SA Grain Legume Development and Extension Project

UOA2105-013RTX

2022 Field Trial Results

Acknowledgements

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Project Investment

Grains Research and Development Corporation: project UOA2105-013RTX Development and extension to close the economic yield gap and maximise faming systems benefits from grain legume production in South Australia

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Cover image: Hart Field Day Site pulse varieties demonstration, 20 September 2022.

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KIMBA

SITE SUMMARY

Kimba received over 200 mm of rainfall in January in 2022 (Figure 1). February and March presented drier than average before a month of increased rainfall in April, including 10 mm around ANZAC day prior to sowing on 4th May 2022. Trials germinated evenly with no establishment issues. Below average rainfall was recorded during June and July and cold temperatures below average were recorded throughout the growing season, which resulted in slow winter growth. Below 0°C temperatures were recorded on six separate occasions in July, three times in August and once on the 3rd of September. These cold events in August and September coincided with early flowering of some lentil varieties.

From September onwards, rainfall recorded was approximately average to above average for the remainder of the year, which resulted in large canopies in all lentil trials. Weeds, particularly barley grass, thistles and mustard were a large issue at Kimba due to wet conditions late in the season.

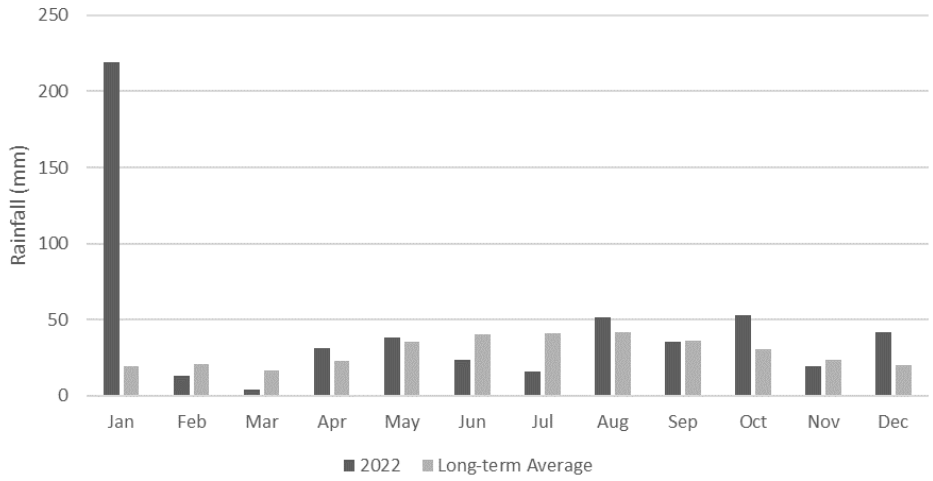

Figure 1. Monthly rainfall recorded at Kimba in 2022 compared to the long-term average rainfall from the Kimba weather station (#018040).

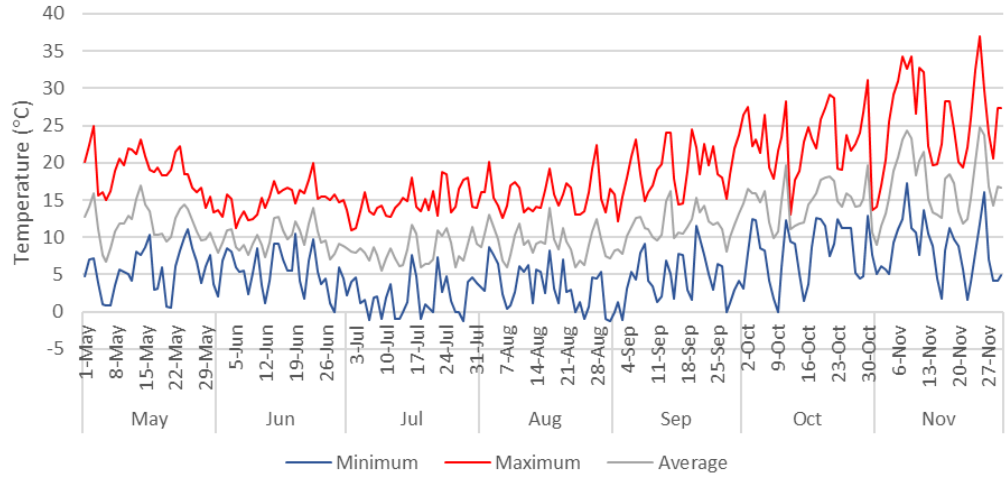

Figure 2. Minimum, maximum and average temperature (°C) recorded during the growing season at the Kimba trial site, 2022.

Table 1. Soil characterisation (loam/clay) for Kimba trial site, 2022.

Depth (cm)	NH_3-N	NO_3-N	P (mg/kg)	K	S	OC (%)	EC (dS/m)	pH ($CaCl_2$)	pH (H_20)	
0-10	2	13	22	397	6.3	1.47	0.155	7.8	8.6	
10-30	1	18	12	254	8.7	0.98	0.215	7.9	9.0	
30-60	<1	9	8	243	33.3	0.45	0.522	8.0	9.6	
Depth	**Cu**	**Fe**	**Mn**	**Zn**	**B**	**Exc Ca**	**Exc Mg**	**Exc K**	**Exc Na**	**Exc Al**
(cm)			**(mg/kg)**					**(meq/100g)**		
0-10	0.60	9.00	3.75	0.68	2.87	21.36	3.61	1.12	0.36	0.070
10-30	0.82	7.60	2.48	0.32	3.92	18.49	6.00	0.80	1.26	0.080
30-60	0.84	15.40	2.81	0.10	10.07	13.12	8.51	0.77	5.11	0.070

LENTIL VARIETY BY DENSITY

Sarah Day, Penny Roberts, ***SARDI***

Aim: This trial aims to assess (1) lentil variety production performance in the low rainfall zone and (2) lentil production when sown at recommended and below recommended sowing densities.

Methodology:

Plots were harvested at crop maturity and grain yield was converted from kg/plot to t/ha. Data was analysed using ANOVA and fisher's least significant difference test in Genstat 21st Edition**.**

Treatments:

Varieties: PBA Jumbo2, PBA Highland XT, PBA Hallmark XT, PBA Hurricane XT, GIA Lightning, CIPAL2122*
*CIPAL2122 is a pre-release experimental line developed as part of the GRDC investment in lentil breeding through Agriculture Victoria in Horsham.

Sowing densities: See Table 2.

Table 2. Lentil target density (plants/m^2) and seeding rate (kg/ha) sown at Kimba, 2022.

Seeding rate	Plants/m^2	kg/ha*
Recommended	120	50-70
Three-quarter	90	35-50
Half	60	25-35

*A range is given for seeding rate per hectare as this will vary depending on seed size and seed weight.

Table 3. Agronomic trial details at Kimba, 2022.

Trial design	RCBD
Replicates	3
Sowing date	04/05/2022
Plant density	As per treatments
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	05/12/2022

Key messages

- Pulse variety selection should be based on herbicide tolerance characteristics and disease resistance, to reduce the risk of a grain yield penalty from weed competition and disease infection.

Results and Discussion:

PBA Jumbo2 is a non-herbicide tolerant lentil variety and was on-average the lowest yielding variety at Kimba, averaged across seed rates, in 2022 (Figure 3).

Reducing the seeding rate of lentil from 120 to 90 plants/m2 did not reduce grain yield production at Kimba, 2022, however, a difference was recorded in grain yield between the recommended and half seeding rates (Figure 4). This is similar to previous findings from lentil seeding rate field experiments in low rainfall environments (Day and Roberts 2021, Day and Keeley 2022, Day and Roberts 2022).

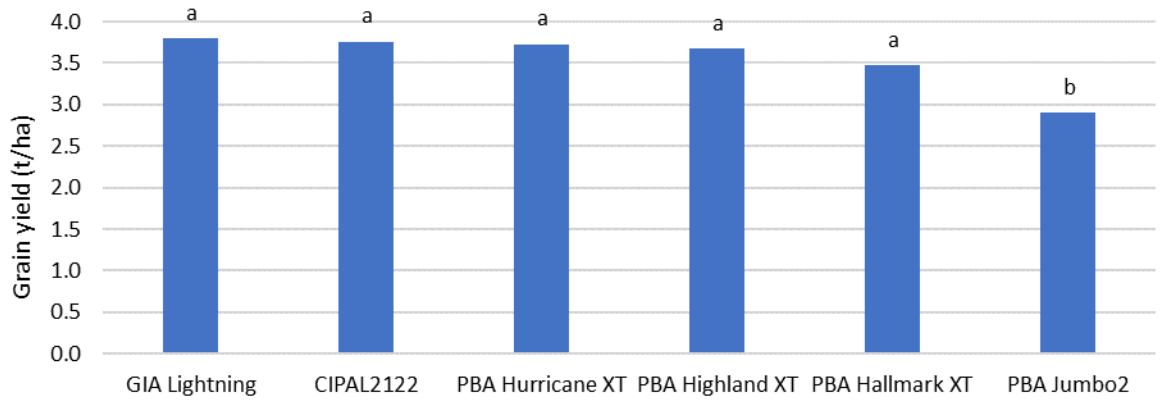

Figure 3. Grain yield (t/ha) response of lentil varieties averaged across seeding densities at Kimba, 2022. Bars labelled with the same letters are not significantly different (P<0.001)

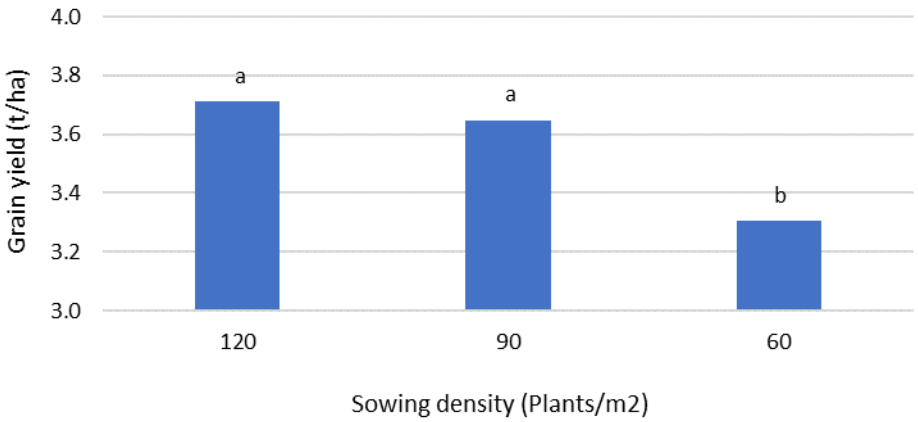

Figure 4. Grain yield (t/ha) response to lentil sowing density averaged across all varieties at Kimba, 2022. Bars labelled with the same letters are not significantly different (P=0.046).

LENTIL PRE-EMERGENT HERBICIDE USE

Sarah Day, Penny Roberts, ***SARDI***

Aim: to assess pre-emergent herbicide management to identify safe, efficient and economic options for use in lentil

Methodology:

Plots were harvested at crop maturity and grain yield was converted from kg/plot to t/ha. Data was analysed using ANOVA and fisher's least significant difference test in Genstat 21st Edition

Treatments:

Variety: PBA Hallmark XT

Herbicide treatments: See Table 4

Table 4. Herbicide products, active ingredients and applications rates applied as treatments to PBA Hallmark XT at Kimba, 2022.

Product	Active Ingredient	Herbicide rate (mL or g per ha)	
		1X rate	2X rate
Metribuzin	750 g/kg Metribuzin	120	240
Diuron	900 g/kg Diuron	400	800
Terbyne® Xtreme®	875 g/kg Terbuthylazine	600	1200
Reflex ®	240 g/L Fomesafen	500	1000

Table 5.Agronomic trial details at Kimba, 2022.

Trial design	RCBD
Replicates	3
Sowing date	04/05/2022
Plant density	120 plants/m^2
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	05/12/2022

Key messages:

- Herbicide type, rate and application timing is important to reduce risk associated with lentil production, as lentils can be sensitive to herbicide use in dry conditions

Results and Discussion:

Minor crop injury from herbicide applications occurred, with an average of 6% plot injury at Kimba, 2022. This herbicide crop injury varied across the site and there were no differences between treatments (P=0.364). Despite the low and varied level of crop injury, herbicide treatments still had an influence on grain yield (Figure 5). Applying metribuzin at a higher rate (2X) reduced grain yield by 570 kg/ha.

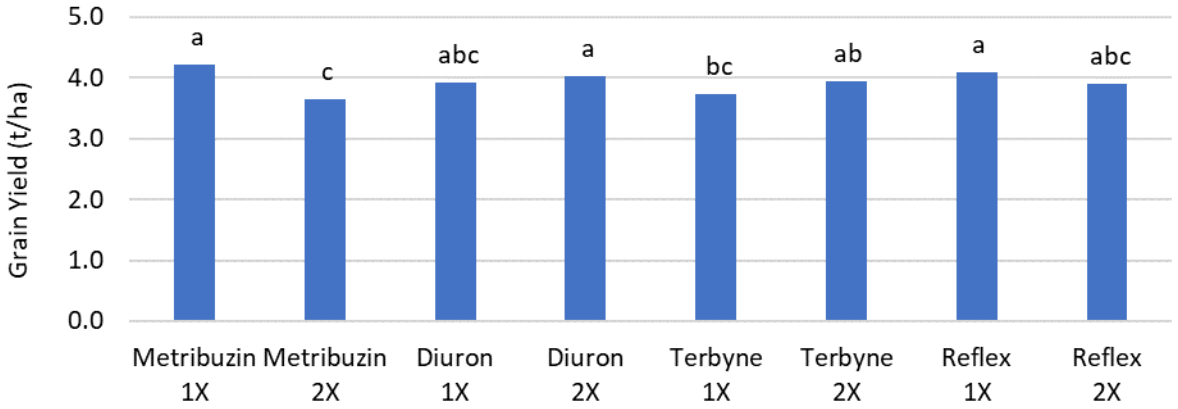

Figure 5. Grain yield (t/ha) of PBA Hallmark XT lentil influenced by the application of different pre-emergent herbicides and rates applied at Kimba, 2022. Bars labelled with the same letters are not significantly different (P=0.003).

TOOLIGIE

SITE SUMMARY

Tooligie recorded a wet start to the year with an extremely high rainfall of 97.9mm recorded in January 2022. March – July received below average rain. Tooligie site was sown between the 27th May and 1st June. During this sowing period, the site received 11.5mm of rain providing essential moisture for herbicide treatments in the broadleaf and grass weed management trials. A wet August, October and November resulted in canopy closure of all crop types at Tooligie. High medic pressure was an issue throughout the season. The lowest temperature recorded during the growing season was 1.6°C, and average monthly temperatures increased from August onwards, avoiding frosts and providing optimal growing conditions (Figure 7). Tooligie site was harvested between 1st December and 15th December 2022 with minimal issues of grain cracking, despite the late season rainfall.

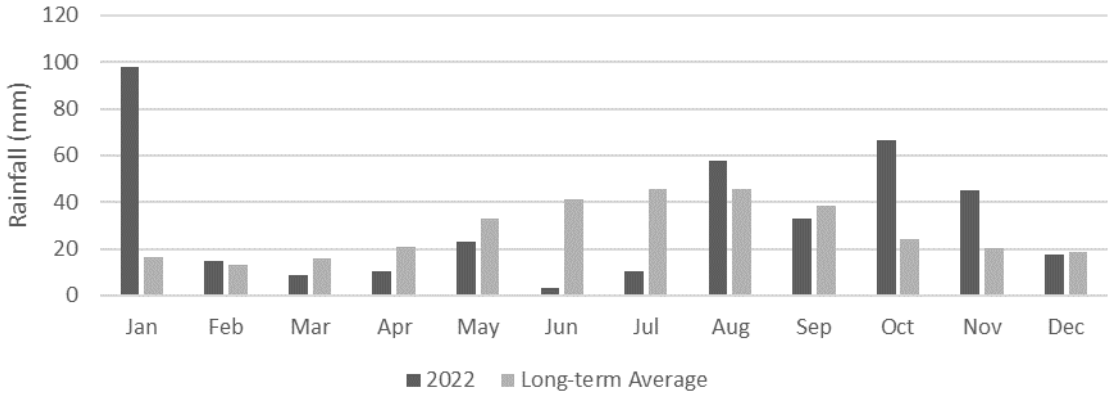

Figure 6. Monthly rainfall recorded at Tooligie Hill in 2022 compared to the long-term average rainfall from the Tooligie Hill weather station (#018164).

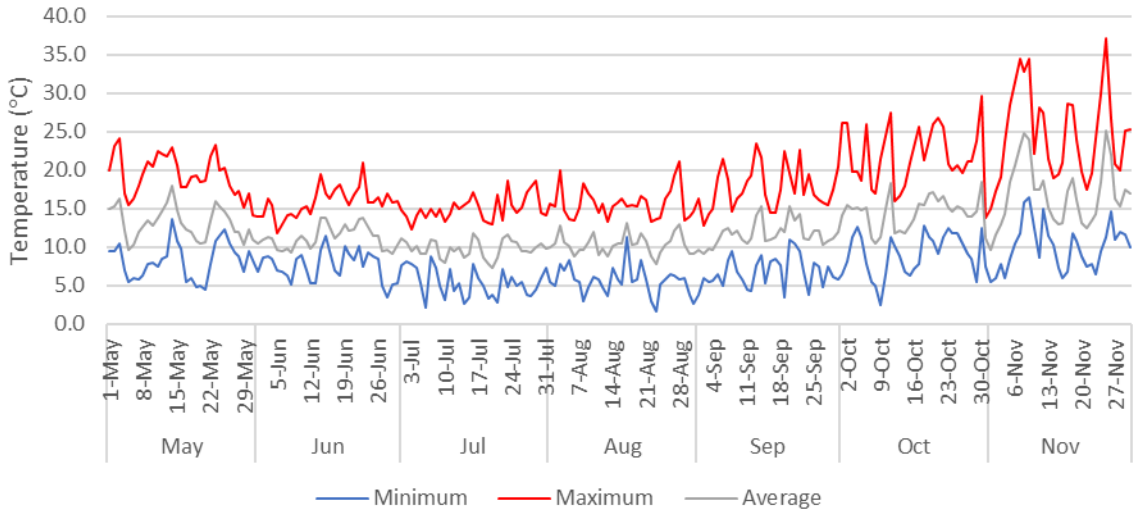

Figure 7. Minimum, maximum and average temperature (°C) recorded during the growing season at the Tooligie trial site, 2022.

Table 6. Soil characterisation (loam/clay) for Tooligie trial site, 2022.

Depth (cm)	NH_3-N	NO_3-N	P (mg/kg)	K	S	OC (%)	EC (dS/m)	pH ($CaCl_2$)	pH (H_20)	
0-10	1	40	31	666	11.1	1.53	0.322	7.9	8.6	
10-30	< 1	23	10	296	20.4	0.76	0.407	8.0	9.0	
30-60	< 1	16	10	494	43.4	0.41	0.933	8.5	10.0	

Depth (cm)	Cu	Fe	Mn (mg/kg)	Zn	B	Exc Ca	Exc Mg	Exc K (meq/100g)	Exc Na	Exc Al
0-10	0.58	8.40	3.57	0.71	5.25	22.39	4.05	1.79	0.62	0.040
10-30	0.51	8.70	1.72	0.10	9.97	16.16	7.51	0.88	2.29	0.040
30-60	0.39	7.40	1.34	0.09	29.76	8.23	10.37	1.33	7.45	0.040

GROUND COVER AND LEGACY OF PULSES

Amy Keeley, Brianna Guidera, Sarah Day, Penny Roberts ***SARDI***

Aim: to assess the ground cover and legacies of pulses in rotation.

Methodology: Three trial phases were established in 2021, to assess the legacies of pulses in rotation.

Phase 1: Pulses in 2021, wheat in 2022 and wheat in 2023.
Phase 2: Wheat in 2021, pulses in 2022 and wheat in 2023.
Phase 3: Canola in 2021, wheat in 2022 and pulses in 2023.

Key messages:

- Legacy effects of pulse crops will be evaluated in 2023.

Results and Discussion:

Faba bean, wheat, and faba bean intercropped with lentil produced the highest levels of total crop biomass at Tooligie, 2022 (Table 8). Despite differences in crop biomass production, there was no differences in grain yield between crops (P=0.162). Average grain yield was 4.72 t/ha, with yields ranging from 3.17 to 6.35 t/ha

Plots will be sown to wheat in 2023 to assess the legacy effects.

Table 7. Biomass yield (t/ha) and grain yield (t/ha) of crops sown in rotation at Tooligie, 2022. Different letters within the same column indicate a significant difference (P<0.001).

Treatment	Total Biomass Yield (t/ha)	Total Grain Yield (t/ha)
Lentil	1.97 b	3.41
Faba bean	3.61 a	4.43
Canola	0.86 c	3.17
Wheat	3.86 a	6.35
Lentil + canola	0.93 c	5.68
Lentil + faba bean	3.18 a	5.29
Average	*2.40*	*4.72*
LSD (P<0.05)	0.757	n.s.

REDUCING SHATTERING AND POD LOSS IN HIGH WIND CONDITIONS

Amy Keeley, Brianna Guidera, Sarah Day ***SARDI***

Aim: To assess pod loss and shattering of different lentil varieties, and to assess the impact of Pod Ceal®, seeding rate and P nutrition on lentil pod retention.

Key messages:

- Higher seed rate increased plant establishment, however, it did not increase grain yield compared to the control in 2022.
- Increasing P nutrition did not benefit grain yield compared to the control in 2022.

Results and Discussion:

Neither varietal selection nor treatment influenced pod drop (P=0.8, data not shown). Crop lodging was prominent at harvest. Applying additional P nutrition did not increase grain yield (Figure 8). A double application of Pod Ceal® (10 days prior to desiccation + at desiccation) increased grain yield compared to single applications at either 10 days prior (T2) to desiccation or at desiccation (T3). However, the double application treatment (T1) recorded equivalent to the control in terms of grain yield. An increased seeding rate did not increase grain yield compared to the control (Figure 8).

Applying extra P nutrition or applying a single application of Pod Ceal® at desiccation reduced the amount of grain shattering compared to the control (Figure 9). This was not reflected in grain yield; therefore, further investigation is required.

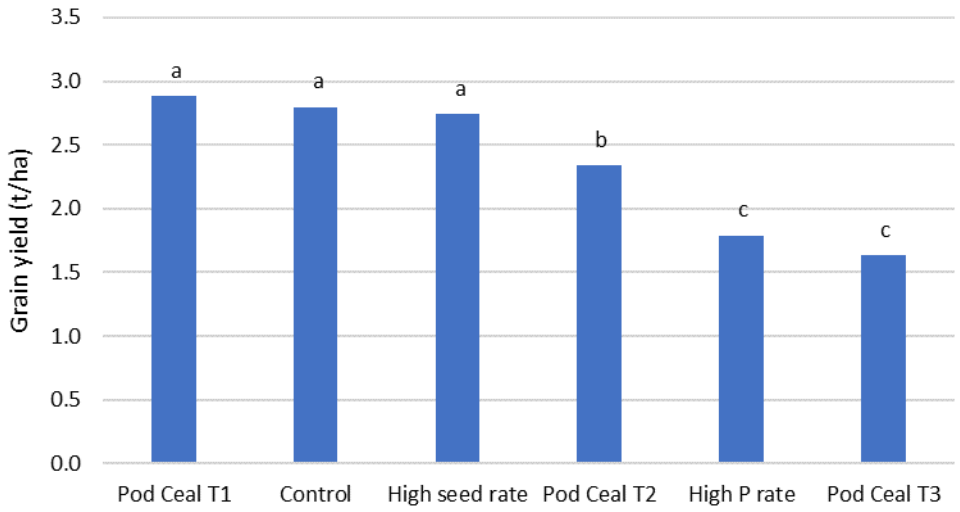

Figure 8. Grain yield of lentil at Tooligie in 2022. Bars labelled with the same letter are not significantly different.

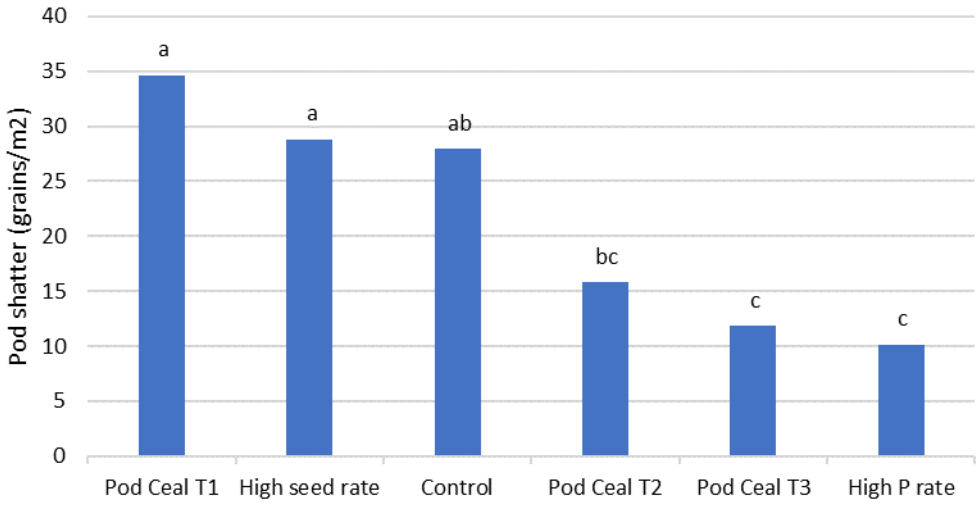

Figure 9. Pod shatter of lentil at Tooligie in 2022. Bars labelled with the same letter are not significantly different.

GRASS AND BROADLEAF WEED MANAGEMENT IN LENTIL

Navneet Aggarwal, Brianna Guidera, Amy Keeley and Penny Roberts, **SARDI**

Aim: To study the efficacy of pre- and post-emergent herbicides for ryegrass, barley grass, Indian Hedge Mustard and common sowthistle control, and productivity of lentil

Methods:

The experiment was established at Tooligie, Lower Eyre-Peninsula, as a randomised complete block design with 15 herbicide treatments (Table 8) and 3 replicates. The site details are summarised in Table 9. There was background population of common sowthistle, Indian hedge mustard, ryegrass, and barley grass at the experimental site. Post-emergent Intercept® and clethodim were applied at the 5-6 crop node stage.

Table 8. Herbicide treatments applied to lentil at Tooligie, 2022.

Treatment (Dose in terms of commercial product (g or mL/ha)		Active Ingredients
T_1	Reflex® 1000 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	Fomesafen (240 g/L) + propyzamide (500g/L)
T_2	Reflex® 1000 ml/ha (IBS) + Ultro® 1700 (IBS)	Fomesafen (240 g/L) + carbetamide (900 g/kg)
T_3	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. diuron 550 (PSPE) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + propyzamide (500g/L) f.b. diuron (900 g/kg) f.b. clethodim (240 g/L)
T_4	Reflex® 750 ml/ha (IBS) + Ultro® 1700 (IBS) f.b. diuron 550 (PSPE) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + carbetamide (900 g/kg) f.b. diuron (900 g/kg) f.b. clethodim (240 g/L)
T_5	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 (PSPE) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + propyzamide (500g/L) f.b. metribuzin (750 g/kg) f.b. clethodim (240 g/L)
T_6	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 (PSPE) f.b. clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	Fomesafen (240 g/L) + propyzamide (500g/L) f.b. metribuzin (750 g/kg) f.b. clethodim (240 g/L) + imazamox (33 g/L) + imazapyr (15 g/L)
T_7	Reflex® 750 ml/ha (IBS) + Ultro® 1700 (IBS) f.b. metribuzin 200 (PSPE) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + carbetamide (900 g/kg) f.b. metribuzin (750 g/kg) f.b. clethodim (240 g/L)
T_8	Reflex® 750 ml/ha (IBS) + Ultro® 1700 (IBS) f.b. metribuzin 200 (PSPE) f.b. clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	Fomesafen (240 g/L) + carbetamide (900 g/kg) f.b. metribuzin (750 g/kg) f.b. clethodim (240 g/L) + imazamox (33 g/L) + imazapyr (15 g/L)
T_9	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	Fomesafen (240 g/L) + propyzamide (500g/L)
T_{10}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 (IBS) + propyzamide 1000 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + terbuthylazine (750 g/kg) + propyzamide (500g/L) f.b. clethodim (240 g/L)
T_{11}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 (IBS) + Ultro® 1700 (IBS) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + terbuthylazine (750 g/kg) + carbetamide (900 g/kg) f.b. clethodim (240 g/L)
T_{12}	Reflex® 750 ml/ha (IBS) + Ultro® 1100(IBS) f.b. Ultro® 600 (PSPE)	Fomesafen (240 g/L) + carbetamide (900 g/kg)
T_{13}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 (IBS)	Fomesafen (240 g/L) + carbetamide (900 g/kg)

T_{14}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 (IBS) + trifluralin 1250 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	Fomesafen (240 g/L) + carbetamide (900 g/kg) + trifluralin (480 g/L) f.b. clethodim (240 g/L)
T_{15}	Unsprayed control	-

*IBS- Incorporated by sowing, PSPE- post-sowing-pre-emergence, POST- post-emergence at 5-6 crop node stage, f.b.- followed by

Table 9. Trial site details, including sowing date and fertiliser

Sowing Date	01 June, 2022
Row Spacing (cm)	25
Fertiliser (kg MAP/ha)[1]	80
Variety	PBA Hurricane XT
Application date for IBS herbicide treatments	01 June, 2022
Application date for PSPE herbicide treatments	01 June, 2022
Application date for POST herbicide treatments	31 August, 2022
Harvest Date	15 December, 2022
Rainfall during the growing season (June-December 2022)	234 mm
Soil texture	Silty loam
Soil pH ($CaCl_2$)	0-10 cm: 7.8 10-20 cm: 7.8

1. MAP (10.0, 22.0, 0.0, 1.5) + Zn (1.0)

Key messages

- Reflex® did not cause in any lentil plant establishment reduction in alkaline silty loam soil.
- Combination of Reflex® with metribuzin caused stunting in lentil as compared to Reflex® with diuron or Terbyne® in alkaline silty loam soil. The above average late winter-spring rainfall (158 mm from August-October 2022) might have allowed better recovery from herbicide damage symptoms due to good moisture availability and longer recovery time.
- Combination of pre-emergent Reflex® (IBS) with post-sowing pre-emergent application of Group 5 metribuzin and diuron proved more effective for common sowthistle and Indian Hedge than herbicide strategies of relying on single broadleaf weed herbicide Reflex® alone.
- Propyzamide and Ultro® provided effective control of both ryegrass and barley grass.

Results and interpretation

Lentil growth and yield

- There were no adverse effects of Reflex® (IBS) on lentil emergence at both rates of 750 mL/ha and 1000 mL/ha in alkaline silty loam soil (Table 10).
- When Reflex® was followed by Group 5 herbicide metribuzin (T_5, T_6, T_7 and T_8), it caused crop height reduction in three out of four treatments (T_6, T_7 and T_8), compared to unsprayed control plots (T_{15}).
- However, Reflex® in combination with Group 5 herbicide diuron (T_3 and T_4), and Terbyne (T_{10} and T_{11}) did not reduce lentil plant height as compared to unsprayed control plots (T_{15}).
- The herbicide strategies of applying Reflex® in combination with Group 5 herbicides metribuzin, diuron and Terbyne did not result in lentil grain yield penalties (
- Table 11).

Broadleaf weed control

- Herbicide strategies having broadleaf weed herbicide Reflex® applied incorporated by sowing (IBS) (T_1, T_2, T_9, T_{12}, T_{13} and T_{14}), all characterised by the absence of any post-sowing pre-emergent (PSPE) and post-emergent (POST) broadleaf weed control treatments, had the lowest levels of weed control (Table 10).
- Reflex® (T_1, T_2, T_9, T_{12}, T_{13} and T_{14}) reduced the pod set of common sowthistle by 49-80%, and of Indian hedge mustard (IHM) by 18-58% as compared to unsprayed control (T_{15}). The lack of broadleaf PSPE treatments meant that common sowthistle and IHM plants in these plots were mostly found in intra-row area, as the applied herbicide was likely moved into the inter-row by the seeding operation. Additionally, late winter-spring season rainfall of 158 mm (August to October 2022) favoured later germination of these broadleaf weeds. Therefore, the surviving and late emerging common sowthistle and IHM plants still could set 77-149 and 26-66 pods/m^2, respectively in Reflex® treated plots (
- Figure 10, Table 10).
- Reflex® at 1000 mL/ha (T_1 and T_2) and 750 mL/ha (T_9, T_{12} and T_{13}) recorded similar level of common sowthistle and IHM control.
- After Reflex® 750 mL/ha IBS, the inclusion of any of the Group 5 herbicide at the PSPE timing improved broadleaf weed control. Metribuzin (T_5, T_7) resulted in >99% control of common sowthistle and 88-96% control of IHM, and treatments that included diuron (T_3, T_4) resulted in 76-84% control of common sowthistle and 87-93% control of IHM (Table 10). The addition of a POST Intercept treatment following metribuzin (T_6 and T_8) did not further improve weed control.
- Treatments that included Reflex® and Terbyne® both as IBS (T_{10}, T_{11}) resulted in 92-98% control of common sowthistle and ~93% control of IHM.

Grass weed control

- Propyzamide 1000 mL/ha or Ultro® 1700 g/ha applied IBS, as well as with additional post-emergent (POST) application of clethodim 500 mL/ha at 5-6 node crop stage resulted in effective control of barley grass (T_1 to T_{14}) (Table 10).
- Propyzamide 1000 mL/ha or Ultro® 1700 g/ha followed by clethodim 500 mL/ha proved equally effective for ryegrass control. However, Ultro® 1700 g/ha (T_2 and T_{13}) recorded lesser ryegrass spike density than propyzamide 1000 mL/ha (T_1 and T_9) when not followed by a clethodim application.

Reflex 750 (IBS) + propyzamide 1000 (IBS)

Reflex 750 (IBS) + Ultro 1700 (IBS)

Reflex 1000 (IBS) + propyzamide 1000 (IBS)

Reflex 1000 (IBS) + Ultro 1700 (IBS)

Figure 10. Broadleaf weed control with Reflex.

Reflex 750 (IBS) + metribuzin 200 (PSPE)

Reflex 750 (IBS) + diuron 550 (PSPE)

Reflex 750 (IBS) + Terbyne 1000 (IBS)

Unsprayed control

Figure 11. Broadleaf weed control with Reflex and Group 5 herbicide combination, compared with unsprayed control.

Table 10. Grass and broadleaf weed pod/spike set as affected by different herbicide strategies at Tooligie, 2022. Different letters within the same column indicate a significant difference (P<0.05).

Treatment (Dose in terms of commercial product		Common sowthistle pods/m²	Indian hedge mustard pods/m²	Ryegrass spikes/m²	Barley grass spikes/m²
T_1	Reflex® 1000 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	9.8* ^{bcd} (96.0)**	6.8* ^{bc} (46.2)**	2.8* ^{b} (7.8)**	0* ^{b} (0)**
T_2	Reflex® 1000 ml/ha (IBS) + Ultro® 1700 g/ha (IBS)	9.2 ^{cde} (84.6)	7.2 ^{bc} (51.8)	0 ^{d} (0)	0 ^{b} (0)
T_3	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	5.4 ^{fg} (29.2)	2.9 ^{ef} (8.4)	0 ^{d} (0)	0 ^{b} (0)
T_4	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	6.6 ^{efg} (43.6)	4.1 ^{def} (16.8)	0.8 ^{d} (3.2)	0 ^{b} (0)
T_5	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	0.4 ^{i} (0.2)	2.2 ^{f} (4.8)	0 ^{d} (0)	0 ^{b} (0)
T_6	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) + clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	0 ^{i} (0)	3.7 ^{def} (13.7)	0.4 ^{d} (0.2)	0 ^{b} (0)
T_7	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	0.7 ^{i} (0.5)	3.9 ^{def} (15.2)	0 ^{d} (0)	0 ^{b} (0)
T_8	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	0.7 ^{i} (0.5)	4.2 ^{def} (17.6)	0 ^{d} (0)	0 ^{b} (0)
T_9	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	12.2 ^{ab} (148.8)	8.1 ^{b} (65.6)	1.9 ^{c} (3.6)	0 ^{b} (0)
T_{10}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 g/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	3.8 ^{gh} (14.4)	2.8 ^{ef} (7.8)	0 ^{d} (0)	0 ^{b} (0)
T_{11}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 g/ha (IBS) + Ultro 1700 g/ha (IBS) f.b. clethodim 500 ml/ha (POST)	1.8 ^{hi} (3.2)	3.0 ^{ef} (9.0)	0 ^{d} (0)	0 ^{b} (0)
T_{12}	Reflex® 750 ml/ha (IBS) + Ultro® 1100 g/ha (IBS) f.b. Ultro 600 g/ha (PSPE)	8.8 ^{cde} (77.4)	5.8 ^{bcd} (33.6)	0 ^{d} (0)	0 ^{b} (0)
T_{13}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS)	10.8 ^{abc} (116.6)	5.1 ^{cde} (26.0)	0.4 ^{d} (0.2)	0 ^{b} (0)
T_{14}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) + trifluralin 1250 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	7.4 ^{def} (54.8)	7.2 ^{bc} (51.8)	0 ^{d} (0)	0 ^{b} (0)
T_{15}	Unsprayed control	13.5 ^{a} (182.3)	11.3 ^{a} (127.7)	5.2 ^{a} (27.0)	4.3 ^{a} (18.5)

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

* Figure after square-root transformation

** Figures in parentheses are original means

Table 11. Lentil establishment, growth and grain yield as affected by different herbicide strategies at Tooligie, 2022. Different letters within the same column indicate a significant difference (P<0.05).

Treatment (Dose in terms of commercial product (g or mL/ha)		Emergence/m^2	Plant height (cm)	Grain yield (t/ha)	100-seed weight (g)
T_1	Reflex® 1000 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	107 ^{a}	12.9 ^{bcde}	4.62 ^{cd}	3.36 ^{bcd}
T_2	Reflex® 1000 ml/ha (IBS) + Ultro® 1700 g/ha (IBS)	115 ^{a}	14.4 ^{ab}	4.83 ^{bcd}	3.35 ^{cde}
T_3	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	115 ^{a}	13.7 ^{abc}	5.07 ^{abc}	3.40 ^{bcd}
T_4	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	104 ^{a}	13.5 ^{abcd}	5.11 ^{abc}	3.41 ^{abcd}
T_5	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	104 ^{a}	12.7 ^{bcde}	5.24 ^{ab}	3.42 ^{abcd}
T_6	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) + clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	120 ^{a}	10.9 ^{e}	4.71 ^{bcd}	3.47 ^{ab}
T_7	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST)	101 ^{a}	11.4 ^{de}	5.19 ^{ab}	3.46 ^{abc}
T_8	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. clethodim 500 ml/ha (POST) + Intercept® 750 ml/ha (POST)	107 ^{a}	11.5 ^{cde}	5.39 ^{a}	3.53 ^{a}
T_9	Reflex® 750 ml/ha (IBS) + propyzamide 1000 ml/ha (IBS)	113 ^{a}	15.7 ^{a}	5.06 ^{abc}	3.37 ^{bcd}
T_{10}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 g/ha (IBS) + propyzamide 1000 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	100 ^{a}	14.2 ^{ab}	5.00 ^{abc}	3.36 ^{bcd}
T_{11}	Reflex® 750 ml/ha (IBS) + Terbyne® 1000 g/ha (IBS) + Ultro 1700 g/ha (IBS) f.b. clethodim 500 ml/ha (POST)	114 ^{a}	14.3 ^{ab}	5.24 ^{ab}	3.23 ^{e}
T_{12}	Reflex® 750 ml/ha (IBS) + Ultro® 1100 g/ha (IBS) f.b. Ultro 600 g/ha (PSPE)	111 ^{a}	13.4 ^{bcd}	5.23 ^{ab}	3.37 ^{bcd}
T_{13}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS)	110 ^{a}	14.2 ^{ab}	5.10 ^{abc}	3.40 ^{bcd}
T_{14}	Reflex® 750 ml/ha (IBS) + Ultro® 1700 g/ha (IBS) + trifluralin 1250 ml/ha (IBS) f.b. clethodim 500 ml/ha (POST)	96 ^{a}	14.3 ^{ab}	5.00 ^{abc}	3.38 ^{bcd}
T_{15}	Unsprayed control	124 ^{a}	14.2 ^{ab}	4.42 ^{d}	3.34 ^{de}

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

BROADLEAF WEED MANAGEMENT IN LENTIL

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Aim:

1. Can we exclude imidazolinone herbicide (IMI) application and get the same level of broadleaf weed control in lentil.
2. Best use of new herbicide Reflex® in combination with other herbicides in alkaline medium textured soils.
3. Benefits from alternate use pattern of metribuzin in new metribuzin tolerant lentil technology.
4. Better understand yield comparisons of IMI tolerant lentil and metribuzin tolerant lentil under different sets of weed management scenarios.

Methods

The experiment was established at Tooligie, Lower Eyre-Peninsula, as a randomised complete block design with 18 herbicide treatments and 3 replicates (Table 12). The site details are summarised in Table 13. There was background population of common sowthistle, prickly lettuce, and Indian hedge mustard (IHM) at the experimental field site. Post-emergent (POST) herbicides were applied at 5-6 crop node stage.

Post emergent application of Metribuzin to GIA Metro is permitted under APVMA permit PER92810.

Table 12. Agronomic tactics/herbicide treatments applied to lentil at Tooligie, 2022.

Treatment (Dose in terms of commercial product (g or mL/ha)		**Active Ingredients**
T_2	GIA Metro: Metribuzin 380 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	Metribuzin (750 g/kg) f.b. diflufenican (500g/L)
T_3	GIA Metro: Reflex® 750 mL/ha (IBS)	Fomesafen (240 g/L)
T_5	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg)
T_6	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST) f.b. Intercept® 750 mL/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
T_7	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg)
T_8	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
T_9	GIA Metro: Unsprayed control	-
T_{10}	PBA Hurricane XT : Reflex® 1000 mL/ha (IBS)	Fomesafen (240 g/L)
T_{11}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS)	Fomesafen (240 g/L)
T_{12}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE)	Fomesafen (240 g/L) f.b. diuron (900 g/kg)
T_{13}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	Fomesafen (240 g/L) f.b. diuron (900 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
T_{14}	PBA Hurricane XT : Reflex 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	Fomesafen (240 g/L) f.b. diuron (900 g/kg) f.b. diflufenican (500g/L)
T_{15}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg)
T_{16}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. diflufenican (500g/L)
T_{17}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
T_{18}	PBA Hurricane XT : Unsprayed control	-

*IBS- Incorporated by sowing, PSPE- post-sowing-pre-emergence, POST- post-emergence at 5-6 crop node stage, f.b.- followed by

Table 13. Trial site details, including sowing date and fertiliser.

Sowing Date	01 June, 2022
Row Spacing (cm)	25
Fertiliser (kg MAP/ha)[1]	80
Variety	GIA Metro (Metribuzin and imidazolinone dual-tolerant variety) PBA Hurricane XT
Application date for IBS herbicide treatments	01 June, 2022
Application date for PSPE herbicide treatments	01 June, 2022
Application date for POST herbicide treatments	31 August, 2022
Harvest Date	15 December, 2022
Rainfall during the growing season (June-December 2022)	234 mm
Soil texture	Silty loam
Soil pH ($CaCl_2$)	0-10 cm: 7.8 10-20 cm: 7.8

1. MAP (10.0, 22.0, 0.0, 1.5) + Zn (1.0)

Key messages

- Group 14 herbicide Reflex® did not reduce plant establishment in both IMI tolerant lentil PBA Hurricane XT and metribuzin tolerant lentil GIA Metro.
- Reflex® caused stunting at rate of 1000 mL/ha compared to 750 mL/ha applied Incorporated by sowing (IBS) in alkaline silty loam soil.
- Combination of Reflex® 750 mL/ha (IBS) followed by (fb) metribuzin 200 g/ha post sowing pre-emergent (PSPE) caused stunting in IMI tolerant lentil PBA Hurricane XT, as compared to Reflex® 750 mL/ha (IBS) alone and Reflex 750 mL/ha (IBS) fb diuron 550 g/ha (PSPE). However, no stunting was recorded in metribuzin tolerant lentil GIA Metro, even at the highest label rate of metribuzin at 380 g/ha.
- Combination of Reflex® 750 mL/ha (IBS) fb metribuzin 380 g/ha (POST) applied to GIA Metro proved as effective for broadleaf weed control as Reflex® 750 mL/ha (IBS) fb Intercept 750 mL/ha (POST) in PBA Hurricane XT.
- Combination of pre-emergent Reflex® (IBS) with post-sowing pre-emergent application of Group 5 metribuzin and diuron proved more effective for common sowthistle, prickly lettuce and Indian Hedge than herbicide strategies of relying on Reflex® alone.

Results and interpretation

Lentil growth

- There were no adverse effects of Reflex® (IBS) on PBA Hurricane XT and GIA Metro emergence in alkaline silty loam soil (Table 15). Similarly, metribuzin applied at the highest label rate at 380 g/ha either as PSPE or POST proved safe for GIA Metro and did not result in any loss of plant numbers (Table 14).
- Reflex® 750 mL/ha (IBS) did not result in stunting of GIA Metro (T_3) compared to unsprayed control (T_9) in alkaline silty loam soil (Table 15). Similarly, Reflex® 750 mL/ha (IBS) proved safe for PBA Hurricane XT (T_{11}). However, stunting was recorded with Reflex 1000® mL/ha (IBS) as compared to both Reflex® 750 mL/ha (T_{11}) and unsprayed control (T_{18}).
- Reflex® 750 mL/ha (IBS) fb metribuzin at the highest label rate of 380 g/ha applied either PSPE (T_7) or POST (T_5) did not result in stunting in GIA Metro (Table 15), due to the improved tolerance of this variety to metribuzin. However, stunting was recorded in PBA Hurricane XT, where metribuzin was applied at 200 g/ha (T_{15}). Combination of Reflex® (IBS) fb diuron (PSPE) (T_{12}) proved safer option than Reflex® fb metribuzin (T_{15}) for stunting symptoms in PBA Hurricane XT.

Lentil yield

GIA Metro grain yield

- GIA Metro sprayed with Reflex® 750 mL/ha (IBS) fb metribuzin 380 (PSPE) (T_7) or metribuzin 380 (POST) (T_5) recorded similar grain yield. Additionally, these treatments were 16% higher yielding than Reflex® 750 mL/ha (IBS) alone (T_3) in GIA Metro.
- The combined POST application of both metribuzin and Intercept together adversely affected GIA Metro yield. The plots treated with Reflex® 750 mL/ha (IBS) fb metribuzin 380 g/ha (POST) with additional application of Intercept® 750 mL/ha (POST) (T_6) recorded 15% yield penalty as compared to plots having no additional IMI application (T_5). On the other hand, Reflex® 750 mL/ha (IBS) fb metribuzin 380 g/ha (PSPE) fb Intercept 750 mL/ha (POST) (T_8) proved a better strategy and recorded 19% higher grain yield of GIA Metro compared to Reflex® 750 mL/ha (IBS) fb metribuzin 380 g/ha (POST) + Intercept® 750 mL/ha (POST) (T_6).

PBA Hurricane XT grain yield

- Reflex® 750 mL/ha (IBS) (T_{11}) and Reflex® 1000 mL/ha (IBS) (T_{10}) recorded similar grain yield, despite the higher rate causing plant stunting (Table 15). The above average late winter-spring rainfall (158 mm from August-October 2022) might have allowed better recovery from herbicide damage symptoms due to good moisture availability and longer recovery time.
- Two-way combination of non-IMI herbicides Reflex® 750 mL/ha (IBS) fb diuron 550 g/ha (PSPE) (T_{12}), and Reflex® 750 mL/ha (IBS) fb metribuzin 200 g/ha (PSPE) (T_{15}) recorded similar grain yield. Additional application of diflufenican to these two-way non-IMI herbicide strategies for weed control (T_{14} and T_{16}) did not impact grain yield.
- Additionally, three-way non-IMI herbicide combinations (T_{14} and T_{16}) recorded similar grain yield to three-way herbicide strategies having IMI-herbicide Intercept® 750 mL/ha (POST) (T_{13} and T_{17}).
- Further, two-way combinations of Reflex® 750 mL/ha (IBS) f.b. either metribuzin 200 g/ha (PSPE) (T_{15}) or diuron 550 g/ha (PSPE) (T_{12}), and three-way combination of Reflex® 750 mL/ha (IBS) f.b. metribuzin/diuron and diflufenican/Intercept® (T_{13}, T_{14}, T_{16} and T_{17}) resulted in improved grain yield of PBA Hurricane XT as compared to Reflex® 1000 mL/ha alone (T_{10}) (Table 15).

<u>GIA Metro vs PBA Hurricane XT</u>

- Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) (T_{12}) recorded the highest grain yield of lentil cultivar PBA Hurricane XT (Table 15). Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 (PSPE) (T_7) recorded highest grain yield of GIA Metro. However, it was 11% lower yielding than highest yielding PBA Hurricane XT plots (T_{12}).
- On the other hand, GIA Metro yielded equally in Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 (PSPE) (T_7) when compared with PBA Hurricane XT plots sprayed with metribuzin ($T_{15,}$ T_{16} and T_{17}) in alkaline silty loam soil.

Broadleaf weed control

- Reflex® (IBS) proved equally effective at 750 ml/ha (T_3 and T_{11}) and 1000 ml/ha (T_{10}) in controlling Indian hedge mustard (IHM), common sowthistle and prickly lettuce (Table 14). Surviving IHM and common sowthistle plants that were mainly growing in the inter-row area still could set significant number of pods.
- Reflex® 750 ml/ha (IBS) fb metribuzin 380 g/ha (PSPE) (T_7) proved more effective than Reflex® 750 ml/ha (IBS) fb diuron 550 (PSPE) (T_{12}) for controlling IHM (Table 14). However, both herbicide treatments recorded similar level of common sowthistle and prickly lettuce control.

- Applying Reflex® 750 ml/ha IBS fb metribuzin 380 g/ha either PSPE (T_7) or POST at 5-6 crop node stage (T_5) was as effective as the same two-way strategy (T_5 or T_7) with an additional application of IMI herbicide Intercept (T_6 and T_8) for broadleaf weed control in GIA Metro lentil.
- Similarly, a three-way non-IMI herbicide strategy of Reflex® 750 (IBS) fb diuron 550 (PSPE) fb diflufenican 200 (POST) (T_{14}), and Reflex® 750 (IBS) fb metribuzin 200 (PSPE) fb diflufenican 200 (POST) (T_{16}) proved equally effective in controlling IHM, common sowthistle and prickly lettuce as achieved with POST application of IMI herbicide Intercept® 750 ml/ha (POST) (T_{13} and T_{17}) instead of diflufenican 200 (POST).
- Therefore, new herbicide Reflex®, and new herbicide usage pattern of metribuzin in GIA Metro not only provided opportunity to diversify the selection pressure, also provided similar level of broadleaf weed control as achieved with strategies having IMI herbicide (Table 14, Figure 12).

Table 14. Broadleaf weed plant or pod numbers as affected by different herbicide strategies at Tooligie, 2022. Different letters within the same column indicate a significant difference (P<0.05).

Treatment (Dose in terms of commercial product (g or mL/ha)		Indian hedge mustard pods/m²	Common sowthistle pods/m²	Prickly lettuce plants/plot
T_2	GIA Metro: Metribuzin 380 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	0 [f] (0)	1.4 [b] (1.9)	0 [c] (0)
T_3	GIA Metro: Reflex® 750 mL/ha (IBS)	16.3 [b] (266.7)	5.8 [a] (34.0)	1.8 [b] (3.3)
T_5	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST)	3.5 [def] (12.3)	2.6 [b] (6.9)	0.9 [bc] (0.8)
T_6	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST) f.b. Intercept® 750 mL/ha (POST)	0 [f] (0)	0.7 [b] (0.4)	0 [c] (0)
T_7	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE)	0 [f] (0)	2.2 [b] (4.8)	0 [c] (0)
T_8	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	0 [f] (0)	0.8 [b] (0.6)	0 [c] (0)
T_9	GIA Metro: Unsprayed control	28.1 [a] (789.6)	7.8 [a] (60.4)	6.1 [a] (37.1)
T_{10}	PBA Hurricane XT : Reflex® 1000 mL/ha (IBS)	6.8 [cd] (46.2)	7.3 [a] (53.9)	0.3 [bc] (0.1)
T_{11}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS)	12.1 [bc] (146.4)	7.4 [a] (54.9)	1.1 [bc] (1.1)
T_{12}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE)	6.3 [de] (39.7)	0.9 [b] (0.9)	1.2 [bc] (1.5)
T_{13}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	0 [f] (0)	0 [b] (0)	0 [c] (0)
T_{14}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	1.9 [def] (3.6)	1.2 [b] (1.3)	0.5 [bc] (0.2)
T_{15}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE)	1.1 [ef] (1.2)	0 [b] (0)	0.3 [bc] (0.1)
T_{16}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	0.4 [f] (0.2)	0.4 [b] (0.1)	0.3 [bc] (0.1)
T_{17}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	0 [f] (0)	0 [b] (0)	0.3 [bc] (0.1)
T_{18}	PBA Hurricane XT : Unsprayed control	23.4 [a] (547.6)	6 [a] (36.0)	5.3 [a] (28.3)

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

* Figure after square-root transformation

** Figures in parentheses are original means

Table 15. Lentil establishment, growth and grain yield as affected by different herbicide strategies at Tooligie, 2022. Different letters within the same column indicate a significant difference (P<0.05).

Treatment (Dose in terms of commercial product		Crop emergence/m^2	Plant height (cm) 11 WAS	Grain yield (t/ha)	100 seed-weight (g)
T_2	GIA Metro: Metribuzin 380 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	106 ^{a}	12.5 ^{fghi}	4.58 ^{cdef}	4.86 ^{cd}
T_3	GIA Metro: Reflex® 750 mL/ha (IBS)	117 ^{a}	11.7 ^{i}	4.05 ^{fgh}	4.74 ^{cd}
T_5	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST)	107 ^{a}	12.5 ^{fghi}	4.49 ^{def}	4.76 ^{cd}
T_6	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (POST) f.b. Intercept® 750 mL/ha (POST)	124 ^{a}	12.2 ^{ghi}	3.84 ^{hi}	5.10 ^{ab}
T_7	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE)	129 ^{a}	11.8 ^{hi}	4.84 ^{bcde}	4.89 ^{abcd}
T_8	GIA Metro: Reflex® 750 mL/ha (IBS) f.b. metribuzin 380 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	105 ^{a}	12.9 ^{efghi}	4.55 ^{cdef}	5.11 ^{a}
T_9	GIA Metro: Unsprayed control	132 ^{a}	12.1 ^{ghi}	3.50 ^{i}	4.69 ^{d}
T_{10}	PBA Hurricane XT : Reflex® 1000 mL/ha (IBS)	129 ^{a}	14.1 ^{def}	4.45 ^{efg}	3.33 ^{ef}
T_{11}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS)	116 ^{a}	16.7 ^{a}	4.90 ^{abcde}	3.36 ^{ef}
T_{12}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE)	94 ^{a}	16.0 ^{abc}	5.44 ^{a}	3.38 ^{ef}
T_{13}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	114 ^{a}	14.3 ^{cde}	5.32 ^{ab}	3.42 ^{e}
T_{14}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. diuron 550 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	93 ^{a}	14.9 ^{bcd}	5.39 ^{ab}	3.39 ^{ef}
T_{15}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE)	130 ^{a}	14.1 ^{def}	5.02 ^{abcd}	3.29 ^{ef}
T_{16}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. diflufenican 200 mL/ha (POST)	117 ^{a}	13.5 ^{defgh}	5.34 ^{ab}	3.42 ^{e}
T_{17}	PBA Hurricane XT : Reflex® 750 mL/ha (IBS) f.b. metribuzin 200 g/ha (PSPE) f.b. Intercept® 750 mL/ha (POST)	113 ^{a}	13.8 ^{defg}	5.09 ^{abc}	3.19 ^{f}
T_{18}	PBA Hurricane XT : Unsprayed control	101 ^{a}	16.1 ^{ab}	3.93 ^{ghi}	3.29 ^{ef}

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

GIA Metro: Unsprayed control

GIA Metro: Reflex 750 (IBS)

GIA Metro: Reflex 750 (IBS) + metribuzin 380 (POST)

GIA Metro: Reflex 750 (IBS) + metribuzin 380 (PSPE) + Intercept 750 (POST)

PBA Hurricane XT: Unsprayed control

PBA Hurricane XT: Reflex 750 (IBS)

PBA Hurricane XT: Reflex 750 (IBS) + diuron 550 (PSPE) + Intercept 750 (POST)

Figure 12. Broadleaf weed control with Reflex and Group 5 herbicide combination in GIA Metro and PBA Hurricane XT.

LOWER EP

WATERLOGGING IN LENTIL ON LOWER EP 2022 (PADDOCK MONITORING)

Key messages

- Waterlogging of lentil crops across many of the 'traditional' lentil growing areas of Lower Eyre Peninsula severely reduced grain yields in 2022. Investigation across six paddocks found that sodicity levels were high where crop damage was at its worst.

Why do the trial?

Waterlogging was experienced by many lentil growers on Lower Eyre Peninsula (EP) in 2022, particularly those on heavier loamy soils. Patterns of waterlogging did not match topography, as apparent waterlogging damage occurred in a mosaic across the landscape, rather than just in the low-lying areas. To investigate this further, soil samples were collected across six paddocks on Lower EP between August and early October, once waterlogging damage was visually apparent. Soil and plant samples were collected from zones with good, moderate and poor growth.

The hypothesis was that the soils would have adverse properties for plant growth driven either by acidity or sodicity. Lentil is very intolerant to sodicity and boron toxicity. Excessive boron or sodic subsoil within the crop root zone can cause plant death and severely limit lentil grain yield. Sodic soils are those with a sodium adsorption ratio (SAR) greater than 15. Less than 1% exchangeable sodium percentage (ESP) on the surface and less than 5% ESP in subsoil will also affect lentil growth (GRDC GrowNotes™).

Results and Discussion:

The grey shaded numbers in Table 16 indicate where the sampled soil tested higher than the critical value for lentil. The % K of CEC is another measure of poor drainage as potassium, like sodium, is a monovalent cation, and doesn't have the ability to bind two soil molecules together as calcium (found in gypsum) does.

The areas that had experienced poor crop growth generally had higher levels of one of the measures for sodicity or potassium, except for the Cummins paddock, which was a heavier textured soil. The heavy textured soil would have slowed the ability of the soil to drain under large and frequent rainfall events that were experienced during August/September, leading to waterlogging.

Patch point soil testing of these poorly performing areas allowed for the identification of the sodicity issue, as the affected area was incredibly localised, confined to areas around 20-30m^2. Multiple samples across a zone may have diluted the sample and not been able to correctly identify the issue.

To remedy the sodicity issue gypsum application is required, with some areas requiring multiple applications over a significant timeframe. Please seek specific soils advice to assist in developing a gypsum application strategy.

Table 16. Soil and plant sampling from lentil paddocks across Lower EP August-October 2022.

Location	Crop condition	Depth (cm)	pH ($CaCl_2$)	SAR	ESP (%)	K% of CEC	Spring dry matter (t/ha)	Nodule score
Yeelanna 1	Good	0-10	7.66	2.2	1.4	3.3	3.68	2.8
	Good	10-30	7.84	1.5	1.0	2.5		
	Good	30-60	8.09	4.1	2.9	8.4		

	Medium	0-10	7.22	1.0	0.8	2.8	2.8	2.5
	Medium	10-30	7.63	1.8	1.2	2.8		
	Medium	30-60	8.08	5.1	3.6	10.5		
	Poor	0-10	7.33	7.4	6.1	26.7	0.16	-
	Poor	10-30	8.09	16.8	10.3	26.5		
	Poor	30-60	8.33	28.5	16.7	42.8		
Yeelanna 2	Good	0-10	7.53	0.6	0.4	1.1	2.56	2.2
	Good	10-30	7.78	1.5	1.0	2.5		
	Good	30-60	8.13	12.3	7.4	18.1		
	Medium	0-10	7.59	1.0	0.7	1.9	0.98	2.6
	Medium	10-30	7.81	1.8	1.1	2.5		
	Medium	30-60	8.03	7.2	4.4	10.8		
	Poor	0-10	7.11	2.6	2.2	9.5	0.35	-
	Poor	10-30	7.62	3.6	2.2	5.2		
	Poor	30-60	8.06	8.0	4.9	11.9		
Cummins	Good	0-10	7.52	0.6	0.4	1.4	3.29	2.4
	Good	10-30	7.7	3.1	2.1	6.1		
	Good	30-60	8.07	13.2	7.5	16.7		
	Medium	0-10	6.4	0.9	0.9	5.0	1.92	1.2
	Medium	10-30	7.19	2.6	2.0	6.9		
	Medium	30-60	7.79	5.0	3.1	7.1		
	Poor	0-10	7.5	0.5	0.4	1.3	0	-
	Poor	10-30	7.74	1.6	1.1	3.3		
	Poor	30-60	7.82	4.8	3.5	11.6		
Karkoo	Good	0-10	7.51	0.4	0.3	1.3	2.40	1.50
	Good	10-30	7.71	0.9	0.6	1.8		
	Good	30-60	7.85	2.6	1.9	5.7		
	Medium	0-10	7.15	0.7	0.8	5.3	2.41	0.8
	Medium	10-30	7.76	2.6	1.7	4.6		
	Medium	30-60	7.99	9.2	6.3	17.9		
	Poor	0-10	6.54	3.3	4.2	45.1	0	0
	Poor	10-30	8.04	20.5	12.0	28.5		
	Poor	30-60	8.24	31.6	17.7	42.2		
Tumby Bay	Good	0-10	7.56	1.7	1.1	3.2	3.12	4.9
	Good	10-30	8.06	11.7	6.8	15.5		
	Good	30-60	8.41	32.8	18.0	42.9		
	Medium	0-10	7.09	0.8	0.8	4.2	2.19	5.9
	Medium	10-30	7.85	4.1	2.7	6.9		
	Medium	30-60	-	-	-	-		
	Poor	0-10	7.18	3.2	2.8	14.0	0	
	Poor	10-30	8.24	32.6	18.2	44.5		
	Poor	30-60	8.51	50.5	24.6	51.2		

Ungarra	Good	0-10	7.33	0.7	0.7	29.6	2.25	5.1
	Good	10-30	7.70	8.8	5.6	16.3		
	Good	30-60	7.60	11.2	7.3	34.9		
	Poor	0-10	6.14	6.9	7.9	62.8	0	1.4
	Poor	10-30	8.17	28.7	15.5	36.0		
	Poor	30-60	8.51	47.4	23.2	49.1		

MT HILL

SITE SUMMARY

This site was selected as a sandy soil, slightly acidic site, that has traditionally only grown lupins and canola as break crops. Higher value pulse crops such as lentil and faba bean have the potential to add diversity to the rotation, providing alternative control options for ryegrass and potentially adding profitability across the rotation.

Rainfall

Av. Annual: 396 mm

2022: Total: 553 mm

Av. GSR: 315 mm

2022 GSR: 364 mm

Table 17. Soil characterisation for Mt Hill, 2022.

	pH 1:5 (H20)	pH CaCl2	Organic Carbon (%)	MIR - Aus Soil Texture	Nitrate - N	Ammonium - N	Colwell P (mg/kg)	PBI + Col P
0-10	7.09	6.61	1.06	Sand	7.7	<1	24	17
10-30	8.13	7.28		Sand	4.3	<1		
30-60	9.14	8.28		Sandy clay	3.1	<1		
60-100	9.62	8.51		Clay loam	6	<1		

PULSE LEGACY

Comparison differing broadleaf 'break crops' on sandy soil Lower EP.

This trial was able to demonstrate that each of the crops trialled were able to be successfully grown (achieve a profitable gross margin) on this soil type (except for the brown manured vetch crop). The high yielding faba bean had the highest gross margin. The brown manured vetch treatment had higher levels of mineral N (to 60cm) at the start of the 2023 growing season.

Table 18. Crop grain and biomass yield (t/ha), and gross margin of break crops trialled Mt Hill 2022.

	Grain Yield	Total Biomass (inc. grain) at Maturity	Gross Margin**	Min N March 2023
Crop type	**(t/ha)**	**(t/ha)**	**($/ha)**	**kg/ha**
Canola	2.68	11.38	913	55.9
Faba Beans	4.44	13.12	1,894	44.6
Lentils	2.26	10.09	1,000	30.4
Lupins	2.94	10.01	783	39.6
Vetch	2.11	11.21	886	45.0
VetchBM*	0	6.59	-381	71.1
lsd	0.47	1.47		

*BM = Brown manured (sprayed off early Oct.)

**variable costs – 2022 Farm Gross Margin and Enterprise Planning Guide.

LENTIL VARIETY TRIAL

Authors: Andrew Ware, **EP AG Research**

Aim: To determine if there are any lentil varietal differences from growing on sandy soil.

Key messages:

- The variety PBA Highland XT yielded lower than the other varieties trialled at this site in 2022.
- GIA Lightning, a new variety with improved adaptation to lighter soil types, yielded similar to GIA Thunder and PBA Hurricane XT at Mt Hill in 2022.

Table 19. Grain yield of lentil varieties at Mt Hill, 2022. Different letters within the same column indicate a significant difference (P<0.05).

Variety	Grain Yield (t/ha)
PBA Highland XT	2.97 b
PBA Hurricane XT	3.54 a
GIA Lightning	3.58 a
GIA Thunder	3.62 a
lsd	0.35

NUTRITION, INCLUDING TRACE ELEMENTS ON PULSE CROPS GROWN ON SANDY SOILS.

Authors: Andrew Ware, **EP AG Research**,

Background: Following consultation with the AIR EP medium rainfall committee, questions were asked regarding if pulses being grown on sandy soils would require additional nutrition to achieve maximum potential.

Treatments:

Seed nutrition (applied to seed): N 250g/t, P 350g/t, K 500g/t, Zn 30g/t, S 2gm/t, Mg 0.5g/t, Fe 4gm/t, Mn 0.5g/t, Cu - 0.3g/t, Mo 0.02g/t, B 0.2g/t, Co 0.01g/t

K (applied IBS): 25kg/ha Potassium

Treatment 1 (T1) (applied foliar): Zn - 120gm/ha, Mn - 150 gm/ha, Cu - 45 gm/ha, B - 200gm/ha, Mo - 2.6 gm/ha, Ca - 50gm/ha

Treatment 2 (T2) (applied foliar): B - 200gm/ha, Mo - 2.6 gm/ha, Ca - 50gm/ha

Treatment 3 (T3) (applied foliar): Zn - 120gm/ha, Mn - 150 gm/ha, Cu - 45 gm/ha, Ca - 50gm/ha

Treatment 4 (T4) (applied foliar): Zn - 120gm/ha, Mn - 150 gm/ha, Cu - 45 gm/ha, B - 200gm/ha, Mo - 2.6 gm/ha

Treatment 5 (T5) (broadcast post-em): 13kg/ha N, 10 kg/ha K, 7kg/ha S, 3 kg/ha Ca, 2.5 kg/ha Si, 1.3kg/ha Fe, 0.8 kg/ha Mg, 366 gm/ha Mn, 68 gm/ha Zn, 35gm/ha Cu, 14 gm/ha B, 0.5 g/ha Mo

Key messages:

- No significant grain yield improvement was achieved through the application of any of the additional nutrition treatments applied.

Table 20. Tissue test results, collected prior to nutrition application

Sample Name	Nitrate - N	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium
	mg/kg	%	%	%	%	%	%
Mt. Hill lentils	194	5.78	0.53	2.87	0.837	0.3	0.094
M. Hill beans	<30	5.41	0.42	2.42	0.637	0.26	0.54

Sample Name	Sulfur	Boron	Copper	Zinc	Manganese	Iron	Aluminium
	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Mt. Hill lentils	0.28	24	5.2	56	83	190	170
M. Hill beans	0.29	18	4.6	36	49	130	79

Sample Name	Molybdenum	Chloride
	mg/kg	%
Mt. Hill lentils	0.22	0.62
M. Hill beans	0.12	0.93

Table 21. Grain yield (t/ha) of lentil treated with various nutrition applications. ns = not significant (P>0.05).

Treatment	Grain Yield (t/ha)
PBA Hurricane XT	3.21
PBA Hurricane XT+ seed nutrition	3.02
PBA Hurricane XT+ K	3.31
PBA Hurricane XT_T1	3.20
PBA Hurricane XT_T2	3.06
PBA Hurricane XT_T3	3.20
PBA Hurricane XT_T4	3.09
PBA Hurricane XT_T5	3.20
lsd	ns

Table 22. Grain yield (t/ha) of faba bean treated with various nutrition applications. ns = not significant (P>0.05).

Treatment	Grain yield (t/ha)
PBA Samira	5.01
PBA Samira_T1	5.09
PBA Samira_T2	4.71
PBA Samira_T3	4.86
PBA Samira_T4	4.75
PBA Samira_T5	4.96
PBA Samira+ K	5.01
lsd	ns

YELTUKKA

SITE SUMMARY

The Yeltukka site is a sand over clay soil, located between Cummins and Kappine. This site was sown to various pulse trials in 2021 and oversown to wheat in 2022.

Rainfall

Av. Annual: 424 mm | 2021: Total: 421 mm | 2022: Total: 539 mm

Av. GSR: 324 mm | 2021 GSR: 377 mm | 2022 GSR: 406 mm

Table 23. Pre-season soil tests Yeltukka (Collected April 2021) .

	pH 1:5 (H20)	pH CaCl2	Organic Carbon (%)	MIR - Aus Soil Texture	Nitrate - N	Ammonium - N	Colwell P (mg/kg)	PBI + Col P
0-10	7.33	6.92	1.42	Sand	15	3.2	23	25.0
10-30	8.40	7.70		Clay	3.8	<1		
30-60	9.18	8.14		Clay loam	2.9	<1		
60-100	9.56	8.34		Clay loam	1.7	<1		

PULSE LEGACY TRIAL

Similar to the pulse legacy trial established at Mt Hill in 2022, this trial looked at the performance of various break crops on subsequent wheat yield.

Table 24. Biomass and grain yield (t/ha) of break crops, at Yeltukka 2021. Different letters within the same column indicate a significant difference (P<0.05).

Crop	October Biomass (t/ha)		Harvest Biomass (t/ha)		Grain Yield (t/ha)	
Canola	7.14	cd	6.11	c	1.93	b
Faba Bean	2.41	ab	3.01	abc	1.80	b
Lentil	2.52	ab	2.68	a	1.53	b
Lupin	4.10	bc	4.32	abc	2.08	b
Vetch	3.90	ab	2.87	ab	1.24	ab
VetchBM	1.46	a	2.36	a	0.00	a

Table 25. Mineral Nitrogen (measured in April) and wheat grain yield (t/ha) in 2022, in response to break crop gown in 2021. Different letters within the same column indicate a significant difference (P<0.05).

2021 Crop	Min N (kg/ha)		Grain yield (t/ha)	
Canola	85.1	a	5.90	b
Faba Bean	40.1	b	5.92	b
Lentil	44.3	b	5.64	b
Lupin	51.1	b	6.24	a
Vetch	36.7	b	5.90	b
VetchBM	39.4	b	6.22	ab
lsd	28.7		0.33	

Wheat yield was better following the pulse crop with the largest biomass (lupin) and brown manured vetch. Indicating the best adapted pulse crops have an impact on subsequent wheat yield and while lower yielding, high value crops (such as lentil) may produce a higher gross margin in the year of planting, this may need to be evaluated including the following wheat crop.

INOCULANT TRIALS

In 2021 both lentil and faba bean trials were established looking at peat vs granular inoculant products, at 1x and 2x label rates, applied dry (3 days prior to the break of the season) and into wet soil. The granular product showed a higher lentil grain yield, but no differences were recorded in the faba bean trial.

In 2022 wheat was sown over these plots.

Key Messages:

- Where there were significant differences created by 2021 treatment, there were differences in 2022 wheat yield.

Table 26. Wheat grain yield (2022) and lentil grain yield (2021) treated with granular vs peat inoculant.

	Wheat Grain Yield (t/ha)	Lentil Grain Yield (t/ha)
Granular	6.19	1.06
Peat	6.05	0.75
lsd (0.05)	0.14	0.22

Table 27. Wheat yield (2022) and lentil grain yield (2021) treated with granular vs peat inoculant. ns = not significant (P>0.05).

	Wheat Grain Yield (t/ha)	Bean Grain Yield (t/ha)
Granular	6.22	1.98
Peat	6.24	1.91
lsd (0.05)	ns	ns

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