023). However, it is not well understood how in-season agronomic decisions relating to pulse crop end-use for instance brown manure, hay or harvesting for grain, affect the yield and quality of the following cereal crop (Hunt, 2023) For instance, which pulse phase and end use contributes the most towards the next seasons wheat crop. Grain legumes provide some, but often insufficient levels, of N for following cereal crops at the current intensity of cereal crops grown in cropping rotations (Finger, 2023). Given the importance of legumes in cereal-based cropping rotations, it's critical to understand how end-use affects following cereal crops. Pulse crops all fix different amounts of N, this is due to inherent differences such as crop productivity, shoot to root ratio, biomass production and N fixation capacity (Farquharson, 2023).

In this instance lentils were used as they have been grown in the region and also trialled in previous BCG experiments. BCG have observed some growers trialling lentils purely for the purpose of brown manuring. For this reason, it allows growers to work with seed on hand or available to them. Field peas have also shown to be a suitable option for the North Central region, in previous BCG trials, this is why field peas were chosen to be included in this experiment.

For further information about pulse end-use effects, 'Vetch end-use and its legacy effect on wheat' on page 240 presents results from the two-year research in the Mallee. These trials highlight there is a still a need to conduct further research on these different pulse crops on their end-use impact for the following seasons crop.

AIM

To measure the legacy effect of different lentil and field pea end-uses on soil mineral N and water for the following cereal crop.

PADDOCK DETAILS

Location:	Pyramid Hill
Previous year rainfall (Nov 2022 – Oct 2023):	379 mm
GSR (Apr–Oct 2023):	250 mm
Crop year rainfall (Nov 2023 – Oct 2024):	428 mm
GSR (Apr–Oct 2024):	169 mm
Soil type:	Clay loam
Paddock history:	Oats (2022)

TRIAL DETAILS

Crop type/s:	Lentils var. GIA Thunder (2023) Field Peas var. PBA Butler (2023) Wheat var. Scepter (2024)
Treatments:	See Table 1
Target plant density:	130 plants/m^2
Seeding equipment:	Knife point, press wheels, 30 cm row spacing
Sowing date:	25 May 2023 (lentil, field pea) 7 May 2024 (wheat)
Replicates:	Four
Harvest date:	6 December 2024

TRIAL INPUTS

Fertiliser:	Granulock Supreme Z + Flutriafol (400 mL/100 kg) @ 60 kg/ha at sowing. See Table 1 for in season urea application rates.

Weeds, pests and diseases were managed as per best practice.

METHOD

Two replicated field trials were sown using a complete randomised block trial design in 2023 to lentils and field peas at Pyramid Hill. Three different end-uses for field pea (brown manure, hay and grain), and two for lentil (brown manure and grain) were implemented.

In 2024 all plots were sown to Scepter wheat. The first grain treatment relied on residual legume N in soil and no urea was applied; the second grain treatment received 150kg/ha urea (70 kg N/ha) in 2024.

Assessments included crop biomass, grain yield and quality. The trial plots were soil sampled on 2 April 2024 for soil available N and water to a depth of 1m. Urea was top dressed over one lentil and one field pea (27 June) treatment in 2024, the rates were determined based on starting soil nitrogen and calculated using Yield Prophet®.

Table 1. Treatment description for 2023 and 2024.

Stubble type	2023 treatment	Treatment	Description	Date urea applied (2024)
Lentil	Brown manure (13 Oct 2023)	BM L – wheat	The previous lentil crop was terminated at flowering on 19 September 2023. No urea applied to wheat in 2024.	
	Harvested for grain	Grain L – wheat 1	Received 0 kg/ha of urea in the 2024 season.	
	Harvested for grain	Grain L – wheat 2	Received 100 kg/ha of urea in the 2024 season.	27 June
Field pea	Brown manure	BM FP – wheat	The previous field pea crop was terminated at flowering on 19 September 2023. No urea applied to wheat in 2024.	
	Harvested for grain	Grain FP – wheat 1	Received 0 kg/ha of urea in the 2024 season.	
	Harvested for grain	Grain FP – wheat 2	Received 150 kg/ha of urea in the 2024 season.	27 June
	Cut for hay (13 Oct 2023)	FP Hay – wheat	Received 0 kg/ha of urea in the 2024 season (treatment only in the field pea stubble).	

RESULTS AND INTERPRETATION

Lentil and field pea biomass and yield results 2023

Biomass was measured at flowering for both lentil and field pea crops on 19 September 2023 (Table 2). Brown manure treatments were terminated on the same date. Data are presented as an average for each crop across all treatments as in-season management was consistent across treatments, with the exception of the end-use.

Table 2. Average lentil and field pea biomass at flowering and grain yield (t/ha) 2023.

	Biomass (t/ha)	Grain yield (t/ha)
Lentil	1.9	1.4
Field pea	3.0	1.9

Soil Mineral N & PAW

Baseline soil N sampling was conducted at the commencement of the trial. In 2023 the site had 105kg/ha of starting soil N (combined ammonium and nitrate) (sampled 22 May 2023).

At the end of 2023, soil sampling on a plot-scale revealed a trend of higher soil mineral N following the brown manure and hay treatments for both lentils and field peas (Table 3). However, the levels of soil N between treatments were not significantly different. This may be due to 150mm of summer rainfall occurring prior to soil sampling in January 2024, potentially influencing soil N and water dynamics, and masking differences between treatments. Similarly, soil chemistry and moisture data collected in March 2024 also showed minimal differences (non-significant) between the treatments.

Table 3. Available soil mineral N and PAW following the 2023 season, (sampled 24 January 2024) after pulse crops, and start of 2024 growing season (sampled 2 April 2024).

2023 crop	2024 treatment	Soil mineral N (kg N/ha)		Plant available water (PAW mm)	
		Jan 24	Mar 24	Jan 24	Mar 24
Lentil	BM L – wheat	110	152	145	69
	Grain L – wheat 1	125	131	121	57
	Grain L – wheat 2	107	134	125	62
	p	NS	NS	NS	NS
	LSD	NS	NS	NS	NS
	CV (%)	25.6	16	26	26
Field pea	BM FP – wheat	97	129	217	78
	Hay FP – wheat	102	135	226	57
	Grain FP – wheat 1	125	119	220	60
	Grain FP – wheat 2	124	115	216	54
	p	NS	NS	NS	NS
	LSD	NS	NS	NS	NS
	CV (%)	27.2	23.7	4.6	24.5

Wheat biomass

Data collected from biomass cuts taken from the wheat crop in 2024 showed that previous end-use treatment for both lentil and field pea produced no differences in terms of wheat biomass production at flowering (data not shown).

Wheat grain yield and protein

The effects of 2023 pulse end-use on 2024 wheat grain yield and protein are presented in Table 4. Wheat yield and protein content were generally consistent across treatments, and no significant differences for either variable were observed. This suggests minimal influence of previous lentil end-use and N application on the following wheat.

In contrast, the field pea brown manure and 150kg/ha urea treatments produced higher yields (0.5t/ha and 0.6t/ha, respectively) than the field pea hay and no additional N treatment (p = 0.016, LSD = 0.39). A significant grain protein difference was also observed between the four field pea treatments, with the 150kg/ha urea treatment (applied in 2024, producing the highest grain protein at 10.2% (p = 0.006, LSD = 0.6).

Table 4. Wheat grain yield (t/ha) and protein (%) following different pulse and end-uses in 2023.

2023 crop	Previous treatment	Wheat grain yield (t/ha)	Wheat grain protein (%)
Lentil	BM L – wheat	4.8	9.3
	Grain L – wheat 1	4.2	8.9
	Grain L – wheat 2	4.8	9.7
	p	NS	NS
	LSD	NS	NS
	CV (%)	10	4.3
Field pea	BM FP – wheat	4.5^{ab}	9.8
	FP Hay – wheat	4.0^{a}	9.6
	Grain FP – wheat 1	4.0^{a}	8.8
	Grain FP – wheat 2	4.6^{b}	10.2
	p	0.016	0.006
	LSD	0.39	0.6
	CV (%)	4.9	3.1

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

The partial gross margin (PGM) for lentils showed that Grain 1, where 0kgN/ha was applied to the wheat, had the highest PGM (Table 5). This is due to the absence of cost for urea, as there were no differences in the wheat yield following the three different lentil treatments, i.e., the only difference in the PGM between the 100kgN/ha treatment is the cost of the urea. The brown manure treatment had the lowest PGM as this treatment did not generate an income in 2023.

The highest PGM for the field pea treatments was field pea grain, that received 150kgN/ha in the subsequent wheat crop. The additional N which resulted in extra wheat yield had an $833/ha higher PGM, largely due to no return in 2023 from the brown manure. High summer rainfall may have negated any possible differences in soil water and N, where in some years a benefit (in the following wheat crop) may be observed from brown manuring a pea crop (Browne, 2012).

Wheat yields following field peas was highest when either 150kgN/ha was applied to the wheat, or the field peas were brown manured (Table 3). The three different lentil end-uses resulted in no differences in the following years wheat yields, even with the addition of N. Lentils typically fix less N in the first place, than field peas due to their low amount of above ground biomass (Seymour N. 2018).

The outcome of these cropping and end-use choices is highly seasonally dependent as in this instance large amounts of summer rain negated many benefits. Crop end use choice should remain selected based on seasonal conditions, to maximise profitability (i.e. cut for hay in drier year) (Browne 2012).

Table 5. Two-year partial gross margin ($/ha) for lentil and field pea followed by wheat.

2023 crop type	2024 treatment	Partial (GM $/ha)
Lentil brown manure	BM L – wheat	$1,437
Lentil	Grain L – wheat 1	$2,718
Lentil	Grain L – wheat 2	$2,643
Field pea brown manure	BM FP – wheat	$1,406
Field pea hay	FP Hay – wheat	$1,924
Field pea	Grain FP – wheat 1	$2,160
Field pea	Grain FP – wheat 2	$2,238

*Assumed $64/t for field pea hay production based on a 3t/ha pea hay yield. Grain prices taken from *The Weekly Times* on 11 December 2024.

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VETCH END-USE AND ITS LEGACY EFFECT ON WHEAT

Brooke Bennett and Angus Butterfield (BCG)

TAKE HOME MESSAGES

- Hay and late termination end-uses resulted in the highest grain yield in the following wheat crop.
- Hay end-use was the most profitable option over two years.
- Brown manure can still be an option for problem-weed paddocks.

BACKGROUND

Common vetch (*Vicia sativa*) has been grown in the Victorian Mallee for many years and has remained a staple due to its versatility as both a source of high protein stock feed and as a nitrogen (N) fixing green manure. It is understood that sowing vetch earlier will increase biomass for grazing and hay yield (GRDC, 2018). There is also a trade-off between brown manure timings: the earlier the termination timing, the higher the soil moisture left behind but the lower fixed nitrogen. In contrast, the later the termination timing, higher levels of soil mineral N are left behind, but this is quite often coupled with lower soil moisture levels (Ferrier et al., 2012). It is not well understood how agronomic decisions made during the season affect soil moisture and soil mineral N levels following the vetch phase, or their influence on yield and quality of the subsequent crop. Findings from year one (2023) of this research can be accessed here: <https://www.bcg.org.au/research-article/vetch-end-use-and-how-it-affects-the-cropping-rotation/>.

Grain legumes provide some N – but often not enough – for the following year's cereal crop at the current intensity cereals are grown. The research outlined in this article was guided by feedback from growers who wanted to understand how in-season management practices of vetch affect the following year's wheat crop.

AIM

To evaluate the effect of vetch variety choice, end-use and in-season decisions on the yield and grain quality of a subsequent wheat crop.

PADDOCK DETAILS

Table 1. Paddock details, Ouyen and Kinnabulla 2024.

Location	Ouyen	Kinnabulla
Crop year rainfall (Nov–Oct)	303mm	273mm
GSR (Apr–Oct)	124mm	139mm
Soil type	Sandy loam	Sandy clay loam
Paddock history	See Table 2 treatments	See Table 2 treatments

TRIAL DETAILS

Crop type: Scepter wheat

Treatments: Refer to Table 2. for 2023 treatments

Target plant density: Wheat: 130 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Sowing date: Ouyen – 15 May 2024
Kinnabulla – 6 May 2024

Replicates: Four

Harvest date: Ouyen – 21 November 2024
Kinnabulla – 1 December 2024

Trial average yield: Ouyen – 2.2t/ha
Kinnabulla – 3.2t/ha

TRIAL INPUTS

Fertiliser: 60kg/ha Granulock Supreme Z @ sowing

Weeds, pests, and diseases were managed as per best practice.

METHOD

Two replicated field trials were sown at Ouyen and Kinnabulla (Table 1) using a complete randomised block trial design in 2023 (Year 1). As a growth promoter, gibberellic acid (GA) was applied mid-June when the vetch was at eight node, targeting about four weeks before grazing. The grazing treatment was carried out just before canopy closure during mid-July for both sites. Early termination timing was undertaken four months after sowing for all varieties irrespective of growth stage, whereas the late termination timing and hay cut timing were determined by variety maturity. Termination or hay cut timing were when the vetch reached 50 per cent flat pod formation. Soil sampling was carried out at each site before sowing in Year 1 to determine baseline soil moisture and soil mineral N levels.

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

Post-harvest and pre-sowing soil tests were carried out in Year 1 and 2 per plot to determine soil mineral N and plant available water (PAW) to a depth of one metre and segmented into depths of 0–10cm, 10–40cm, 40–70cm and 70–100cm.

In Year 2, both trials were sown to Scepter wheat on 15 May at Ouyen and 6 May at Kinnabulla. Assessments carried out in Year 2 included soil moisture, soil N, NDVI, biomass, grain yield, and quality.

Table 2. Vetch varieties, end-uses, and in-season treatments in 2023

	Varieties (maturity)	End-use	In-season
Treatments	Studenica (Very early)	Early termination: 4 months post sowing	Grazing
	Volga (Early)	Late termination: 50% flat pod	Gibberellic acid
	Morava (Late)	Hay: 50% flat pod	Grazing + Gibberellic acid
		Grain: maturity	

RESULTS AND INTERPRETATION

Soil moisture and soil mineral N

PAW and soil mineral N were lowest following the vetch grain harvest treatments, as shown by post-harvest soil sampling (Tables 3 and 4). The early termination timing treatment produced the highest soil N content, which was unexpected given the large differences in biomass produced from the two termination timings. However, measurements taken closer to sowing showed a higher level of mineralisation in the late termination timing at Kinnabulla. By contrast, the grain treatment at Kinnabulla produced the lowest soil mineral N. Differences in PAW close to sowing were insignificant; likely due to higher-than-average rainfall between harvest and sowing (November to March) at both sites.

Significantly higher soil mineral N was detected following harvest for the earlier termination timing treatments across both sites, and this is likely due to increased time for soil mineralisation (Farquharson et al., 2022), whereas soil mineral N for the late termination and hay treatments at the pre-sowing measurement timing were relatively lower and similar (Table 3). With 3–6t/DM/ha of biomass removed in the hay cut treatments, a large difference in soil mineral N for these treatment plots would be expected. This demonstrates that time is needed for fixed N to break down into available soil mineral N.

When measured prior to sowing in the following year, the amount of N in the later termination timing treatment had increased, but not to the expected amount. A substantial amount of vetch stubble was still present at the time of sowing the subsequent crop in Year 2, and it is likely extra time is needed to realise full N mineralisation through biomass breakdown.

Table 3. The effect of end-use decision on plant available water (PAW) (mm) (0–100cm). Superscript letters within columns indicate significant differences.

End use	Kinnabulla		Ouyen	
	Post-harvest	Pre-sow	Post-harvest	Pre-sow
Early termination	184^{a}	210	87^{a}	113
Hay	165^{bc}	209	78^{ab}	121
Late termination	151^{c}	212	53^{cd}	118
Grain	151^{c}	193	37^{d}	109
P value	0.001	0.2	<0.001	0.2
LSD (P=0.05)	16	NS	17	NS
CV%	13.7		32.7	

Table 4. The effect of end-use decision on soil mineral N (kg N/ha) (0–100 cm).

End use	Kinnabulla		Ouyen	
	Post-harvest	Pre-sow	Post-harvest	Pre-sow
Early termination	87^{a}	156^{ab}	190^{a}	272
Hay	72^{b}	153^{ab}	145^{bc}	243
Late termination	65^{b}	170^{a}	135^{c}	287
Grain	46^{c}	114^{c}	104^{d}	258
P value	<0.001	<0.001	<0.001	NS
LSD (P=0.05)	8	20	10	NS
CV%	16.5	16.9	23.2	

Wheat yield and quality

Of all the end-use treatments, the late termination and hay end-uses of vetch in Year 1 were the only treatments to consistently show improved wheat yields in Year 2 (Table 5). Early termination and grain end-use legacy effects on yield were inconsistent, showing no trends at the two sites. The hay treatment was not expected to have a significant legacy effect on yield, as 3–6t/DM/ha of biomass removed is likely to result in less mineralisation compared to the brown manure treatments. This is consistent with observations reported previously in other studies (Grain Orana Alliance, 2024; Browne et al., 2012).

There was no significant difference between treatments in grain protein which averaged 10.2 per cent at Kinnabulla and 11.6 per cent at Ouyen. Year 2 wheat grain quality was not affected by Year 1 end-use at either site, with no evidence of haying-off or low screenings (data not shown).

Table 5. The effect of vetch end-use decision in 2023 on wheat grain yields (t/ha) in 2024.

End-use	Kinnabulla	Ouyen
Early termination	3.2^{bc}	2.3^{ab}
Hay	3.4^{ab}	2.3^{ab}
Hay + grazing	3.1^{bc}	2.1^{bc}
Late termination	3.6^{a}	2.3^{a}
Grain	3.3^{abc}	1.9^{c}
P value	0.021	0.002
LSD (P=0.05)	0.30	0.18
CV%	11.3	9.8

CONTENTS
VARIETIES AND THEIR MANAGEMENT
FARMING SYSTEMS
CROP AGRONOMY
WEED MANAGEMENT
PESTS AND DISEASE MANAGEMENT
LIVESTOCK
SOILS
SOWING CONSIDERATIONS
CROP END USE
APPENDICES

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Producing vetch hay in 2023 followed by wheat in 2024 was the most profitable option, compared with brown manure vetch or vetch grown for seed (Figure 2). This was due to high hay yields in 2023 when the Ouyen site yielded 4.9t/DM/ha, resulting in a gross margin of $1334/ha, and the site at Kinnabulla yielded 6.2t/DM/ha resulting in a gross margin of $1825/ha for Year 1. Growing vetch seed was the second most profitable outcome at both sites. Both brown manure timings had the lowest gross margin due to having no income in Year 1.

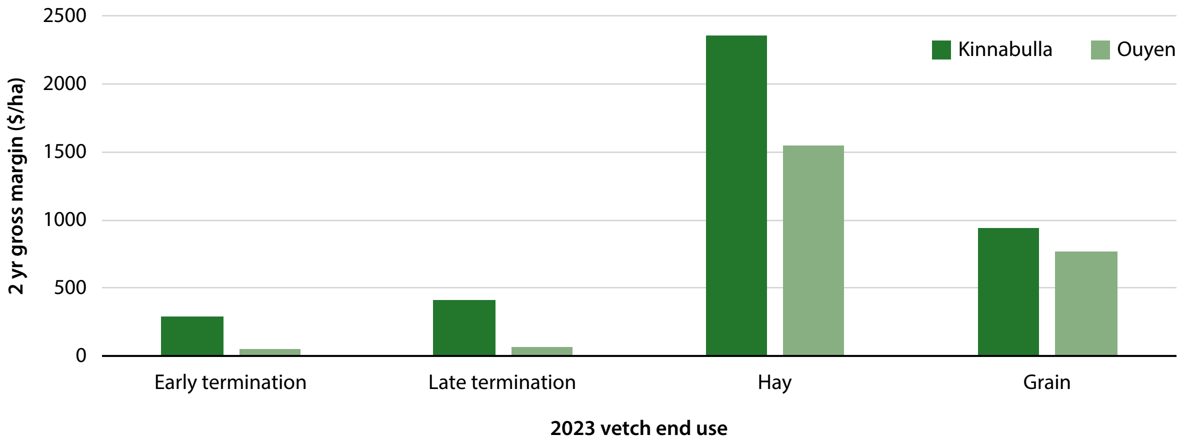

Figure 1. Two-year gross margin including 2023 and 2024 season, gross margin was estimated with the 2024 Farm Gross Margin Guide – SAGIT.

Although brown manure was not profitable in this trial, it is still an important option in a rotation. Brown manure vetch can be an excellent way to deal with problem weeds and can provide ground cover over summer (note: $160/ha was used in this gross margin for brown manure production costs; however, these costs can vary and if end-use is decided mid-season, costs can be significantly higher as more expensive inputs may be used for a hay or grain crop).

This research illustrates the impact of vetch end-use decisions on soil nitrogen, soil moisture, and the subsequent wheat crop's yield and quality. Early termination of vetch resulted in higher soil N content post-harvest, presumably due to a longer opportunity for soil N mineralisation. However, the late termination and hay end-use treatments consistently improved wheat yields, demonstrating their potential for long-term soil fertility benefits. The findings of this research illustrate the importance of including vetch within a cropping rotation and provides practical insights for growers aiming to optimise vetch management. BCG will continue to explore the effects of vetch end-use on subsequent crops.

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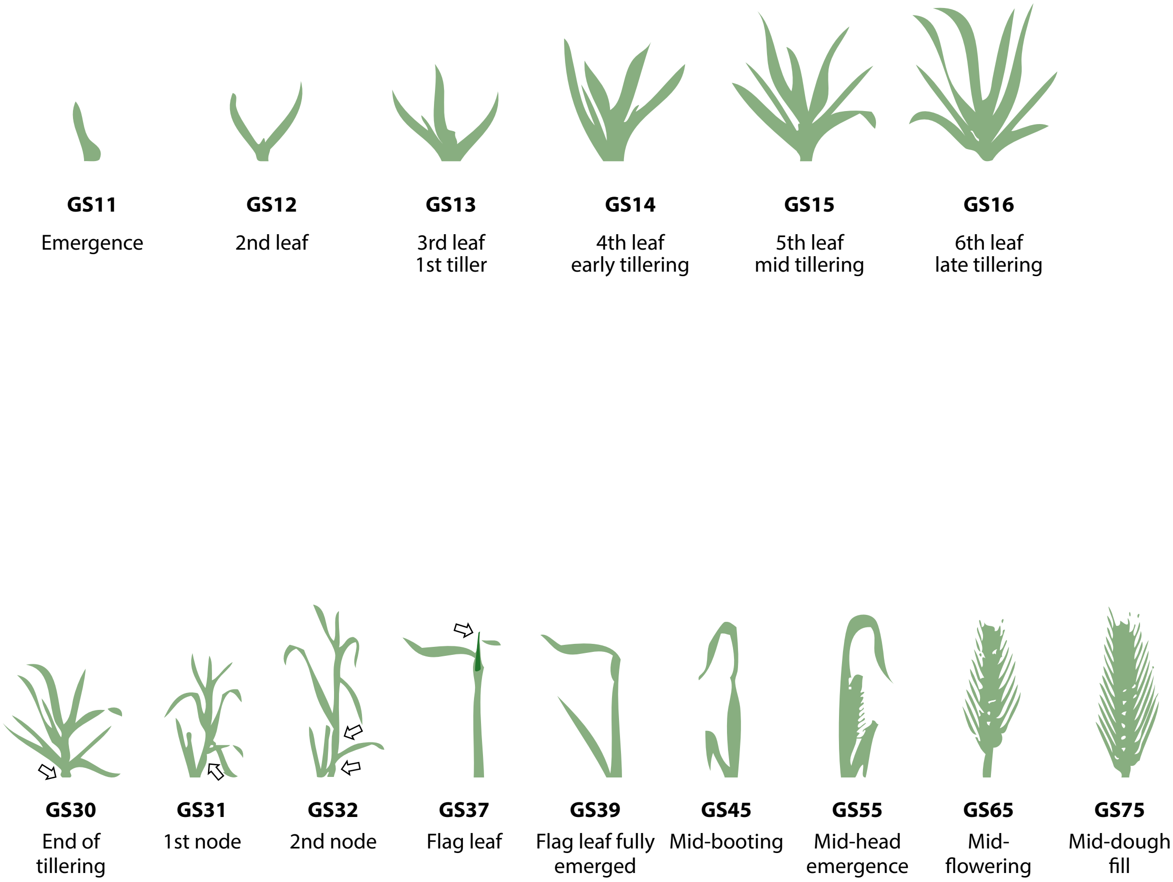
APPENDICES

APPENDIX 1
ACRONYMS AND ABBREVIATIONS

4N	Node
ADF	Acid detergent fibre
AGT	Australian Grain Technologies
AH	Australian Hard
ANOVA	Analysis of variance
APW	Australian Premium White
ASW	Australian Standard White
BD	Bulk density
BGA	Blue green aphids
C	Carbon
CCN	Cereal Cyst Nematode
CL	Clearfield®
CP	Crude protein
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CV	Coefficient of variation
cv.	Cultivar
DAP	Diammonium phosphate
DLPS	Dryland Legume Pasture Systems
DM	Dry matter
EC	Electrical conductivity
G	Gravel
GAI	Grams active ingredient
GIA	Grains Innovation Australia
GRDC	Grains Research and Development Corporation
GS	Growth stage
GSR	Growing season rainfall
HRZ	High rainfall zone
HS%	Approximate level of hard seed remaining at break of the season
HT	Intervix® residue tolerant
IBS	Incorporated by sowing
IMI	Imidazolinone
IOD	Indian Ocean Dipole
K	Potassium
LRZ	Low rainfall zone
LSD	Least significant difference
LVE	Low volatile ester
MAP	Monoammonium phosphate
MCPA	2-methyl-4-chlorophenoxyacetic acid
ME	Metabolisable energy
MET	Multi-environment trial
MIR	Mid-infrared
MR	Moderately resistant

MRMS	Moderately resistant to moderately susceptible
MRZ	Medium rainfall zone
MS	Moderately susceptible
MSS	Moderately susceptible to susceptible
N	Nitrogen
NC	North Central
NDF	Neutral detergent fibre
NDVI	Normalised difference vegetation index
NFNB	Net form of net blotch
p	Provisional rating
NIR	Near infrared
NS	Not significant
NVT	National Variety Trials
OP	Open pollinated
P	Phosphorus
PH	Pod Holding
PM	Powdery mildew resistant
PSPE	Post sowing pre-emergent
QMR	Quantum Market Research
R	Resistant
R&D	Research and Development
RMR	Resistant to moderately resistant
S	Susceptible
SAM	Southern Annular Mode
SARDI	South Australian Research and Development Institute
SCaRP	Soil Carbon Research Program
SFNB	Spot form of net blotch
SH	Seed harvestable
Sig. diff.	Significant difference
SOC	Soil organic carbon
SPAD	Soil plant analysis development
STB	Septoria tritici blotch
SU	Sulfonylurea
SVS	Susceptible to very susceptible
TOS	Time of sowing
TuYV	Turnip Yellows Virus
VS	Very susceptible
WSC	Water soluble carbohydrates
YLS	Yellow leaf spot
Z	Zadok's growth scale

APPENDIX 2
CEREAL GROWTH STAGE CHART



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