

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:	GAWE06324-2
Season/year:	Winter 2024
Farm name and Location:	"Pier Pier", Coonamble
Grower/co-operator:	Jack Brennan
Agronomist/trial partner:	Will Archer

Keywords

GAWE063, wheat, WeedSmart, Big6, plant populations, competition, varieties, sowing rates, Coonamble

Take home messages

- Increasing sowing rates and crop populations did not negatively impact yields.
- Increasing sowing rates and crop populations had no practical effect on screenings or protein.
- Increasing sowing rates, increased crop populations and presumably weed competition.
- Quicker growing varieties, such as Condo^A, Coolah, LRPB Lancer and LRPB Raider, may be a better choice in paddocks with problem weeds than a slower variety such as Beckom, LRPB Hellfire and Mustang.
- Increasing sowing rates and choosing a variety with early season vigour are recommended in paddocks with problem weeds.

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 some 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 is likely to be one of the easiest weed management tools that growers can adopt.

This trial focuses on the impact on yield and grain quality when increasing crop competitiveness through increased sowing rates and varietal choice.

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.

Treatment descriptions

Eight main season varieties commonly grown in the GOA region were sown at 4 target plant populations (Table 1).

The 2 lower seeding rates, 30 and 70 plants/m², are indicative of the recommended plant population range for Northern NSW (30–70 plants/m²), and the 2 higher seeding rates, 110 and 150 plants/m², are indicative of 50% and 100% higher seeding rates, respectively, of the recommended sowing range ³.

¹ US00084 <https://www.csu.edu.au/research/gulbali/research/food-beverage-agricultural-innovation/projects/innovative-crop-weed-control-for-northern-region-cropping-systems>

² <https://www.weedsmart.org.au/big-6/>

³ GRDC GrowNote, Wheat - Northern region, https://grdc.com.au/__data/assets/pdf_file/0025/370672/GrowNote-Wheat-North-03-Planting.pdf

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Table 1: Varieties (sorted from earliest to latest recommended sowing times), target plant populations and actual sowing rates⁴.

Sowing rate (kg/ha)	Target population (plants/m ²)					
	30	70	110	150	Breeder	Growth habit
Beckom	13	33	58	88	AGT	Short plant type
LRPB Lancer	15	38	66	100	Pacific	Short-medium plant type
LRPB Reliant	15	39	68	104	Pacific	Medium plant type
Condo	17	43	75	114	AGT	Tall plant type
LRPB Mustang	16	41	72	110	Pacific	Medium Plant type
LRPB Raider	15	39	68	104	AGT	Short plant type
Coolah	16	41	71	108	AGT	Tall plant type
LRPB Hellfire	17	44	77	118	Pacific	Medium plant type
ESTABLISHMENT FACTOR	0.90	0.82	0.74	0.66	-	-

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.

Rainfall

At Coonamble in 2024, the season was above average. The in-crop rainfall was ~186.3 mm (Table 2).

⁴ Growth habit adapted from NSW Winter crop variety sowing guide 2024

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Table 2: Monthly rainfall⁵ (mm) and long-term average (LTA) at trial site

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	In crop rainfall
2024	75	31	21	40	43	66	30	33	13	56	68	70	546	186
LTA	56	48	39	31	34	35	32	24	28	37	41	43	448	-

Results

Results were analysed by ANOVA and results compared by using an LSD method with a 95% confidence interval. Any references to differences between treatments should be assumed to be statistically different unless otherwise stated. The full list of results is provided in the appendix.

Plant populations:

- Establishment declined with increasing plant populations and the actual establishment achieved was slightly lower than targeted (Table 3).

Table 3: 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	83	95
70	0.82	76	95
110	0.74	65	91
150	0.66	55	86

Plant establishment

- Plant establishment was close to the targeted population, and for each variety the established populations were different except for the 2 highest populations of Coolah^A (Figure 1).

⁵ Gridded data for the trial site from: Access Gridded Data | LongPaddock | Queensland Government

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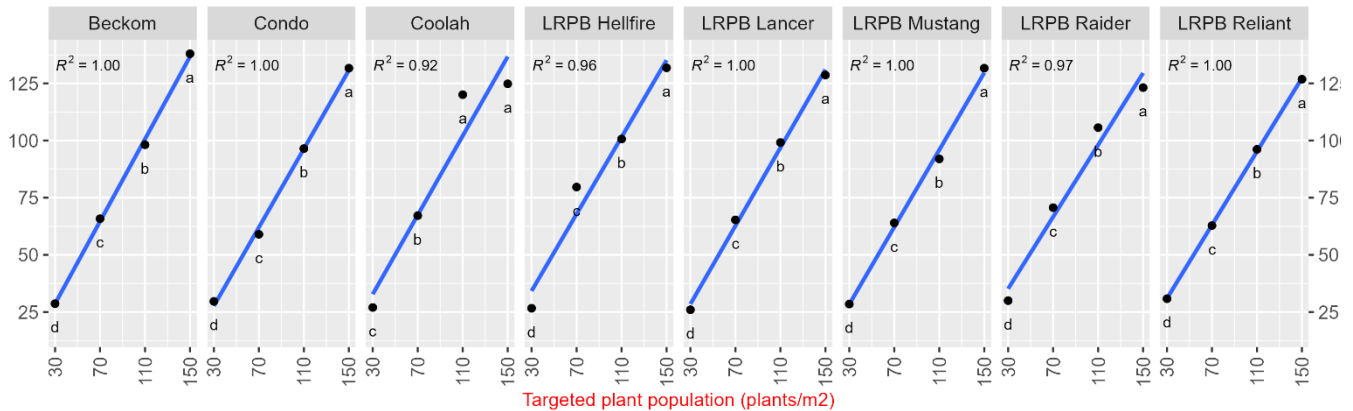


Figure 1: Plant establishment (plants/m²) by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

Vegetation index (VI)

VI was measured with a handheld Trimble Ag Greenseeker which records the normalized difference vegetation index (NDVI) ranging from 0.00 to 0.99. The higher numbers indicate a greater density of green material and are an indicator of crop competition. The VI was assessed 67 days after sowing, and when most of the treatments were at canopy closure.

- The VI was lowest for all varieties at 30 plants/m² target population (Figure 2).
- The VI for Coolah^A and Hellfire was the same at 70, 110 and 150 plants/m² populations.
- The VI for Beckon^A, Condo^A, Lancer^A, Raider^A, and Reliant^A was the same at the 2 higher populations.

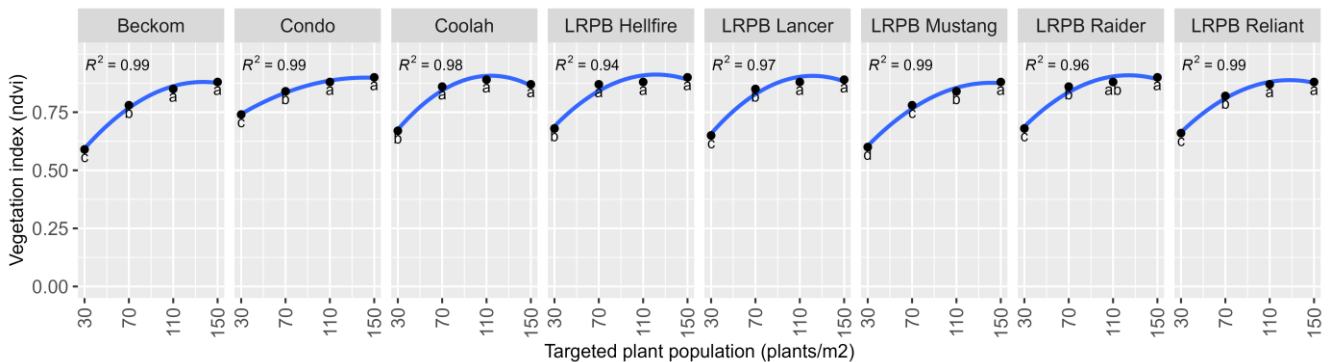


Figure 2: Vegetation index (NDVI) 67 days after sowing by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Yield

- Yields were high, with most treatments yielding >5 t/ha (the long-term average wheat yield for NSW is 1.93 t/ha (Figure 3)).
- For all varieties except Lancer^A, the lowest population resulted in the lowest yield.
- For all varieties except Lancer^A, there was no difference in yield between the 3 highest populations.
- For Lancer^A, yield increased as population increased.

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- There were no cases where any of the three highest populations yielded lower than the lowest population.

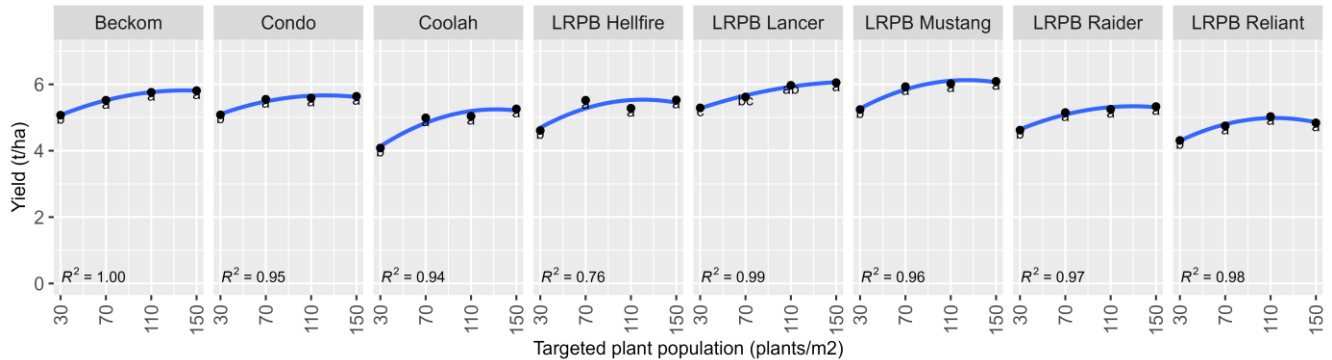


Figure 3: Yield by variety. Treatments with the same letter are not significantly different.

Protein

- Population had no effect on protein in Reliant^A.
- For all varieties aside from Reliant^A, the highest 2 populations reduced protein compared to the lowest population.
- In Beckom^A, Condo^A, Lancer^A, and Raider^A, there was no difference in protein between the 2 lowest populations.
- In all varieties except Lancer^A, there was no difference in protein between the 2 middle populations.

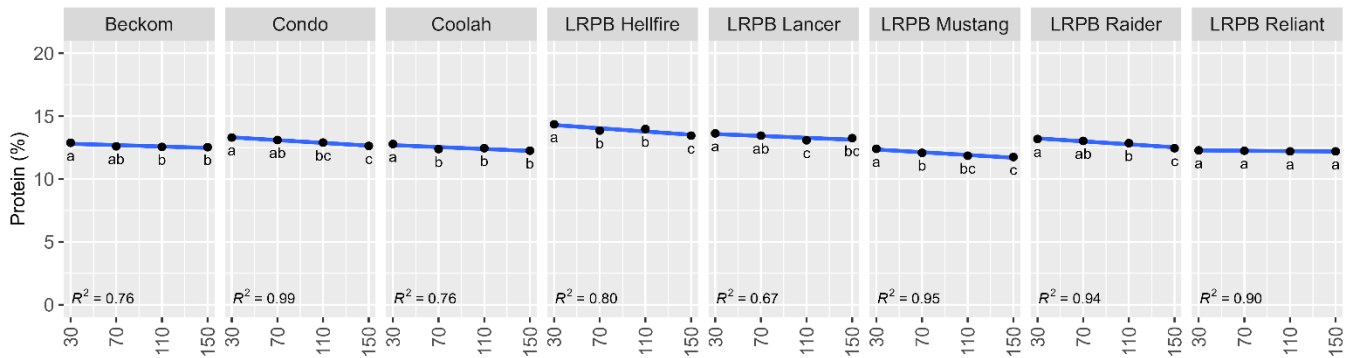


Figure 4: Wheat protein (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Screenings

- Apart from the lowest or 2 lowest populations in Beckom^A, Coolah^A, Raider^A, and Reliant^A, all screenings were below 5%, the threshold for moving to a lower bin grade.
- For all varieties tested, increasing population had either no effect on or reduced screenings.

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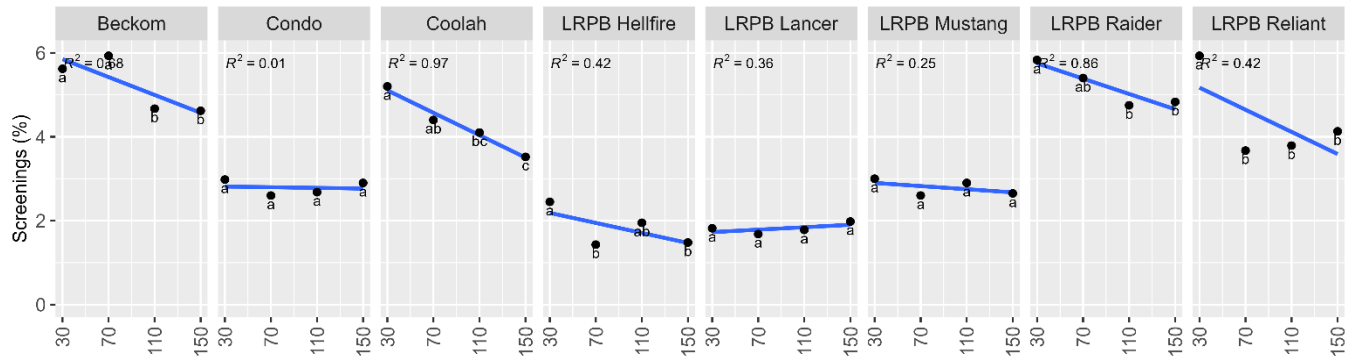


Figure 5: Wheat screenings (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Discussion

The 2024 season was above average for in-crop rainfall, which was 186.3mm. The resulting 2024 wheat crop was above average for the region, the mean site yield was 5.3 t/ha (Figure 3), and the mean site protein levels were 13% (Figure 4).

Generally, growers target ~50 plants/m² i.e. sowing rates of 25-35 kg/ha in low rainfall environments. Some research looking at row spacing suggests that increasing populations results in decreased establishment, possibly due to competition between germinating seeds in the row.

It is generally accepted that germination rates can be reduced at higher sowing rates. A 90% establishment factor was assumed at a target of 30 plants/m² and a 66% establishment factor for 150 plants/m². Plant establishment was close to the target populations, which 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 close to 1.7 t/ha difference between the highest (6.1 t/ha) and lowest (4.3 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 LRPB Hellfire had 12% higher NDVI reading than Beckom where both had a target population of 70 plants/m². This supports the idea that using higher sowing rates can improve crop competition as a weed control 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 compared to the lowest target population regardless of variety. There were also no grain quality effects that would result in a downgrade in the binned grade.

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. 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).

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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) in a practical way. 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

Variety	Target population	Plant establishment			Vegetation index			Yield			Screenings		
		(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	28.70	h	d	0.59	l	c	5.10	hij	b	5.60	a	a
	70	65.80	fg	c	0.78	i	b	5.50	efg	a	5.90	a	a
	110	98.20	d	b	0.85	efgh	a	5.80	abcde	a	4.70	bcd	b
	150	138.00	a	a	0.88	abcdef	a	5.80	abcde	a	4.60	bcd	b
Condo	30	29.70	h	d	0.74	j	c	5.10	hij	b	3.00	gh	a
	70	59.00	g	c	0.84	gh	b	5.50	defg	a	2.60	hij	a
	110	96.50	d	b	0.88	abcde	a	5.60	cdef	a	2.70	hi	a
	150	131.70	ab	a	0.90	a	a	5.60	bcdef	a	2.90	gh	a
Coolah	30	27.00	h	c	0.67	k	b	4.10	m	b	5.20	abc	a
	70	67.20	fg	b	0.86	defg	a	5.00	hijk	a	4.40	cde	ab
	110	120.10	bc	a	0.89	abcde	a	5.00	hij	a	4.10	def	bc
	150	124.80	ab	a	0.87	abcdef	a	5.30	fgh	a	3.50	fg	c
LRPB Hellfire	30	26.70	h	d	0.68	k	b	4.60	kl	b	2.50	hijk	a
	70	79.70	ef	c	0.87	bcdefg	a	5.50	efg	a	1.40	l	b
	110	100.70	d	b	0.88	abcde	a	5.30	fgh	a	2.00	ijkl	ab
	150	131.80	ab	a	0.90	abc	a	5.50	efg	a	1.50	l	b
LRPB Lancer	30	26.00	h	d	0.65	k	c	5.30	fgh	c	1.80	jkl	a
	70	65.30	fg	c	0.85	fgh	b	5.60	cdef	bc	1.70	kl	a
	110	99.20	d	b	0.88	abcde	a	6.00	abc	ab	1.80	kl	a
	150	128.70	ab	a	0.89	abcd	a	6.00	a	a	2.00	ijkl	a
LRPB Mustang	30	28.50	h	d	0.60	l	d	5.20	fgh	b	3.00	gh	a
	70	64.00	g	c	0.78	i	c	5.90	abcd	a	2.60	hij	a
	110	92.00	de	b	0.84	gh	b	6.00	ab	a	2.90	gh	a
	150	131.70	ab	a	0.88	abcde	a	6.10	a	a	2.70	hi	a
LRPB Raider	30	30.00	h	d	0.68	k	c	4.60	kl	b	5.80	a	a
	70	70.70	fg	c	0.86	cefg	b	5.10	ghi	a	5.40	ab	ab
	110	105.70	cd	b	0.88	abcde	ab	5.30	fghi	a	4.80	bcd	b
	150	123.20	ab	a	0.90	ab	a	5.30	fgh	a	4.80	bcd	b
LRPB Reliant	30	30.80	h	d	0.66	k	c	4.30	lm	b	5.90	a	a
	70	62.80	g	c	0.82	h	b	4.80	jk	a	3.70	efg	b
	110	96.20	d	b	0.87	abcdef	a	5.00	hij	a	3.80	ef	b
	150	126.80	ab	a	0.88	abcde	a	4.80	ijk	a	4.10	def	b
lsd	lsd	15.50	na	na	0.03	na	na	0.40	na	na	0.80	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