SA Grain Legume Development and Extension Project

UOA2105-013RTX

2022 Field Trial Results

GRDC Grains Research & Development Corporation
The University of Adelaide
Government of South Australia, Department of Primary Industries and Regions
SARDI South Australian Research and Development Institute
Frontier Farming Systems
FAR
EPAG Research
Trengove Consulting
agcommunicators.
Mallee Sustainable Farming
UNFS Upper North Farming Systems
Hart — SA's premier cropping field site
AIR EP Ag Innovation & Research Eyre Peninsula
Mid North High Rainfall Zone

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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RIVERTON

SITE SUMMARY

The Riverton field trial site was situated on a brown to light brown clay loam soil. The soil was slightly alkaline with high levels of potassium and low salinity (Table 1).

Riverton received over double the annual rainfall for January but well-below average rainfall from February to April (Figure 1). Average rainfall in May and June provided adequate soil moisture for seed germination and even establishment across the site. Below average rainfall in July slowed the development of foliar disease infection in lentil and faba bean. However, above average spring rainfall combined with large crop canopies favoured the rapid development of botrytis grey mould in lentil and chocolate spot in faba bean. These foliar diseases are favoured by mild temperatures and high humidity over an extended period, with conditions maintained with frequent rainfall events.

Overnight temperatures reached below zero degrees in July on three occasions and on two occasions in September, with the lowest temperature recorded at -2.8°C in early September (Figure 2). High frequency of rainfall events in spring reduced the number of frost events occurring during reproductive growth stages.

Site average grain yield was 1.05 t/ha for lentil (0.08-3.58 t/ha range) and 3.26 t/ha for faba bean (2.19-4.80 t/ha range).

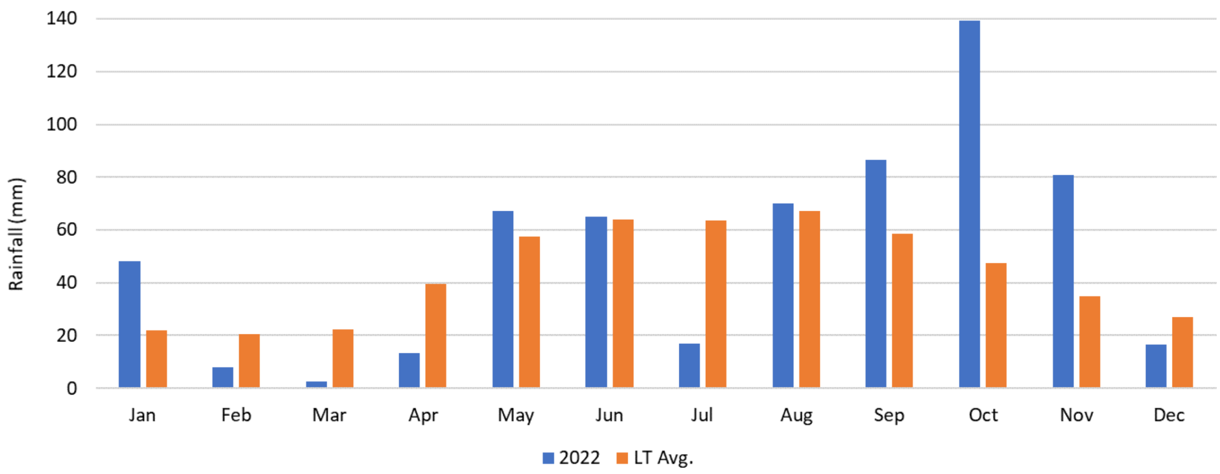


Figure 1. Monthly rainfall recorded at the Riverton field trial site in 2022 compared to the long-term average rainfall from the Riverton BOM weather station (#23314).

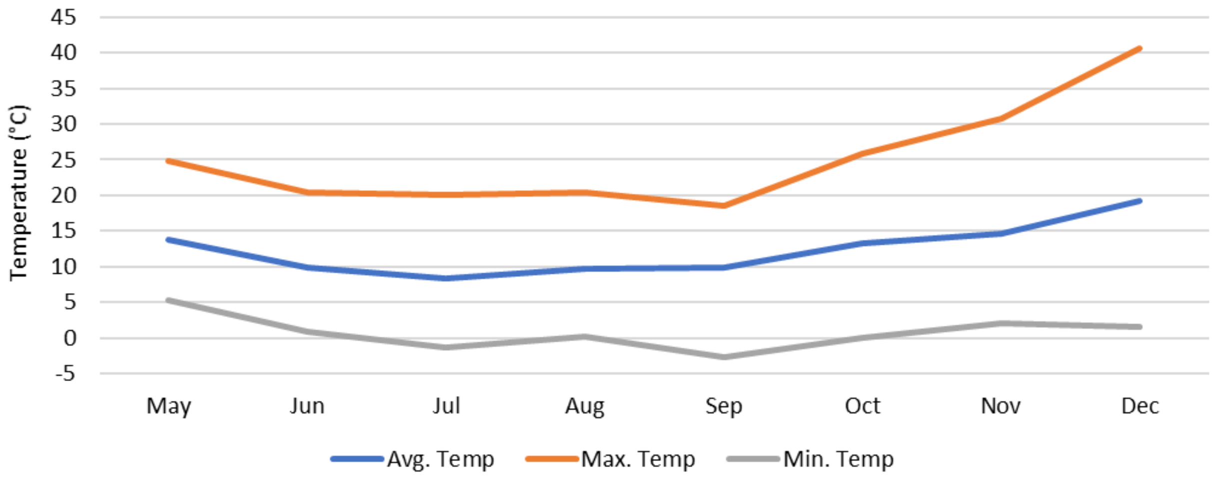


Figure 2. Average, maximum and minimum temperature (°C) recorded during the growing season at the Riverton field trial site in 2022.

Table 1. Soil profile characterisation (brown to light brown clay loam soil) for the Riverton field 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_2O)
0-10	1.0	14.0	37	731	8.4	1.40	0.245	7.3	7.8
10-20	1.0	7.5	10	405	5.5	0.77	0.235	7.4	8.1
20-50	2.0	6.5	4	276	9.8	0.48	0.223	7.1	8.0
50-80	1.0	6.7	2	251	5.4	0.29	0.197	7.6	9.1
80-110	1.0	4.2	<2	262	11.1	0.18	0.237	7.5	9.2

Depth (cm)	Cu	Fe	Mn (mg/kg)	Al	B	Exc Ca	Exc Mg	Exc K (meq/100g)	Exc Na	Exc Al
0-10				<0.02	1.40	17.40	3.58	2.07	0.23	0.02
10-20				<0.02	1.41	20.14	4.59	1.25	0.37	0.02
20-50				<0.02	1.68	25.99	6.59	0.90	0.83	0.04
50-80				<0.02	2.12	18.89	7.81	0.78	1.66	0.05
80-110				<0.02	4.37	17.05	9.99	0.93	3.11	0.05

LENTIL DISEASE MANAGEMENT

*Sarah Day, Sara Blake, Penny Roberts, **SARDI***

Aim: This trial aims to assess (1) yield loss from disease infection, (2) economics of disease management control strategies, and (3) disease infection under different crop canopies.

Treatments:

Varieties: PBA Bolt, PBA Highland XT, PBA Jumbo2

Sowing density: 120 and 150 plants/m^2

Fungicide treatments: See Table 2.

Each treatment consisted of 3 key fungicide application stages; prior to canopy closure, post-canopy closure but prior to podding applied ahead of rain, and at early podding. All fungicides are applied ahead of a rain event where > 5 mm is forecast.

Table 2. Five fungicide treatments applied lentil at Riverton, 2022.

No.	Fungicide (rate)		
	Pre-CC	Post-CC, pre-podding	At early podding
T1	Untreated control		
T2	Carbendazim (500)	Carbendazim (500)	Chlorothalonil (2000)
T3	Veritas (1000)	Veritas (1000)	Veritas (1000)
T4	Aviator Xpro (600)	Carbendazim (500)	Chlorothalonil (2000)
T5	Miravis Star (750)	Carbendazim (500)	Chlorothalonil (2000)

Key: CC = canopy closure

Table 3. Fungicide product details including rate, active ingredient, and concentration, as used at Riverton 2022.

Product	Active Ingredient (concentration)	Rate (mL or g/ha)
Aviator® Xpro®	Prothioconazole (150 g/L) + Bixafen (75 g/L)	600
Carbendazim	Carbendazim (500 g/L)	500
Chlorothalonil	Chlorothalonil (720 g/L)	2000
Miravis® Star	Fludioxonil (150 g/L) + Pydiflumetofen (100 g/L)	750
Veritas®	Tebuconazole (200 g/L) + Azoxystrobin (120 g/L)	1000

Table 4. Agronomic trial details, Riverton 2022.

Trial design	RCBD
Replicates	3
Sowing date	27/05/2022
Plant density	As per treatments
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Fungicide Application dates	*Pre-canopy closure:* 16/08/2022 *Post-canopy closure:* 05/09/2022 *Early podding:* Not applied, due to no ascochyta blight infection
Harvest date	06/01/2022

Key messages

- The first step to good disease management is choosing a resistant variety.
- Newer fungicides with dual actives can provide superior disease control of BGM of lentil and may preserve yields in a high disease situation.

Botrytis grey mould (BGM) is favoured by mild temperatures and high humidity. Spring conditions in 2022 were favourable for BGM infection in lentil and the disease was frequently reported and observed as aggressive in South Australia. Due to the nature of the season and the high disease pressure, fungicide strategies controlled the disease at a similar level (Fungicide P=0.13, Fungicide x Variety P=0.519). Average disease infection was 26% across all varieties, regardless of resistance rating. Variety selection with disease resistance was critical in reducing disease infection (P<0.001) and grain yield loss (P=0.033) (Figure 3). PBA Jumbo2, rated RMR for BGM, was the highest yielding variety with 1.37 t/ha. PBA Bolt, which is susceptible to BGM infection, had a 38% decrease in grain yield, compared to PBA Jumbo2.

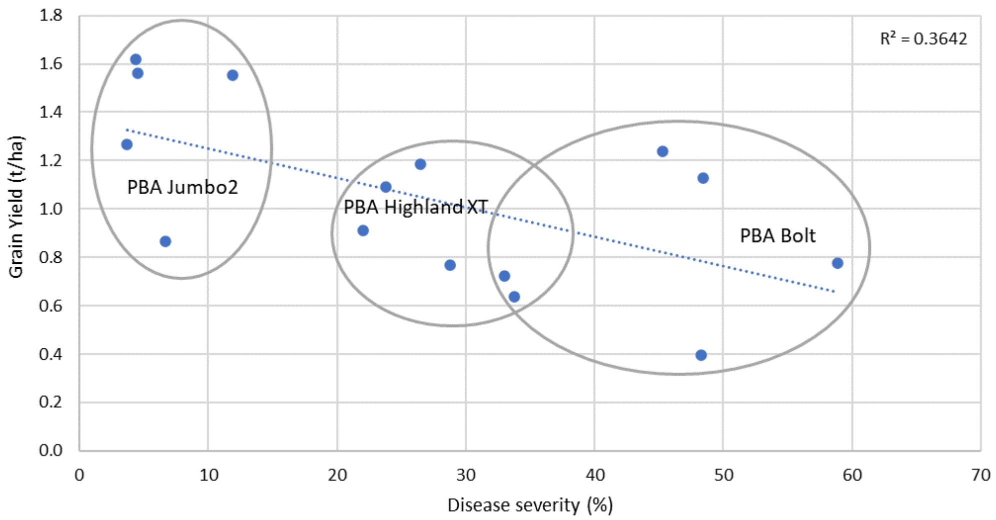


Figure 3. Botrytis grey mould severity (0-100% plot disease) and grain yield (t/ha) for PBA Jumbo2, PBA Highland XT and PBA Bolt at Riverton, 2022.

Figure 4. BGM infected lentil plots at Riverton under high disease pressure, despite fungicide applications to control BGM applied prior to and post-canopy closure, at Riverton 2022.

FABA BEAN DISEASE MANAGEMENT

*Sarah Day, Sara Blake, Penny Roberts, **SARDI***

Aim: This trial aims to assess (1) yield loss from disease infection, (2) economics of disease management control strategies, and (3) disease infection under different crop canopies.

Treatments:

Varieties: PBA Bendoc, PBA Amberley

Sowing densities: 24 and 30 plants/m^2

Fungicide treatments: See Table 5.

All fungicides are applied ahead of a rain event where > 5 mm is forecast.

Table 5. Five fungicide treatments applied to faba bean at Riverton, 2022.

Treatment	Details
T1	Untreated control
T2	Tebuconazole at 6 weeks post sowing f/b Carbendazim prior to canopy closure f/b Carbendazim post-canopy closure
T3	Veritas prior to canopy closure f/b Veritas post-canopy closure
T4	Aviator Xpro prior to canopy closure f/b Aviator Xpro post-canopy closure
T5	MiravisStar prior to canopy closure f/b MiravisStar post-canopy closure

Key: f/b = followed by

Table 6. Fungicide product details including rate, active ingredient, and concentration, as used at Riverton 2022.

Product	Active Ingedient (concentration)	Rate (mL or g/ha)
Aviator® Xpro®	Prothioconazole (150 g/L) + Bixafen (75 g/L)	600
Carbendazim	Carbendazim (500 g/L)	500
Miravis® Star	Fludioxonil (150 g/L) + Pydiflumetofen (100 g/L)	750
Tebuconazole	Tebuconazole (430 g/L)	350
Veritas®	Tebuconazole (200 g/L) + Azoxystrobin (120 g/L)	1000

Table 7. Agronomic trial details at Riverton, 2022.

Trial design	RCBD
Replicates	3
Sowing date	27/05/2022
Plant density	As per treatments
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
	Tebuconazole: 07/07/2022 *Pre-canopy closure:* 16/08/2022 *Post-canopy closure:* 05/09/2022
Harvest date	20/12/2022

Key messages

- The first step to good disease management is choosing a resistant variety.
- Newer fungicides with dual actives can provide superior disease control of CS of faba bean and may preserve yields in a high disease situation.

Results and Discussion:

Chocolate spot (CS) is promoted by mild temperatures and high humidity persisting over 4-5 days during flowering and after canopy closure. Spring conditions in 2022 were favourable for CS infection in faba bean and the disease was frequently reported across South Australia as aggressive, blackening and rapidly defoliating plants. A moderate level of chocolate spot developed in faba beans at Riverton and PBA Amberley recorded half the disease severity compared to PBA Bendoc in the control (Figure 5), highlighting the important of variety resistance in disease management. Miravis Star provided the greatest control of CS from the fungicides applied (Figure 5-Figure 7) however when looking at grain yield, the combination of variety and fungicide were critical and the application of both Miravis Star and Aviator resulted in higher grain yield in PBA Amberly compared to all other treatments (Figure 6). Grain yield was influenced by both variety resistance and fungicide strategy (Figure 6).

Harvested grain samples were assessed for disease seed staining. Despite the high levels of foliar disease in 2022, disease seed staining was relatively low and key outcomes remain unclear and need further investigation (Figure 8).

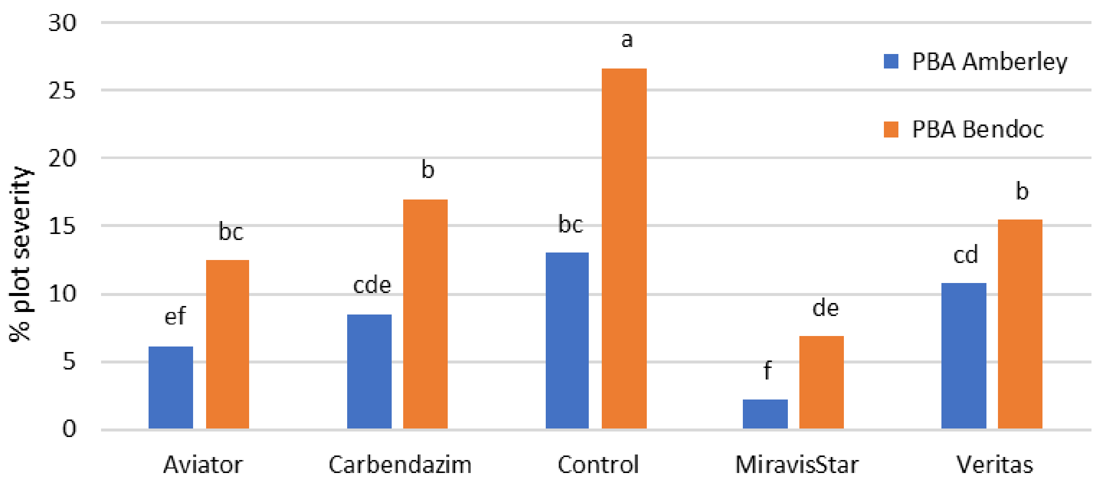


Figure 5. Chocolate spot severity (0-100% plot severity) on PBA Amberley and PBA Bendoc rated on 19 October at Riverton, 2022. Bars labelled with the same letters are not significantly different (P=0.041).

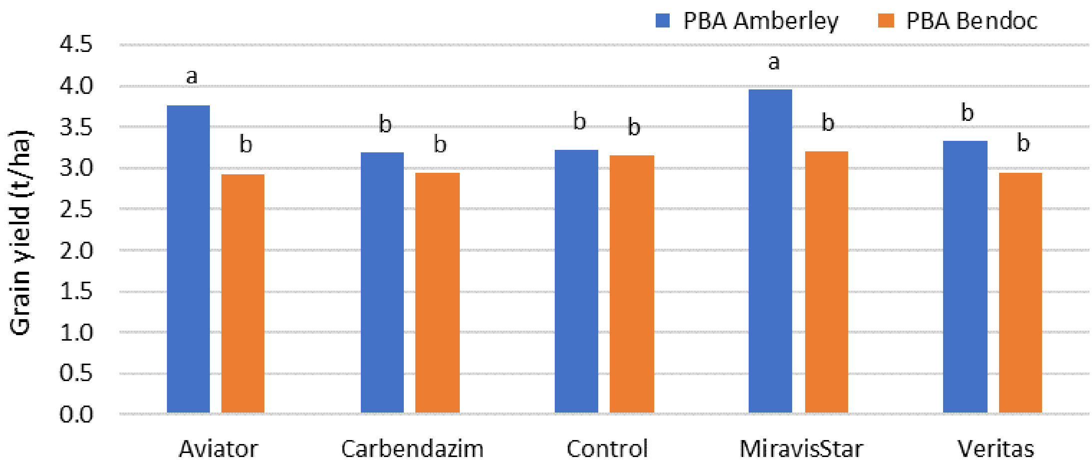


Figure 6. Grain yield (t/ha) of PBA Amberly and PBA Bendoc when treated with fungicide strategies to control chocolate spot at Riverton, 2022. Bars labelled with the same letters are not significantly different (P=0.032).

Figure 7. Disease levels in the lower and upper canopy of faba bean kept to a minimum using a fungicide strategy with MiravisStar compared to the untreated control, Riverton 2022.

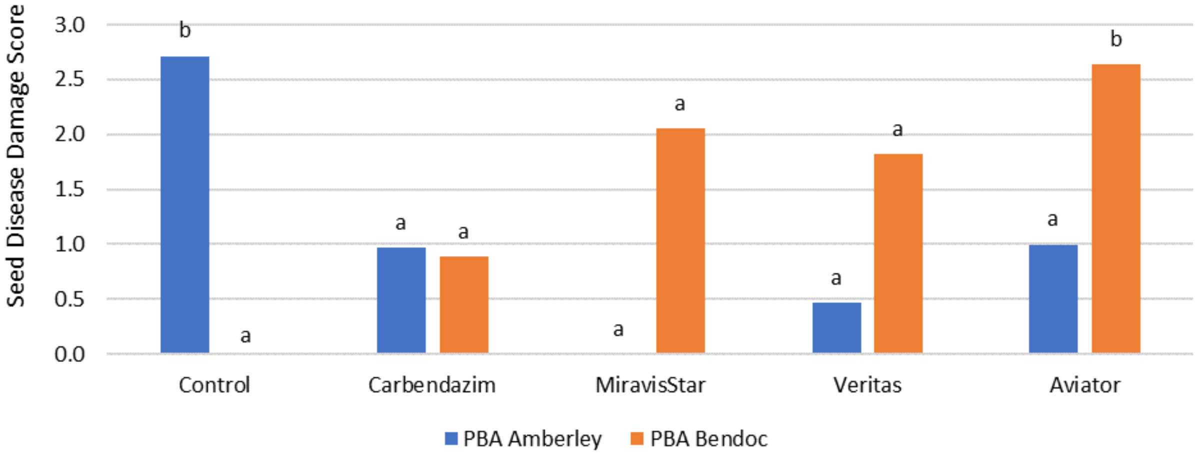


Figure 8. Seed disease damage score (1-5) of PBA Amberly and PBA Bendoc when treated with fungicide strategies to control chocolate spot at Riverton, 2022. Bars labelled with the same letters are not significantly different (P=0.019). Seed disease damage score: 1 = pin prick, 2 = <5%, 3 = 5%, 4 = 20%, 5 = >20%.

MELROSE

SITE SUMMARY

The Melrose field trial site was situated on a brown-green, loamy clay loam soil. The soil had high levels of potassium, low salinity and had a slightly acidic topsoil shifting to slightly alkaline as you move down the soil profile (Table 8).

Melrose received more than double the annual rainfall for January but well-below average rainfall from February to April (Figure 9). Average rainfall in May provided adequate soil moisture for seed germination and even establishment across the site. Below average rainfall in June and July slowed vegetative crop growth and the development of foliar diseases. Above average spring rainfall coincided with pulses reaching reproductive growth stages, boosting the grain yield potential.

Overnight temperatures reached below zero degrees frequently throughout winter and early spring, with 21 frost events occurring at Melrose during the 2023 growing season (Figure 10). Low rainfall in July coincided with the largest number of frost events, with 12 events occurring in July and the coldest night getting as low as -4°C. High frequency of rainfall events in spring reduced the number of frost events occurring during reproductive growth stages.

Site average grain yield was 2.86 t/ha for field pea and 3.50 t/ha for lentil.

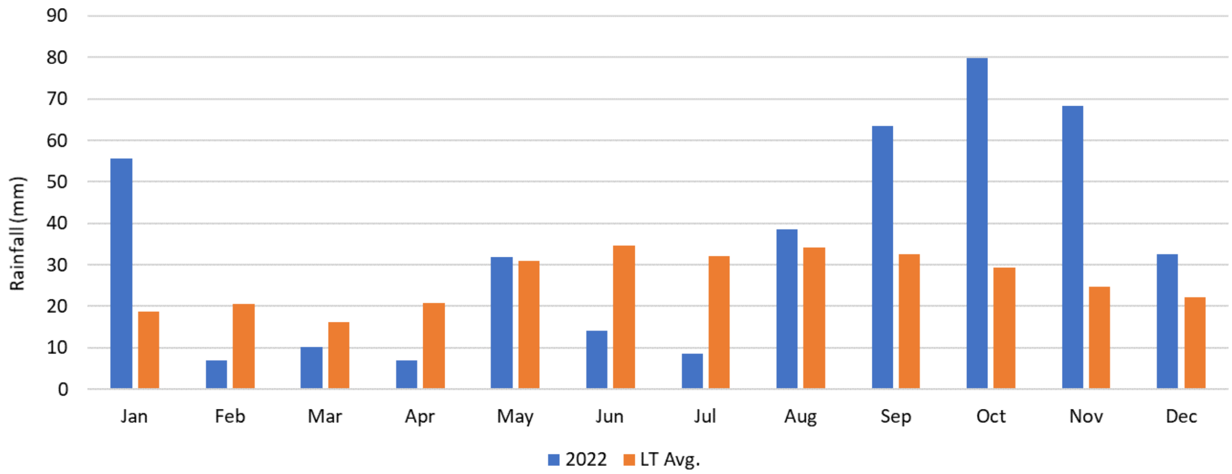


Figure 9. Monthly rainfall recorded at the Melrose field trial site in 2022 compared to the long-term average from the Booleroo Whim (Callum Brae) BOM weather station (#19116).

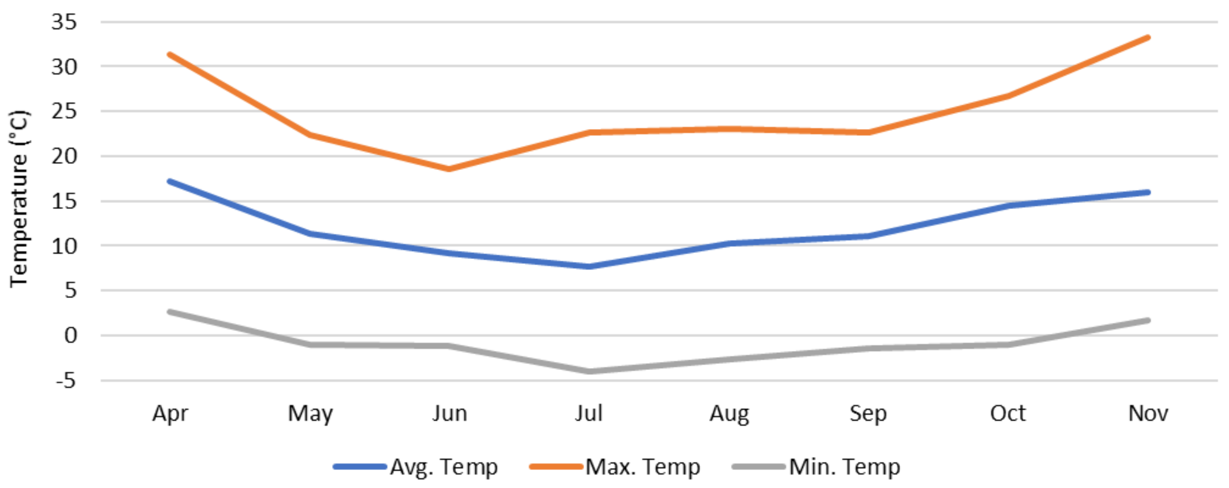


Figure 10. Average, maximum and minimum temperature (°C) recorded during the growing season at the Melrose field trial site in 2022.

Table 8. Soil profile characterisation (brown-green loamy clay) for the Melrose field 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	2	42	555	3.8	0.39	0.066	6.1	6.6
10-30	1	1	27	472	3.3	0.31	0.051	7.0	8.0
30-60	<1	2	26	340	10.5	0.27	0.114	7.0	7.9
60-90	1	3	28	355	33.8	0.34	0.213	7.5	8.1
90-120	2	3	24	306	17.8	0.20	0.231	7.4	8.2

Depth (cm)	Cu	Fe	Mn (mg/kg)	Zn	B	Exc Ca	Exc Mg	Exc K (meq/100g)	Exc Na	Exc Al
0-10	1.38	13.6	18.72	0.55	0.68	6.49	1.51	0.89	0.11	0.03
10-30	1.36	6.5	13.47	0.46	0.80	7.64	2.36	0.71	0.14	0.04
30-60	1.13	9.8	9.42	0.32	0.72	7.81	2.62	0.49	0.26	0.04
60-90	1.08	9.0	9.90	0.52	0.51	7.48	2.73	0.47	0.41	0.04
90-120	0.89	7.5	7.59	0.41	0.47	7.38	2.92	0.43	0.46	0.05

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:

Biomass was measured as each variety reached 50% flowering by cutting the 4 middle rows by 1m for each plot and drying samples before recording the weight of dry matter. 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

Sowing densities: See Table 9.

Table 9.Lentil target density (plants/m²) and seeding rate (kg/ha) sown at Melrose, 2022.

Seeding rate	Plants/m²	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 10. Agronomic trial details at Melrose, 2022.

Trial design	RCBD
Replicates	3
Sowing date	20/05/2022
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.
- Reducing your seeding rate did not reduce biomass or grain yield potential.

Results and Discussion:

The later flowering varieties, GIA Lightning and CIPAL2122, had the highest biomass at mid flowering, more than double of the early to mid-flowering varieties (Figure 11). The early to mid-flowering varieties had low and similar levels of dry matter production at mid flowering (0.53 – 1.06 DM t/ha), with only PBA Highland XT producing less biomass than PBA Jumbo2. Despite these differences observed in flowering and biomass, there were no differences in grain yield between lentil varieties near Melrose, 2022 (Figure 11). This is likely due to the high levels of spring rainfall aiding reproductive development. However, the interaction between lentil biomass and grain production required further research.

Reducing the seeding rate of lentil from the recommended 120 plants/m^2 did not affect biomass dry matter at mid flowering (P>0.05) or grain yield (P>0.05). 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).

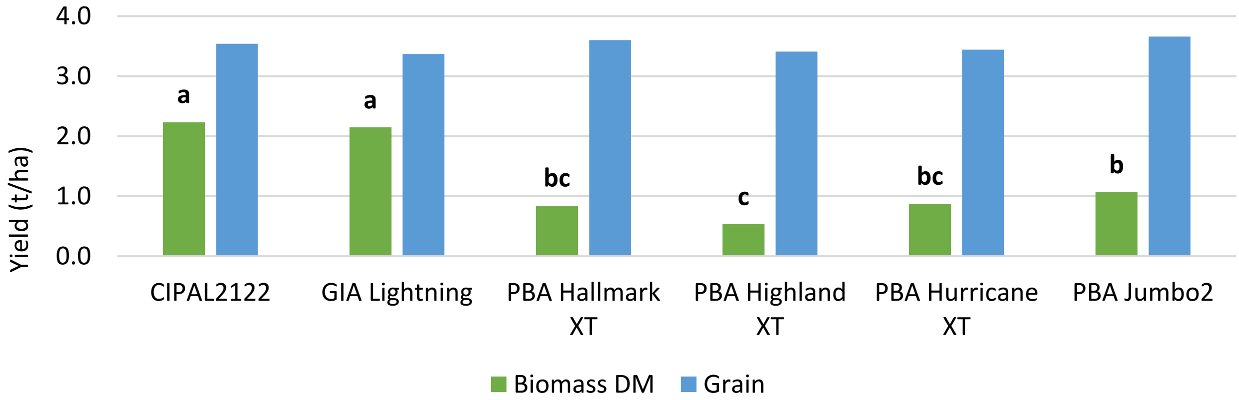


Figure 11. Crop biomass measured at 50% flowering (DM t/ha) and grain yield (t/ha) of six lentil varieties averaged for the different sowing densities sown near Melrose, 2022. For each biomass and grain yield, columns labelled with the same letter are not significantly different (P<0.05). Columns within the same series with no labels indicates no significant difference (P>0.05).

Table 11. Lentil variety flowering characteristics and the date biomass dry matter cuts were taken as each variety reached 50% flowering near Melrose, 2022. Source: (GRDC 2022)

Variety	Flowering characteristic	Biomass dry matter cut date (50% flowering)
CIPAL2122	-	14 September
GIA Lightning	Mid-Late	14 September
PBA Hallmark XT	Mid	8 September
PBA Highland XT	Early	2 September
PBA Hurricane XT	Mid	14 September
PBA Jumbo2	Mid	14 September

FIELD PEA VARIETY X DENSITY

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

Aim: This trial aims to assess (1) field pea variety production performance in the low rainfall zone, and (2) field pea production and weed suppression when field pea are sown at different seeding densities.

Treatments:

Varieties: PBA Butler, PBA Taylor, PBA Percy, GIA Ourstar, GIA Kastar, GIA breeding line (pre-release line)

Sowing densities: See Table 12.

Table 12. Field pea target plant density (plants/m^2) and seeding rate (kg/ha) sown at Melrose, 2022.

Seeding rate	Plants/m^2	kg/ha*
High	60	130-160
Recommended#	50	110-130
Low	40	80-110

*A range is given for seeding rate per hectare as this will vary depending on seed size and seed weight.
#Average of the recommended plant density for conventional (45 plants/m^2) and semi-leafless (55 plants/m^2) field pea varieties.

Table 13. Agronomic trial details at Melrose, 2022.

Trial design	RCBD
Replicates	3
Sowing date	20/05/2022
Plant density	As per treatments
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	17/11/2022

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.
- Reducing or increasing field pea seeding rate did not affect biomass or grain yield potential.

Results and Discussion:

There were differences in biomass production measured at 50% flowering (Figure 12), as field pea varieties vary in phenology and flowering time (Table 14). The two earliest flowering varieties, PBA Percy and GIA Ourstar, had the lowest crop biomass at flowering (1.43 and 1.34 t/ha, respectively). The mid to late flowering variety, PBA Butler, had the highest production of biomass at flowering (4.4 DM t/ha). Despite this difference in biomass production between varieties, there were no differences in grain yield production at Melrose 2022 ($P>0.05$) (Figure 12). Average field pea grain yield was 2.89 t/ha for the site.

Changing the field pea seeding rate to higher or lower than the recommended seeding rate did not impact crop biomass measured at mid-flowering ($P>0.05$) or grain yield ($P>0.05$).

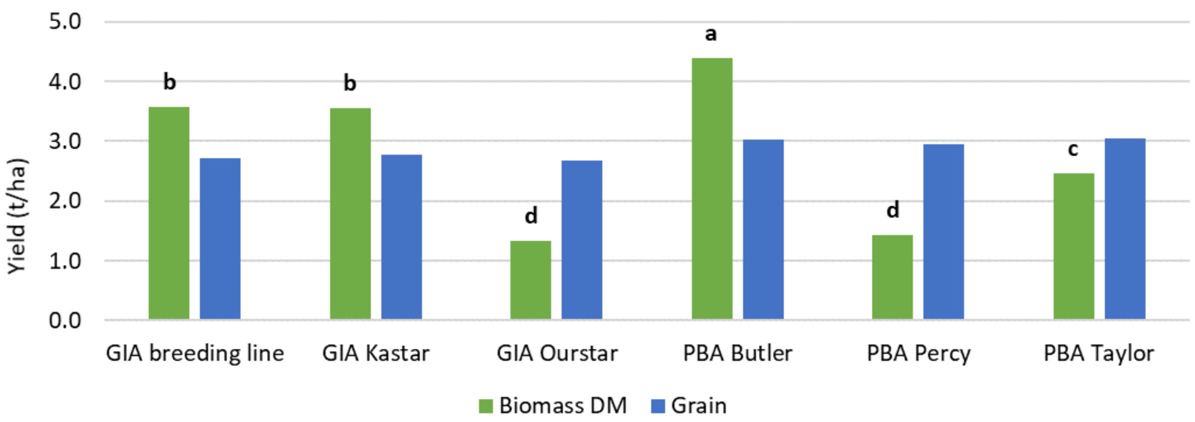


Figure 12. Crop biomass measured at 50% flowering (DM t/ha) and grain yield (t/ha) of six field pea varieties averaged for the different sowing densities sown near Melrose, 2022. For each biomass and grain yield, columns labelled with the same letter are not significantly different (P<0.05). Columns within the same series with no labels indicates no significant difference between varieties (P>0.05).

Table 14. Field pea variety flowering characteristics and the date biomass dry matter cuts were taken as each variety reached 50% flowering near Melrose, 2022. Source: (GRDC 2022)

Variety	Flowering characteristic	Biomass dry matter cute date (50% flowering)
GIA breeding line	-	14 September
GIA Kastar	Mid	14 September
GIA Ourstar	Early-mid	8 September
PBA Butler	Early-mid	14 September
PBA Percy	Early	2 September
PBA Taylor	Mid	14 September

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 15.

Table 15. Herbicide products, active ingredients and applications rates applied as treatments to PBA Hallmark XT at Melrose, 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 16.Agronomic trial details at Melrose, 2022.

Trial design	RCBD
Replicates	3
Sowing date	20/05/2022
Plant density	120 plants/m^2
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	17/11/2022

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:

No herbicide damage occurred from applied treatments on PBA Hallmark XT lentil at Melrose, 2022. Dry conditions following sowing reduced the risk of herbicide leaching and causing off-target crop injury. Therefore, there was no impact of herbicide application on lentil grain yield (P=0.153). The average grain yield for PBA Hallmark XT lentil was 3.28 t/ha at Melrose, 2022.

HART/CONDOWIE

SITE SUMMARY

The Condowie field trial site was situated on a brown-green loamy clay soil with a loamy top soil. The soil was moderately alkaline with adequate to high levels of potassium and low to moderate salinity (Table 17).

Condowie received double the annual rainfall for January but well-below average rainfall from February to April (Figure 13). Average rainfall in May and June provided adequate soil moisture for seed germination and even establishment across the site. Below average rainfall in July slowed the development of foliar disease infection in lentil and chickpea. Equal to annual average rainfall was received in August, followed by well-above average annual rainfall throughout spring. This rainfall occurred in conjunction with early reproductive development and the increase in the soil moisture profile assisted pulse pod development through until harvest.

Overnight temperatures reached zero degrees in July but did not go below zero until September (Figure 14). Two consecutive frost events occurred in early September, with a low of -2°C. High frequency of rainfall events in spring reduced the number of frost events occurring during reproductive growth stages.

Site average grain yield was 3.2 t/ha for chickpea and 4.6 t/ha for lentil.

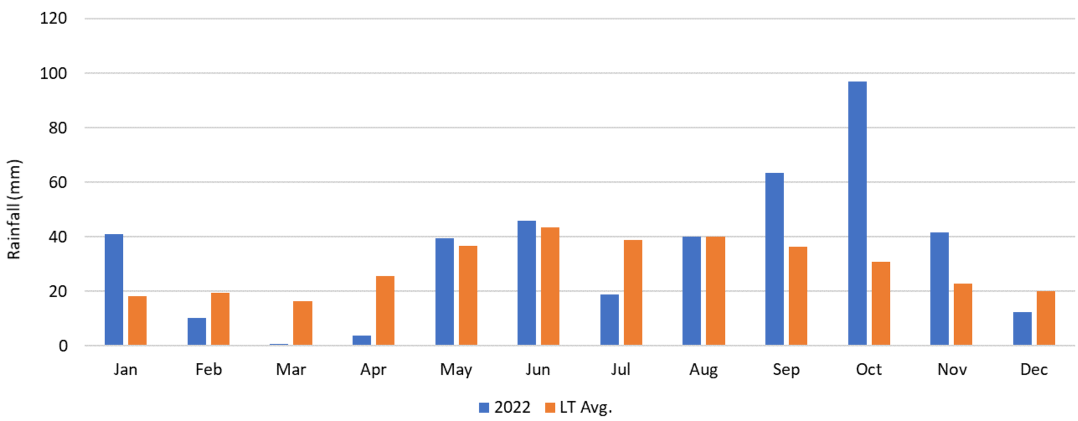


Figure 13. Monthly rainfall recorded at the Condowie field trial site in 2022 compared to the long-term average rainfall from the Snowtown (Condowie) BOM weather station (#21015).

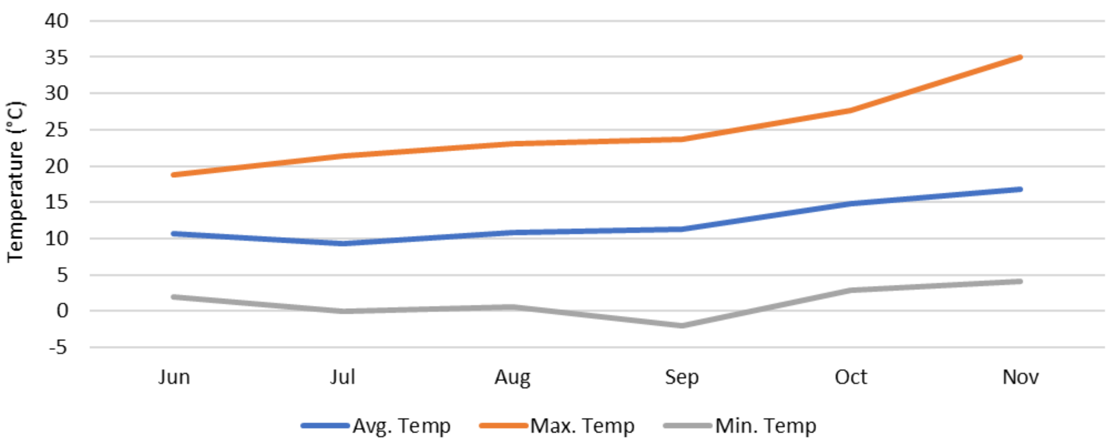


Figure 14. Average, maximum and minimum temperature (°C) recorded during the growing season at the Condowie field trial site in 2022.

Table 17. Soil profile characterisation (brown-green loamy clay soil with loamy topsoil) for the Condowie field 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	18	44	463	4.0	1.12	0.141	7.6	8.6	
10-30	<1	5	18	219	2.5	0.42	0.115	7.7	8.8	
30-60	<1	4	9	148	7.0	0.30	0.137	7.7	8.9	
60-90	<1	4	6	169	20.0	0.20	0.268	7.7	9.2	
90-120	<1	4	4	272	63.7	0.14	0.566	7.8	9.7	

Depth (cm)	Cu	Fe	Mn (mg/kg)	Zn	B	Exc Ca	Exc Mg	Exc K (meq/100g)	Exc Na	Exc Al
0-10	0.85	10.1	6.39	2.07	1.79	12.83	1.20	1.16	0.10	0.02
10-30	1.15	9.2	2.45	0.41	1.55	13.80	1.68	0.60	0.16	0.02
30-60	1.09	8.1	1.89	0.31	2.40	12.79	2.81	0.42	0.42	0.02
60-90	1.00	8.3	1.46	0.20	6.90	11.22	4.10	0.46	1.40	0.02
90-120	0.96	7.9	0.93	0.36	19.15	9.08	4.82	0.67	3.80	0.02

LENTIL DISEASE MANAGEMENT

*Sarah Day, Sara Blake, Penny Roberts, **SARDI***

Aim: This trial aims to assess (1) the yield loss from disease infection in lentil and (2) the economics of disease management control strategies.

Treatments:

Varieties: PBA Bolt, PBA Highland XT, PBA Jumbo2

Fungicide treatments: See Table 18.

Each treatment consisted of 3 key fungicide application stages; prior to canopy closure, post-canopy closure but prior to podding applied ahead of rain, and at early podding. All fungicides were applied ahead of a rain event where > 5 mm is forecast.

Table 18. Five fungicide treatments applied to lentil at Hart, 2022.

No.	Fungicide (rate)		
	Pre-CC	Post-CC, pre-podding	At early podding
T1	Untreated control		
T2	Carbendazim (500)	Carbendazim (500)	Chlorothalonil (2000)
T3	Veritas (1000)	Veritas (1000)	Veritas (1000)
T4	Aviator Xpro (600)	Carbendazim (500)	Chlorothalonil (2000)
T5	Miravis Star (750)	Carbendazim (500)	Chlorothalonil (2000)

Key: CC = canopy closure

Table 19. Fungicide product details including rate, active ingredient, and concentration, as used at Hart 2022.

Product	Active Ingredient (concentration)	Rate (mL or g/ha)
Aviator® Xpro®	Prothioconazole (150 g/L) + Bixafen (75 g/L)	600
Carbendazim	Carbendazim (500 g/L)	500
Chlorothalonil	Chlorothalonil (720 g/L)	2000
Miravis® Star	Fludioxonil (150 g/L) + Pydiflumetofen (100 g/L)	750
Veritas®	Tebuconazole (200 g/L) + Azoxystrobin (120 g/L)	1000

Table 20. Agronomic trial details, Hart 2022.

Trial design	RCBD
Replicates	3
Sowing date	22/04/2022
Plant density	120 plants/m^2
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Fungicide Application dates	*Pre-canopy closure:* 17/08/2022 *Post-canopy closure:* 06/09/2022 *Early podding:* Not applied, due to no ascochyta blight infection
Harvest date	29 November

Key messages

- The first step to good disease management is choosing a resistant variety.
- Newer fungicides with dual actives can provide superior disease control of BGM of lentil and may preserve yields in a high disease situation.

Results and Discussion:

Botrytis grey mould (BGM) is favoured by mild temperatures and high humidity. Spring conditions in 2022 were favourable for BGM infection in lentil and the disease was frequently reported and observed as aggressive in South Australia. BGM infection occurred relatively late at Hart in 2022, with infection only becoming visible on the top of the canopy in November. Due to the nature of the season and the high disease pressure, fungicide strategies controlled the disease at a similar level (Fungicide P=0.808, Variety x Fungicide P=0.279). Variety selection with disease resistance was critical in reducing disease infection and grain yield loss (P<0.001). PBA Jumbo2, rated RMR for BGM, was the highest yielding variety with 4.2 t/ha. PBA Bolt, which is susceptible to BGM infection, had a reduced grain yield of 2.76 t/ha. Disease score and grain yield of lentil were highly correlated, where greater disease infection resulted in lower grain yields (Figure 15).

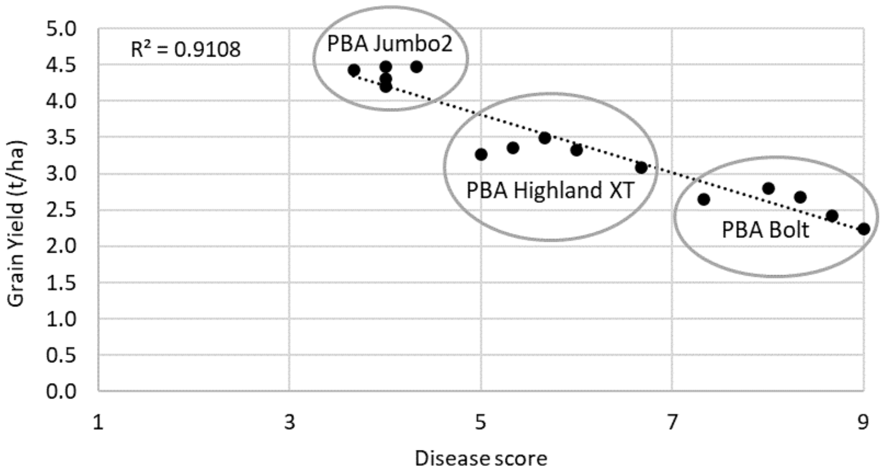


Figure 15. Lentil grain yield was highly correlated with disease severity at Hart, 2022.

Figure 16. Lentil varieties PBA Jumbo2 (left), PBA Highland XT (middle) and PBA Bolt (right) with varying levels of botrytis grey mould infection in November due to varying varietal disease resistance, at Hart 2022.

HERBICIDE MIXTURES AND ROTATION IN CHICKPEA AND LENTIL

*Navneet Aggarwal, Penny Roberts, **SARDI***

Aim: This trial aims to

(1) Improve herbicide rotation strategy with a focus on reducing selection pressure and dependence on imidazolinone (IMI) herbicides.
(2) Compare the level of weed control achieved with low and high inputs of non-IMI herbicides when used at their own or in combination with IMI herbicides.

Methods:

The experiment was established at Hart Field Site, Mid-North as a randomised complete block design with 12 herbicide treatments and 3 replicates (Table 21). The site details are summarised in Table 22. The seeds of common sowthistle and wild radish susceptible to commonly used herbicides were acquired from Plant Science Consulting and were broadcast in each plot before sowing. There was background population of vetch at the experimental site. Intercept was applied post-emergent at the 5-6 crop node stage.

Table 21. Agronomic tactics/herbicide treatments applied to chickpea and lentil at Hart, 2022.

Crop	Strategy	Herbicide strategy (Dose in terms of commercial product)	Active Ingredients
Chickpea	S_1 : IMI herbicide	Intercept® 750 ml/ha (POST)	Imazamox (33 g/L) + imazapyr (15 g/L)
	S_2 : Non-IMI strategy (low inputs)	Balance® 100 g/ha (IBS) f.b. Simazine 800 g/ha (PSPE)	Isoxaflutole (750 g/kg) f.b. Simazine (900 g/kg)
	S_3 : Non-IMI strategy (high inputs)	Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f.b. Simazine 800 g/ha (PSPE)	Fomesafen (240 g/L) + Isoxaflutole (750 g/kg) f.b. Simazine (900 g/kg)
	S_4 : Non-IMI strategy (low inputs) + IMI herbicide	Balance® 100 g/ha (IBS) f.b. Simazine 800 g/ha PSPE f.b. Intercept® 750 ml/ha (POST)	Isoxaflutole (750 g/kg) f.b. Simazine (900 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
	S_5 : Non-IMI strategy (high inputs) + IMI herbicide	Reflex® 750 ml/ha IBS + Balance® 100 g/ha (IBS) f.b. Simazine 800 g/ha (PSPE) f.b. Intercept® 750 ml/ha (POST)	Fomesafen (240 g/L) + isoxaflutole (750 g/kg) f.b. Simazine (900 g/kg) f.b. imazamox (33 g/L) + imazapyr (15 g/L)
	S_6 : Nil	Unsprayed control	-
Lentil	S_1 : IMI herbicide	Intercept® 750 ml/ha (POST)	Imazamox (33 g/L) + imazapyr (15 g/L)
	S_2 : Non-IMI strategy (low inputs)	Reflex® 750 ml/ha (IBS) f.b. metribuzin 180 g/ha (PSPE)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg)
	S_3 : Non-IMI strategy (high inputs)	Reflex® 750 ml/ha (IBS) f.b. metribuzin 180 g/ha (PSPE) f.b. Brodal 200 ml/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. diflufenican (500 g/L)
	S_4 : Non-IMI strategy (low inputs) + IMI herbicide	Reflex® 750 ml/ha (IBS) f.b. metribuzin 180 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)

	S_5 : Non-IMI strategy (high inputs) + IMI herbicide	Reflex® 750 ml/ha (IBS) f.b. metribuzin 180 g/ha (PSPE) f.b. Brodal® 200 ml/ha (POST) + Intercept® 750 ml/ha (POST)	Fomesafen (240 g/L) f.b. metribuzin (750 g/kg) f.b. diflufenican (500 g/L) + imazamox (33 g/L) + imazapyr (15 g/L)
	S_6 : Nil	Unsprayed control	-

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

Table 22. Trial site details, including sowing date and fertiliser, Hart 2022.

Location	Hart Field Site (Mid-North)
Sowing Date	13 May, 2022
Row Spacing (cm)	23
Target plant density	Lentil: 120/m^2 , Chickpea : 50 plants/m^2
Fertiliser (kg MAP/ha)[1]	80
Varieties	Lentil: PBA Hurricane XT, Chickpea: CBA 2061
Application date for IBS herbicide treatments	13 May, 2022
Application date for PSPE herbicide treatments	14 May, 2022
Application date for POST herbicide treatments	27 July, 2022
Harvest Date	15, December, 2022

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

Key Messages:

- Following a non-IMI strategy in chickpea (Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f.b. Simazine 800 g/ha (PSPE)) was equally as effective for controlling wild radish and common sowthistle as the same strategy with an additional spray of IMI herbicide.
- Following a non-IMI strategy in lentil (Reflex® 750 ml/ha (IBS) f.b. metribuzin 180 g/ha (PSPE)) proved equally as effective for controlling wild radish and common sowthistle as with the same strategy with an additional spray of either diflufenican or Intercept.
- IMI application was found essential to control vetch in both chickpea and lentil.

Results and interpretation

Good levels of chickpea plant establishment were seen across the whole site, with no differences between herbicide treatments and the unsprayed control (Table 23). There was no herbicide damage across herbicide strategies having pre-emergent herbicides Reflex® 750 ml/ha (IBS), Balance® 100 g/ha (IBS) and Simazine 800 g/ha (PSPE). New IMI tolerant chickpea breeding line CBA 2061 did not show any herbicide damage symptoms from POST application of Intercept® 750 mL/ha (S_1, S_4 and S_5).

In chickpea, low input non-IMI strategy (S_2: Balance® 100 g/ha (IBS) + Simazine 800 g/ha (PSPE)) provided control of wild radish only, while recorded highest level of common sowthistle and vetch pod-set as well as the lowest chickpea grain yield compared to the other herbicide strategies (

Table 23. Crop response to different herbicide strategies in chickpea and lentil in 2022 at Hart.

	Treatment (Dose in terms of commercial product (g or mL/ha)		Crop emergence /m^2	Yield (t/ha)
Chickpea	S_1	Intercept® 750 ml/ha (POST)	34.8 ^{b}	3.80 ^{cd}
	S_2	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	43.7 ^{b}	3.29 ^{d}
	S_3	Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	36.7 ^{b}	4.07 ^{c}

	S_4	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha PSPE f/b Intercept® 750 ml/ha (POST)	41.5^{b}	3.98^{c}
	S_5	Reflex® 750 ml/ha IBS + Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)	34.1^{b}	4.04^{c}
	S_6	Unsprayed control	40.0^{b}	2.48^{e}
Lentil	S_1	Intercept® 750 ml/ha (POST)	123.0^{a}	5.50^{ab}
	S_2	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE)	119.6^{a}	4.96^{b}
	S_3	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST)	116.3^{a}	5.33^{ab}
	S_4	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)	115.6^{a}	5.49^{ab}
	S_5	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST) f/b Intercept® 750 ml/ha (POST)	115.6^{a}	5.79^{a}
	S_6	Unsprayed control	110.7^{a}	3.87^{c}
		LSD 5%	10.3	0.57

Table 24 and 24, Figure 17). However, additional application of Reflex® 750 ml/ha (IBS) in high input non-IMI strategy (S_3) provided similar levels of control of both common sowthistle and wild radish as achieved with strategies having IMI herbicide (S_1, S_4 and S_5), however, failed to control vetch when compared to the stand-alone IMI treatment.

Similarly in lentil, good plant establishment were seen across the whole site, with no differences between herbicide treatments and the unsprayed control (Table 23). All herbicide strategies resulted in higher lentil grain yield compared to the unsprayed control.

When looking at weed control in the lentil, all herbicide strategies provided a comparable level of common sowthistle and wild radish control compared to stand alone IMI herbicide (Table 24). However, low input non-IMI strategy (S_2: Reflex® 750 ml/ha (IBS) + metribuzin 180 g/ha (PSPE)) did not effectively control vetch compared to any of the IMI strategies (S_1, S_4 and S_5). Additional application of Brodal® 200 ml/ha (POST) to Reflex® 750 ml/ha (IBS) + metribuzin 180 g/ha (PSPE) provided similar level of vetch control as seen with IMI strategies (S_1, S_4 and S_5). In addition, the low input non-IMI strategy suffered a slight lentil grain yield reduction compared to the high-input non-IMI + IMI strategy (S_5), but lentil grain yield was comparable for all other strategies.

IMI tolerance in chickpea will provide new opportunities for controlling broadleaf weeds, such as vetch, that are not effectively controlled with non-IMI herbicides. The availability of the new Group 14 herbicide Reflex® applied in combination with registered Group 5 and 12 herbicides has increased the options for broadleaf weed control in both chickpea and lentil and will reduce reliance on IMI herbicides. Rotating IMI herbicides with other effective modes of action will reduce resistance selection pressure on this vulnerable herbicide group and sustain its efficacy on important weed populations further into the future.

Table 23. Crop response to different herbicide strategies in chickpea and lentil in 2022 at Hart.

	Treatment (Dose in terms of commercial product (g or mL/ha)		Crop emergence /m²	Yield (t/ha)
Chickpea	S_1	Intercept® 750 ml/ha (POST)	34.8 [b]	3.80 [cd]
	S_2	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	43.7 [b]	3.29 [d]
	S_3	Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	36.7 [b]	4.07 [c]
	S_4	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha PSPE f/b Intercept® 750 ml/ha (POST)	41.5 [b]	3.98 [c]
	S_5	Reflex® 750 ml/ha IBS + Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)	34.1 [b]	4.04 [c]
	S_6	Unsprayed control	40.0 [b]	2.48 [e]
Lentil	S_1	Intercept® 750 ml/ha (POST)	123.0 [a]	5.50 [ab]
	S_2	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE)	119.6 [a]	4.96 [b]
	S_3	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST)	116.3 [a]	5.33 [ab]
	S_4	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)	115.6 [a]	5.49 [ab]
	S_5	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST) f/b Intercept® 750 ml/ha (POST)	115.6 [a]	5.79 [a]
	S_6	Unsprayed control	110.7 [a]	3.87 [c]
		LSD 5%	10.3	0.57

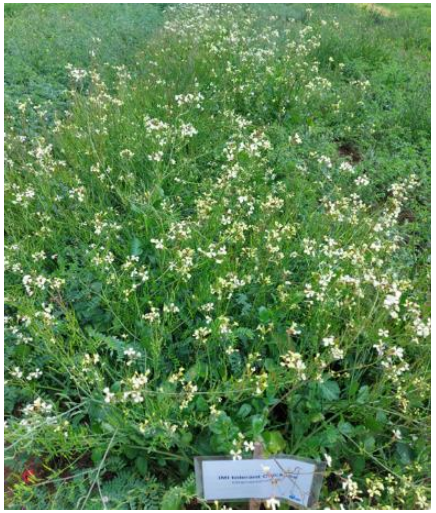
Table 24. Weeds' pod set and crop yield in response to different herbicide strategies in chickpea and lentil at Hart, 2022.

Crop	Herbicide strategy		Common sowthistle pods/m²	Wild radish pods/m²	Vetch pods/m2
Chickpea	S_1	Intercept® 750 ml/ha (POST)	4.9* [b] (23.7)**	2.6* [cd] (6.9)**	0* [d] (0)**
	S_2	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	11.2 [a] (126.3)	5.9 [c] (34.7)	17.5 [a] (307.0)
	S_3	Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha (PSPE)	1.6 [b] (2.6)	3.9 [cd] (15.2)	10.3 [abc] (105.7)
	S_4	Balance® 100 g/ha (IBS) f/b Simazine 800 g/ha PSPE f/b Intercept® 750 ml/ha (POST)	3.3 [b] (11.2)	0 [d] (0)	0 [d] (0)
	S_5	Reflex® 750 ml/ha (IBS) + Balance® 100 g/ha (IBS) f/b	0 [b] (0)	0 [d] (0)	0 [d] (0)

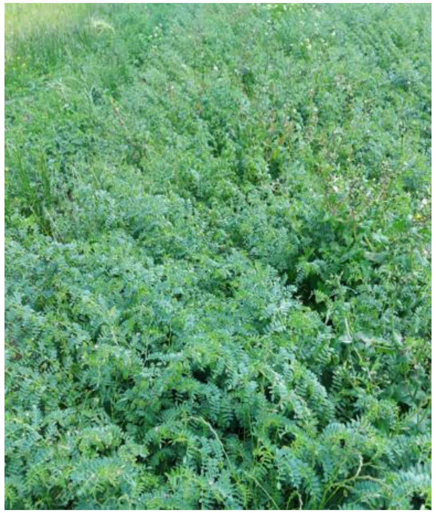
		Simazine 800 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)			
	S_6	Unsprayed control	14.9 [a] (222.6)	36.6 [a] (1335.9)	11.5 [ab] (132.5)
Lentil	S_1	Intercept® 750 ml/ha (POST)	1.4 [b] (2.0)	2.7 [cd] (7.3)	0 [d] (0)
	S_2	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE)	0.8 [b] (0.7)	2.3 [cd] (5.3)	9.0 [bc] (80.1)
	S_3	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST)	1.4 [b] (2.0)	0.8 [d] (0.6)	4.1 [cd] (16.7)
	S_4	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Intercept® 750 ml/ha (POST)	0 [b] (0)	0 [d] (0)	0 [d] (0)
	S_5	Reflex® 750 ml/ha (IBS) f/b metribuzin 180 g/ha (PSPE) f/b Brodal® 200 ml/ha (POST) f/b Intercept® 750 ml/ha (POST)	0 [b] (0)	0 [d] (0)	1.3 [d] (1.6)
	S_6	Unsprayed control	10.4 [a] (108.2)	30.6 [b] (938.2)	9.8 [bc] (96.6)
		LSD 5%	5.3	5.1	7.3

* Figure after square-root transformation

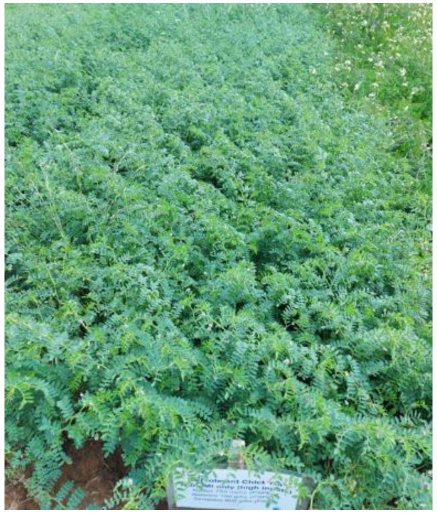
** Figures in parentheses are original means



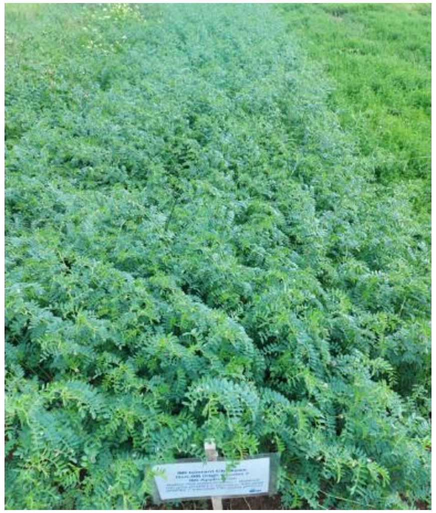
Chickpea: Unsprayed control



Chickpea: Balance + Simazine



Chickpea: Reflex + Balance + Simazine



Chickpea: Reflex + Balance + Simazine + Intercept

Lentil: Unsprayed control

Lentil: Reflex + metribuzin

Lentil: Reflex + metribuzin + diflufenican

Lentil: Reflex + metri + diflufenican + Intercept

Figure 17. Broadleaf weed control with different herbicide strategies in imidazolinone tolerant chickpea and lentil.

LENTIL VARIETY X SEED SIZE

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

Aim: This trial aims to assess the effect of seed size on establishment, yield and yield components.

Treatments:

Varieties: GIA Leader, PBA Hallmark XT, PBA Jumbo2, PBA Kelpie XT

Seed size: Separated into three categories (small seed size, unseparated, and large seed size) depending on seed size (Table 25).

Table 25. Seed size categories of lentil varieties separated into small and large seed lots and the grain weight (g per 100 seeds) of the unseparated lot, Condowie 2022.

Variety	Small Seed Size (SSS)	Large Seed Size (LSS)	Unseparated Grain weight (g/100 seeds)
GIA Leader	< 4.5 mm	> 4.5 mm	4.62
PBA Hallmark XT	< 4.5 mm	> 4.5 mm	4.24
PBA Jumbo2	< 5.5 mm	> 5.5 mm	5.09
PBA Kelpie XT	< 5.0 mm	> 5.0 mm	5.00

Table 26. Trial site details, Condowie 2022.

Trial design	RCBD
Replicates	3
Sowing date	26/05/2022
Plant density	120 plants/m^2
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	08/12/2022

Key messages:

- Harvest index and grain yield were influenced by lentil variety, but not by seed size category.

Results and Discussions:

Plant establishment numbers were influenced by an interaction between lentil variety and seed size category (Figure 18). While the large seed size segregation of PBA Hallmark XT improved plant establishment compared to the small seed size segregation, neither were different from the unseparated control. No other varieties had establishment that differed from the unseparated lot by sowing larger or small seed size lots.

Harvest index (HI) percentage was dependent on variety but was not influenced by seed size category (Figure 19). Generally, the larger seed size varieties had higher HIs. PBA Kelpie XT had the highest HI, followed by PBA Jumbo2 and GIA Leader. The smallest of the four varieties, PBA Hallmark XT, had the lowest HI.

Grain yield (t/ha) was influenced by variety, but not dependent on seed size category (Figure 20). PBA Jumbo2 is the highest yielding commercial lentil variety currently available, and was the highest yielding at Condowie, 2022. PBA Hallmark XT had the lowest grain yield as well as HI, but not lower yielding than GIA Leader.

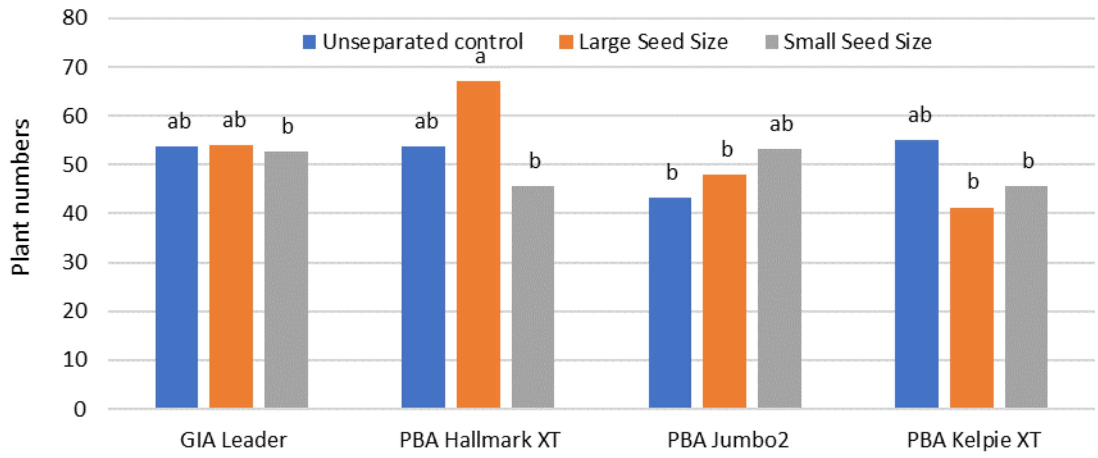


Figure 18. Plant establishment numbers (plants/m^2) were influences by an interaction between lentil variety and sown seed size categories at Condowie, 2022. Bars labelled with the same letters are not significantly different (P=0.047).

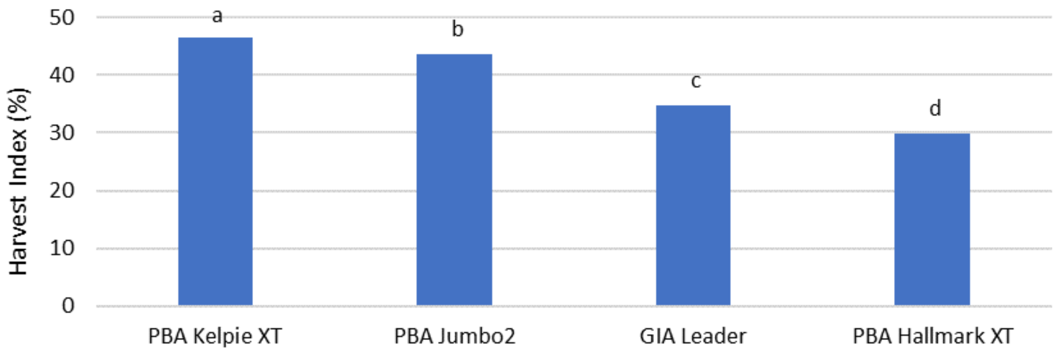


Figure 19. Harvest index (%) of lentil varieties at Condowie, 2022. Bars labelled with the same letters are not significantly different (P<0.001).

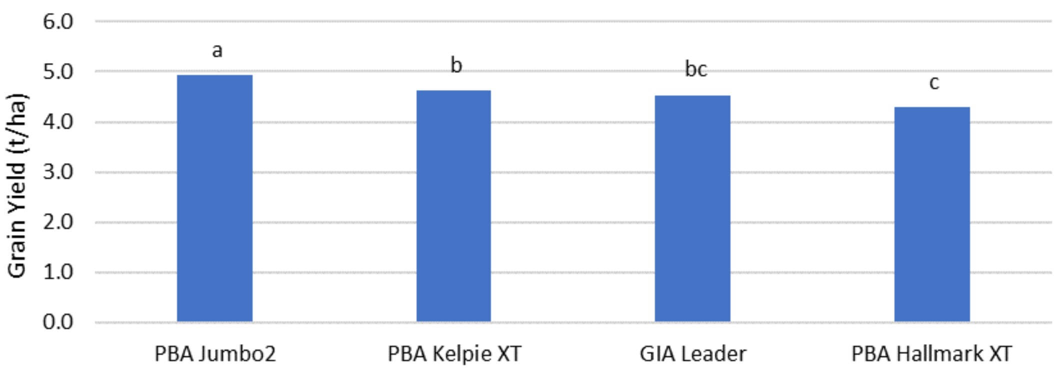


Figure 20. Grain yield (t/ha) of lentil varieties at Condowie, 2022. Bars labelled with the same letters are not significantly different (P<0.001).

CHICKPEA VARIETY X SEED SIZE

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

Aim: This trial aims to assess the effect of seed size on establishment, yield and yield components.

Treatments:

Varieties: PBA Magnus, PBA Monarch, PBA Royal

Seed size: Separated into three categories (small seed size, unseparated, and large seed size) depending on seed size (Table 27).

Table 27. Seed size categories of chickpea varieties separated into small and large seed lots and the grain weight (g per 100 seeds) of the unseparated lot, Condowie 2022.

Variety	Small Seed Size (SSS)	Large Seed Size (LSS)	Unseparated Grain weight (g/100 seeds)
PBA Magnus	< 10 mm	> 10 mm	54.24
PBA Monarch	< 9 mm	> 9 mm	45.76
PBA Royal	< 9 mm	> 9 mm	43.76

Table 28. Trial site details, Condowie 2022.

Trial design	RCBD
Replicates	4
Sowing date	26/05/2022
Plant density	35 plants/m^2
Row spacing	23 cm
Fertiliser	80 kg/ha MAP + Zn
Harvest date	08/12/2022

Key messages:

- Plant establishment and grain yield were not influenced by chickpea seed size category.

Results and Discussions:

Plant establishment was not influenced by variety (P=0.175), seed size category (P=0.069), or the interaction between the two (P=0.132, data not shown).

Harvest index (HI) percentage (%) was influenced by chickpea variety (P<0.001), but not seed size category (P=0.38) at Condowie in 2022 (Figure 21). The larger seed size variety, PBA Magnus, had the lowest HI, while PBA Monarch had the highest HI.

Chickpea grain yield was not influenced by variety (P=0.173), seed size category (P=0.736), or the interaction between the two (P=0.542, data not shown). The average chickpea grain yield was 3.27 t/ha at Condowie, 2022.

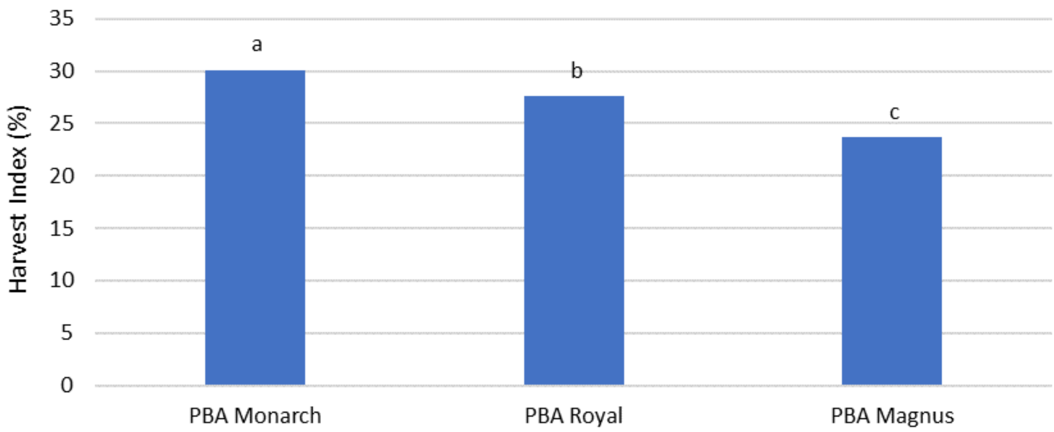


Figure 21. Harvest index percentage (%) of chickpea varieties, averaged across seed size categories, at Condowie, 2022. Bars labelled with the same letter are not significantly different (P<0.001).

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