MINNIPA AG CENTRE

Annual Field Day

9 September 2026

Minnipa Agricultural Centre
EYRE PENINSULA

Government of South Australia
Department of Primary Industries and Regions

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE



Minnipa Agricultural Centre Annual Field Day Booklet

Information current as of 9 September 2026

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Minnipa Agricultural Centre Field Day Program

9 SEPTEMBER 2026

Start Time	*Finish Time*	*Speak Time*	*Topic*	*Speaker*	*Location*
8:30	9:00	30:00	Registration		
9:00	9:10	10:00	SARDI welcome - MAC research and MAC Farm update	Amanda Cook, SARDI	Agronomy Shed
9:10	9:20	10:00	Opening address	Prof Mike Steer, SARDI	Agronomy Shed
9:20	9:30	10:00	Grain marketing update	Tess Walch, Market Check	Agronomy Shed
9:30	10:10	40:00	Herbicide residues, geospatial herbiscide risks and microbial acitivity in EP soils	Dr Mick Rose, Associate Professor Southern Cross University, Soil CRC project leader introduced by Brad Koster, AGT	Agronomy Shed
10:10	10:20	10:00	Impact of alternative P sources on wheat growth	Anna Osmond, AIR EP and SARDI Intern introduced by Naomi Scholz, AIR EP	Agronomy Shed
10:20	10:30	10:00	AGT new barley variety release	Stewart Coventry, AGT	Agronomy Shed
10:30	11:00	30:00	**Morning Tea**	**Kindly provided by Rabobank**	**Agronomy Shed**
11:00	11:10	10:00	Travel to paddock on buses/utes		Travel
11:10	11:30	20:00	Netblotch and disease risk update	Dr Tara Garrard, SARDI	South 3 and 4
11:30	11:50	20:00	De-risking the seeding program	Elijah Luo, SARDI	South 4
11:50	12:00	10:00	Travel to paddock on buses/utes		Travel
12:00	12:20	20:00	NVT Break crops	Emma Turner, SARDI (NVT) and plant breeders	South 5
12:20	12:40	20:00	Lentil Nutrition - Lock and Kimba	Emma Turner, SARDI (NVT)	South 5
12:40	12:45	0:05	Travel to shed on buses/utes		Travel
12:45	13:40	0:55	**Lunch**		**Agronomy Shed**
13:40	14:00	20:00	Water quality and livestock research update	Alice Wever, SARDI and Stephanie Lokan, SARDI	Agronomy Shed
14:00	14:20	20:00	Drone demo - aerial application techniques	Matthew Fatouris, Ag Solution Specialist	Agronomy Shed
14:20	14:30	10:00	**Break**		**Travel**

Start Time	*Finish Time*	*Speak Time*	*Topic*	*Speaker*	*Location*
14:30	14:35	05:00	Travel to paddock on buses/utes		Travel
14:35	14:55	20:00	NVT wheat and barley	Emma Turner (NVT) and plant breeders	North 8
14:55	15:00	05:00	Walk to trial		Travel
15:00	15:20	20:00	GRDC Time of Sowing and Varieties	Amanda Cook, SARDI and Cathy Paterson, SARDI	North 8
15:20	15:25	05:00	Travel to paddock on buses/utes		Travel
15:25	15:45	20:00	SA Discovery Farms Barley Biomass trial	Brendan Kupke, SARDI, and Cathy Paterson, SARDI	North 10
15:45	15:50	05:00	Travel to paddock on buses/utes		Travel
15:50	16:05	15:00	GRDC Geospacial Herbicide Risk	Mick Rose, SCU, and Elijah Luo, SARDI	Airport
16:05	16:20	15:00	Broadacre herbicide residues	Andong Shi, SARDI	Airport
16:20	16:30	10:00	GRDC and SA Discovery Farms Stripper Stubble systems	Amanda Cook, SARDI	Airport
16:30	16:35	05:00	Thanks and end of Field Day	Amanda Cook, SARDI	Airport
16:35	16:40	05:00	Travel to shed on buses/utes		Travel
16:40	16:45		**SARDI MAC Field Day finishes**		**Agronomy Shed**

Organisations

Government of South Australia
Department of Primary Industries and Regions

SARDI
South Australian Research and Development Institute

AIR EP
Ag Innovation & Research
Eyre Peninsula

GRDC
Grains Research & Development Corporation

SAGIT

SOIL CRC
Performance through collaboration

NSW Government
Department of Primary Industries and Regional Development

Adelaide University

Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

SA DROUGHT HUB

This program received funding from the Australian Government's Future Drought Fund

MALLEE SUSTAINABLE FARMING

Flinders University

BFIG
Buckleboo Farm Improvement Group

CSIRO

Minnipa Agricultural Centre EPFS Summary and Extension Sponsors

AGT

LongReach Plant Breeders

MarketCheck
Empowering Australian Growers

INTERGRAIN

2026 Field Day Sponsors

Thanks sincerely to our 2026 Field Day sponsors

GOLD

AGT

SILVER

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Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

SA DROUGHT HUB

This program received funding from the Australian Government's Future Drought Fund

BRONZE

INTERGRAIN

LongReach PLANT BREEDERS

MarketCheck
Empowering Australian Growers

Thank you also to the Upper Eyre Hunt Club; who provided our lunch catering.

AGT-
Reaper CL$^{\Phi}$ barley

- An excellent replacement for Maximus$^{\Phi}$ CL, or alternative to Neo$^{\Phi}$ CL
- Tolerant to Clearfield® Intervix® herbicide
- 8-10% higher yielding than most widely grown variety Maximus$^{\Phi}$ CL
- Compact plant type, similar to Maximus$^{\Phi}$ CL, with quicker maturity
- Wider adaptation than Neo$^{\Phi}$ CL, suited to all key barley growing areas of Australia
- Useful resistance to spot form and net form net blotch
- Has entered the Grains Australia malt accreditation program but is currently deliverable as Barley/Feed

For more information:
Brad Koster, Variety Support Manager, SA 0400 812 475



Welcome

Hello and welcome to the 2026 SARDI Minnipa Agricultural Centre (MAC) Annual Field Day. Today is about showcasing and sharing some of the latest SARDI research being conducted at MAC and providing the Eyre Peninsula farming community access to a range of researchers including the visiting researchers who conduct work locally. SARDI continues to provide independent, publicly available research to growers.

AMANDA COOK
SARDI Minnipa Agricultural Centre, Senior Research Scientist

MAC Staff in 2026

Amanda Cook	MAC Crop Agronomy, Senior Research Scientist
Wade Shepperd	MAC Farm Manager
Dr Nigel Wilhelm	Senior Research Scientist, Waite
Jessica Gunn	Livestock Research Officer
Elijah Luo	Research Officer
Cathy Paterson	Research Officer
Anna Osmond	SAGIT AIR EP Intern
Tammie Mullen	Senior Agricultural Officer (Crop Agronomy)
Nicole Baty	Project Management Support Officer
Ricca Moyse	Agricultural Officer (MAC Farm)
Marina Mudge	Senior Agricultural Officer (NVT/Crop Agronomy)
Leala Hoffmann	Administration Officer
Jo Rynne	Administration Officer
Katrina Brands	Casual Field Assistant
Rebbecca Tomney	Casual Field Assistant
Sophie Davis	Casual Field Assistant
Craig Midgley	Principal Regional Advisor – Eyre and Western

Upcoming events

Port Kenny/Mt Cooper Sticky Beak Day
10 September

Streaky Bay Sticky Beak Day
11 September

Far West Crop Comp & Sticky Beak Day
14 September

Goode Ag Bureau Sticky Beak Day
15 September

BFIG Crop Walk
16 September

Elliston Sticky Beak Day
18 September

Minnipa Farmer Sticky Beak Day
21 September

Wirrullla Farmers Sticky Beak Day
22 September

Roberts Verran Sticky Beak Day
25 September 2026

Barley Grass and Brome Grass Workshop, MAC Conference Room
8 October

SARDI EP Farmer Meetings
2 – 4 March 2027

Lentil check group survey



Barley grass and Brome grass weed management workshop

The South Australian Research and Development Institute (SARDI) and the University of Adelaide (UoA) are hosting a Brome grass and Barley grass weed management workshop at Minnipa.

Topics

- Summary of current Barley grass and Brome grass research by Amanda Cook (SARDI) and Ben Fleet (UoA)
- Lessons from brome grass management trials by Dr Gurjeet Gill (UoA)
- Ben Fleet will provide an update on current Barley grass and brome grass resistance

Date and location

8 October 9-11 AM, Minnipa Agricultural Centre Conference Room

Morning tea provided.

Please arrive 10 minutes early to register at the event.

Microsoft Teams link available for those who cannot attend in person.
https://teams.microsoft.com/meet/489511279366145?p=Lh6uLV3vXbzKAfVKQY

More information

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Australian Government
Department of Agriculture, Fisheries and Forestry
Future Drought Fund
Government of South Australia
Department of Primary Industries and Regions
SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Farm manager's report

Wade Shepperd | SARDI Minnipa Agricultural Centre

Summary

The Minnipa Agricultural Centre (MAC) continues to be a key component in low-rainfall, mixed-farming RD&E in South Australia. The MAC farm team strives to provide a typical low rainfall farming system for the hosting of research activities, including, but not limited to; SARDI research projects, other breeding plot trials, technology demonstrations and livestock research, while also managing broad-acre demonstrations and evaluations that are of relevance and interest to local growers.

Table 1. Rainfall stats for Minnipa Agricultural Centre, bold figures are manual readings, remainder source: Bureau of Meteorology.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	GSR
2025	1.4	1.6	18.6	1.8	6.4	50.8	95.4	34.6	6.0	40.6	32.4	2.8	312.4	270.4
2026	0.0	120.0	69.8	23.2	75.6	122.8	48.8	70					530	340.4
Decile 5	8.0	14.8	10.7	14.1	23.5	34.6	32.0	34.5	20.4	19.1	18.3	12.0	242.0	178.2
Avg.	12.9	15.9	18.0	16.5	28.9	37.2	34.7	38.2	26.8	21.8	19.6	18.4	288.9	204.1

Cropping

Seeding at MAC began on the 21 April sowing 4 0ha of Butler peas, followed by 200 ha of lentils from the 24 to 28 April. 96ha Canola was sown on the 30 April to 1 May in drying conditions with rain forecast in the next few days. Setting up seeders to sow comparison strips of the disc and tyne seeders in Lentils and Barley occurred between the 4 to 6 May. Catapult Wheat (54 ha) was sown on the 7 May and 40ha Bigfoot barley on 8 May followed by 110ha of Combat barley to the 11 May. Shotgun wheat, 105 ha, was sown on the 12 and 13 May, followed by 50 ha Tomahawk wheat on the 14 May. Seeding concluded on the 19 May sowing 44 ha of Cyclops barley. Overall seeding went very well in ideal conditions, with the Root boot razor disc system performing very well with gains of 2-3 ha/hr over the Horward tyne system.

Total cultivars sown for 2026, Butler peas 40 ha @100kg/ha, Canola 96 ha @3kg/ha, Thunder Lentils 200 ha @50kg/ha, Wheat Shotgun and Tomahawk 250 ha@70kg/ha, Barley Combat, Bigfoot and Cyclops 250 ha@55kg/ha, medic pasture (regenerating) 206 ha.

MAP + Zinc fertiliser was applied at 50 kg/ha rates across the program, targeting our mean yield levels of production (1.95t/ha in wheat), with current nutrient levels determined via soil sampling in March.

Crop emergence and establishment was exceptional with ample sub soil moisture and record season rainfall so far in 2026. Urea and SOA blend of 80/20 was spread on wheat and barley at 40 kg/ha between the 28 and 30 June. Canola received 50L/ha UAN on the 9 June, and 50 kg/ha urea and SOA blend on 29 June. The MAC crops are now looking very healthy with potentially record-breaking yields in 2026.

Livestock

427 Merino ewes were mated to 8 rams beginning the 1 February, resulting in a conception rate of 95% (22 dry). 689 foetuses were scanned, with a scanning percentage of 161%.

At marking we recorded 531 lambs present for a marking percentage of 131%.

	Ewes joined	Lambs scanned	Lambs born	Lambs marked	Scanning %	Marking %	Survival at birth %	Survival at marking %
2016	422	532	632	502	126	119	118.8	94
2017	366	428	458	361	117	99	107.0	84
2018	335	434	382	294	130	88	88.0	68
2019	342	486	485	434	142	127	99.8	89
2020	367	543	551	464	148	126	101.5	85
2021	398	625	512	485	157	122	81.9	
2022	366	620	548	518	169	142	88.4	84
2023	398	661	-	521	166	131	-	79
2024	422	662	-	496	157	118	-	75
2025	352	550	-	363	156	103	-	66
2026	405	689		531	161	131		77
Av.	381	566	510	452	147	117	98	80

*2016 & 2017 had 1 x sire failure

Other items of interest

In the 2026 season MAC farm through the SA Drought Hub De-risking the Seeding Program has undertaken a side-by-side comparison of the two different seeding systems, Horward 12" Tynes vs Root boot 10" discs in lentils (South 3) and barley (South 4)

UAN strips in N7 and S2 with varying rates 98 L/ha equivalent to 40 units, 196 L/ha equivalent 80 units, 294 L/h equivalent 120 units, and 392 L/ha equivalent 160 units.

Acknowledgements
Wade Shepperd (Acting Farm Manager)
Ricca Moyse (Agricultural Officer)

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Market Check

Market Check is an independent, Australian owned business that specialises in offering innovative year-round grain marketing strategies, information and execution services to Australian growers. Our annual Membership subscription service offers a range of exclusive grain marketing information, education and networking events. Our team of advisers offer growers customised grain marketing support and personalised strategies which can be executed through our execution services, grain agency and managed programs. Lastly, we are proud to bring our members the Market Check Academy - a self-directed online learning tool comprised of more than 20 videos that go through the basics to the more advanced elements of grain marketing.

Please feel free to contact us to discuss a trial of our membership services and how we may be able to assist you with any grain marketing needs.

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Geospatial analytics to predict the impact of residual herbicides on establishment and yield

Michael Rose[1], Buddhi Chaudhary[2, 5], Elijah Luo[2], Nicolas Dimopoulos[1], Brad Keen[3], Mark Congreve[4], Amanda Cook[2,5,6] and Lukas Van Zwieten[3]

[1] Southern Cross University, Lismore NSW; [2] SARDI; [3] NSW Department of Primary Industries and Regional Development, Wollongbar NSW; [4] ICAN; [5] The University of Adelaide; [6] Flinders University

Key messages

- **Field experiments have been established in Minnipa, SA; Geraldton, WA; Toowoomba, Qld and near Griffith, NSW, to improve modelling and soil residue analysis approaches for quantifying crop toxicity risk posed by herbicide carryover in soil.**
- **Three different rotation crops planted into the residues of last season's herbicide show carryover crop suppression (biomass at approximately 6 weeks after emergence) of label-rate Reflex® applications to canola on the heavier soil type; of label-rate Sentry® and Terrain® to wheat in both soil types. Note that some herbicide treatments and application rates are atypical and do not represent local practice, but are included to provide data to validate herbicide persistence and toxicity models.**
- **Ongoing analysis will measure effects on yield and determine whether glasshouse dose-response toxicity thresholds accurately reflect in-field toxicity.**

Why do the trial?

Herbicides are an important tool for weed management in Australian cropping systems, but herbicide residue carryover in soil can pose risks to rotation crops. Across Australia, it is estimated that around 10% of grain-production paddocks have herbicide residues that could result in crop damage and economic losses to growers in any given season (Rose et al., 2022). Although we know the major factors that drive herbicide breakdown and bioavailability, such as soil moisture, temperature, texture, organic matter, and microbial activity, these factors do not operate uniformly in time or space. The aim of the broader project is to better understand and predict the persistence of herbicides in soil across a paddock so that growers can better manage potential plant-back risk. Specifically, the trials here are generating data to validate herbicide persistence models and also determining how soil type, environment and rotation crop type influence potential crop toxicity. This article provides updated data on last year's report in the Minnipa Field Day trial booklet.

How was it done?

The research trials are being carried out in multiple sites of Queensland, New South Wales, Western Australia and South Australia to represent different soil types and climatic conditions of Australia. Two research trials were set up at Minnipa Agricultural Centre (MAC), South Australia (SA) – one in loamy sand (lighter soil type) and one in red loam (heavier soil type) – in 2024. Two crops, Tomahawk CL wheat and Butler field pea, were sown in randomised complete block design (RCBD) with three replications, under different residual herbicide applications (Table 1). An individual plot size was 20 m long and 1.7 m width. As the key aim is to measure herbicide persistence for the development of climate-driven models, and subsequent risk to rotation crops in 2025 across multiple environments, some herbicide treatments and application rates are atypical and do not represent local practice. Double rate applications of herbicides were off-label but used to ensure sufficient carryover and damage if seasonal conditions were conducive to full dissipation of the label rate.

In 2024, pre-emergent knock down herbicides were applied to all plots the day before the application of residual pre-emergent herbicides. Spray cards were used to ensure uniform spray application of herbicides in each plot. Wheat was sown on 12 June 2024 and inoculated field pea was sown on 19 June 2024 after background medic had germinated and was controlled by a knockdown herbicide.

Table 1. Details of herbicides and the concentration of their application, applied on two different soil types at MAC in 2024.

Wheat – Tomahawk CL				Field Pea - Butler			
ID	Herbicide	Rate (g or mL/ha)	MOA Group	ID	Herbicide	Rate (g or mL/ha)	MOA Group
1	Sentry (525 g imazapic 175g imazapyr/kg)	50	2	1	Terbyne Extreme (875 g/kg terbuthylazine)	1200	5
2	Terrain (500 g/kg flumioxazin)	120	14	2	Reflex (240 g/L fomesafen)	1500	14
3	Metsulfuron (600 g/kg metsulfuron-methyl)	7	2	3	Overwatch (400 g/L bixlozone)	1250	13
4	Lontrel Advanced (600 g clopyralid/L)	75	4	4	Untreated		
5	Untreated			5	Terbyne Extreme (875 g/kg terbuthylazine)	2400	3
6	Sentry (525 g imazapic 175 g imazapyr/kg)	100	2	6	Reflex (240 g/L fomesafen)	3000	14
7	Terrain (500 g/kg flumioxazin)	240	14	7	Overwatch (400 g/L bixlozone)	2500	13
8	Metsulfuron (600 g/kg metsulfuron-methyl)	14	2				
9	Lontrel Advanced (600 g clopyralid /L)	150	4				

Soil samples were collected four times in 2024 at different growth stages of crops with first one after the first substantial rainfall event (above 10 mm) in June. Soil was sampled from two depths, 0-10 and 10-30 cm. Each sample was a composite of six sub-samples collected from three on-row and three off-row. Soil samples were stored in the freezer before herbicide residue analysis.

Soil samples were collected from the plots on 9th April, 2025 to provide pre-sowing (residual) herbicide concentrations prior to sowing rotational crops into the plots. The herbicide plots were then divided into three and cross-sown with three rotation crops: wheat (cv. Calibre), canola (cv. Diamond) and lentil (cv. Jumbo2 and Thunder XT) on 16th May, 2025. These rotation subplots were 4 m long and 1.7 m width. Plant counts and cuts were taken from 4 x 0.5 m row length per plot for wheat and canola; and 8 x 0.5 m row length per plot for lentil on 24th July, 2025. Fresh biomass was recorded and then dried at 60°C for 48 h for dry weight. NDVI measures for each plot were also taken on 13 August, 2025. Lentils and canola were harvested on 10-11/12/2025 and wheat was harvested on 3/12/2025.

The entire study was replicated in 2025/2026 as per the 2024/2025 experiment on a Loamy (heavier soil) and Sand (lighter soil), but with a reduced number of herbicide treatments –metsulfuron-methyl or clopyralid (Lontrel Advanced) were not applied in the second trial. Rotation crops were sown into carryover residues on 30/4/206 (wheat cv. Tomahawk and lentil cv. Jumbo2 and Thunder XT) and 1/05/2026 (canola cv. Diamond). Early season biomass cuts were taken on 6-7/07/2026.

What happened?

First trial – herbicides applied in 2024 and rotational crops planted in 2025

Herbicide residues at sowing in 2025 (carryover from 2024 application)

Mean herbicide concentrations in soil samples taken in April 2025 prior to sowing rotation crops ranged from non-detectable (both rates of metsulfuron-methyl in the lighter soil type, label rate flumioxazin in both soil types, and label rate imazapyr in the light soil type) to over 100 ng/g (fomesafen at 2 times label rate) (Table 2). Herbicide residue concentrations in soil were generally higher (by 2-5 times) at this Minnipa compared to the WA and NSW core sites, particularly fomesafen (Reflex®). This is likely related to the low rainfall in 2024 at Minnipa, SA - growing season rainfall (GSR) (June-Nov) for 2024 was 154 mm, followed by 31 mm during the summer/autumn fallow (Dec-May), compared to 453 and 37 mm, respectively, at the WA core site. The amount of carryover of all herbicides was generally higher on the red loam, as compared with the lighter soil type.

Table 2. Soil herbicide concentrations (ng g^{-1}) in April 2025 in topsoil (0-10cm) prior to sowing rotation crops at the Minnipa site, SA. Concentrations at sowing are means ± 95% confidence interval (n=3). Rates are label rate (LR) and 2 times label rate (2XLR) applied in 2024 to a loamy sand soil and red loam soil. Estimated initial concentrations in 2024 are based on a distribution of the applied amount in the top 0-10 cm immediately after application.

Herbicide	Rate	Estimated concentration at application 2024 (ng/g)	Red loam (heavier soil)		Loamy sand (lighter soil)	
			Concentration at sowing 2025 (ng/g)	Average % of applied remaining	Concentration at sowing 2025 (ng/g)	Average % of applied remaining
Bixlozone	1XLR	313	60 ± 6	19	24 ± 7	8
	2XLR	626	47 ± 6	8	29 ± 14	5
Clopyralid	1XLR	28	2.6 ± 5.2	9	1.3 ± 1.3	5
	2XLR	56	3.1 ± 3.7	7	3.7 ± 4.9	7
Flumioxazin	1XLR	38	<0.5	0	<0.5	0
	2XLR	76	1.0 ± 1.9	1	2.2 ± 2.3	3
Fomesafen	1XLR	225	88 ± 32	39	40 ± 49	18
	2XLR	550	114 ± 41	21	78 ± 23	14
Imazapic	1XLR	16	1.7 ± 2.6	11	0.4 ± 0.2	3
	2XLR	32	5.7 ± 4.1	18	1.6 ± 1.4	5
Imazapyr	1XLR	5.5	0.6 ± 1.0	11	<0.5	0
	2XLR	11	1.9 ± 1.5	17	0.6 ± 0.6	5
Metsulfuron-methyl	1XLR	2.6	<0.2	4	<0.2	0
	2XLR	5.2	0.4 ± 0.4	8	<0.2	0
Terbuthylazine	1XLR	656	4.6 ± 2.9	1	0.7 ± 0.7	0
	2XLR	1312	2.9 ± 3.2	0	1.9 ± 2.9	0

Note: In lighter soils, the amount of herbicide remaining a year after application may be similar regardless of whether the herbicide was applied at the label rate or at twice the rate. This is because lighter soils have fewer binding sites, so excess herbicide remains in the soil water where it is available for plant uptake, degradation and leaching. Once this herbicide is used or broken down, herbicide that was bound to the soil is slowly released, which can control how long residues persist. As a result, residue levels after 12 months may be similar despite different application rates. In heavier soils with more clay and organic matter, there are more binding sites, so differences between application rates tend to persist for longer. Compounding this is the fact that there is significant spatial variability, which means that concentrations can appear to be similar just through one replicate plot having higher or lower measurable concentrations where the sample was taken.

Effect of herbicide residues on early growth rotation crops in 2025

Carryover from several herbicides following their application in 2024 affected the early biomass of rotation crops in 2025 (Table 2). Reflex at both rates reduced wheat growth in both soil types, and canola growth in the lighter textured soil. Double-rate Reflex also reduced canola growth in the heavier textured soil. Sentry also reduce canola growth at both rates in both soil types, and wheat growth in the heavier soil type. Double-rate Overwatch dramatically reduced canola biomass in the heavier textured soil. Although there appeared to be an effect of Lontrel and Metsulfuron on wheat biomass in the heavier textured soil, this was not supported by NDVI readings (data not shown).

Table 3. Effect of herbicide carryover from 2024 application on biomass (t ha^{-1}) of rotation crops wheat, lentil and canola on the Loam and Sand soil at Minnipa, 2025. 1XLR indicates label rate application, 2XLR is double the standard application rate. Numbers are percentage biomass relative to the untreated control. Numbers in bold are statistically significant (P<0.05). Dark shaded boxes show mean biomass reduction greater than 20% relative to the untreated control, regardless of statistical significance.

Herbicide	Rate	Canola		Lentil		Wheat	
		Red loam	Loamy sand	Red loam	Loamy sand	Red loam	Loamy sand
clopyralid	LR	105	90	100	97	**62**	101
	2XLR	58	105	101	117	83	86
metsulfuron-methyl	LR	60	60	92	101	**50**	90
	2XLR	41	130	103	144	**62**	107
bixlozone	LR	119	100	70	88	90	124
	2XLR	**14**	167	88	97	96	126
fomesafen	LR	124	58	83	112	64	**31**
	2XLR	63	**3**	97	88	**60**	**11**
imazapic + imazapyr	LR	**32**	58	101	103	**54**	94
	2XLR	**32**	**10**	114	112	**51**	80
terbuthylazine	LR	50	150	105	81	101	121
	2XLR	120	103	91	103	82	122
flumioxazin	LR	57	75	122	108	**74**	94
	2XLR	41	90	108	124	84	112

Effect of herbicide residues on yield of rotation crops in 2025

At harvest, average yields for the untreated control plots were 1.20 (Canola), 0.63 (Lentil) and 3.04 (Wheat) t/ha on the light soil type (loamy sand) and 1.58 (Canola), 0.81 (Lentil) and 2.53 (Wheat) t/ha on the heavier soil type (red loam). Many of the plots where early season biomass reductions were observed recovered to yield statistically similar grain weights to control plots (Table 4).

The exceptions were for fomesafen which significantly (P<0.05) reduced canola yields by 61% and 92% on the light soil type at the single and double application rates respectively, and also reduced wheat yields by 26% at the double rate on the light soil type. Double application rates of imazapic + imazapyr also reduced canola yields on the light soil type (by 43%); lentil yields on the heavier soil type (by 43%) and wheat yields on both soil types (by 43% on heavy soil type and 15% on light soil type). Label rate application of imazapic + imazapyr also reduced wheat yields by 20% on the heavier soil type. Flumioxazin at label rate also reduced wheat yields by 17% on the heavier soil type.

Table 4. Effect of herbicide carryover from 2024 on grain yield of rotation crops wheat, lentil and canola on the Loamy sand and Red loam soil at Minnipa, 2025. 1XLR indicates label rate application, 2XLR is double the standard application rate. Numbers are percentage biomass relative to the untreated control. Numbers in bold are statistically significant (P<0.05). Dark shaded boxes show mean biomass reduction greater than 20% relative to the untreated control, regardless of statistical significance

Herbicide	Rate	Canola		Lentil		Wheat	
		Red loam	Loamy sand	Red loam	Loamy sand	Red loam	Loamy sand
clopyralid	LR	96	105	118	165	91	104
	2XLR	104	112	135	204	95	104
metsulfuron-methyl	LR	80	97	121	115	92	98
	2XLR	95	117	95	204	93	103
bixlozone	LR	87	101	82	76	96	112
	2XLR	77	116	97	115	115	113
fomesafen	LR	98	**39**	125	122	108	91
	2XLR	97	**8**	114	113	92	**74**
imazapic + imazapyr	LR	78	100	91	120	**80**	101
	2XLR	74	**57**	**57**	118	**57**	85
terbuthylazine	LR	116	141	121	82	114	112
	2XLR	120	135	106	128	109	108
flumioxazin	LR	89	105	127	109	**83**	98
	2XLR	83	110	151	152	89	104

Second trial – herbicides applied in 2025 and rotational crops planted in 2026

Herbicide residues at sowing in 2026 (carryover from 2025 application)

Pre-sowing soil samples were taken on 20/04/2026, prior to sowing of rotation crops. These have not yet been analysed for herbicide residues.

Effect of herbicide residues on early growth rotation crops in 2026

Despite the 150 mm rainfall event in Feb-March 2026, carryover from several herbicides following their application in 2025 still affected the early biomass of rotation crops in 2026 (Figure 1).

As with the 2024/25 trial, double-rate Reflex reduced canola growth in the both soil types, and the label rate also reduced growth in the heavier-textured loam soil. Reflex at double-rate also reduced the growth of wheat and lentil in this loam soil. Sentry reduced the biomass of canola and wheat at the double-rate in the loam soil, and wheat in the lighter Sand. At label rate, Sentry reduced biomass of wheat on both soils. Double-rate Overwatch reduced lentil biomass in the light-textured sand. Flumioxazin at both rates reduced the biomass of wheat on the Loam soil and at the label rate on the Sand.

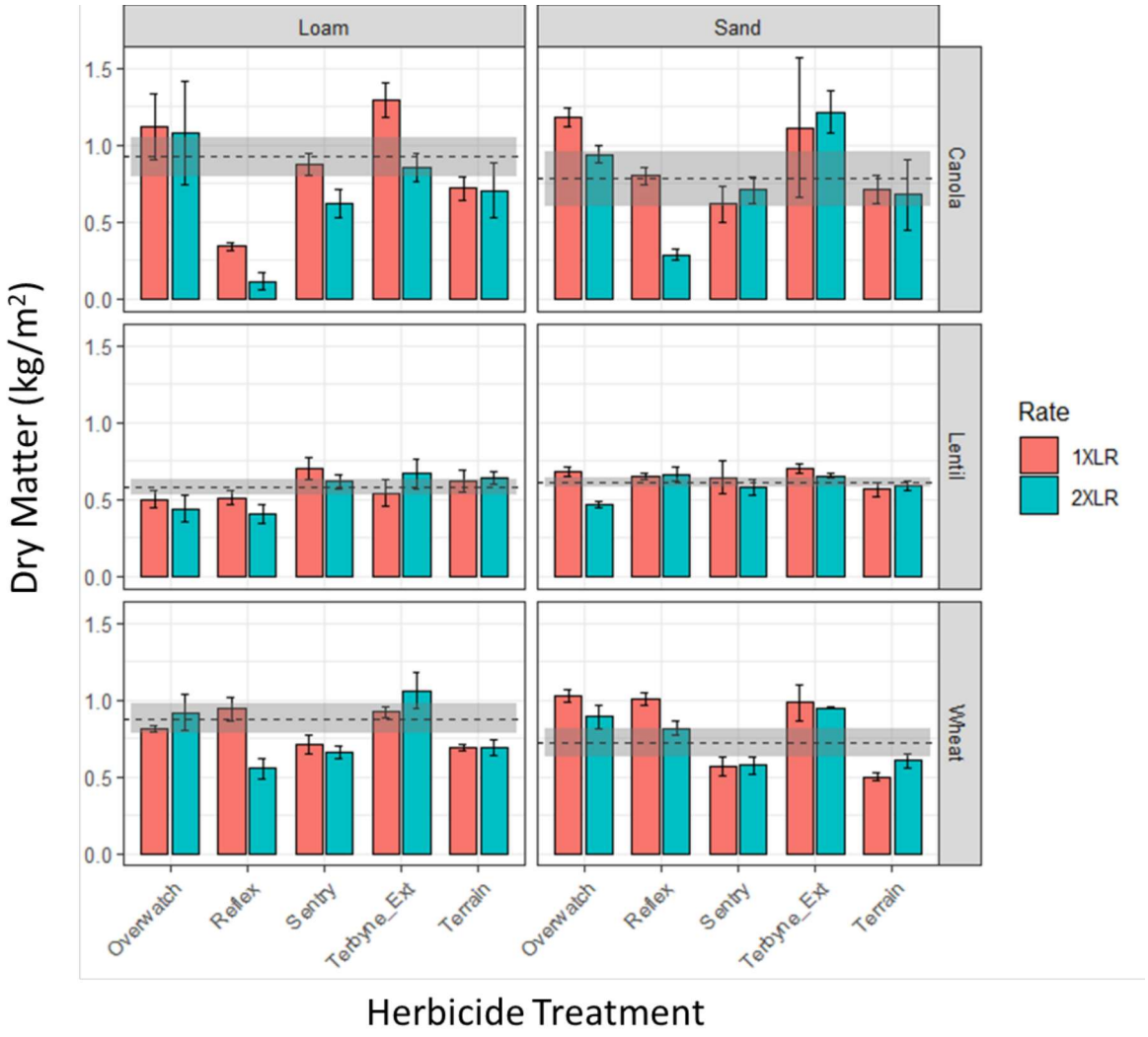

Figure 1. Effect of herbicide carryover from 2025 application on biomass (kg/m-2) of rotation crops wheat, lentil and canola on the Loam (heavier) and Sand (lighter) soil at Minnipa, 2026. Error bars represent standard error (n=3). The black dashed line is the mean biomass of the untreated control plots and the grey shaded area is the standard error of the control (n=3). 1XLR indicates label rate application, 2XLR is double the standard application rate.

What does this mean?

The primary drivers of herbicide breakdown are qualitatively well known, with factors such as rainfall, soil texture, organic matter, pH and microbial activity, being key drivers. However, simple decision support tools to predict the level of herbicide remaining in soil over time, and the risk to rotation crops, are not currently available. This research aims to validate herbicide breakdown in different soil types and link this to carryover damage for different crop types and in different climates and regions of southern Australia. Of particular interest is the spatial variation of herbicide persistence in different soil types and our ability to accurately predict this persistence under different soil by environment by crop combinations.

Our results confirm that there is significant spatial variability in herbicide residue concentration in soil, even within a controlled field experiment (shown by the confidence intervals for the herbicide concentrations in Table 1). For the 2024/2025 trial, herbicide residue concentrations were generally higher in the topsoil of the heavier red loam soil

at the start of 2025, suggesting that there was greater binding, less leaching and/or less degradation in this soil compared to the lighter loamy sand soil type. However, in 2025 there was greater damage from fomesafen (Reflex) residues on the lighter soil type, despite lower residue concentrations in the topsoil; whereas the reverse was true for imazapic/imazapyr, metsulfuron-methyl and possibly flumioxazin, where damage was greater (for wheat) in the heavier soil type.

It is also interesting that despite the 150 mm of rain at the end of February in 2026, there is still significant damage from fomesafen to canola in the heavier soil type from 2025 applications – but not the lighter soil type. This demonstrates the complexities of herbicide residue risk, since we need to take into account not only herbicide persistence, but also bioavailability.

Notably, even where there was early-season damage to the 2025 rotation crops, there was significant crop recovery for many of the herbicide treatments. This is a well-known phenomenon for many herbicides – but in certain circumstances where early season damage is severe, such as that for canola planted into fomesafen residues on the light soil type at Minnipa in 2025, recovery is not always guaranteed and yields can be impacted. It will be interesting to see whether the canola in fomesafen-treated plots will also have reduced yields in this higher-rainfall growing season, or whether they will recover to yield similar to control (untreated) plots.

This data is now being used to develop and validate models for predicting carryover risk, based on both herbicide residue persistence and bioavailability. Additional work within this and other projects (e.g. UOA2501-005RTX) will better define crop toxicity thresholds for different soil-herbicide combinations, to enable better interpretation of herbicide residue analysis in soil samples. A combined understanding of spatial variation of herbicide residue concentrations and crop toxicity thresholds will allow for improved understanding and ability to manage herbicide carryover risk.

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Acknowledgements

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Appendix

Trial plan of the sandy soil block

2025	Plot #	REP 1		Buffer	Buffer	Plot #	REP 2	Buffer	Buffer	Plot #	REP 3
IT wheat - Tomahawk	4m wide	7001/7002	**Sentry** (525g imazapic 175g imazapyr/kg) 50 g/ha	Buffer	Buffer	8001/8002	**Sentry** (525g imazapic 175g imazapyr/kg) 150 g/ha	Buffer	Buffer	9001/9002	Untreated
IT wheat - Tomahawk		7003/7004	Untreated	Buffer	Buffer	8003/8004	**Terrain** (500g/kg flumioxazin) 120 g/ha	Buffer	Buffer	9003/9004	**Sentry** (525g imazapic 175g imazapyr/kg) 150 g/ha
IT wheat - Tomahawk		7005/7006	**Terrain** (500g/kg flumioxazin) 120 g/ha	Buffer	Buffer	8005/8006	**Terrain** (500g/kg flumioxazin) 360 g/ha	Buffer	Buffer	9005/9006	**Terrain** (500g/kg flumioxazin) 120 g/ha
IT wheat - Tomahawk		7007/7008	**Sentry** (525g imazapic 175g imazapyr/kg) 150 g/ha	Buffer	Buffer	8007/8008	**Sentry** (525g imazapic 175g imazapyr/kg) 50 g/ha	Buffer	Buffer	9007/9008	**Sentry** (525g imazapic 175g imazapyr/kg) 50 g/ha
IT wheat - Tomahawk		7009/7010	**Terrain** (500g/kg flumioxazin) 360 g/ha	Buffer	Buffer	8009/8010	Untreated	Buffer	Buffer	9009/9010	**Terrain** (500g/kg flumioxazin) 360 g/ha
Buffer			Buffer	Buffer	Buffer		Buffer	Buffer	Buffer		Buffer
Peas - Butler	4m wide	7019/7020	**Terbyne Extreme** (875g/kg terbuthylazine) 3.6 kg/ha	Buffer	Buffer	8019/8020	**Reflex** (240g/L fomesafen) 1.5 L/ha	Buffer	Buffer	9019/9020	**Terbyne Extreme** (875g/kg terbuthylazine) 3.6 kg/ha
Peas - Butler		7021/7022	**Reflex** (240g/L fomesafen) 4.5 L/ha	Buffer	Buffer	8021/8022	Untreated	Buffer	Buffer	9021/9022	**Reflex** (240g/L fomesafen) 4.5 L/ha
Peas - Butler		7023/7024	Untreated	Buffer	Buffer	8023/8024	**Terbyne Extreme** (875g/kg terbuthylazine) 1.2 kg/ha	Buffer	Buffer	9023/9024	Overwatch (400g/L bixlozone) 3.75 L/ha
Peas - Butler		7025/7026	**Reflex** (240g/L fomesafen) 1.5 L/ha	Buffer	Buffer	8025/8026	Overwatch (400g/L bixlozone) 1.25 L/ha	Buffer	Buffer	9025/9026	Overwatch (400g/L bixlozone) 1.25 L/ha
Peas - Butler		7027/7028	Overwatch (400g/L bixlozone) 3.75 L/ha	Buffer	Buffer	8027/8028	Overwatch (400g/L bixlozone) 3.75 L/ha	Buffer	Buffer	9027/9028	Untreated
Peas - Butler		7029/7030	Overwatch (400g/L bixlozone) 1.25 L/ha	Buffer	Buffer	8029/8030	**Terbyne Extreme** (875g/kg terbuthylazine) 3.6 kg/ha	Buffer	Buffer	9029/9030	**Terbyne Extreme** (875g/kg terbuthylazine) 1.2 kg/ha
Peas - Butler		7031/7032	**Terbyne Extreme** (875g/kg terbuthylazine) 1.2 kg/ha	Buffer	Buffer	8031/8032	**Reflex** (240g/L fomesafen) 4.5 L/ha	Buffer	Buffer	9031/9032	**Reflex** (240g/L fomesafen) 1.5 L/ha
Buffer			Buffer	Buffer	Buffer		Buffer	Buffer	Buffer		Buffer

The Impact of Alternative Phosphorous Sources on Wheat Growth and Soil Phosphorous in Contrasting Soil Types of the Upper Eyre Peninsula

Anna Osmond[1], Amanda Cook[1], Nigel Wilhelm[1] and Sean Mason[2]

[1] SARDI; [2] Agronomy Solutions

Background

Phosphorous (P) is an essential macronutrient in plant growth and P deficiency remains a major constraint on Upper Eyre Peninsula. It is important to invest and evaluate alternative P fertilisers to diversify the market and maintain/improve crop productivity, particularly given the high cost and price volatility of phosphate rock-derived products.

Aims

1. Evaluate the performance of alternative P fertiliser sources on wheat growth, P uptake and soil P availability compared with MAP and phosphoric acid.
2. Determine whether the effectiveness of alternative P sources varies across different soil types.
3. Assess the economic viability of recycled P sources relative to MAP and phosphoric acid fertilisers using cost-efficiency analysis.

Experiment setup

- Crop: Tomahawk wheat (20 plants per pot)
- 3 soil types
- Location: Minnipa Agricultural Centre
- Design: Randomised complete block design
- Measurements: soil characterisation, plant tissue analysis (P concentration), shoot biomass, post-harvest soil analysis, cost efficiency

Preliminary pot trial – P response curve

- 0, 10, 30, 50, 90 kg P/ha – MAP
- 2 replications
- 29/5/2026 – 29/7/2026

Main pot trial

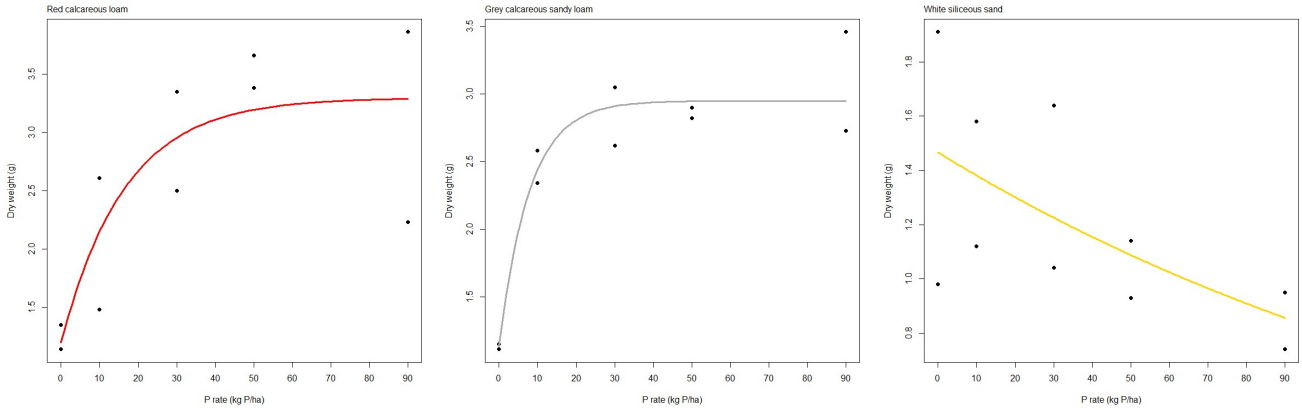
- 5 fertiliser treatments (MAP, phosphoric acid, PeKacid, EURO IPE, ICL Puraloop)
- 4 replications
- Applied at 10 kg P/ha (single rate)
- Sown 14/8/2026
- Harvest late-November

Current results and progression

Soil characteristics

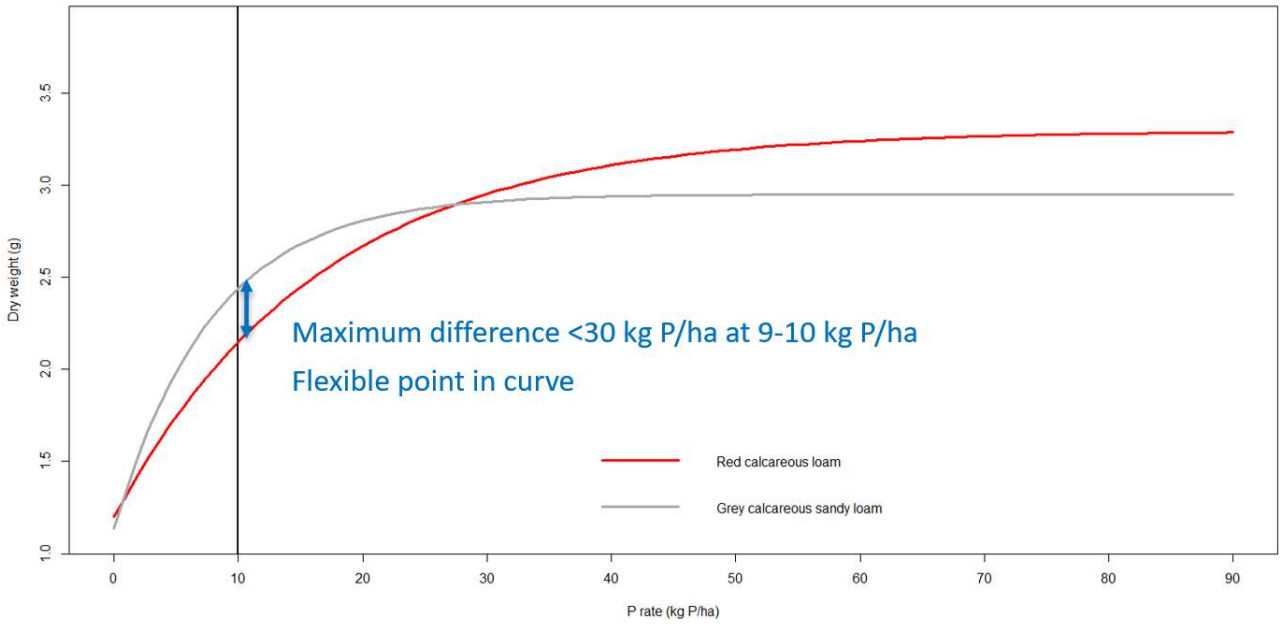
Parameter	Unit	Grey calc sandy loam	White siliceous sand	Red calc loam
Locality		Port Kenny	Condada	Minnipa
EC	dS/m	0.14	0.045	0.12
pH ($CaCl_2$)		8.26	6.98	8.11
Organic carbon	%	1.86	0.31	1.58
Nitrate-N	mg/kg	5.3	1.9	3.2
Ammonium-N	mg/kg	4.9	3.6	1.3
Colwell P	mg/kg	<5.0	14	<5.0
DGT-P	µg/L	<4	208	4
PBI		216	25	160
Colwell K	mg/kg	410	46	560
KCl Sulphur	mg/kg	10	<2.5	4.4
CEC	cmol/kg	27	1.7	32
GWC	g/g	0.161	0.029	0.124
$CaCO_3$	%	65	<1.00	7.4

Preliminary pot trial – P response curve



Key takeaways:

- Red and grey soil was responsive to P addition however the sand was not.
- Sand shows a more decay relationship to added P, suggesting potential toxicity (salinity or P toxicity).



- Since the sand was unresponsive to P, only the red and grey soils were used to determine the 10 kg P/ha rate for the main trial. This rate was selected based on the point of maximum separation between the response curves, while remaining below 30 kg P/ha. This constraint ensured the rate was within the most responsive region of the curve and represented a midpoint for assessing treatment effects.

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De-risking the sowing program on EP – a comparison of different seeding systems and crops in 2026

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[1] SARDI; [2] Adelaide University; [3] Flinders University

This project will address knowledge and adoption gaps in crop establishment and seeding decision-making under increasingly variable seasonal conditions across South Australian cropping regions. As the timing and reliability of the seasonal break and stored soil moisture at seeding becomes less reliable, farmers are required to adapt establishment strategies on a year-by-year basis. Building on the outcomes of previous work, this project will consolidate existing research and regional experience to strengthen farmer understanding of the key factors influencing successful crop establishment in dry and uncertain seasons.

By improving farmer capacity to manage establishment risk and respond to seasonal variability, the project will contribute to increased drought resilience and more consistent cropping system performance across South Australia. The SA Drought Hub funded demonstration sites have been a valuable tool in engaging farmers in discussion and increasing awareness of options to improve plant establishment and show the impacts of fertiliser and herbicide toxicity on seed germination and emergence, especially in dry sowing situations.

The Minnipa Agricultural Centre operates two broadacre seeding systems. One is a tyne-based Horwood Bagshaw Precision Seeding System (PSS), the other is a RootBoot Razor, single disc hybrid system. The vision of this project is to compare the two seeding system's effect on crop establishment and vigour in cereal and lentils particularly in the early stages of growth.

Historically the PSS has performed very well in our soil type, as it is designed with maximum ability to fine-tune depth and breakout pressure settings, it has little issue penetrating heavier soils. The RootBoot Razor has also proven itself somewhat after using it nearly exclusively to sow our 2025 cropping program. However, it is less configurable and seems to be less forgiving regarding seed depth settings.

A seeding comparison is being conducted with a side-by-side analysis of paddock strips in a cereal paddock (South 4) and a lentil paddock (South 3) on Minnipa Agricultural Centre, replicated 3 times. The specifications of the two seeding systems are as follows:

1. Horwood Bagshaw PSS - Twin shoot (fertiliser placement below seed), 300mm tyne spacing, trailing presswheels, 9.6m swath width
2. RootBoot Razor - Twin shoot (fertiliser placement below seed), 250mm disc spacing, trailing presswheels, 12m swath width.

There are two demonstration sites on MAC

Trial 1. Cereal paddock (S4) – compare two seeding systems sown with Combat barley in early May (3 May for Rootboot, 7 May for PSS) for crop vigour and final yield.

Trial 2. Lentil paddock (S3) – compare two seeding systems x pre-emergent herbicides x timing of rolling on early crop vigour and final yield on GIA Thunder Lentils.

Table 1: Early herbicide, seeding systems and timing of rolling treatments tested in the lentil paddock, South 4, at Minnipa Agricultural Centre in 2026.

Main plot treatment (Herbicide)	Description
1.	Metribuzin 150 ml/ha (IBS) + Diuron 350 g/ha (IBS) + Glean 2.5 g/ha (IBS) + Trifluralin 800 ml/ha (IBS)
2.	Reflex 550 ml/ha (IBS) + Diuron 300 ml/ha (IBS) + Glean 2.5 g/ha (IBS) + Trifluralin 800 ml/ha (IBS)
3.	Trifluralin 800 ml/ha (IBS) + Imazapyr 750ai (PSPE) 20 g/ha
4.	Brodal Options 50 ml/ha (IBS) + Diuron 250 g/ha (IBS) + Glean 2.5 g/ha (IBS) + Trifluralin 800 ml/ha (IBS) + Brodal Options 20 ml/ha (PSPE) + Diuron 100 g/ha (PSPE)
5.	Overwatch 750 ml/ha (IBS) + Terbyne 600 ml/ha (IBS) + Reflex 600 ml/ha (IBS)

Sub-Plot Treatment (seeding systems)	Description
1.	RootBoot Razor (4 May)
2.	Horwood Bagshaw PSS (7 May)

Sub-sub-Plot treatment (rolling timing)	Description
1.	Rolling after seeding (22 May)
2.	Rolling at 5 nodes (9 June)
3.	Rolling late (17 July)

IBS herbicide treatments were applied on 4 May. The site was sown with Thunder lentils into moist soil on the 4 and 7 May (due to swapping seeders and hose configurations) at 3-4cm deep. The PSPE chemical treatments were applied on 8 May. After-seeding rolling was done on 22 May, 5-nodes rolling was done on 9 June, and late rolling was done on 17 July. Plant counts for the lentil paddock were done on 25 June. NDVI assessment was done on 29 June (Tendrils present). The barley site was sown on 6 May with 2-3cm seeding depth. the establishment and NDVI was done on 13 August (GS32).

Results

Lentil Plant establishment

There is no significant difference in average plant numbers between chemical treatments (99 plants/m^2), or in the rolling timing treatments (99 plants/m^2). However, the plant numbers in Horwood Bagshaw PSS strips were statistically higher than the RootBoot Razor.

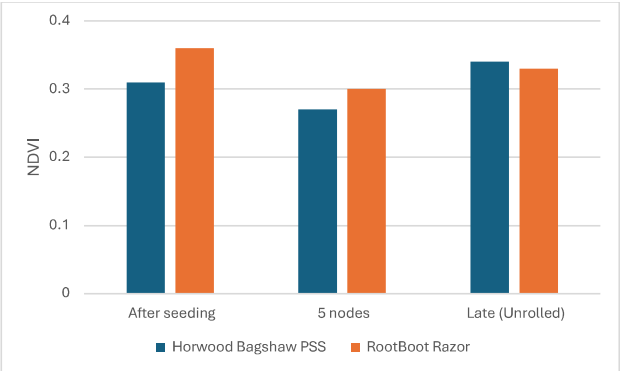
Table 2: The average plant density of lentils of each seeding systems treatment in the lentil paddock at Minnipa Agricultural Centre in 2026

Seeding System	Plant density (plants/m^2)
Horwood Bagshaw PSS	104
RootBoot Razor	95
LSD (P=0.05)	*4.84*

Early NDVI (29 June)

There is no significant difference between chemical treatments. RootBoot razor strips have a significantly higher average NDVI value than Horwood Bagshaw PSS and rolling at 5 nodes (9 June) produced lower NDVI values than rolling after seeding (22 May).

Figure 1: The average early lentil NDVI for the Horwood Bagshaw PSS and RootBoot Razor at different times of rolling in 2026.



Acknowledgement

This project 'Derisking the sowing program on EP in 2026 – a comparison of different seeding systems and crops in 2026' addresses the South Australian Drought Hub priority themes of Farm planning and decision making to manage climate and operational risk and Soil and land management strategies, technologies, and innovations. This project is supported by the South Australian Drought Resilience Adoption and Innovation Hub, through funding from the Australian Government's Future Drought Fund, led by Agricultural Innovation & Research Eyre Peninsula (AIR EP) and delivered by SARDI. Previous SA Drought Hub and Future Drought Fund projects were 'De-risking the seeding program - Adoption of key management practices for the success of dry early sown crops' (4-IMX2CLR) 2024 and 'Best practice for early sowing opportunities' with demonstration sites located at Cowell and Penong in 2022 and 2023 (DN1_23_03 and DN1_22_02).

Special thank you to Wade Sheppard and Ricca Moyse for establishing managing and maintaining both demonstration sites. And to Anna Osmond, Tammie Mullen and Katrina Brands for their assistance in completing field work.

De-risking the seeding program 2025 – early sowing and the performance of pre-seeding herbicides

Key messages

- **TOS1 occurred on 24 April before a predicted rainfall event and TOS2 on 16 June after rainfall, with crop establishment being lower in TOS1 (8 weeks from seeding) compared to TOS2 by 29 plants/m^2.**
- **In 2025 crop establishment did not occur earlier with early and dry sowing so the advantage was only operational timeliness.**
- **There was no effect of herbicide treatments on plant establishment at either seeding times. Ideally weed seed banks would be low for dry sowing paddocks.**
- **All herbicides achieved some level of weed control in a high weed burden paddock compared to the Untreated control and the early post emergent (EPE) herbicide treatment.**
- **Mateno Complete 1 L/ha IBS, and Trifluralin 1.8 L/ha + Avadex (a.i.500 g) 1.6 L/ha + Sakura 118 g/ha IBS had the lowest weed numbers with early and dry sowing eleven weeks after sowing, however these are also the more expensive herbicide packages tested.**
- **There was a grain yield decrease of 0.18 t/ha with TOS1 but ensuring timeliness of large seeding programs is important.**

Why do this trial?

Dry seeding is now an option which many farmers in the western and southern regions of Australia consider due to increased farm size, more variable breaks to the season and to make better use of all available water. In the 2025 season, most farming regions in southern Australia recorded well below average summer and autumn rainfall. Many farmers seeded a large portion of their program before the season break that occurred in mid-June. However, early and dry sown crops can be more vulnerable to water and nutrient deficiencies, higher soil temperature and pre-emergent herbicide toxicity, which may lead to patchy crop establishment.

The research reported here is to further fill knowledge gaps with dry sowing by investigating the effects of sowing time and early grass-control herbicides on crop establishment and yield of Calibre wheat on upper Eyre Peninsula (EP).

How was it done?

In 2025 a demonstration site with a split-plot design was conducted at Poochera in a calcareous sandy loam with a high burden of annual ryegrass with some brome grass and barley grass also present. The soil profile was dry prior to the first time of seeding (8-11% gravimetric water content in the top 80 cm on 11 June). Sowing with Primary Sales split system and press wheels took place on 24 April (TOS1) and 16 June (TOS2), with 75 kg/ha of Calibre wheat and 75 kg/ha of MAP banded below the seed. Herbicide treatments for early grass weed control were applied immediately prior to sowing at both times of sowing and were incorporated by seeding (IBS) (Table 1), except for Mateno Complete 1 L/ha EPE which was applied when plants reached 3 leaf stage (Z13).

Table 1. Early season herbicide treatments at Poochera in 2025 on Calibre wheat.

Herbicide Treatments		Chemical Cost ($/ha)
1	Untreated	0
2	Sakura 118 g/ha IBS	$30
3	Overwatch 1.25 L/ha IBS	$43
4	Prosulfocarb 3 L/ha IBS	$24
5	Mateno Complete 1 L/ha IBS	$53
6	Mateno Complete 1 L/ha EPE (GS13)	$53
7	Trifluralin 1.8 L/ha + Metribuzin 100 g/ha IBS	$19
8	Trifluralin 1.8 L/ha + Avadex (a.i.500 g) 1.6 L/ha + Sakura 118 g/ha IBS	$61

Crop establishment, grass weed density and NDVI assessments were made on 24 June, 1 July, 10 July or 17 July. 50 kg/ha of urea was spread on all plots on 14 July. Treatment 6, Mateno Complete 1 L/ha EPE was applied on 11 July (Z13). Early biomass (Z30) cuts were taken on 18 August. Late biomass (Z70) was measured on 8 October. Harvest was undertaken on 10 December. Grain quality was assessed in January.

What happened?

There was very little moisture available in the soil profile on the 11 June. In 2025 the first significant rainfall event was on 20 March with 19 mm, but only small events occurred in April (3.6 mm) and May (3.4 mm) which was not enough moisture for wheat to emerge. The first significant rainfall event to enable germination and seedling emergence was not until 12 June with 12 mm received. The late seasonal break resulted in most crops being dry sown followed by good winter rainfall (Karcultaby had 46 mm in June, 102 mm in July and 19 mm in August). October rainfall was 30 mm with cooler conditions which resulted in good grain fill and higher than expected yields in the area.

The season break in 2025 occurred on 12 June with 12 mm of rain and the growing season was a decile 4. The first time of sowing (TOS1) was undertaken on 24 April before a predicted rainfall event which ended up being only 1.5 mm, and TOS2 on 16 June after 12 mm of rainfall.

Wheat from TOS1 did not emerge until 24 June (8 weeks after sowing) with an average of 36 plants/m^2, but wheat in TOS2 had still to emerge. However, by 1 July crop establishment was the same for both times of sowing (Table 2). Herbicide treatments had impacted on crop establishment by 1 July with untreated and Prosulfocarb 3 L/ha IBS having the best crop establishment. Plant numbers were lowest with Overwatch 1.25 L/ha IBS and Trifluralin 1.8 L/ha + Metribuzin 100 g/ha IBS.

By 17 July, there was no effect of herbicide treatments on wheat plant density. On 17 July, wheat density in TOS1 was lower by 29 plants/m^2 than in TOS2 (Table 2).

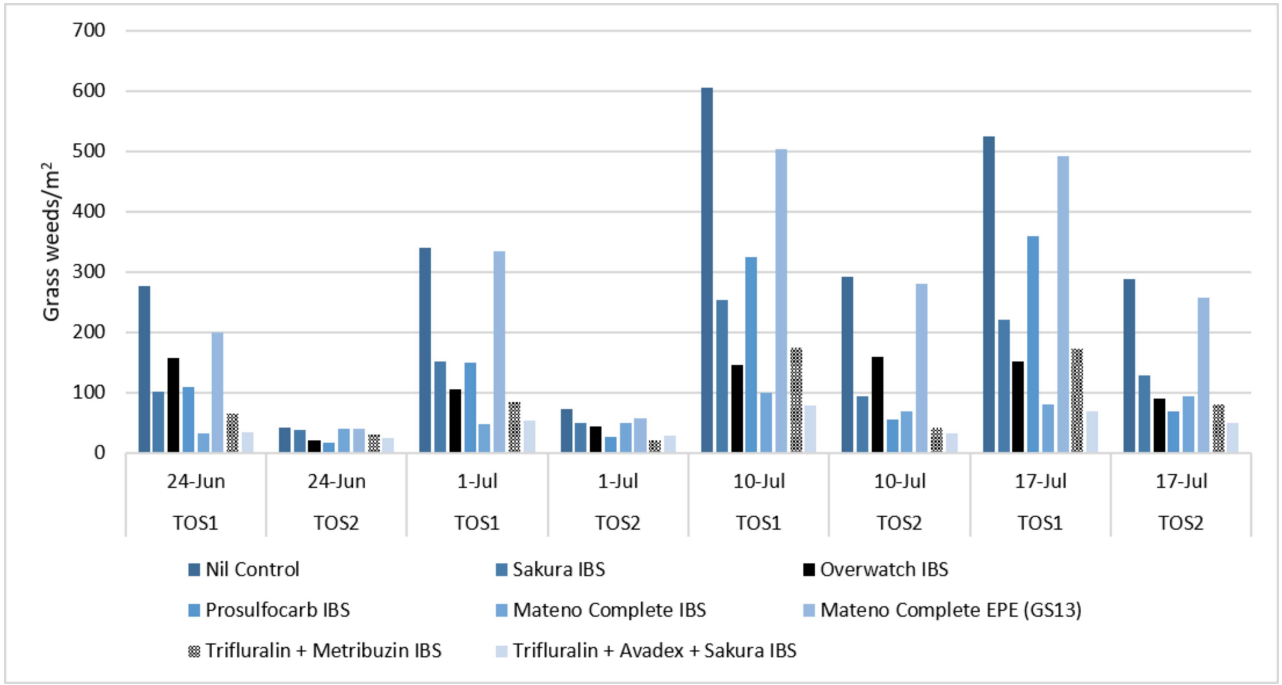
Table 2. Wheat density (plants/m^2) in herbicide treatments at two times of sowing at 4 sampling times at Poochera in 2025. First time of sowing (TOS1) was 24 April and the second timing was 16 June. Treatments followed by the same letter are not statistically different.

Treatment		24 June		1 July		10 July			17 July	
		TOS1	TOS2	TOS1	TOS2	TOS1	TOS2	Average	TOS1	TOS2
1.	Untreated	52	0	122	83	122	125	123 a	108	108
2.	Sakura IBS	44	0	101	70	88	110	98 bc	82	100
3.	Overwatch IBS	29	0	77	71	59	90	75 d	53	104
4.	Prosulfocarb IBS	52	0	120	76	103	112	107 ab	91	107
5.	Mateno Complete IBS	27	0	68	61	61	122	91 bcd	67	111
6.	Mateno Complete EPE (GS13)	35	0	93	82	91	113	102 bc	83	102
7.	Trifluralin + Metribuzin IBS	23	0	66	77	59	106	82 cd	72	100
8.	Trifluralin + Avadex + Sakura IBS	25	0	68	67	65	136	100 bc	63	112
Average TOS		36 a	0 b	89	73	81 b	114 a		77 b	106 a
*LSD TOS*Herbicide (P = 0.05)*		*ns*		*ns*		*ns*			*ns*	
LSD TOS (P = 0.05)		*28*		*ns*		*28*			*28*	
LSD Herbicide (P = 0.05)		*ns*		*21*		*23*		*23*	*ns*	

Table 3. Grass weed density at 4 sampling times (plants/m²) in herbicide treatments at two times of sowing at Poochera in 2025. First time of sowing (TOS1) was 24 April and the second timing was 16 June. *Treatment 6 applied on 11 July. Treatments followed by the same letter are not statistically different

Treatment		24 June		1 July		10 July		17 July	
		TOS1	TOS2	TOS1	TOS2	TOS1	TOS2	TOS1	TOS2
1.	Untreated	276 a	42 e	340 a	72 cde	605 a	292 c	525 a	288 bc
2.	Sakura IBS	101 d	37 e	152 b	50 de	253 c	93 efg	221cde	128 efgh
3.	Overwatch IBS	158 bc	20 e	106 bc	43 de	145 def	160 de	152 efg	90 fgh
4.	Prosulfocarb IBS	110 cd	16 e	150 b	27 e	324 c	56 fgh	360 b	69 gh
5.	Mateno Complete IBS	32 e	40 e	48 de	49 de	100 def	69 fg	80 fgh	94 fgh
6.	Mateno Complete EPE (GS13)*	200* b	40* e	334* a	58* cde	504* b	280* c	492 a	257 cd
7.	Trifluralin + Metribuzin IBS	65 de	30 e	85 cd	21 e	175 d	41h	173 def	81 fgh
8.	Trifluralin + Avadex + Sakura IBS	34 e	24 e	53 de	28 e	79 fg	32 h	69 gh	49 h
Average TOS		122	31	159	44	273	128	259	132
*LSD TOS*Herbicide (P = 0.05)*		*53*		*53*		*78*		*100*	
LSD TOS (P = 0.05)		*45*		*55*		*40*		*48*	
LSD Herbicide (P = 0.05)		*32*		*39*		*59*		*70*	

Figure 1. Grass weeds early in the season (plants/m²) in herbicide treatments at two times of sowing at Poochera in 2025. Treatment 6 Mateno Complete EPE applied on 11 July 2025 (GS13). See Table 3 for statistical analysis and more detail of treatments.



Grass weed pressure was high at Poochera site with an average of 195 grass weeds/m^2 on 17 July. TOS1 had higher grass weed numbers compared to TOS2 at all samplings, indicating that herbicide activity from the later application timing was greater when rainfall finally fell. Untreated and Mateno Complete 1 L/ha EPE had higher grass weed numbers than most other herbicide treatments (Table 3 and Figure 2). By 17 July most herbicide treatments had reduced grass weed numbers compared to untreated and Mateno Complete 1 L/ha EPE.

Table 4. Early (Zadoks growth stage 30, stem elongation) and late (Zadoks growth stage 70, early grain fill) biomass (t/ha) of wheat in herbicide treatments from two times of sowing at Poochera in 2025. First time of sowing (TOS1) was 24 April and the second timing was 16 June. Treatment 6 was applied on 11 July. Treatments followed by the same letter are not statistically different

		Z30 Biomass (t/ha)			Z70 Biomass (t/ha)	
	Treatment	TOS 1	TOS 2	Average	TOS 1	TOS 2
1.	Untreated	0.36	0.29	0.32 a	1.41 a	2.03 a
2.	Sakura IBS	0.26	0.28	0.27 ab	1.81 a	2.30 a
3.	Overwatch IBS	0.23	0.25	0.24 bc	1.91 a	2.24 a
4.	Prosulfocarb IBS	0.40	0.34	0.37 a	1.82 a	2.38 a
5.	Mateno Complete IBS	0.22	0.56	0.24 bc	2.06 a	2.66 a
6.	Mateno Complete EPE (GS13)	0.22	0.22	0.22 bc	2.08 a	2.61 a
7.	Trifluralin + Metribuzin IBS	0.27	0.08	0.17 c	1.91a	1.22 b
8.	Trifluralin + Avadex + Sakura IBS	0.24	0.29	0.27 ab	1.96 a	2.76 a
Average TOS		0.27	0.25		1.87	2.29
*LSD TOS*Herbicide (P = 0.05)*		*ns*			*0.55*	
LSD TOS (P = 0.05)		*0.02*			*0.28*	
LSD Herbicide (P = 0.05)		*0.08*		*0.08*	*0.41*	

At Z30, biomass from TOS1 was 0.2 t/ha more than TOS2. Trifluralin 1.8 L/ha + Metribuzin 100 g/ha IBS had lower biomass at both growth stages compared to untreated and Prosulfocarb 3 L/ha IBS.

Grain yield with TOS1 averaged 0.9 t/ha and 1.1 t/ha with TOS2. The Trifluralin 1.8 L/ha + Metribuzin 100 g/ha IBS and untreated treatment had similar and low yields (Table 5). Grain proteins were high in untreated and low with Overwatch 1.25 L/ha IBS, and Trifluralin 1.8 L/ha + Metribuzin 100 g/ha IBS treatments.

Table 5. Combined grain yield and protein of wheat in herbicide treatments from two different times of sowing at Poochera in 2025. Treatments followed by the same letter are not statistically different.

	Treatment	Yield (t/ha)	Protein (%)
1.	Untreated	0.81 bc	10.8 a
2.	Sakura IBS	0.99 ab	10.6 ab
3.	Overwatch IBS	1.28 a	10.2 b
4.	Prosulfocarb IBS	1.05 ab	10.4 ab
5.	Mateno Complete IBS	1.16 a	10.3 ab
6.	Mateno Complete EPE (GS13)	1.10 a	10.3 ab
7.	Trifluralin + Metribuzin IBS	0.69 c	10.2 b
8.	Trifluralin + Avadex + Sakura IBS	0.93 ab	10.4 ab
LSD (P = 0.05)		*0.40*	*0.3*

What does this mean?

The 2025 season had a late and dry start to the season which resulted in seed and herbicides with early and dry seeding being in the soil for eight weeks before reasonable rains allowed emergence and herbicides to become active. The large gap between sowing and germination resulted in slower crop establishment and increasing seeding rates may be a tool to increase early plant numbers when sowing dry and early.

Neither times of sowing had a knock down herbicide applied, which is most often the situation when dry sowing, which places more pressure on the pre-emergent herbicides. The performance of pre-emergent herbicides is dependent on soil moisture, the persistence of the herbicide and the mobility of the herbicide in the soil which will depend on soil type. The low moisture conditions at TOS1 and the eight-week period before rainfall resulted in some herbicides which rely on soil moisture to be activated not performing as well in TOS1 as TOS2. However, all herbicides achieved some level of weed control in a high weed burden paddock compared to untreated and the early post emergent herbicide application.

There are large differences in the cost of herbicides and herbicide mixes (Table 1) so choosing herbicides depending on the timing of seeding, paddock weed burdens and potential to cause crop damage are important considerations. Mateno Complete 1 L/ha IBS, and Trifluralin 1.8 L/ha + Avadex (a.i.500 g) 1.6 L/ha + Sakura 118 g/ha IBS had the lowest weed numbers with early and dry sowing eleven weeks after sowing, however these are also

the more expensive herbicides tested. Ensuring weed seed set and the seed bank are minimised every season is an important weed management tool.

Grain yields with early and drier seeding were 0.2 t/ha below seeding after the break but ensuring timeliness of large seeding programs in current farming systems is important to maximise plant growth and yield potential over the whole farm. In 2025 the exceptional winter rains and cooler than normal grain fill conditions may have resulted in better yields from the later seeding than might result in other seasons with poorer finishes.

De-risking the seeding
Complete the learning activity

Acknowledgement
This project 'Derisking the sowing program on EP in 2025' (DN1_25_02) addresses the South Australian Drought Hub priority themes of Farm planning and decision making to manage climate and operational risk and Soil and land management strategies, technologies, and innovations. This project is supported by the South Australian Drought Resilience Adoption and Innovation Hub, through funding from the Australian Government's Future Drought Fund, led by Agricultural Innovation & Research Eyre Peninsula (AIR EP) and delivered by SARDI. Previous SA Drought Hub and Future Drought Fund projects were 'De-risking the seeding program - Adoption of key management practices for the success of dry early sown crops' (4-IMX2CLR) 2024 and 'Best practice for early sowing opportunities' with demonstration sites located at Cowell and Penong in 2022 and 2023 (DN1_23_03 and DN1_22_02).

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Is nutrition holding back lentils on sandy alkaline soils

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Key Messages

- **A range of nutrition treatments did not improve grain yield of lentil compared to grower practice at Murdinga on Eyre Peninsula in 2025.**
- **Grower practice of 80 kg/ha MAP applied at sowing was sufficient for maximum yield where Colwell Phosphorus was marginal.**
- **Further research into P management for lentils is required on sandy alkaline soils.**

Why do the trial?

According to the 2025/26 state crop and pasture report, lentil production increased by 13% compared to 2024/25. A large part of this increase has occurred on Eyre Peninsula (EP). Second only to wheat, lentil area is now the largest on the Upper EP. However, growing lentil has not come without its problems, including the inability to successfully grow lentil on calcareous sandy soils, which are common on Upper EP.

In 2025, a trial was established at Murdinga on EP to assess the effects of various nutrition treatments on grain yield of lentil grown on a sandy alkaline rise. This work is a continuation of the lentil nutrition trials performed in 2024 (EPFS 2024, p. 89) where low and high phosphorus (P), and new nutrition treatments, were investigated.

How was it done?

After consultation with local agronomists who service the Murdinga area, eight nutrition treatments were selected (Table 1) and a site adjacent to the NVT trial was chosen. P reserves at this site were marginal (Colwell P of 21 mg/kg and PBI of 44, in the top 10 cm). GIA Thunder CL Lentil was sown into moisture at Murdinga on 3 June 2025. Treatments were allocated to a randomised complete block design with four replicates. Machinery restrictions meant that treatments (other than grower practice) had to be broadcast by hand prior to seeding. The trial experienced a dry start with below average rainfall from January–May, followed by above average winter rainfall, a dry September and average October – November. The trial was managed throughout the season as per best grower practice and label rates were adhered to when applying chemicals for the control of weeds, pests and diseases. The trial was harvested on 12 November 2025. Data was statistically analysed using standard analysis of variance (ANOVA) and Fisher's least significant difference (LSD) test was used to compare the treatment means in base R.

What happened?

There were no significant differences in August NDVI, however, visual assessments in early spring indicated a slight increase in growth with gypsum (0.5 t/ha) or sulphate of ammonia (SOA; 40 kg/ha) (Table 2). The visual observations of gypsum (0.5 t/ha) were reflected in early spring NDVI (3 Sept in table 2) where gypsum @ 0.5 t/ha and the high P rate recorded the highest readings. All except MOP @ 50 kg/ha recorded higher NDVI than low P.

The nutrition treatments did not significantly change grain yield of lentil compared to grower practice. Grain yield averaged 2.1 t/ha for the trial. Lack of responses to SOA and MOP are consistent with the soil having reasonable reserves of both sulphur and potassium (see trial information at the end of this article).

Table 1. Nutrition treatments applied to lentil at Murdinga, 2025.

Treatment		Product	Timing of Application	Rate
1	(Grower practice	Mono-ammonium Phosphate (10-22-0-1.5)	Applied in-furrow at seeding	80 kg/ha
2	Low P		Spread immediately prior to sowing	40 kg/ha
3	High P			200 kg/ha
4	Gypsum Low	Gypsum Clay Breaker (0-0-0-18)		0.5 t/ha
5	Gypsum High			2.5 t/ha
6	SOA Low	Sulphate of Ammonia (21-0-0-24)		40 kg/ha
7	SOA High			80 kg/ha
8	MOP Low	Muriate of Potash (0-0-50-0)		30 kg/ha
9	MOP High			50 kg/ha

Table 2. Nutrition treatment effects on NDVI and Grain Yield of GIA Thunder CL lentil at Murdinga, 2025. Data labelled with the same letters within a column are not significantly different (P<0.05).

Treatment	NDVI 7 Aug 2025	NDVI 21 Aug 2025	NDVI 3 Sep 2025	Grain Yield (t/ha)
Control	0.263	0.312	0.588 ab	1.96
Low P	0.217	0.273	0.467 c	2.14
High P	0.252	0.343	0.600 a	2.16
Gypsum Low	0.253	0.340	0.610 a	2.26
Gypsum High	0.235	0.325	0.555 ab	1.97
SOA Low	0.258	0.323	0.578 ab	2.13
SOA High	0.255	0.335	0.588 ab	1.92
K Low	0.233	0.318	0.522 bc	1.98
K High	0.228	0.328	0.540 abc	2.06
Average	0.244	0.322	0.561	2.06
P-Value	0.771	0.319	0.021	0.392
LSD	ns	ns	0.08	ns

What does this mean?

The application of 9 fertiliser options prior to sowing did not increase grain yield of lentil at Murdinga in 2025 compared to the grower practice of 80 kg/ha MAP at seeding. Little response was seen in the high gypsum application, which is consistent with no sodicity being detected at the site. The late rain break resulted in slow early crop vigour and the lentils may not have reaped the full benefits of additional fertiliser in such cold conditions in June. Inconclusive nutrition trials over the past couple of seasons on the EP demonstrate the need to further investigate different nutrient applications and their impact on lentil yields. In 2026, we aim to look more specifically at P across a larger range of rates in sandy, calcareous soils, and that have higher PBI levels than that investigated at Murdinga in 2025, to understand the impact of P on grain yield of lentils on lower fertility soils.

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Trial Information	
	Location: Town or District: Murdinga **Rainfall** Av. Annual: 386 mm Av. GSR: 291 mm 2025 Total: 347 mm 2025 GSR: 302 mm **Paddock history** 2025: Lentil 2024: Wheat 2023: Canola **Soil test** **(0-10cm)** pH ($CaCl_2$): 7.4 Ammonium N: 1 mg/kg Nitrate N: 18 mg/kg Phosphorus: 21 mg/kg Potassium: 267 mg/kg Sulphur: 7 mg/kg Organic Carbon: 0.70% PBI: 44.0 **(10-60cm)** pH ($CaCl_2$): 7.9 Ammonium N: <1 mg/kg Nitrate N: 13 mg/kg Sulphur: 25 mg/kg **Plot size** 10 m x 1.5 m x 4 reps **Trial design** Randomised complete block design

NGN Broadleaf weed management in lentil

Navneet Aggarwal[1,2], Jamal Khan[1,2], Amanda Cook[1,2,3], Zhohan Luo[1], Stefan Schmitt[3] and Jeff Braun[2]

[1] SARDI; [2] Adelaide University; [3] Flinders University

GRDC project codes: UoA2301-004RTX, UOA2503-008RTX and UOA2303-007RTX

Key messages

- **Intercept® at 500 mL/ha provided 53-55% control of medics and three corner jacks, while the efficacy improved to >89% at the highest label rate of 750 mL/ha. However, Indian hedge mustard (IHM) and common sowthistle were not controlled with Intercept® 750 mL/ha except at Mundoora, most likely due to background resistance development to this mode of action.**
- **Reflex® followed by Intercept® provided control of wards weed, common sowthistle and IHM. Growers must refer to the Reflex® product label for rates as per their soil type to avoid crop injury and residue issue in the sub-sequent year crop.**
- **Industry practice of sub-lethal rates of Group 5 herbicides such as diuron did not provide satisfactory control of medics, common sowthistle and Indian hedge mustard. Sub-lethal rates of Terbyne Xtreme® provided control of common sowthistle and IHM in imidazolinone (IMI) tolerant lentils but was associated with the crop injury in alkaline loamy-sand soils.**
- **Metribuzin 380 g/ha post-emergent at 5-6 crop node stage (POST) provided broad-spectrum broadleaf weed control including capeweed, three corner jacks, medics, wards weed, common sowthistle, and Indian hedge mustard, including the weeds that survived with Intercept® 750 mL/ha (POST).**
- **Metribuzin applied at the highest label rate of 380 g/ha did not show any herbicide damage in GIA Metro grown on alkaline loamy sand soil (Mundoora and Ceduna) and acidic loamy sand soil (Pinnaroo) and sandy clay loam soil (Minnipa).**

Background

Lentil production in the upper Eyre Peninsula (EP) is rapidly expanding, particularly on red loam and grey calcareous soils. Growers attending the GRDC National Grower Network (NGN) Forum held at Minnipa in August 2022 identified that whilst local (Minnipa) rainfall patterns were like some parts on the Yorke Peninsula, lentil yields achieved were substantially lower. Most of these paddocks where lentils are expanding, had medics grown as a pasture crop, historically. These NGN Forums raised weed management, especially medics, brassica weeds, and wards weed, in low rainfall environments, as one of the most significant challenges for achieving sustainable lentil yields.

The expansion in the growing area of lentils has resulted in this crop now being produced on a diverse range of soil types, including alkaline and sandy soil types in Mid- and upper-North, Yorke Peninsula, and SA-Mallee regions. The industry feedback from the GRDC NGN indicated that spiny *Emex* species (term collectively used for both *Emex australis (three corner jacks)* and *E. spinosa (small jacks)* issue is a rapidly growing concern especially in high value lentil crops in the mid- and upper-North and Yorke Peninsula. They are declared weeds and are categorised as a noxious weed in SA. Spiny *Emex* species are difficult to manage due to their competitive effects arising from quick vegetative and reproductive growth. The presence of the spiny *Emex* weed at harvest can adversely affect harvest efficiency and grain quality through weed seed contamination. Capeweed is also a problematic weed for lentil cultivation across different regions of SA.

The research work has expanded into the SA-Mallee through the GRDC funded "NGN Effective control of broadleaf weed species in lentil crops of the Southern region" to enable growers to make sound decisions around varietal suitability and associated herbicide strategies for effective broadleaf weed control supported by region-specific data.

Growers have reported that unsuccessful control of broadleaf weeds apart from reducing grain yields, significantly contaminates lentil grains, which requires additional cleaning to meet the market requirements. Growers face dual penalties, firstly weed seed contamination reduces marketability by $15-20 per tonne and secondly additional cleaning cost of around $50 per tonne. It implies that an improved management strategies are required to reduce seed set of broadleaf weeds and avoid yield penalties in lentil.

How it was done?

A total of four sites were established at Minnipa and Ceduna (upper Eyre-Peninsula), Pinnaroo (SA-Mallee) and Mundoora (Yorke Peninsula) in 2025, to assess crop herbicide safety and weed control on IMI tolerant, and IMI and Metribuzin dual-tolerant lentils. The site details including soil type, varieties grown, and sowing and harvest dates of four research experiments are summarised in Tables 1 and 2. A pre-seeding spray of glyphosate (600 g ai/L) at 1200 mL/ha and Hammer® (carfentrazone 400 gai/L) at 30 mL/ha was applied to control existing weeds in the field. Lentil was sown at a depth of 4-5cm with a target plant density of 120 plants/m^2 by using a no-till plot seeder fitted with knife-point tines and press wheels. Plots were 10m long and contained six crop rows spaced 22.5cm apart. Fertiliser rate was consistent with the local grower practice of 80 kg/ha of monoammonium phosphate banded below the seed at sowing. The experiments were laid out in a randomised complete-block design with three replications. The solubility and adsorption coefficient values of the herbicides used as incorporated by sowing (IBS) or post-sowing pre-emergent (PSPE) in the study are summarised in Table 3. All herbicide rates used in the experiments are mentioned in terms of the commercial product (Tables 4-7). Not all herbicides used at these sites are registered for all the target weeds. Broadleaf weed pod/seed set was assessed near crop harvest from three randomly selected spots within a plot using a 50cm × 50cm quadrant. The statistical analysis was done with ANOVA, using GENSTAT version 23.

Table 1: The range of soil pH (in $CaCl_2$), organic carbon (OC) per cent and soil texture of the Eyre-Peninsula, SA-Mallee and Yorke Peninsula trial sites in 2025.

Location	pH $CaCl_2$		Soil OC %		Soil texture	
	0–10cm	10–20cm	0–10cm	10–20cm	0–10cm	10–20cm
Minnipa (EP)	7.2	7.6	0.94	0.74	Sandy clay loam	Sandy clay loam
Ceduna (EP)	7.9	8.0	1.01	0.96	Loamy sand	Sandy loam
Pinnaroo (SA-Mallee)	6.2	6.0	0.48	0.22	Loamy sand	Loamy sand
Mundoora (Yorke Peninsula)	7.7	7.8	0.76	0.36	Loamy sand	Clayey sand

Table 2: Target weed species, lentil variety, and sowing and harvest dates of the trial sites in 2023.

Location	Target weed species	Variety	Sowing date	Harvest date
Minnipa (EP)	Medics	GIA Metro^P and GIA Thunder^P	28/05/2025	24/11/2025
Ceduna (EP)	Indian hedge mustard, common sowthistle and wards weed	GIA Metro^P and GIA Thunder^P	29/05/2025	25/11/2025
Pinnaroo (SA-Mallee)	Capeweed and medics	GIA Metro^P and GIA Thunder^P	14/05/2025	19/11/2025
Mundoora (Yorke Peninsula)	Three corner jacks and common sowthistle	GIA Metro^P and GIA Thunder^P	22/05/2025	14/11/2025

Table 3: Solubility and adsorption coefficient values of herbicides used in five trial sites in 2023.

Herbicide (Group)	Application timing in the experiments	Active ingredient	Solubility (mg/L @ 20°C)		Adsorption coefficient, Koc value	
Diuron (5)	IBS*/PSPE**	900g/kg diuron	36	Low solubility	813	Slightly mobile
Metribuzin (5)	IBS/PSPE	750g/kg metribuzin	1165	High solubility	60	Mobile
Reflex® (14)	IBS	240g/L fomesafen	50	Moderate solubility	228	Moderately mobile
Terbyne Xtreme® (5)	IBS	875g/kg terbuthylazine	7	Low solubility	230	Moderately mobile
Broadstrike® (2)	IBS	Flumetsulam	5650	High solubility	28	Mobile

*IBS: Incorporated by sowing, **PSPE: Post-sowing pre-emergence

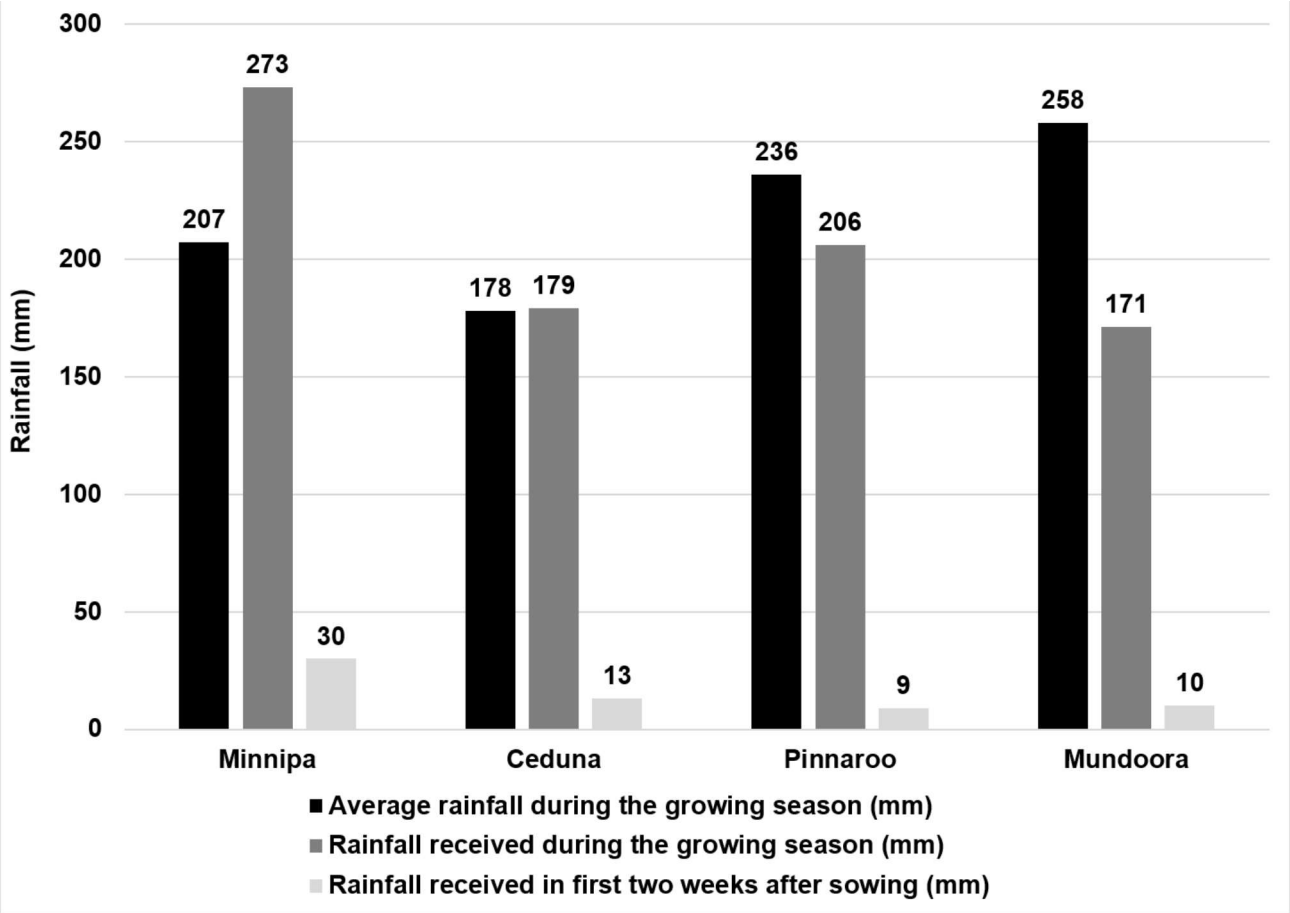
Source: GRDC pre-emergent herbicide fact sheet.

Rainfall conditions

Minnipa received 32% higher in growing season rainfall (GSR) in 2025 than the long-term average (Figure 1). However, this rainfall was not distributed uniformly during the growing season resulting in conditions not optimum for crop growth. About 60% of this rainfall (159 mm) was received early winter, June and July. Only 49 mm of rainfall was received from August to mid-October. About 63 mm of the rainfall was received from last week of October to crop harvest in end November. Ceduna received growing season rainfall equal to the long-term average rainfall. About 60% of this rainfall (107 mm) was received early winter, June and July. Only 31 mm of rainfall was received from August to mid-October. Below average rainfall in late winter onwards adversely impacted crop biomass accumulation at both the EP trial sites.

The field experimental sites at Pinnaroo and Mundoora received less than average growing season rainfall (GSR) in 2025 (Figure 1). Pinnaroo and Mundoora sites received 87% and 66% of the average GSR rainfall, respectively.

Figure 1. Long term, growing season, and two-weeks post sowing rainfall totals for four sites in 2025 (data obtained from weather station installed within 1 km at Minnipa, Pinnaroo and Mundoora sites, and within 5 km of Ceduna site).



Crop safety

Crop damage in lentil was assessed using plant emergence counts, and visual assessments for chlorosis and necrosis. The level of crop damage in lentil from the use of Group 14 herbicide Reflex®, and Group 5 herbicides, diuron, metribuzin and Terbyne Xtreme® at different sites is summarised below.

Plant establishment

There was no reduction in plant establishment of IMI tolerant lentils observed from the application of Group 14 herbicide Reflex, and sub-lethal rates of Group 5 herbicides diuron and Terbyne Xtreme® compared with the untreated control at all the four experimental sites in 2025 (Tables 4, 5, 6 and 7). Metribuzin applied as PSPE at 380g/ha in GIA Metro proved safe, and the plant establishment. was similar to industry practices of using sub-label rates of Group 5 Terbyne Xtreme® at 600 g/ha and diuron at 100-350 g/ha as IBS/PSPE in IMI tolerant lentils. Reflex® 500 mL/ha (IBS) did not reduce lentil establishment on calcareous loamy sand soil.

Chlorosis and necrosis

Metribuzin applied post-sowing pre-emergent (PSPE) or post-emergent at 5–6 crop node stage (POST) did not cause chlorosis or necrosis in GIA Metro at 380g/ha at any trial site (Tables 4, 5, 6 and 7). Industry practice including a combination of Reflex® and diuron applied at the sub-label rate of 250 g/ha (IBS) caused higher levels of chlorosis and necrosis in GIA Thunder compared to GIA Metro sprayed at highest label rate of metribuzin 380 g/ha on calcareous loamy sand soil (Table 5). Similarly, Terbyne Xtreme® 600 g/ha (IBS) + diuron 350 g/ha (IBS) (both below the minimum label rates) combined with Intercept® 500 mL/ha (POST) caused 17% chlorosis with additional 27% necrosis of lentils on the calcareous loamy sand soils.

Efficacy of herbicides on broadleaf weeds

Three corner jacks

Intercept® applied at the highest label rate of 750 mL/ha (POST) was the most effective treatment amongst registered products and reduced three corner seed set by 98% (4 seeds/m^2) as compared to unsprayed control (153 seeds/m^2). The growers and consultants are however reluctant to use Intercept® at the highest label rate of 750 mL/ha (POST) in lighter textured soils due to the anticipated risk of crop safety. The visual herbicide damage assessments revealed biomass suppression proportionate to increasing the rate of intercept from 600 mL/ha to 750 mL/ha in the alkaline sandy soils and is undesirable especially in low rainfall environments in most seasons. The district practice of Intercept at 500-600 mL/ha did not provide satisfactory control of three corner jacks in the commercial paddocks (Personal communication, Stefan Schmitt). Trial results also revealed that Intercept application at 500 mL/ha did not improve three corner jack control compared to metribuzin 380 g/ha (PSPE) alone. The available herbicide options in IMI tolerant lentil providing unreliable control for three corner jacks, force growers to leave sections of the crop unharvested to avoid grain contamination and the potential for grain rejection.

GIA Metro can be a viable option in such niche areas where weed competition resulting from lack of effective herbicide options for three corner jack control prohibit economical and sustainable IMI lentil production. The timing of metribuzin application had a significant impact on its efficacy on three corner jacks. Metribuzin applied at 380 g/ha (POST) reduced three corner jack seed set by 98% (2 seeds/m^2) compared to same rate when applied at the PSPE (127 seeds/m^2) (Table 4). The growth stage of three corner jacks at the time of metribuzin POST can also impact the level of control achieved, as two true leaf three corner jack plants were found to be more vulnerable than four true leaved plants in a pot trial (data not shown). Broadstrike®, currently registered at 25 g/ha applied post-emergence in lentils, was not effective for three corner jack control (61 seeds/m^2, Table 4). A new usage pattern for this registered herbicide is being further explored to improve three corner jack control.

Common sowthistle

Metribuzin at 380 g/ha applied POST was more effective in reducing common sowthistle pod set (0 pods/m^2) compared to its PSPE application (27 pods/m^2) in GIA Metro at Mundoora (Table 7). A sub-sequent spray of Intercept® 500 mL/ha (POST) after metribuzin 380 g/ha (PSPE) provided control of common sowthistle (0 pods/m^2). Having pre-emergent diuron in the herbicide strategy provided control of common sowthistle at this trial site. Intercept® 750 mL/ha (POST) also proved more effective for common sowthistle control (2 pods/m^2) compared to its lower rate of 500 mL/ha. On the other hand, Intercept® 750 mL/ha (POST) proved in-effective to control common sowthistle at Ceduna (Table 5), most likely due to the background resistance to IMI in this population at this site. This suggested that effective pre-emergent herbicide option is crucial to control of this weed specie, especially when the target weed population has developed resistance to IMI herbicides.

Indian hedge mustard (IHM)

Intercept® did not provide adequate control of IHM and was not significantly different to the untreated control at Ceduna trial site (Table 5). This poor control of IHM may be explained by resistance to IMI herbicides building up in IHM populations in the area. This suggests that strategic use of IMI herbicides in combination with alternative modes of action is needed to delay the resistance build up in broadleaf weeds or manage resistant populations. Reflex® was effective at controlling the IMI resistant IHM populations at Ceduna site.

Capeweed

Intercept® at highest label rate of 750 mL/ha did not provide adequate control of capeweed (152 flower heads/m^2) and reduced weed seed set by only 57% as compared to unsprayed control plots at Pinnaroo (Table 6). Capeweed populations that have developed resistance to Group 2 herbicide metosulam have been reported in Western Australia (International herbicide-resistant weed database). Poor control of capeweed with Group 2 herbicide Intercept® may be explained by the increase of other broadleaf weed populations resistant to IMI herbicides in SA (Boutsalis et al, 2023).

Metribuzin applied at the highest label rate of 380 g/ha in GIA Metro, both as PSPE and POST, reduced capeweed density by >98% (0-4 flower heads/m^2) as compared to Intercept® 750 mL/ha (POST) in GIA Thunder. This poor control of capeweed in IMI lentil reduced the fitness penalty gap between GIA Thunder and GIA Metro.

Capeweed was not effectively controlled with district practices of using sub-lethal rates of diuron (350 g/ha IBS f.b. 100 g/ha as PSPE) (34-123 flower heads/m^2) (Table 6).

Medic

Like common sowthistle control, the timing of metribuzin application had a significant impact on its efficacy on medics. Metribuzin applied at 380 g/ha (POST) reduced medic pod set by 60% compared to its PSPE timing in GIA Metro at Minnipa that had higher background

medic population (up to 164 plants/m^2) in 2025 (Table 7). Metribuzin (POST) reduced medic pod set by up to 100% compared to its PSPE timing at Pinnaroo trial site that had lesser background population of medics (10-13 plants/m^2) (Table 6) compared to Minnipa. A follow up application of Intercept® 600 mL/ha (POST) was needed after metribuzin 380 g/ha (PSPE) for controlling medic. Intercept® 750 mL/ha POST also provided a high level of control of medics.

Metribuzin 380 g/ha (POST) did not prove effective to control medics compared to its PSPE timing at both Minnipa and Mudamuckla trial sites in 2024, though it was effective in 2025 research trials (Table 8). Prolonged dry conditions at the time of post emergence metribuzin application might have reduced its efficacy in 2024 season. Metribuzin permit for GIA Metro (PER92810) also suggests that rainfall of >1 mm and <12 mm within 1-2 days post emergence application this herbicide is needed to get its maximum efficacy. The medic plants are also likely to have been under moisture stress due to dry conditions, which may have further reduced metribuzin efficacy (Black, 1984).

Wards weed

Reflex® 500 mL/ha (IBS) + diuron 250 g/ha (IBS) f.b. Intercept® 500 (POST) provided effective control of wards weed (0 plant/m^2) as compared to unsprayed control plots (149 plants/m^2). Metribuzin on its own applied at 380 g/ha either PSPE or POST in GIA Metro proved equally effective in controlling wards weed (0-0.2 plants/m^2), and provided >99% control as compared to unsprayed control plots (104 plants/m^2) at Ceduna site (Table 5).

Grain yield

The average lentil yields were very low at Minnipa (average 0.09 t/ha) and Ceduna (average 0.04 t/ha), therefore the treatment differences on grain yield from these two locations were non-significant and are not presented in this paper. The average lentil yields were 1.81 t/ha at Mundoora and 0.46 t/ha at Pinnaroo (Tables 4 and 6). Uncontrolled growth of weeds resulted in 16-65% loss of yields of the GIA Metro compared to the best herbicide strategy. Similarly, GIA Thunder recorded in 22-51% yield reductions in unsprayed control plots compared to the best herbicide strategy.

Amongst registered herbicide strategies, GIA Thunder produced maximum yields of 2.46 t/ha when treated with Intercept® 750 mL/ha (POST), largely due to cleaner plots having effective control of both three corner jacks and common sowthistle at Mundoora trial site (Table 4). Grain yield of GIA Metro sprayed with metribuzin at 380 g/ha (POST), in-spite of having similar level of three corner jacks and common sowthistle control, was 25% lower than GIA Thunder. Metribuzin applied at 380 g/ha (POST) recorded highest grain yield of GIA Metro (0.75 t/ha) at Pinnaroo trial site (Table 6). Lack of effective capeweed and medics control, and crop damage with diuron and diflufenican in IMI lentil GIA Thunder resulted in yield penalties at Pinnaroo. While effective control of capeweed and medics with metribuzin 380 g/ha (POST), and no herbicide damage, reduced the fitness penalty effects in GIA Metro, and this variety yielded the same as GIA Thunder in such scenario. These results are in line with the previous research findings (Aggarwal et al, 2024).

Off-label industry practices: The use of Glean® at sub lethal rates can be associated with recurrent selection through exposure to reduced rates of herbicides thereby risks of rapid evolution of herbicide resistance in some weeds and should be avoided (Neve and Powles 2005, Gressel 2011). The follow up application of Intercept® means using same mode of action herbicides (Group 2) twice in the same season, and it carries added risk of early build-up of resistance in the target weed species. Off-label industry practices of using sub-lethal rates of Group 5 herbicides diuron 350 g/ha (IBS) f.b. diuron 100 g/ha (PSPE) also did not provide effective control of capeweed and medics (Table 6). Diuron 350 g/ha (IBS) did not prove effective for IHM control (Table 5). Terbyne Xtreme® 600 g/ha (IBS) + diuron 350 g/ha (IBS) (both below the minimum label rates) combined with Intercept® (POST), though improved control of IHM and common sowthistle as compared to Intercept® alone, but these Group 5 herbicides caused 17% chlorosis with additional 27% necrosis of lentils on the calcareous loamy sand soils at Ceduna trial site.

What does this mean?

The expanding cultivation of lentil on marginal, alkaline sandy soils of the Yorke Peninsula and SA-Mallee, and on calcareous sandy loam soils of the Eyre Peninsula, has been accompanied by grower adoption of sub-label rates of registered herbicides, undertaken in an effort to mitigate the risk of crop injury. Field trial data indicate that pre-emergent Group 5 herbicides provide sub-optimal broadleaf weed suppression during the early stages of crop growth, with sub-label rates of pre-emergent herbicides shown to be less effective than label rates for broadleaf weed control. The herbicide strategy for broadleaf weed management in lentils grown on marginal soils will require careful planning to maintain the delicate balance between adequate crop safety and satisfactory weed control.

IMI herbicides remain an important tool for broadleaf weed control in lentil, particularly for species not yet resistant to this mode of action, and for weeds such as medic and three-corner jack that are not effectively controlled by alternative registered products. Extensive reliance on this chemistry has generated substantial selection pressure toward a single mode of action. Strategic integration of IMI herbicides with alternative modes of action is required both to delay further proliferation of resistant broadleaf weed populations and to manage biotypes in which resistance is already established.

The release of GIA Metro, a lentil cultivar combining IMI and metribuzin dual tolerance, has created new opportunities for broadleaf weed management. Trial evidence indicates that metribuzin applied post-sowing pre-emergent at 380 g/ha in GIA Metro was safe on plant establishment, comparable to industry-standard sub-label use of Group 5 products in IMI-tolerant varieties. Post-emergent metribuzin application has provided greater flexibility and improved control of wide-spectrum broadleaf weeds, including those resistant to IMI herbicides. Broader adoption of GIA Metro is therefore expected to relieve selection pressure on Group 2 chemistry and slow the accumulation of IMI resistance, offering a pathway to reduce the yield risk associated with Group 5 herbicide injury and incomplete broadleaf weed control in conventional IMI lentil systems. GIA Metro presents an opportunity in these niche areas, especially, when we get a timely break for early establishment. Growers must refer to the new permit for metribuzin use in GIA Metro in varying soil and weather conditions, as granted by the Australian Pesticides and Veterinary Medicines Authority (PER92810, valid up to 31-12-2030).

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Table 4. Efficacy of various herbicides and herbicide mixtures on three corner jacks and common sowthistle in three lentil varieties, and lentil grain yield on alkaline loamy sand soil at Mundoora (York Peninsula), in 2025. Means value labelled with the same letters within a column are not significantly different (P≥0.05).).

Lentil cultivar	Herbicide strategy	Crop emergence/ m² (10 WAS)	Chlorosis (14 WAS)	Necrosis (14 WAS)	Three corner jack seeds/m²	Common sowthistle pods/m²	Grain yield (t/ha)
GIA Metro	T_1: Metribuzin 380 g/ha (PSPE)*	108 [a]	0 [a]	0 [a]	127 [a]	27 [b]	1.47 [bc]
	T_2: Metribuzin 380 g/ha (PSPE)* f.b. Intercept® 500 mL/ha (POST)	89 [a]	0 [a]	0 [a]	62 [b]	2 [c]	1.23 [c]
	T_3: Metribuzin 380 g/ha (POST)*	102 [a]	0 [a]	0 [a]	2 [c]	0 [c]	1.86 [b]
	T_4: Unsprayed control	110 [a]	0 [a]	0 [a]	142 [a]	154 [a]	1.59 [bc]
GIA Thunder	T_5: Broadstrike® 25 (POST) 6 weeks after sowing	90 [a]	0 [a]	0 [a]	61 [b]	178 [a]	1.83 [b]
	T_6: Intercept® 750 mL/ha (POST)	95 [a]	0 [a]	0 [a]	4 [c]	2 [c]	2.46 [a]
	T_7: Unsprayed control	110 [a]	0 [a]	0 [a]	153 [a]	164 [a]	1.92 [b]

IBS: Incorporated by sowing, PSPE: Post-sowing pre-emergence, POST: Post-emergent at 5-6 crop node stage, f.b.: Followed by
WAS: weed after sowing

Table 5. Efficacy of various herbicides and herbicide mixtures on medic pod set, and growth and grain yield of three lentil varieties on alkaline sandy clay loam soils at Ceduna in 2025. Data labelled with the same letters within a column are not significantly different (P≥0.05).

Variety	Herbicide treatment (dose in terms of commercial product)	Crop emergence/ m²	Chlorosis	Necrosis	Common sowthistle plants/m²	Indian hedge mustard plants/m²	Wardsweed plants/m²
GIA Metro	T_1: Metribuzin 380 g/ha (PSPE)	121.5 a	0.1 b	0 c	2 bc	1 b	0 b
	T_2: Metribuzin 380 g/ha (PSPE) f.b. Intercept® 500 mL/ha (POST)	108.6 a	0 b	0 c	1 bc	1 b	0 b
	T_3: Metribuzin 380 g/ha (POST)	105.2 a	0 b	0 c	8 b	3 b	0.2 b
	T_4: Metribuzin 380 g/ha (POST) + f.b. Intercept® 500 mL/ha (POST)	122.5 a	0 b	0 c	8 b	6 b	0 b
	T_5: Unsprayed control	116.0 a	0 c	0 c	18 a	28 a	104 a
GIA Thunder	T_8: Reflex® 500 mL/ha (IBS) + diuron 250 g/ha (IBS)* f.b. Intercept® 500 (POST)	102.2 a	1.3 a	1.2 b	2 bc	2 b	0 b
	T_9: Intercept® 750 mL/ha (POST)	112.6 a	0 b	0 c	16 a	29 a	5 b
	T_{20}: Terbyne Xtreme® 600 g/ha (IBS)* + diuron 350 g/ha (IBS)* f.b. Intercept® 500 mL/ha (POST)	98.8 a	1.7 a	2.7 a	0 c	3 b	1 b
	T_{10}: Unsprayed control	104.7 a	0 b	0 c	21 a	25 a	149 a

*Sub-lethal rates-industry practice

IBS: incorporated by sowing, PSPE: post-sowing pre-emergence, POST: post-emergent at 5-6 node stage, f.b.: followed by

Table 6. Efficacy of various herbicides and herbicide mixtures on capeweed and medics in three lentil varieties, and lentil grain yield on acidic sandy soils at Pinnaroo, in 2025. Means value labelled with the same letters within a column are not significantly different (P≥0.05).

Lentil cultivar	Herbicide strategy	Crop emergence/ m² (10 WAS)	Chlorosis (14 WAS)	Necrosis (14 WAS)	Capeweed flowers/m²	Medic pods/m²	Grain yield (t/ha)
GIA Metro	T1: Metribuzin 380 g/ha (PSPE)*	124 ^{a}	0 ^{b}	0 ^{b}	4 ^{c}	44 ^{c}	0.48 ^{bc}
	T2: Metribuzin 380 g/ha (PSPE)* + Intercept® 600 mL/ha (POST)	110 ^{a}	0.2 ^{b}	0 ^{b}	1 ^{c}	0.2 ^{d}	0.58 ^{ab}
	T3: Metribuzin 380 g/ha (POST)*	109 ^{a}	0 ^{b}	0 ^{b}	0 ^{c}	0 ^{d}	0.75 ^{a}
	T4: Metribuzin 380 g/ha (POST)* f.b. Intercept® 600 mL/ha (POST)	109 ^{a}	0.2 ^{b}	0.3 ^{b}	0 ^{c}	0 ^{d}	0.56 ^{ab}
	T5: Unsprayed control	115 ^{a}	0 ^{b}	0 ^{b}	371 ^{a}	139 ^{a}	0.26 ^{c}
GIA Thunder	T6: Intercept® 750 mL/ha (POST)	100 ^{a}	0.5 ^{b}	0.2 ^{b}	152 ^{b}	0 ^{d}	0.61 ^{ab}
	T7: Diuron 350 g/ha (IBS)* + diuron 100 g/ha (PSPE)* f.b. diflufenican 200 mL/ha at 5-6 node stage	109 ^{a}	3.2 ^{a}	1.5 ^{a}	123 ^{b}	52 ^{bc}	0.64 ^{ab}
	T_8: Unsprayed control	104 ^{a}	0 ^{b}	0 ^{b}	356 ^{a}	96 ^{ab}	0.32 ^{bc}

*Sub-lethal rates-industry practice

IBS: Incorporated by sowing, PSPE: Post-sowing pre-emergence, POST: Post-emergent at 5-6 crop node stage, f.b: Followed by

Table 7. Efficacy of various herbicides and herbicide mixtures on medic pod set, and growth and grain yield of three lentil varieties on alkaline sandy clay loam soils at Minnipa in 2025. Data labelled with the same letters within a column are not significantly different (P≥0.05).

Variety	Herbicide treatment (dose in terms of commercial product)	Crop emergence/ m²	Chlorosis	Necrosis	Medic pod set/m²
GIA Metro	T_1: Metribuzin 380 g/ha (PSPE)	96 [a]	0 [a]	0 [a]	370 [a]
	T_2: Metribuzin 380 g/ha (PSPE) f.b. Intercept® 500 mL/ha (POST)	109 [a]	0 [a]	0 [a]	64 [b]
	T_3: Metribuzin 380 g/ha (POST) + f.b. Intercept® 500 mL/ha (POST)	101 [a]	0 [a]	0 [a]	76 [b]
	T_4: Metribuzin 380 g/ha (POST)	113 [a]	0 [a]	0 [a]	150 [b]
	T_5: Unsprayed control	105 [a]	0 [a]	0 [a]	506 [a]
GIA Thunder	T_6: Intercept® 750 mL/ha (POST)	104 [a]	0 [a]	1.0 [a]	51 [b]
	T_7: Unsprayed control	97 [a]	0 [a]	0 [a]	467 [a]

IBS: incorporated by sowing, PSPE: post-sowing pre-emergence, POST: post-emergent at 5-6 node stage, f.b.: followed by

Table 8. Efficacy of various herbicides and herbicide mixtures on medic pod set, and growth and grain yield of three lentil varieties on alkaline sandy clay loam soils at Minnipa and Mudamuckla in 2024. Data labelled with the same letters within a column are not significantly different (P≥0.05).

Variety	Herbicide treatment (dose in terms of commercial product)	Medic pod set/m² Minnipa	Medic pod set/m² Mudamuckla
GIA Metro	T_1: Metribuzin 380 g/ha (PSPE)	131 [b]	4 [d]
	T_2: Metribuzin 380 g/ha (POST)	173 [ab]	43 [bc]
	T_3: Reflex® 500 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST)	141 [b]	39 [c]
	T_4: Unsprayed control	148 [ab]	92 [ab]
GIA Thunder	T_5: Intercept® 500 mL/ha (POST)	54 [c]	35 [c]
	T_6: Reflex® 500 mL/ha (IBS)	216 [a]	36 [c]
	T_7: Reflex® 500 mL/ha (IBS) f.b. Intercept® 500 mL/ha (POST)	70 [c]	49 [bc]
	T_8: Unsprayed control	159 [ab]	102 [a]

IBS: incorporated by sowing, PSPE: post-sowing pre-emergence, POST: post-emergent at 5-6 node stage, f.b.: followed by

Lentil check group survey

Cost-effective drone application of fungicides, insecticides and baits in Eyre Peninsula dryland cropping systems

Matthew Fatouris,
XAG Australia

Take home messages

- **A worked operating-cost model for XAG's P150 Max spray drone puts low-rate application such as fungicide, insecticide and baiting at $13.05 per hectare, based on 2,000ha of annual use at an average work rate of 22ha/hour.**
- **On the Eyre Peninsula, the drone's real value is less about replacing the ground rig and more about being able to respond quickly to wet ground, calcareous soils or narrow spray windows that would otherwise delay or hinder operations.**

Background

Snail and slug management alone is estimated to cost the Australian grains industry in the order of $170 million a year, with the Eyre Peninsula among the more heavily affected cropping regions due to its calcareous soils, stubble retention systems and established populations of Mediterranean snail species. Effective baiting is time-critical: bait needs to go out soon after rain and before egg-laying, and mice have also been reported across the Upper Eyre Peninsula in recent seasons, adding a second timing-sensitive input to the same wet-weather window.

Fungicide timing for foliar disease control operates under similarly tight constraints, tied to specific growth stages rather than convenient weather.

The difficulty is that these same wet conditions are often what keep a ground rig out of the paddock. EP dryland systems already run on tight, unpredictable spray windows — annual rainfall across the region ranges from a reliable 600mm near Port Lincoln to a highly variable 270mm further north and west, and soils vary from shallow calcrete through to sandy plains, both of which affect trafficability after rain.

Multirotor spray drones are increasingly used across broadacre operations for exactly these low-rate applications, such as fungicide, insecticide and granular bait spreading, because they remove the ground-pressure constraint entirely and can fly a paddock regardless of surface conditions, provided wind and weather allow. What has been less clear, and what this paper sets out to establish, is a realistic per-hectare operating cost for this kind of platform once it is actually running a season's workload.

Aim

To build a bottom-up operating cost model for a high-capacity spray drone used for low-rate fungicide, insecticide and bait applications, and assess its practical fit for Eyre Peninsula dryland cropping conditions.

Method

Operating cost data was provided by Jock Barnett of Stratos Ag, a drone dealer based in northern NSW, drawn from operations on his mixed farming property at Delungra, NSW. The model uses a single XAG P150 Max unit (80kg/80L payload) with a 24kVA generator, water tank, pump/vat and transport trailer, operating at an average rate of 22ha/hour across an assumed 2,000ha of annual application work.

Costs were split into two categories:

Annual (fixed) costs — depreciation across all major equipment, using a straight-line depreciation schedule matched to expected working life of each item (drone: 4 years; generator: 10 years; water tank: 15 years; pump/vat: 10 years; trailer: 15 years).

Hourly (variable) costs — operator time, diesel for the generator, and maintenance for both the drone and the generator. Operator cost was loaded at 1.2× the base rate to account for time spent on non-spraying tasks (mixing, transport, setup) alongside actual spraying. Drone maintenance was based on component wear across major consumables (impeller, prop brackets, props, pump, nozzle motors, ESCs) each rated to a service life in flight hours, weighted at 90% to reflect the proportion of total operating time actually spent in the air.

The two cost categories were then combined into a single cost-per-hectare figure by spreading each across the assumed annual hectares and hours.

Results

Table 1. Annual (fixed) costs

Item	Total
Depreciation (all equipment)	$15,316.67
Total annual cost	$15,316.67

Table 2. Depreciation schedule

Item	Purchase price	Life (years)	Annual depreciation
XAG P150 Max	$48,000.00	4	$12,000.00
24kVA generator	$11,500.00	10	$1,150.00
Water tank	$4,000.00	15	$266.67
Pump/vat	$7,000.00	10	$700.00
Trailer	$18,000.00	15	$1,200.00
Total	$88,500.00		$15,316.67

Table 3. Hourly (variable) costs

Item	Qty	Base rate	Hourly total
Operator (loaded for non-spray time)	1.2	$50.00	$60.00
Diesel	7L	$3.00	$21.00
Drone maintenance (90% airborne)	0.9	$36.32	$32.69
Generator maintenance	1	$5.00	$5.00
Total hourly cost			$118.69

Table 4. Drone maintenance detail

Component	Qty	Service life (hrs)	RRP	Total	$/hr
Impeller	1	50	$70.00	$70.00	$1.40
Prop bracket	4	100	$115.00	$460.00	$4.60
Props	4	250	$350.00	$1,400.00	$5.60
Pump	1	250	$480.00	$480.00	$1.92
Nozzle motors	2	250	$450.00	$900.00	$3.60
ESC	4	250	$1,200.00	$4,800.00	$19.20
Total					$36.32

Table 5. Cost per hectare

Component	$/ha
Hourly component	$5.39
Annual component	$7.66
Total cost per hectare	$13.05

Discussion

At $13.05/ha, this is a genuinely low cost to put an aircraft to work on fungicide, insecticide and baiting jobs — cheap enough that timing and access, rather than price, become the main consideration for when a grower reaches for it.

Three applications stand out as the clearest fit on the Eyre Peninsula:

Baiting. Snail and mouse baiting both need to happen soon after rain, which is precisely when paddocks are least trafficable. A drone removes that constraint entirely, and the adjustable spread rate suits the variable snail densities seen across a paddock — heavier populations along fence lines and stubble-retained areas, lighter elsewhere.

Spot spraying. Rather than running a full rig pass for a partial-area job, a drone can be sent to treat weed patches, wet spots or problem zones on their own, without the cost or compaction risk of covering the whole paddock to reach a fraction of it.

Fungicide. Growth-stage-critical fungicide timing benefits from the same access advantage — the application can go ahead on schedule rather than waiting for ground conditions to improve, which on the EP's variable rainfall pattern may take longer than the effective treatment window allows.

None of this positions the drone as a replacement for the ground rig on broadacre herbicide work, and it isn't intended to be. Its value is in keeping the rig out of the wet spots — avoiding the ten or twenty times a season it might otherwise get bogged — while covering the low-rate, timing-critical jobs that the rig would otherwise have to wait on.

The platform's portability is also a practical factor for the region. Packed onto its trailer with generator and tank, a single unit can move between properties as easily as a ute, which matters for the multi-block and leased-country operations common across EP dryland systems. A self-propelled sprayer moving the same distance is a materially bigger undertaking.

Conclusion

This cost model demonstrates that a high-capacity spray drone, run as a season-long operation rather than a one-off contract job, can deliver low-rate fungicide, insecticide and baiting applications at approximately $13/ha — competitive with existing contract options and without the capital commitment of traditional spray rigs. For Eyre Peninsula dryland growers, the case for adoption rests less on replacing existing spray infrastructure and more on the access, timing and portability advantages the platform offers for baiting, spot treatment and fungicide programs specifically. Further on-ground validation of this cost model under EP conditions — ideally through a trial coordinated with SARDI Minnipa — would help confirm these figures against real seasonal operating data.

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NGN Optimising seeding rate in wheat, barley and lentil to take advantage of late summer rainfall on the upper EP

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Trial background

The role of crop density in maximising productivity and profitability is being investigated at the Minnipa Agricultural Centre in 2026. Interest in this topic stemmed from discussions at the Eyre Peninsula Low Rainfall Committee meeting held in Wudinna in March, where growers, consultants and agronomists highlighted the need to re-examine seeding rate recommendations in modern cropping systems. Following an early seasonal break across the upper Eyre Peninsula, many growers were considering very early sowing opportunities in barley, wheat and lentils and questioning whether traditional seeding rate guidelines remain relevant for current varieties.

Many seeding rate recommendations used today were developed over 20 years ago and may not fully account for advances in crop breeding. Modern cereal varieties differ markedly in growth habit, tillering capacity and canopy structure, creating opportunities to reconsider optimum plant populations. Questions were raised around whether lower plant densities could maintain yield while reducing seed costs, particularly in high-tillering varieties. Conversely, growers were interested in whether increased seeding rates could offset reduced tillering under later sowing scenarios.

The discussion also reflected changing industry practice. Some growers have reduced barley seeding rates in an effort to improve grain quality and reduce screenings, while previous research in lentils has suggested that lower seeding rates in low rainfall environments may not compromise yield.

To help address these questions under local conditions, replicated trials have been established at the Minnipa Agricultural Centre in 2026. The project aims to evaluate the impact of different plant densities on crop establishment, growth, yield and grain quality in wheat, barley and lentil crops relevant for upper EP farming systems. In addition to potential productivity benefits, the work will help assess opportunities to reduce input costs and better manage risk when early sowing opportunities arise.

How it was done?

Replicated trials have been sown at MAC in 2026 to investigate the interaction between sowing time and seeding rate to optimise profitability and agronomic performance in low-rainfall environments and are summarised in table 1. Three time of sowing treatments have been applied:

- April 16 for cereal trials and April 17 for the lentil trial
- April 27 (all crop types)
- May 18 (all crop types)

Table 1: Crop type and varieties used in the trial with relative plant type, maturity and release year.

Crop Type	Variety	Plant Type	Maturity	Release year	Target Plant Density (plants/m^2)
Lentils	GIA Thunder	Upright IMI-tolerant red lentil	Mid	2023	80, 120
	GIA Metro	Semi-upright dual herbicide-tolerant (MET + IMI) red lentil	Mid	2023	80, 120
Wheat	Calibre	Spring type, moderate height, broadly adapted	Quick- mid	2021	65, 135, 180
	Tomahawk CI Plus	Clearfield spring type, moderate height	Quick-mid	2023	65, 135, 180
	Mohawk	Erect growth habit, high tillering	Quick winter	2024	65, 135, 180
Barley	Neo CI	Semi-prostrate	Mid	2023	65, 135, 180
	Maximus CI	Erect	Quick-mid	2020	65, 135, 180
	Beast	Tall	Quick	2020	65, 135, 180

Crop assessments conducted during 2026 will include:

- Pre-seeding soil characterisation
- Establishment
- Early vigour
- Tillering
- Ground cover and/or biomass production
- Grain yield

An economic analysis of all treatments will also be undertaken to evaluate the potential benefits, savings, and trade-offs associated with varying seeding rates across different sowing times. Results will be presented at the annual farmer meetings in March 2027, and a summary article outlining the key findings will be published in the 2026 Eyre Peninsula Farming Systems Summary.

Acknowledgements
This project is supported funding through the GRDC NGN. Thank you to Tammie Mullen, Marina, Mudge Katrina Brands, and the SARDI MAC agronomy team for their help with the field work. Thank you also to Dr Nigel Wilhelm and Colin Edmondson for project support.

Maximising barley biomass production through phenology and plant architecture in mixed farming systems

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Trial background

Barley is a versatile species for mixed farming systems because it offers opportunities for fast feed production for livestock, as well as reliable grain production in the low rainfall zone (LRZ). Previous work has demonstrated the benefits of wheat and to a lesser extent barley, in providing dual purpose (graze and grain) crops that maximise gross margins by increasing livestock carrying capacity in the medium-high rainfall zones. Other recent work with wheat in the LRZ has shown the value of sowing slower developing winter wheats early. The release of new winter barley phenologies, as well as different canopy architecture types, may provide more opportunities to optimise barley biomass for forage, grain, or opportunistic grain and graze scenarios in the LRZ. The aim of this project is to identify opportunities to exploit new barley phenologies and architecture types to further improve mixed farming production across variable growing seasons.

This is the third year of this SA Discovery Farms long term trial project funded by the Australian Government Future Drought Fund and the South Australian Grain Industry Trust. The trial is being run across four field sites at Minnipa, Loxton/Wunkar, Tarlee and Struan. For the Eyre Peninsula, some key questions to be answered include:

- What variation is available in current barley varieties for early season growth rate for quick feed production in the autumn gap?
- Does plant architecture make a significant difference in terms of biomass production and opportunistic grain and graze scenarios in the LRZ?
- Is there a fit for winter phenology types for grain and/or graze systems on the Eyre Peninsula?

How was it done?

A field trial was established on Minnipa Ag Centre with two times of sowing (TOS) in 2026. Significant February to April rainfall helped establish two earlier times of sowing at the site compared to previous trial seasons. The first TOS was sown on the 25 March into good soil moisture for establishment, with the second TOS sown on the 6 May. Rainfall has been very high for the growing season (decile 9-10), which has produced a good contrast to the drier 2024 and 2025 trial seasons.

There were eight barley varieties that varied for both phenology and plant architecture, with a summary of each in Table 1, that are all the same as the 2025 trial. Sowing rates were targeted at 150 plants/m^2, with sowing rate adjusted for seed size of each variety. The starting soil mineral nitrogen was 60 kg/ha with 80 kg/ha of DAP applied at sowing and 100 kg/ha of urea applied in June. Four different grazing treatments demonstrated different uses for barley in mixed farming systems. A summary of each treatment is presented in Table 2, where a mower was used to simulated grazing for each grazing treatment.

Table 1: Barley varieties used in the trial with relative plant type, maturity and release year.

Variety	Plant Growth Type	Maturity Group	Release year
Beast	Tall	Quick	2020
Neo CL	Semi-prostrate	Mid	2023
Kraken	Semi-prostrate	Mid	2021
Maximus CL	Erect	Quick-Mid	2020
Newton	Prostrate	Slow Winter	2023
Titan AX	Tall	Mid-Slow	2022
AGTB1010	Semi-prostrate	Winter	-
Cyclops	Erect	Quick-Mid	2022

Table 2: Four grazing treatments with the farming system scenario, activities performed and projected outcomes of each. Z30 = Zadoks growth stage 30 (start stem elongation, Zadoks, 1974)

Treatment	Scenario	Grazing Activity	Outcome
Untreated control (UTC)	Grain	None, managed as grain crop	Grain yield, determine yield of each variety across TOS
Up to Z30	Rotational Grazing to Z30 and Grain	Multiple grazes before Z30, before being left for grain	Value of longer phenological vegetative phase duration of winters and final grain yield
Z30	Graze and Grain	Single graze at Z30 (mown once), before being left for grain	Total vegetative biomass production value and final grain yield
Forage	Continuous Grazing	Repeated grazing at regular time intervals (monthly) during the growing season	Early vigour and total seasonal biomass production value for each variety (re-growth potential)

2025 Trial Key Results

The 2025 growing season had closer to average rainfall, which helped produce higher grain yields and more biomass in contrast to the dry 2024. Spring rainfall was below average, which did strain biomass recovery in the warmer part of the season, and resulting grain yield. However, final grain yields were still considerably higher in 2025 (2.43 t/ha site mean) compared to 2024 (0.91 t/ha site mean) with early sowing yielding higher than later sown (Table 3). In TOS 1, Beast, Maximus CL, Newton and Titan AX were able to maintain the same grain yield in both grazing treatments (Z30 and Up to Z30) compared to ungrazed. This was consistent with trial results from 2024. Neo CL was the highest yielding variety across all grazing treatments in TOS 1, but it did have reduced grain yield for the Up to Z30 treatment compared to the UTC. Beast and Titan AX are both 'Tall' plant types that have good daily growth rates which may be aiding their recovery post grazing. However, in 2024 the semi prostate types of Neo CL and RGT Planet were the standouts for graze and grain indicating a potential growing season influence.

In TOS 2, in contrast to 2024, there was a general reduction in grain yield following grazing compared to the UTC. The reduction in TOS 2 was due to the simulated grazing occurring later than Z30 for the spring types. This resulted in the developing head on primary tillers being grazed off. In addition, the drier spring conditions with warmer temperatures hindered re-growth across both times of sowing. However, there were some varieties that maintained similar grain yields following grazing (Table 3), including Kraken and Newton.

Table 3: Grain yield of 8 barley varieties for two TOS and two grain and graze treatments at Minnipa in 2025. UTC representing un-grazed plots, Z30 a single simulated graze at the start of stem elongation then left for grain, and Up to Z30 representing multiple grazes from the 3-4 leaf stage until the start of stem elongation before being left for grain. Different letters represent statistically significant differences between treatments.

Grain Yield (t/ha)	TOS 1			TOS 2		
Variety	UTC	Z30	Up to Z30	UTC	Z30	Up to Z30
AGTB1010	4.12 $^{q-u}$	3.33 ^{mnop}	3.63 $^{o-s}$	2.58 ^{jkl}	1.26 $^{d-h}$	1.73 ^{ghi}
Beast	4.47 ^{tu}	4.27 ^{stu}	3.88 $^{p-t}$	3.39 $^{n-q}$	0.93 $^{a-e}$	1.32 $^{d-h}$
Cyclops	4.45 ^{tu}	3.78 $^{p-t}$	3.52 $^{n-r}$	2.83 $^{k-n}$	0.90 $^{a-e}$	1.31 $^{d-h}$
Kraken	1.95 ^{hij}	2.14 ^{ijk}	2.08 ^{ij}	1.06 $^{b-g}$	0.63 $^{a-d}$	0.96 $^{b-e}$
Maximus CL	4.30 ^{stu}	4.05 $^{q-u}$	3.58 $^{o-s}$	2.94 $^{l-o}$	0.82 $^{a-e}$	1.20 $^{c-g}$
Neo CL	4.72 ^{u}	4.31 ^{stu}	3.93 $^{p-t}$	2.65 $^{j-m}$	1.01 $^{b-g}$	1.43 $^{e-i}$
Newton	0.52 ^{abc}	0.97 $^{b-f}$	0.80 $^{a-e}$	0.17 ^{a}	0.52 ^{abc}	0.40 ^{ab}
Titan AX	4.16 $^{r-u}$	4.08 $^{q-u}$	3.84 $^{p-t}$	2.92 $^{l-o}$	1.13 $^{b-g}$	1.68 $^{f-i}$
p-value (tos x grazing x variety)	*<0.001*					

The slow winter Newton struggled again under both TOS, being significantly lower yielding across all treatments than every other variety, including the forage variety Kraken. The second winter type, breeding line (AGTB1010), had a competitive grain yield in TOS 1 UTC treatment compared to the spring lines (Table 3). This breeding line flowered much earlier than Newton (approximately one month earlier) with early sowing (Table 4). Even in TOS 2, AGTB1010 produced reasonable grain yields, despite later emergence compared to the spring types, which are normally better suited, whilst Newton struggled to fill any grain at all due to the late finish. However, AGTB1010 did not maintain grain yield in the Z30 grazing treatment compared to the UTC, with less time to recover before warmer and drier spring conditions on the Upper EP. This sharper growing season shut off compared to other medium to high rainfall environments is likely to be the main factor preventing the slow winter Newton from achieving higher grain yields. Further investigation of earlier sowing into early April would be beneficial in determining if earlier establishments could help lower the risk of heat and moisture stress late in the season.

Table 4: Total vegetative dry matter (DM) removed in a single simulated graze at Z30 in TOS 1 for each variety at Minnipa in 2025. Statistically significant differences between varieties are represented by different letters. The dates for the start of stem elongation (Z30) and awn peep (Z49) for TOS 1 are included.

Variety	Vegetative dry matter removal (t/ha)	Z30	Z49
AGTB1010	0.90 [ab]	16 Jul	2 Sep
Beast	0.87 [ab]	30 Jun	18 Aug
Cyclops	0.82 [ab]	30 Jun	21 Aug
Kraken	0.61 [a]	6 Jul	28 Aug
Maximus CL	0.71 [a]	1 Jul	20 Aug
Neo CL	0.61[a]	3 Jul	24 Aug
Newton	1.05 [b]	1 Aug	1 Oct
Titan AX	0.60 [a]	4 Jul	25 Aug
p-value (variety)	0.048		

The variation in relative development between the springs and winters was evident from the timing of Z30. AGTB1010 and Newton reached Z30 2 and 4 weeks later respectively than the spring types due to their vernalisation requirement delaying the transition to reproductive development. This phenology influence created some significant differences in vegetative DM as shown in Table 4, especially for Newton, which was significantly higher than many spring types at 1.05 t/ha DM. However, the slower development of Newton meant that it only reached awn peep on 1 Oct, significantly later than all other varieties and coinciding with increased spring temperatures and drier conditions. This likely caused the lower grain yields mentioned previously (Table 3). AGTB1010 also had a relatively high amount of vegetative DM, but not statistically more than spring types, Cyclops and Beast. However, AGTB1010 produced competitive grain yields to spring types unlike Newton, a trend seen at other field trials in the project. The other advantage with winters in grazing systems, is the relatively later increase in undigestible fibres as well as later decrease in crude protein in the DM, that reduces livestock feed quality. These parameters normally increase during stem elongation, marking a decline in feed quality as observed at sites in 2024. With winters reaching Z30 later, it is likely the quality of the feed on offer would have remained high for longer compared to the springs that progressed through from tillering to stem elongation quickly.

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Effect of herbicide residues in soil on wheat and barley in two EP soils

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Project background

It has been estimated that between 20-30% of paddocks across Australia contain soil-borne herbicide residues that constrain crop selection, and 10% of paddocks have residues that could result in crop damage and economic losses to growers. Several National Grower Network forums in South Australia have identified herbicide residues as a major concern for growers, especially in low rainfall regions, which has led to GRDC funding this project, "Understanding herbicide residues on challenging soil types within the Southern Region" (Project code: UOA2501-005RTX). The aim of this study is to measure the impact of different levels of herbicide in soils on the establishment and growth of cereal crops, both in field trials and greenhouse trials. In this article, we report the results from two trials on the Eyre Peninsula, one at Wirrulla (Upper EP) and the other at Coulta (Lower EP), and from three greenhouse trials in which these two soils were involved.

What was done in the project

Residues from Intervix®, Imazapic®, Sakura®, Reflex® and Propyzamide were listed as major concerns in the regions of Upper Eyre Peninsula (EP) and Lower EP, Lower YP, Upper North, Mid North and Murray Mallee. At Wirrulla, the field trial studied the impact of residue levels of Sakura on the growth of barley (variety: Commodus CL). At Coulta, the trial investigated the impact of residue levels of Reflex on canola (variety: PY421C). For both field trials, three rates of herbicide were applied: control (background residue at the paddock), simulated medium and simulated high residue levels, which corresponded to 25% and 50% of the recommended field application rate (RFR). At Wirrulla, herbicides were applied by boom spray on 30 April 2025, followed by sowing of barley in May by the grower. Each strip was 12 m wide x 50 m long. Plant establishment was assessed on 9 July, and shoot dry matter was measured on 2 September. Harvest cuts were taken on 12 November 2025. At Coulta, herbicide application was by boom spray on 1 May 2025. The paddock was sown with canola in June by the grower. Plant establishment was assessed on 9 July and shoot dry matter on 2 September.

In the greenhouse trial, seven simulated herbicide residue rates for each herbicide were used. The rates were 3x, 1x, 0.3x, 0.1x, 0.03x, 0.01x and 0x (control), where "x" represented the RFR, meaning that the simulated rates are either 300%, 100%, 30%, 10%, 3% and 1% of RFR. Soil from Coulta was tested with two herbicide types: Reflex and Sakura, and soil from Wirrulla was tested with Sakura and Imazapic. Wheat (variety: Calibre) was used for experiments with Reflex and Imazapic; barley (variety: Maximus CL) was used in an experiment with Sakura. Crops were grown for six weeks at Turretfield Research Centre, SARDI, in September/October 2025. Shoot dry weight were recorded at the end of each pot trial, and soil samples were collected from each pot to determine the remaining herbicide residues in soil. The response of shoot dry matter to increasing concentrations of applied herbicide residue levels was determined by Analytics for the Australian Grains Industry (AAGI). Effective dose (ED) values were produced, including ED10, ED20 or ED50. These ED values were used to indicate sensitivity of crops to herbicide residue levels, and for the comparison between soil types. Selected soil properties are presented below (Table 1).

Table 1. Selected characteristics for soil from Coulta and Wirrulla used in the pot studies.

Soil	pH1:5 water	Clay %	ECEC cmol/kg	Soil organic C %	Nitrate-N mg/kg	Ammonium-N mg/kg	Colwell P mg/kg	PBI
Coulta	8.0	7.6	25	3.2	150	3.9	67	99
Wirrulla	8.6	5.7	19	1.0	8.5	2.1	44	48

What did we find

Field trials in 2025

Prior to seeding at the Wirrulla site, Pyroxasulfone (Sakura) was detected in the 0-10 cm layer of the soil at 0.01 mg/kg, but none was detected in the 10-30 cm layer. The residues in the 0-10 cm layers were equivalent to approximately 14% of RFR of Sakura. As a result, the treatments of medium and high rate were actually 39% and 64% of RFR, respectively. Despite the high residue levels in the soil, the applied Sakura treatments did not change the establishment of barley. In the high treatment, shoot dry matter weight and grain yield tended to be higher, compared to the other two treatments (Table 2). Barley is not registered for Sakura and is recommended to be sown after an interval of at least 9 months and with minimum interim rainfall of 250 mm. Our result at Wirrulla trial suggested that the growth and yield of barley variety Commodus CL was not affected by Sakura residues at up to 64% of label rate.

Table 2. Effect of Sakura residues: control, medium and high on establishment, shoot dry matter and grain yield of barley at Wirrulla in 2025.

Sakura residue treatments	Plant establishment (plant/m²)	Flowering shoot dry matter (t/ha)	Grain yield
Control (paddock background)	156	1.6	0.86
Medium (control + 25% of RFR)	148	1.6	0.81
High (control + 50% of RFR)	150	1.9	0.96

Fomesafen (Reflex) residues were detected at the Coulta site, both at a soil depth of 0-10 cm (0.05 mg/kg) and at 10-30 cm (0.01 mg/kg). The concentration of active ingredient was equivalent to approximately 70 g/ha of product at 0-10 cm and 28 g/ha at 10-30 cm, reaching 98 g/ha as the soil background residues (54% of RFR) across those two layers. As a result, the imposed medium and high residue treatments increased the effective rate to 79% and 104% of RFR. Reflex treatments at medium and higher rates tended to reduce plant numbers, but the high rate had the highest shoot dry matter per ha when compared to other treatments (Table 3). Canola is not a crop registered for Reflex and for re-cropping, the recommendation is to sow after 9 months with rainfall of at least 250 mm. Our preliminary result at the Coulta is that growth of IMI-tolerant canola (PY421C) was not influenced by high Reflex residue level of up to 104% of label rate.

Table 3. Effect of Reflex residues: control, medium and high on establishment and shoot dry matter of canola at Coulta in 2025.

Reflex residue treatments	Plant establishment (plant/m²)	Flowering shoot dry matter (t/ha)
Control (paddock background)	47	4.6
Medium (control + 25% of RFR)	41	4.8
High (control + 50% of RFR)	40	5.6

Dose-response pot experiments

The results from the pot studies are summarised in the figures below. These figures show the effect of increasing rates of herbicide in the soil on the shoot biomass of the crop, relative to a control which had no added herbicide. A value of 1 for relative shoot biomass can be interpreted as no effect from the added herbicide, while values less than 1 indicate reduction in shoot growth due to the presence of the herbicide in the soil.

Effect of increasing rates of Reflex herbicide in Coulta soil on early growth of wheat (Calibre)

The predicted ED10 and ED20 values were 0.9% and 10% of RFR in this soil (Figure 1), which indicated that 0.9% and 10% of residue level could cause 10% and 20% reduction in shoot biomass.

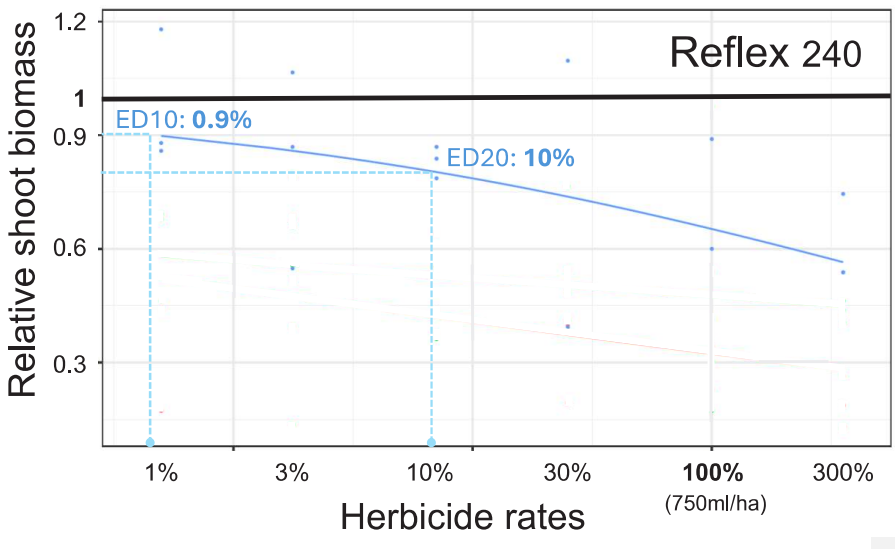
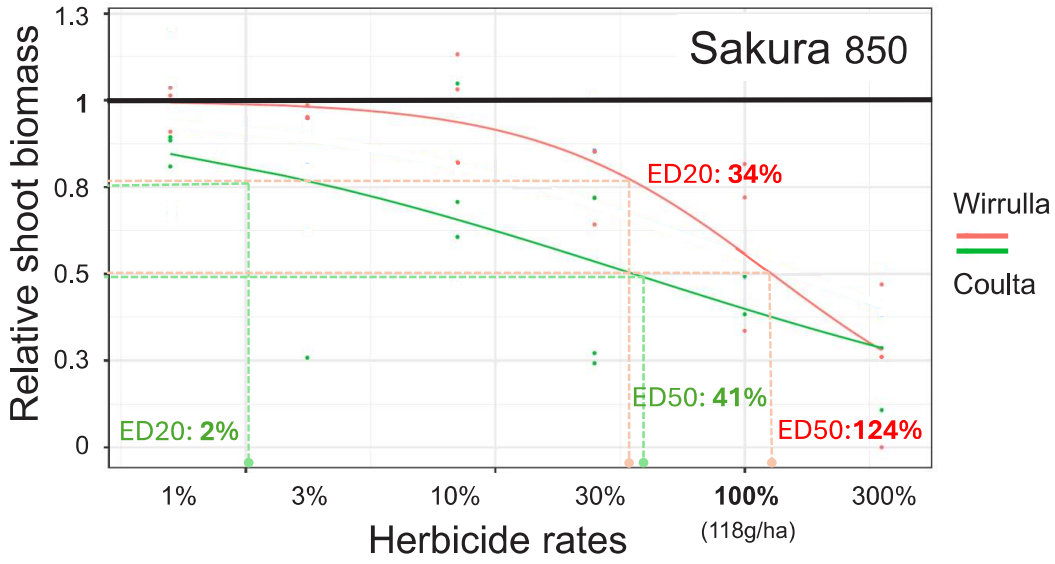


Figure 1. Changes in relative shoot biomass of wheat to increasing rates of Reflex 240 herbicide in Coulta soil. The application rate of 750 ml/ha under 100% on X axis is a recommended field application rate (RFR). The black line at relative shoot biomass of 1 provides a reference for comparison. The values of ED10 and ED20 on the curve present the corresponding rates of Reflex to cause 10% or 20% reduction in shoot biomass, respectively.

Effect of increasing rates of Sakura herbicide in Coulta or Wirrulla soils on early growth of barley (Maximus CL)

Barley was most sensitive to Sakura in soil from Coulta, with the ED20 and ED50 of 2% and 41% of RFR (Figure 2). However, in Wirrulla soil, relative barley biomass had ED20 and ED50 values of 34% and 124% of RFR, respectively.

Figure 2. Changes in relative shoot biomass of barley to increasing rates of Sakura 850 herbicide in soils collected at Coulta (Green in colour) and Wirrulla (Red in colour). The application rate of 118 g/ha under 100% on X axis is a recommended field application rate (RFR). The black line at relative shoot biomass of 1 provides a reference for comparison. The values of ED20 and ED50 on the curve present the corresponding rates of Sakura to cause 20% or 50% reduction in barley shoot biomass in the two soils, respectively.



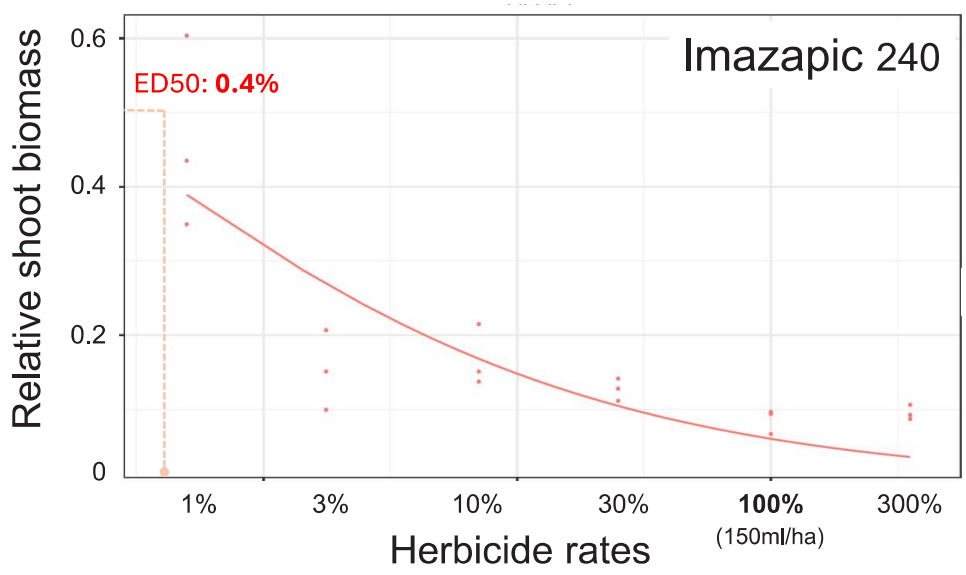
Effect of increasing rates of Imazapic herbicide in Wirrulla soil on early growth of wheat (Calibre)

Calibre wheat was found to be very sensitive to Imazapic in this soil with a very low rate of 0.4% of RFR as the ED50 value (Figure 3). This suggests large crop biomass reduction is likely in this soil if Imazapic levels are higher than 0.4% of RFR.

Conclusions

We found a high tolerance level of barley (Commodus CL) and canola (PY421C) to Sakura and Reflex residues in the field trials at Wirrulla and Coulta, respectively. Specifically, up to 64% of recommended field application rate of Sakura residue did not affect the growth and yield of barley at Wirrulla. A similar result was found at Coulta, where the growth and shoot dry matter of canola (PY421C) was not influenced by high Reflex residue level of up to 104% of RFR. In the greenhouse trial, we observed very contrasting results for Coulta soil with different Reflex rates. The predicted ED20 values is 10% of RFR, which suggests 10% of herbicide application rate could cause 20% reduction in shoot biomass of wheat (Calibre). Both canola and wheat are not registered crops for Reflex. Our trials indicate that selection of crop type could lead to very different result in the shoot damage caused by Reflex residues.

Figure 3. Changes in relative shoot biomass of wheat to increasing rates of Imazapic 240 herbicide in Wirrulla soil. The application rate of 150 ml/ha under 100% on X axis is a recommended field application rate (RFR). The value of ED50 on the curve present the corresponding rates of Imazapic to cause 50% reduction in wheat shoot biomass.



Comparing the Sakura field trial at Wirrulla to the greenhouse trial with Wirrulla soil, different tolerance levels were observed. Barley growth and grain yield (Commodus CL) was not affected by up to 64% of RFR. However, in greenhouse trial, the predicted values of ED20 and ED50 were 34% and 124% of RFR, respectively. Following the response curve at Wirrulla soil (red curve in Figure 2), 64% of RFR would suggest a reduction of shoot biomass of approximately 30% in barley (Maximus CL). The different results between field and greenhouse trial could suggest 1) environmental factors have great influences on response of barley to Sakura residues; 2) impact of variety selection (Commodus CL in field vs. Maximus CL in greenhouse); or 3) the response curves could be improved by extending the experiment length, as it only covered early vegetative growth for six weeks. This certainly warrants further investigation to close the gap in findings between field and greenhouse trials. Worth noting is that there have been a lot of ongoing projects providing guidelines on the sensitivity of crops to a wide range of common herbicide residues, so that soil tests for presence of herbicides can be interpreted for their risk of damage to following crops.

EP Strip and disc systems

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Key messages

- **In 2024, the first season of evaluating the use of stripper fronts with low and medium height draper fronts in low rainfall systems, there were moderate summer rainfall events at two sites (Cleve and Minnipa) for potential soil moisture conservation.**
- **At Cleve, in a red sandy loam soil, the trial showed stubble from the low height draper front had the lowest average probe-measured soil moisture, followed by high stripper stubble height and medium draper stubble.**
- **There was an interaction between stubble height and depth at which the soil moisture was measured but the greatest loss of soil moisture was in the 0-10 cm depth in both locations and soil types.**
- **At both Cleve and Minnipa in the stubble and summer weed control trial, having no summer weed control significantly lowered the average soil moisture compared to the sprayed treatments, independent of stubble height.**

Background

In 2023, Eyre Peninsula (EP) growers identified the need to better understand the benefits and issues of the strip and disc system in low rainfall environments as a research priority. Growers would like to better understand the components of managing their cropping system prior to transitioning from a draper and tyne system to a strip and disc system. In the first season of research, measurements were taken in low rainfall environments to evaluate if stripper stubble and disc seeding systems;

- reduce evaporation and contribute to any growth or yield improvement in marginal years with summer and early autumn fallow rain.
- potentially minimise soil disturbance to conserve more soil moisture at seeding.
- improve seeding and harvest logistics, particularly speed of operations.
- potentially improve grain yield in water limited seasons.

Some of the challenges of the strip and disc system include the impact of high stubble load on summer spray efficacy and pest populations (such as snails, mice, and weeds), justifying the financial return on investment (ROI) for machinery changes and understanding herbicide options for disc systems in the absence of soil throw. A grower workshop was held on the 15 February 2024 at Minnipa on 'Implementing strip and disc systems – tips and tactics for set up, seeding strategies, herbicide control and pest management' and this workshop helped to co-design the research trials in this study and determine priorities for research in this area.

Method

In November 2023, three replicated broadacre stubble management treatments (stripper stubble [full height], medium height draper stubble and low height draper stubble) were implemented using growers' harvester fronts at Cleve and Minnipa. The Cleve soil type is a red sandy loam, and the Minnipa site was implemented on a sand to capture differences in soil moisture with 0-30 cm soil moisture probes. Stubble treatments were implemented at the Cleve site on 17 November 2023 and at Minnipa on 21 November 2023. Stubble height treatments for each site are detailed in Table 1.

Table 1. Summary of treatments at Cleve and Minnipa sites.

Treatment [Height of stubble]	Average height of stubble (cm)	
	Cleve Site	Minnipa Site
Stripper stubble [full]	55	70
Draper medium stubble [medium]	25	38
Draper low stubble [low]	15	23

Rainfall, humidity and soil moisture were measured at both sites. Sentek Drill & Drop Bluetooth soil moisture probes were placed within the stubble systems to measure at 10 cm intervals to 30 cm soil depth. Gravimetric soil moisture (0 - 100 cm) was also manually measured at both sites, with soil nitrogen levels also being tested.

Soil moisture probes were placed in Plots 1-6 of each strip trial to measure soil temperature and moisture from December 2023 to May 2024. This placement ensured two probe readings per stubble type. At Cleve, readings were taken every half hour until a certain point during 25/01/2024, after which they were taken at two-hour intervals as this was deemed sufficient to detect and track changes over a six week period after a rain event. Similarly, at Minnipa, readings were taken every half hour until a point in 29/01/2024, after which they were taken every two hours. In addition to soil probes, above-ground temperature loggers (TinyTag) were placed in the same plots to record air temperature at stubble level.

Generalised Linear Mixed effects Models (GLMM) were fit to the data for inference and prediction. Models were fit with GLMMTMB (Brooks et al. 2017) or ASREML-R (Butler et al. 2017) depending on the distributional family required. Model fit, presence of outliers and adherence to statistical assumptions were checked by diagnostic residual and quantile-quantile plots. Model performance was further assessed using the Bayesian Information Criterion (BIC) to identify the model with the best balance between fit and complexity. Significance of fixed effects was tested by performing sequential chi-square Wald tests on the models. Response predictions were calculated by computing the estimated marginal mean for the respective treatment and a 95% confidence interval.

A replicated trial to assess the impact of stubble on summer spray efficacy was also implemented across the three stubble systems at both sites (Table 2). These trials measured the effect of weed management on soil water losses over summer. Herbicides were applied at 80 or 120 L/ha water rates, either early in the morning with a low delta T or at mid-day with a high delta T, and a Nil and total weed control treatment which was sprayed twice over summer. The six herbicide treatments were replicated nine times at each site. Spray cards were used to capture herbicide coverage (% spray card coverage) in the different stubble systems at the initial application. Gravimetric soil moisture (0-100 cm) was manually measured at both sites.

Table 2. Stubble height and summer spray trial at Cleve (17 November) and Minnipa (5 January 2024) with different stubble heights, water rate and Delta T.

Site		Cleve	Minnipa
Water rate (L/ha)	Delta T	Delta T value (°C)	Delta T value (°C)
80	Low	3.3	3.4
120	Low	4.4	4.5
80	Higher	5.6	11
120	Higher	5.7	12

The grower herbicide mix used at Cleve was Glyphosate 1.2 L/ha, Garlon 80 mL/ha, Hammer 80 mL/ha, SOA 1 kg/100 L and LI700 wetter, applied on 20 December, 2023. The herbicide mix at Minnipa was Glyphosate 1.5 L/ha, Garlon 120 ml/ha, SOA 1 kg/100 L and wetter which was applied on 5 January 2024. The main weeds were volunteer cereals from the previous crop and heliotrope, and milk thistle at the Cleve site also.

Results and discussion

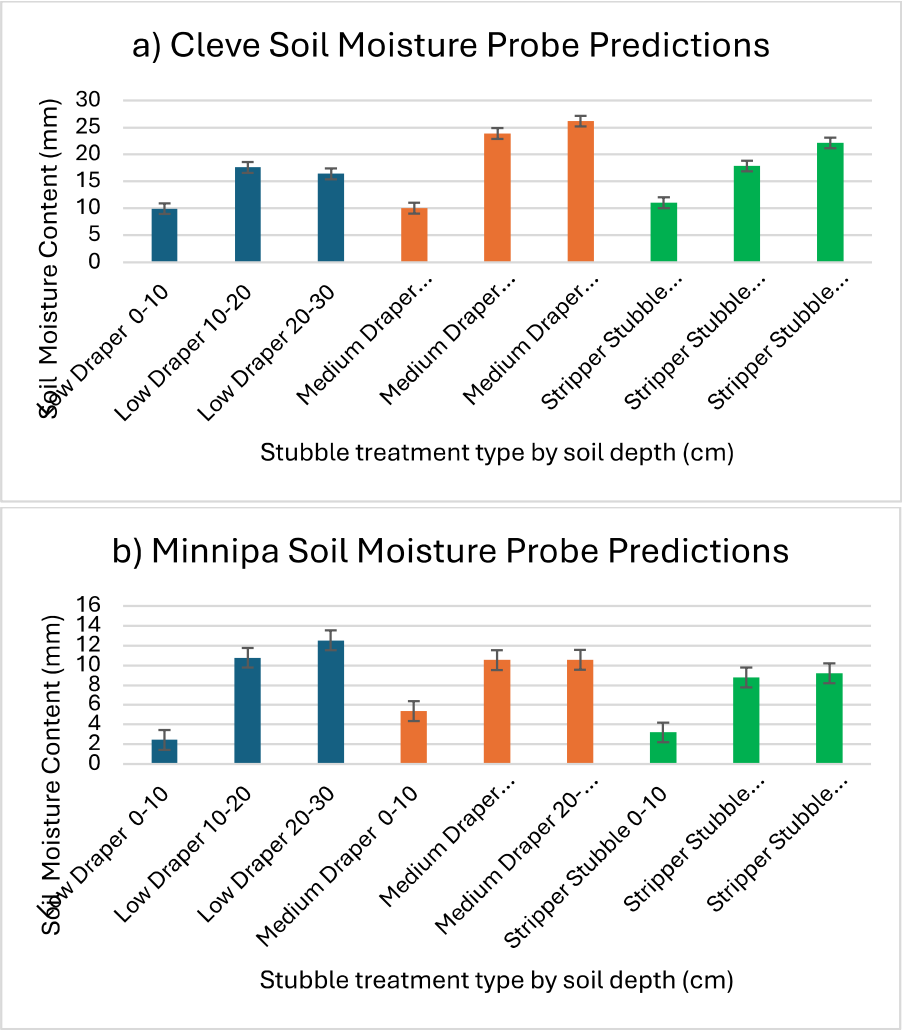
2024 Impact of stubble management and soil moisture

To investigate the benefits of summer or early autumn rainfall and the potential trade-offs between the implemented stubble systems, two trials were run at Cleve and Minnipa, South Australia. Cleve had an average stubble load of 3.5 t/ha in November, and the Minnipa sand averaged 2.1 t/ha. There were adequate summer and autumn rainfall events to measure potential benefits of the implemented systems with the rainfall per month for the period of monitoring listed in Table 3. The soil moisture and temperature data analysed for soil moisture retention under the different stubble systems was from December 2023 to March 2024.

Table 3. Monthly summer rainfall (mm) at Cleve and Minnipa for November 2023 to March 2024.

Rainfall (mm)	Cleve	Minnipa
November	29	46
December	96	21
January	19	23
February	0	2
March	1	12
Total rainfall Nov-March (mm)	**145**	**104**

Figure 1. Soil Moisture Probe Predictions of a) Cleve and b) Minnipa with different stubble type and soil depth (cm).



In the Cleve stubble trial, the low draper stubble corresponded to the lowest average probe-measured soil moisture, followed by high stripper and medium draper stubble. Since there was an interaction between stubble and soil depth, the effect of stubble choice was different depending on the depth of measurement (Figure 1). The greatest loss of soil moisture was in the 0-10 cm depth in both locations regardless of front type. The stubble and spray trial at Cleve showed no significant stubble effect for gravimetric soil moisture across all treatments.

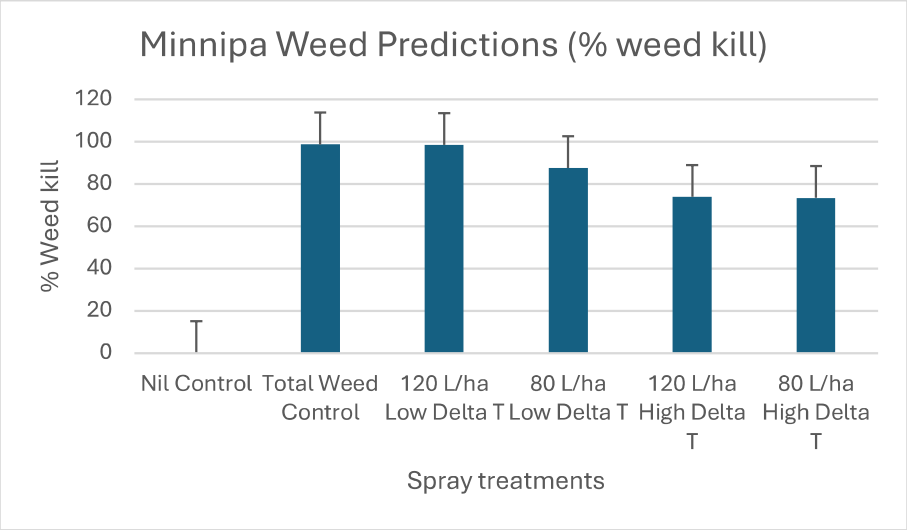
The Minnipa stubble trial in a sand, stripper stubble had the lowest average probe-measured soil moisture, however the size of the differences between different stubble types was minimal. There was similarly a stubble and depth interaction. The strip and spray trials again showed no significant stubble effect for gravimetric soil moisture.

Impact of stubble height and summer spray on soil moisture and weed control

At both the Cleve and Minnipa sites there were soil moisture differences between the spray treatments with the Nil Control plots having significantly lower average soil moisture than other treatments. Average moisture differences between the other spray regimes were much smaller, with Total Control always corresponding to the highest measured soil moisture content, reinforcing the importance of summer weed control. The stubble height by spray treatment interaction was non-significant, meaning that the effect of spray was independent of stubble height.

Weed control differences measured between stubbles and spray treatments at Minnipa included the proportion of dead weeds to total weeds (% weed kill) (Figure 2). Stubble height did not have a significant effect on weed presence. On the other hand, there were large differences in the efficacy of weed control between the Nil Control (no weed kill) and Total Control spray treatments (99% weed kill), which corresponded to the lowest and levels of weed control respectively. High delta T (mid-day application) spray treatments were also found to have lower efficacy (73%) than low delta T (early morning application) treatments (93%).

Figure 2. Weed control (% weed kill) between spray treatments at Minnipa 2024.



Spray penetration was measured using spray coverage cards and the stubble and spray main effects were found to be significant at both locations. At Cleve, the interaction was significant while at Minnipa it was not. Coverage was found to increase from stripper to medium draper to low draper stubble. Also found was that 80 L/ha lower water spraying rates and high delta T admitted less coverage compared to higher spray rate (120 L/ha) and low delta T treatments respectively, on average. In higher stubble situations growers may need to increase water rates and spray in lower delta T conditions to improve weed control.

Conclusion

In the first season of evaluating stripper stubble systems with medium and low draper stubble systems in low rainfall systems, there was reasonable summer rainfall events at both sites meaning there was an opportunity to evaluate the harvest system's abilities to conserve soil moisture. The broadacre stubble trial in a red sandy loam soil at Cleve showed the low draper stubble had the lowest average probe-measured soil moisture, followed by high stripper and medium draper stubble. There was an interaction between stubble height and depth with the greatest loss of soil moisture was in the 0-10 cm depth, independent of location and soil types. The Minnipa stubble trial in a sand, stripper stubble had the lowest average probe-measured soil moisture, however, the size of the differences between different stubble types was minimal. There was also a stubble and depth interaction.

At both the Cleve and Minnipa sites there were soil moisture differences between the spray treatments with the Nil Control having significantly lower average soil moisture than other plots. Average soil moisture differences between the other spray regimes were much smaller, with Total Control always corresponding to the highest measured soil moisture content. The stubble and spray interaction was non-significant, meaning that the effect of spray was independent of stubble choice.

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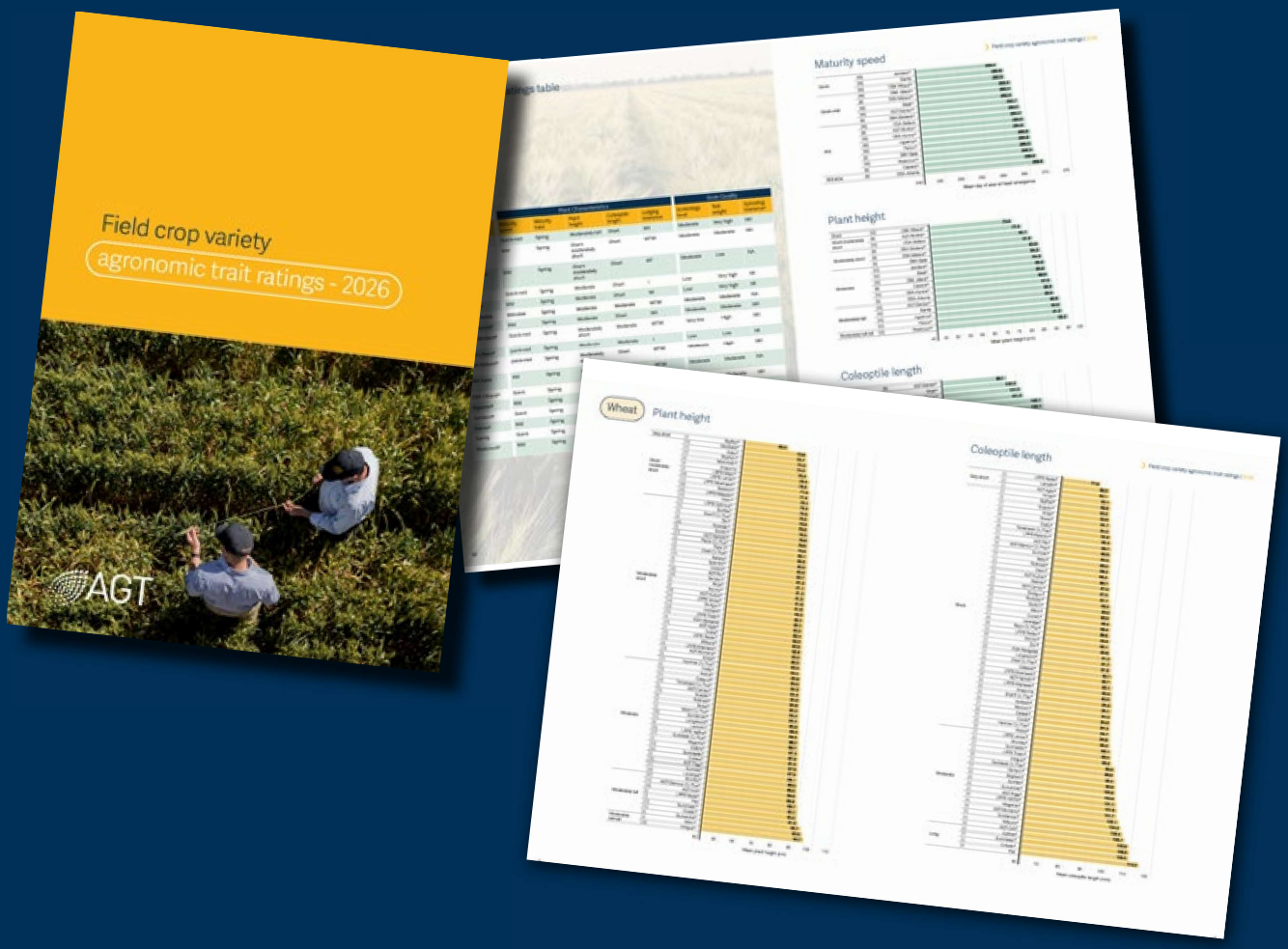
Field crop variety

agronomic trait ratings - 2026



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