

GOA trial site report

Wheat: improving confidence in high sowing rates as a weed control tool in lower rainfall environments.

Grain Orana Alliance

Trial code:	GAWE06323-1
Season/year:	Winter 2023
Location:	Nyngan
Trial partners:	Breil Jackson
Trial establishment date:	19/05/2023

Keywords

GAWE063, wheat, plant populations, competition, varieties, sowing rates, Nyngan

Take home messages

- Increasing sowing rates increased crop populations and assumed weed competition. Varieties with earlier peak biomass may aid control in weedy paddocks.
- Increasing sowing rates and crop populations did not decrease yields.
- Increasing sowing rates and crop populations did not result in higher screenings.
- Some varieties, such as Condo^A, had a higher early vegetative index (VI) compared to other varieties.
- Increasing sowing rates and choosing a variety with early season vigour are recommended in paddocks where weeds are a problem.

Background

Improving weed control by improving crop competitiveness is well documented. This can be practical measures such as:

- decreasing row spacing
- increasing plant populations.

A key barrier to adoption, particularly in marginal yielding, lower rainfall environments, is the perceived yield instability and risk of lowering grain quality (e.g. increasing screenings). Growers are reluctant to decrease row spacing as this can impede trash flow with tine sowing systems, particularly in minimum tillage farming systems.

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Moving to narrower row spacing usually requires additional machinery investment. Moving to higher sowing rates can also increase costs, but to a much smaller degree.

Recent investments, such as the ongoing “Innovative crop weed control for northern region cropping systems” conducted by CSU ¹, suggest that changes in crop competitiveness through variety, population, spacing, and crop choice, requires further regional validation against standard district practices or commonly grown varieties.

Higher seeding rates in the number one recommendation of the “Crop Competition” pillar of the Weed Smart Big 6 ¹ and is likely to be one of the easiest weed management tools that growers can adopt.

The trial will focus on the impact on yield and grain quality of increasing crop competitiveness through sowing rates and variety.

Aims

- To investigate if increasing sowing rate impacts yield and grain quality of a range of varieties common to the Grain Orana Alliance (GOA) region.
- Investigate any interactions between population and variety on crop biomass as a measure of crop competition.

Methodology

Trial design	
Plot size	Small plot (~12m x 2 m)
Design	Randomized complete block
Varieties	8 varieties
Target populations	30, 70, 110 and 150 plants/m ²
Replications	4
Analysis	ANOVA (ASREML)
Confidence interval	95%

Site Selection

The site selected was in the more western areas of the GOA region where the adoption of heavier sowing rates as a weed control tool is less commonly used.

Trials were placed in paddocks with a good rotational history to minimise disease risk.

¹ <https://www.weedsmart.org.au/big-6/>

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Table 1: Nyngan rainfall² for 2023 and the long-term average (LTA).

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2023	46	0	35	29	2	38	27.4	2.4	1.4	7.4	93	29	319
LTA	52	48	43	34	35	36	31.0	29.0	28.0	37.0	38	41	452

Treatments

Table 1: Varieties (sorted from earliest to latest recommended sowing times), target plant populations and actual sowing rates used at Nyngan 2023[^] [Growth habit adapted from NSW DPI Winter Crop Variety Sowing Guide 2023].

Variety	Sowing rate (kg/ha)				Breeder	Growth habit
	30	70	110	150		
<i>Target population (plants/m²)</i>	30	70	110	150		
<i>Establishment factor</i>	0.9	0.82	0.74	0.66		
Beckom	9	24	41	63	AGT	Short plant type
LRPB Lancer	12	31	54	83	Pacific	Short medium plant height
LRPB Reliant	12	31	54	83	Pacific	
Condo	13	33	57	87	AGT	Tall plant type
LRPB Mustang	13	33	57	88	Pacific	Medium plant type
LRPB Raider	13	33	57	86	AGT	Shorter high tillering plant type
Coolah	14	37	65	99	AGT	Tall plant type
LRPB Hellfire	14	37	64	98	Pacific	Medium Plant type

Results

Plant populations

Growers generally target a plant population of ~50 plants/m² (i.e. sowing rates of 25-35 kg/ha) in low rainfall areas.

² Gridded data from: [Access Gridded Data](#) | [LongPaddock](#) | [Queensland Government](#)

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Some research looking at row spacing suggests that increasing the population results in decreased establishment. This could be due to competition between germinating seeds in the row.

Establishment percentage declined with increasing plant populations, even though the establishment achieved was higher than targeted (Table 2).

Table 2: Targeted populations, establishment factor, actual establishment, and the ratio of establishment to target population.

Target population	Establishment factor	Actual establishment (%)	Establishment as a percent of target (%)
30	0.90	112	120
70	0.82	97	114
110	0.74	89	116
150	0.66	78	114

Plant establishment

The plant establishment was close to the target population. For each variety the established populations were different (Figure 1).

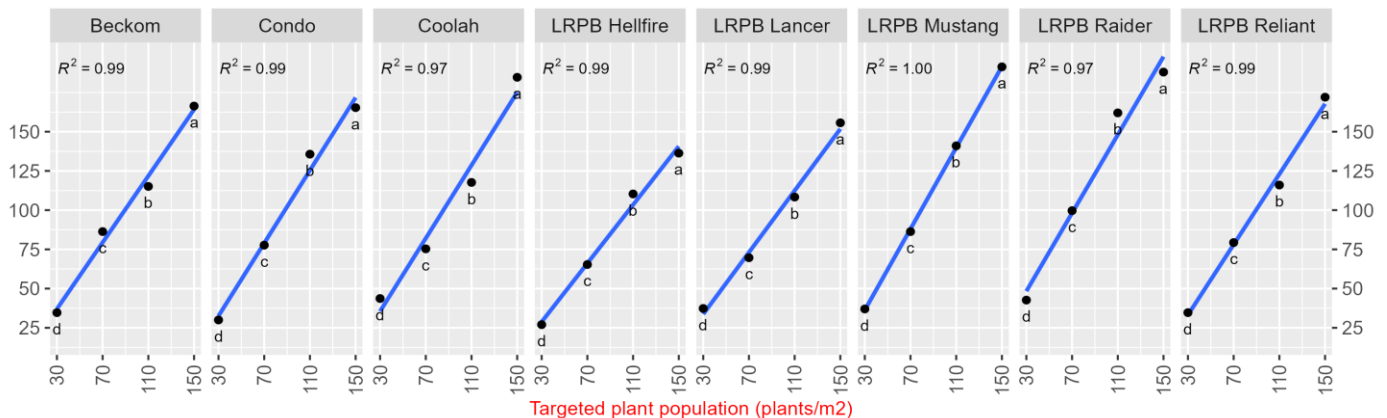


Figure 1: Plant establishment by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

Vegetation index

VI was measured with a hand-held Trimble Ag Greenseeker which records the normalized difference vegetation index (NDVI) ranging from 0.00 to 0.99, where higher numbers indicate a greater density of green material and is an indicator of crop competition. VI was assessed 84 days after sowing, and when most of the treatments were at canopy closure.

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- The VI was the lowest for all varieties at 30 plants/m² target population (Figure 2).
- The VI for Condo^A and Hellfire^A was the same at 70, 110 and 150 populations.
- The VI for Coolah^A, Lancer^A and Raider^A was the same at the two higher populations,
- At the highest population, Lancer^A and Raider^A had the highest VI of all varieties (except for Coolah^A @ 110 plants/m²).
- LRPB Reliant^A was the only variety where VI was lower at the highest population than the second highest population.

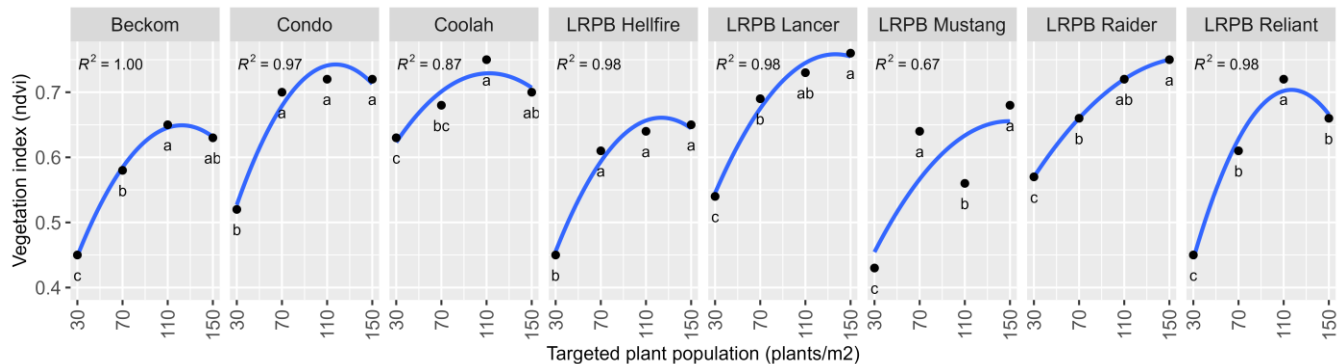


Figure 2: Vegetation index on the 16/8/2023 (84 days after sowing) by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

Yield

- Yields were on the low side with most treatments yielding between 1 – 2 t/ha (the long-term average wheat yield for NSW is 1.93 t/ha (Figure 3)).
- For half of the varieties (Coolah^A, LRPB Hellfire^A, LRPB Lancer^A and LRPB Raider^A), yields were not different regardless of population.
- For Mustang^A, the lowest yield was at the lowest population.
- Beckom^A and Condo^A yields increased as population increased from 30 to 70 plants/m² target population (for LRPB Reliant^A yields increased from 30 to 110 plants/m²).
- There were no cases where the highest populations had lower yields than the lowest populations.

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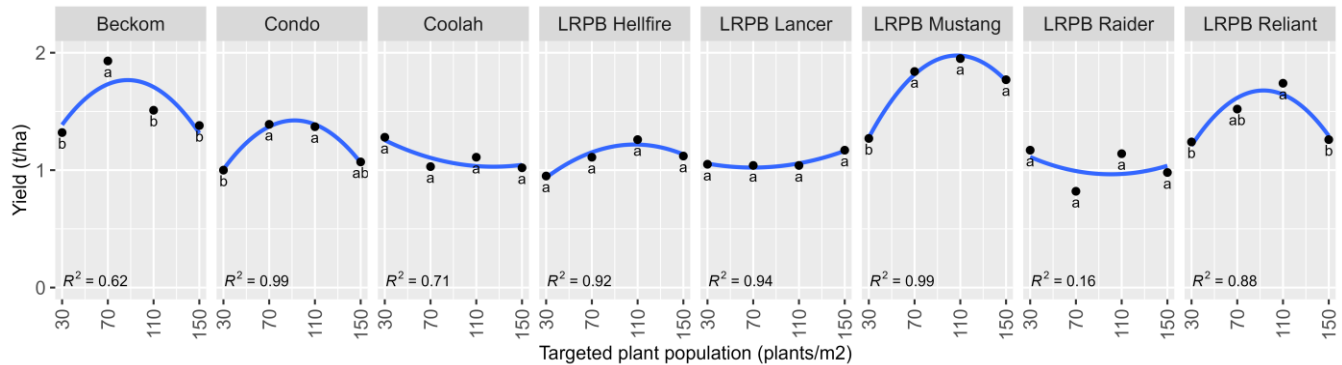


Figure 3: Wheat yield (t/ha) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Protein

- Protein levels were not influenced by population for 3 of the 8 varieties (Condo^A, Hellfire^A and LRPB Mustang^A).
- For 3 varieties (Coolah^A, Lancer^A and LRPB Raider^A), protein declined with increasing populations (Figure 4).
- LRPB Hellfire^A had the highest protein levels.

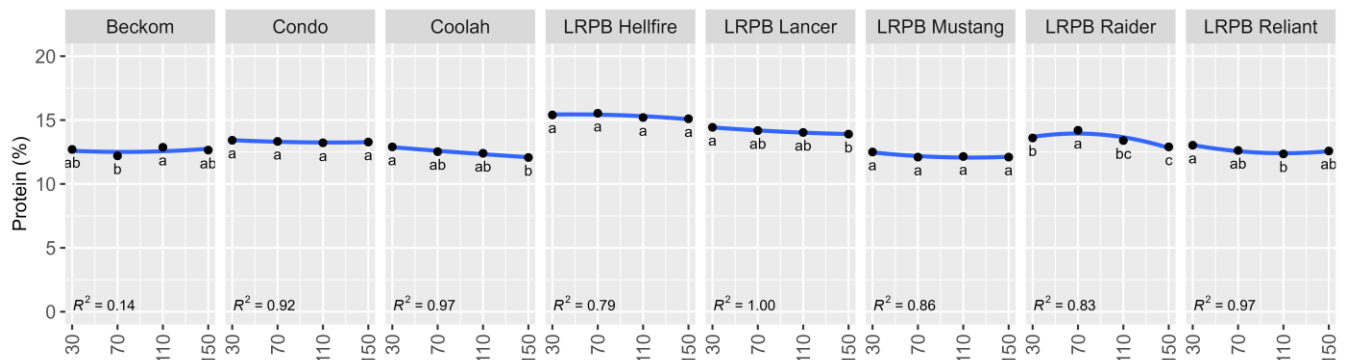


Figure 4: Wheat protein (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Screenings

All screenings were below 5%, the threshold for moving to a lower bin grade. For half the varieties population had little or no effect on screenings. Coolah^A, LRPB Lancer^A and LRPB Raider^A had higher screenings at the higher populations (Figure 5).

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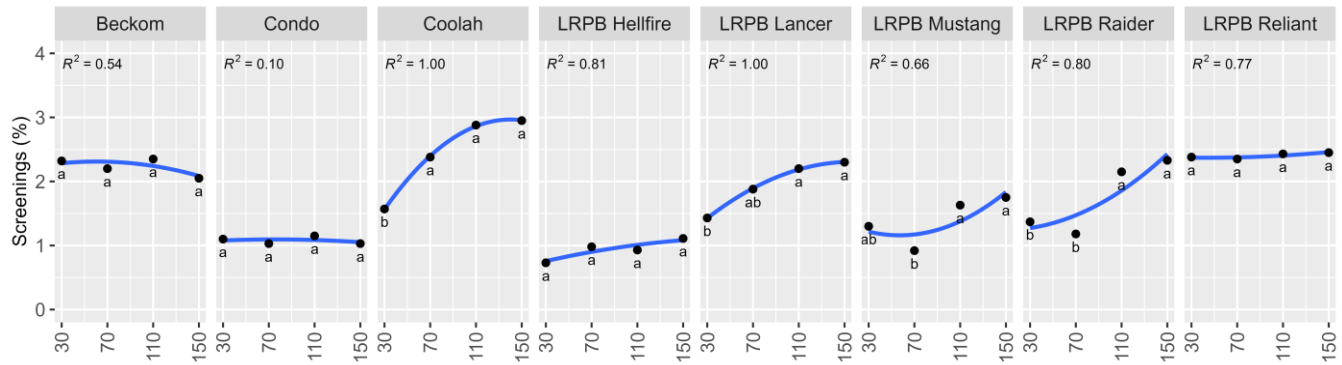


Figure 5: Wheat screenings (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Discussion

2023 was very dry with the in-crop rainfall at the site ~77.1 mm. This resulted in a below average wheat crop. The mean site yield was 1.3 t/ha (Figure 3) and mean protein levels were 13% (Figure 4).

It is generally accepted that germination rates can be reduced at higher sowing rates, 90% establishment was assumed at a target of 30 plants/m² and 66% establishment at 150 plants/m². The fact that the plant establishment was close to the target populations supports the use of a factor to compensate for lower germinations at higher populations.

There was a substantial yield response to both variety and population, with a ~1.5 t/ha difference between the highest (1.9 t/ha) and lowest (0.38 t/ha) yielding treatments.

At mid-season there was a clear indication that the lowest populations had the lowest VI regardless of variety. There was also a considerable difference in VI between varieties, for example Condo^A had 21% higher NDVI reading than Beckom^A where both had a target population of 70 plants/m². This supports using higher sowing as a crop competition tool, and consideration could be given to selecting varieties that display vigorous early season growth.

Increasing plant populations, even to the very high levels of ~150 plants/m² (roughly 3 times the district average), did not reduce yields when compared to the lowest target population regardless of variety. There were also no effects on grain quality that would result in a binned grade downgrade. The fact that yields and quality did not decline at the higher sowing rates suggests that experiences or perceptions of yield instability may have occurred in the presence of other factors, such as crown rot in the paddocks. Other factors that contribute to yield stability may be related to early vigour and the establishment of a more robust root system and/or earlier row closure allowing for better water use efficiency (less surface evaporation).

These results can give growers the confidence to increase sowing rates without compromising yield or quality in problem weed paddocks. There is also an opportunity for growers to select varieties that display higher levels of early-season vigour.

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Conclusions

- Any increase in sowing rates, regardless of variety, is likely to increase crop competition and improve weed control.
- Varieties that grow faster are likely to be better suited to providing earlier in-crop weed competition.
- Increasing sowing rates did not negatively impact yields or grain quality (screenings or protein). In fact, evidence from this trial showed that yields and screenings were the same or better at higher sowing rates as low sowing rates.

Acknowledgements

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Appendix

Table 3: Trial results 2023

		Plant establishment			Vegetation index			Yield			Screenings		
Variety	Target population	(plants/m ²)			(June)			(t/ha)			(%)		
		p.v. ¹	s1 ²	s2 ³	p.v. ¹	s1 ²	s2 ³	p.v. ¹	s1 ²	s2 ³	p.v. ¹	s1 ²	s2 ³
Beckom	30	34.70	l	d	0.45	n	c	1.30	defg	b	2.30	abcd	a
	70	86.30	ij	c	0.58	ijklm	b	1.90	a	a	2.20	cde	a
	110	115.10	fgh	b	0.65	ghi	a	1.50	bcd	b	2.30	abcde	a
	150	166.30	bc	a	0.63	hijk	ab	1.40	de	b	2.00	cdef	a
Condo	30	30.00	l	d	0.52	m	b	1.00	ghi	b	1.10	ijkl	a
	70	77.70	jk	c	0.70	bcdefg	a	1.40	cde	a	1.00	ijkl	a
	110	135.70	efg	b	0.72	abcde	a	1.40	def	a	1.20	hijkl	a
	150	165.30	bc	a	0.72	abcde	a	1.10	efghi	ab	1.00	ijkl	a
Coolah	30	43.70	l	d	0.63	hij	c	1.30	defgh	a	1.60	efghij	b
	70	75.30	jk	c	0.68	defgh	bc	1.00	efghi	a	2.40	abcd	a
	110	117.70	fgh	b	0.75	ab	a	1.10	efghi	a	2.90	ab	a
	150	184.70	ab	a	0.70	bcdefg	ab	1.00	fghi	a	2.90	a	a
LRPB Hellfire	30	27.00	l	d	0.45	n	b	1.00	hi	a	0.70	l	a
	70	65.30	k	c	0.61	ijkl	a	1.10	efghi	a	1.00	jkl	a
	110	110.30	h	b	0.64	ghij	a	1.30	defgh	a	0.90	jkl	a
	150	136.30	def	a	0.65	ghij	a	1.10	efghi	a	1.10	hijkl	a
LRPB Lancer	30	37.30	l	d	0.54	m	c	1.10	efghi	a	1.40	fghijk	b
	70	69.70	jk	c	0.69	cdefgh	b	1.00	efghi	a	1.90	cdefg	ab
	110	108.30	h	b	0.73	abcd	ab	1.00	efghi	a	2.20	cde	a
	150	155.70	cd	a	0.76	a	a	1.20	defgh	a	2.30	bcd	a
LRPB Mustang	30	37.00	l	d	0.43	n	c	1.30	defgh	b	1.30	ghijkl	ab
	70	86.30	ij	c	0.64	ghij	a	1.80	ab	a	0.90	kl	b
	110	141.00	de	b	0.56	lm	b	1.90	a	a	1.60	efghi	a
	150	191.30	a	a	0.68	defgh	a	1.80	ab	a	1.80	defgh	a
LRPB Raider	30	42.70	l	d	0.57	klm	c	1.20	defghi	a	1.40	ghijkl	b
	70	99.70	hi	c	0.66	efghi	b	0.80	i	a	1.20	hijkl	b
	110	162.00	c	b	0.72	abcdef	ab	1.10	efghi	a	2.20	cde	a
	150	188.00	a	a	0.75	abc	a	1.00	ghi	a	2.30	abcd	a
LRPB Reliant	30	34.70	l	d	0.45	n	c	1.20	defgh	b	2.40	abcd	a
	70	79.30	jk	c	0.61	ijkl	b	1.50	bcd	ab	2.30	abcd	a
	110	116.00	gh	b	0.72	abcde	a	1.70	abc	a	2.40	abc	a
	150	172.00	abc	a	0.66	fghi	b	1.30	defgh	b	2.50	abc	a
	lsd	19.90	na	na	0.06	na	na	0.40	na	na	0.70	na	na

¹ predicted.value

² values with the same letter within variable are not significantly different

³ values with the same letter within variable and VARIETY only are not significantly different