

GOA trial site report

Wheat: improving confidence in high plant populations as a weed control tool in lower rainfall environments.

Grain Orana Alliance.

Trial code:	GAWE06323-2
Season/year:	Winter 2023
Location:	Warren
Trial partners:	Jack Brennan (Paraway Pastoral Company Limited)
Trial establishment date:	22/05/2023

Keywords

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

Take home messages

- Increasing sowing rates and crop populations did not negatively impact yields.
- Increasing sowing rates and crop populations did not result in higher screenings.
- Increasing sowing rates increased crop populations and presumably weed competition.
- Quicker growing varieties such as Condo^A, Coolah^A, LRPB Lancer^A and LRPB Raider^A may be better choices in paddocks where weeds are a problem than slower varieties such as Beckom^A, LRPB Hellfire^A and Mustang^A.
- 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 achieved by 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

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spacing as this can impede trash flow with tine sowing systems, particularly in minimum tillage farming systems. 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 ² and are 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.
- To investigate any interactions between population and variety on crop biomass as a measure of crop competition.

Methodology

Trial design	
Plot size	Small plot (~12 m 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 was selected in the western area of GOA’s region where the adoption of heavier sowing rates as a weed control tool are used less. Trials were placed in paddocks with a good rotational history to minimise disease risk.

Table 1: Warren rainfall for 2023 and the long-term average (LTA).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2023	32	1	9	24	7	27	28	3	0	10	117	27	285
LTA	47	45	43	32	37	35	28	26	27	35	38	41	434

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Treatments

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

Sowing rate (kg/ha)	Target population (plants/m ²)					
	30	70	110	150	Breeder	Growth habit
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	
Coolah	14	37	65	99	AGT	Tall plant type
LRPB Hellfire	14	37	64	98	Pacific	Medium plant type
ESTABLISHMENT FACTOR	0.90	0.82	0.74	0.66		

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.
- Some research into row spacing suggests that increasing the plant population decreases establishment. This could be due to competition between germinating seeds in the row.
- The establishment percentage declined with increasing plant populations, even though the establishment achieved was higher than targeted (Table 2).

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Table 2: Target 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	78	83
70	0.82	75	88
110	0.74	64	83
150	0.66	53	77

Plant establishment

The plant establishment was close to the target. For each variety, the established populations were different except for the middle 2 Coolah^A populations and the 2 highest LRPB Flanker^A populations (Figure 1).

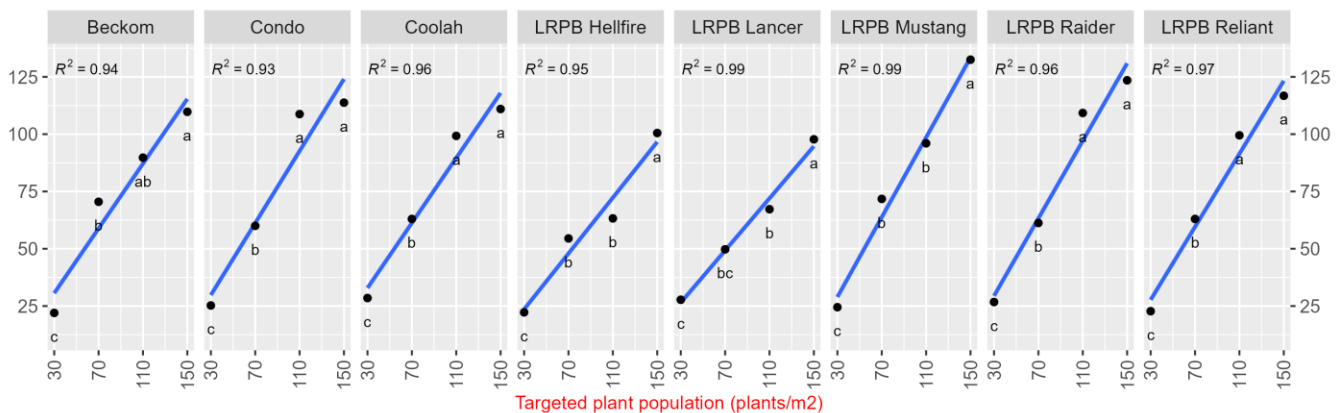


Figure 1: Plant establishment (plants/m²) by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

Vegetation index (VI):

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.

- The lowest VI for all varieties was at 30 plants/m² target population (Figure 2).
- The VI for all varieties was highest at the top two populations (110 and 150 plants/m²)
- At the highest population Condo^A, Lancer^A and Raider^A had the highest VI of all varieties.

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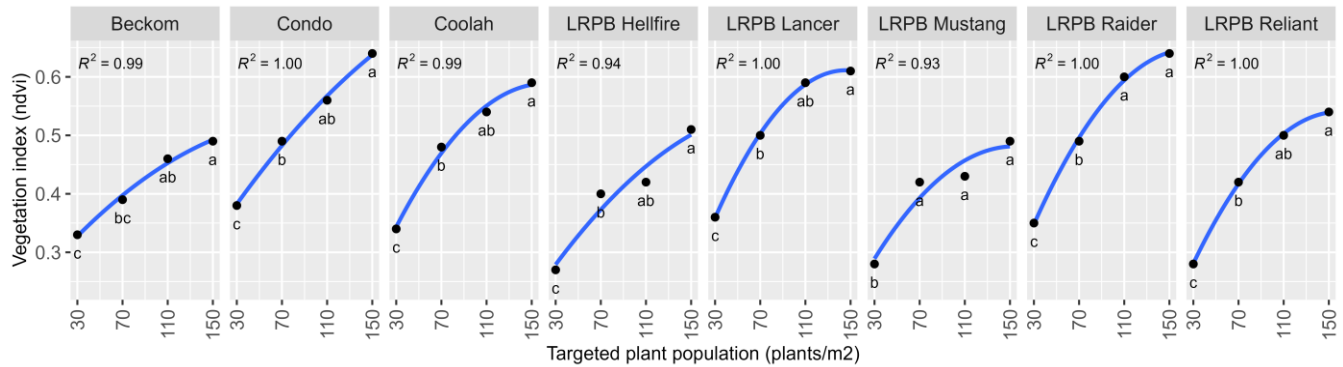


Figure 2: Vegetation index (NDVI) on the 16/8/2023 (84 days after sowing) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Yield

- The yields were low. Most treatments yielding >1 t/ha (the long-term average wheat yield for NSW is 1.93 t/ha (Figure 3)).
- Yields were lowest at the lowest population for all varieties except for Coolah^A.
- Beckom^A and Condo^A yields increased as the target population increased from 30 to 70 plants/m².
- LRPB Reliant^A yields increased as the target population increased from 30 to 110 plants/m².
- There were no cases where the highest populations had yields lower than the lowest populations.

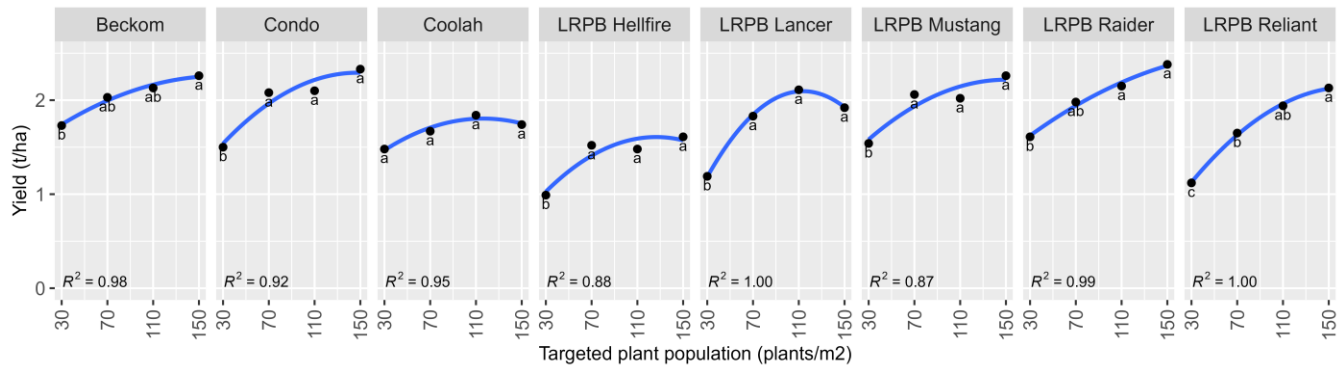


Figure 3: Wheat yield (t/ha) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Protein

- The plant population had no effect on protein levels for 3 of the 8 varieties tested.
- All varieties, except for Coolah^A and LRPB Raider^A, had a protein decline with increasing populations (Figure 4).
- LRPB Hellfire^A had the highest protein levels.

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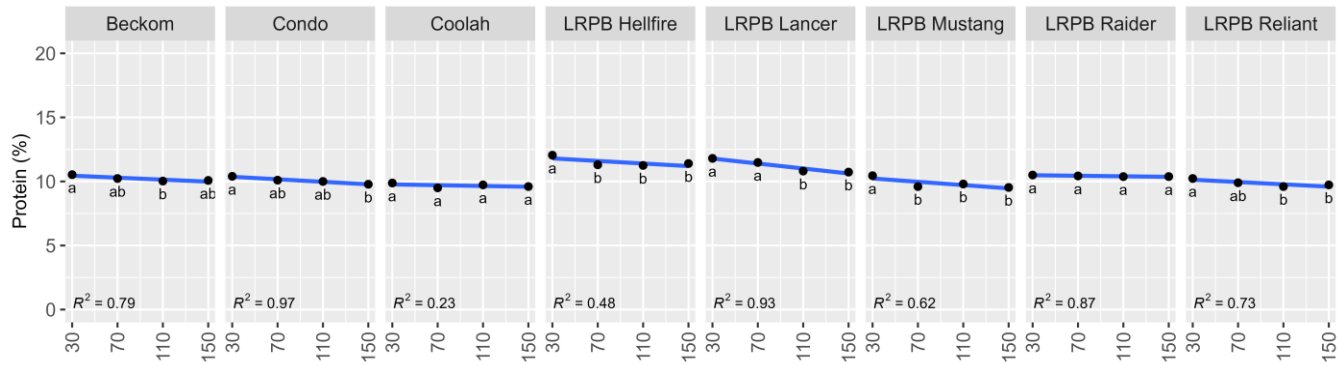


Figure 4: Wheat protein (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Screenings

- All screenings levels were below 5%, (except for Coolah^A, but only at the highest populations), the threshold for moving to a lower bin grade.
- For 7 out of 8 varieties, the population had little or no effect on screenings.
- Coolah^A, had higher screenings at the highest population (Figure 5).

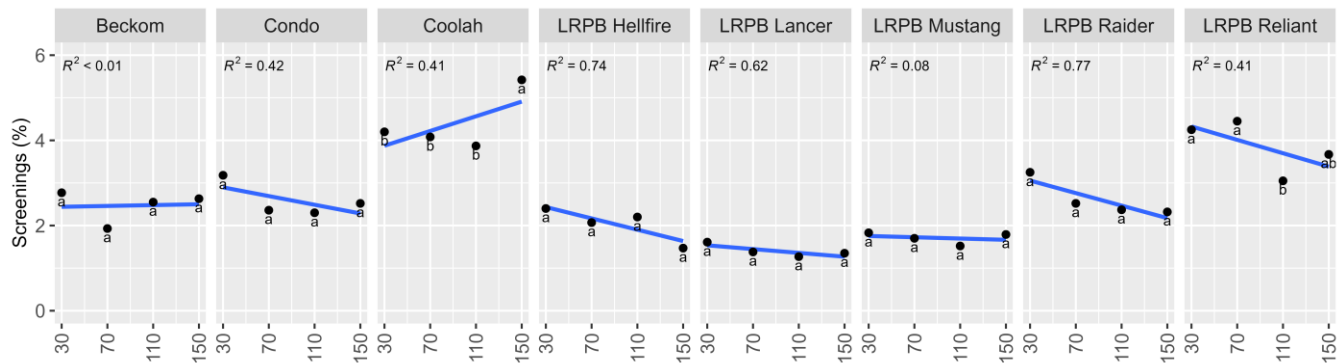


Figure 5: Wheat screenings (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Discussion

The 2023 season was very dry. The site in-crop rainfall was 101.8 mm. The yield of the resulting wheat crop was below average (the mean site yield was 1.8 t/ha) (Figure 3) and the mean protein level was 10% (Figure 4).

It is 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 plant establishment was close to the target population and supports the use of a 'factor' to compensate for lower germinations at higher populations.

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There was a substantial yield response to both variety and population, with close to 1.4 t/ha difference between the highest (2.4 t/ha) and lowest (1.0 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.

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 population, regardless of variety. There was also no effect on grain quality that would result in a quality downgrade.

The proof that yield and quality did not decline at the higher sowing rates suggests that perceptions of yield instability may have occurred where other factors were at play, such as the presence of crown rot. 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.

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). This trial data showed that yields were greatly improved by moving to higher sowing rates but screenings did not blow out.

Acknowledgements

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Appendix

Table 3: Trial results 2023

Variety	Target population	Plant establishment			Vegetation index			Yield			Screenings		
		(plants/m ²)			(June)			(t/ha)			(%)		
		p.v. ¹	s ¹ ²	s ² ³	p.v. ¹	s ¹ ²	s ² ³	p.v. ¹	s ¹ ²	s ² ³	p.v. ¹	s ¹ ²	s ² ³
Beckom	30	22.00	i	c	0.33	mno	c	1.70	defghijk	b	2.80	fghi	a
	70	70.50	fg	b	0.39	ijklm	bc	2.00	abcdefg	ab	1.90	ijklmno	a
	110	89.70	def	ab	0.46	ghij	ab	2.10	abcd	ab	2.50	ghijk	a
	150	109.80	abcd	a	0.49	efgh	a	2.30	abc	a	2.60	ghij	a
Condo	30	25.20	i	c	0.38	ijklm	c	1.50	ijklm	b	3.20	defg	a
	70	60.00	g	b	0.49	efgh	b	2.10	abcdef	a	2.40	ghijkl	a
	110	108.70	abcd	a	0.56	abcde	ab	2.10	abcde	a	2.30	ghijklmn	a
	150	113.70	abcd	a	0.64	a	a	2.30	ab	a	2.50	ghijk	a
Coolah	30	28.50	hi	c	0.34	lmno	c	1.50	klm	a	4.20	bc	b
	70	63.00	g	b	0.48	efghi	b	1.70	efghijk	a	4.10	bcd	b
	110	99.20	bcd	a	0.54	bcdef	ab	1.80	cdefghijk	a	3.90	bcde	b
	150	111.00	abcd	a	0.59	abc	a	1.70	defghijk	a	5.40	a	a
LRPB Hellfire	30	22.20	i	c	0.27	o	c	1.00	n	b	2.40	ghijkl	a
	70	54.50	g	b	0.40	ijklm	b	1.50	ijklm	a	2.10	ijklmno	a
	110	63.20	g	b	0.42	ghijkl	ab	1.50	klm	a	2.20	hijklmno	a
	150	100.50	bcd	a	0.51	cdefg	a	1.60	ghijkl	a	1.50	lmno	a
LRPB Lancer	30	27.70	hi	c	0.36	klmn	c	1.20	lmn	b	1.60	klmno	a
	70	49.70	gh	bc	0.50	defgh	b	1.80	cdefghijk	a	1.40	mno	a
	110	67.20	fg	b	0.59	abcd	ab	2.10	abcdef	a	1.30	o	a
	150	97.70	cd	a	0.61	ab	a	1.90	bcdefghijk	a	1.30	no	a
LRPB Mustang	30	24.50	i	c	0.28	no	b	1.50	ijklm	b	1.80	ijklmno	a
	70	71.70	efg	b	0.42	hijklm	a	2.10	abcdefg	a	1.70	ijklmno	a
	110	96.00	cde	b	0.43	ghijk	a	2.00	abcdefgh	a	1.50	lmno	a
	150	132.50	a	a	0.49	efgh	a	2.30	abc	a	1.80	ijklmno	a
LRPB Raider	30	26.70	hi	c	0.35	lmno	c	1.60	hijkl	b	3.20	cdefg	a
	70	61.20	g	b	0.49	efgh	b	2.00	abcdefghi	ab	2.50	ghijk	a
	110	109.20	abcd	a	0.60	ab	a	2.10	abcd	a	2.40	ghijkl	a
	150	123.50	ab	a	0.64	a	a	2.40	a	a	2.30	ghijklm	a
LRPB Reliant	30	22.70	i	c	0.28	no	c	1.10	mn	c	4.20	b	a
	70	63.00	g	b	0.42	ghijkl	b	1.70	efghijk	b	4.40	b	a
	110	99.50	bcd	a	0.50	defgh	ab	1.90	abcdefghij	ab	3.10	efgh	b
	150	116.70	abc	a	0.54	bcdef	a	2.10	abcd	a	3.70	bcdef	ab
Isd	Isd	24.60	na	na	0.09	na	na	0.50	na	na	1.00	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