# 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:** | GAWE06324-1 |
| **Season/year:** | Winter 2024. |
| **Farm name and Location:** | "Dysart", Tottenham. |
| **Grower/co-operator** | Paul Adams. |


## Keywords

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


## Take home messages

- Increasing sowing rates and crop populations did not decrease yields.
- Increasing sowing rates and crop populations had no effect on screenings or protein.
- 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 with problem weeds.

## Background

Improving weed control by improving crop competitiveness is well documented. This can 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 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

## Treatment descriptions

- Eight main season varieties commonly grown in the GOA region were sown at 4 target plant populations (Table 1).
- The lower seeding rates, 30 and 70 plants/$m^2$, are indicative of the recommended plant population range for Northern NSW (30–70 plants/$m^2$),
- The higher seeding rates, 110 and 150 plants/$m^2$, 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

# GOA trial site report

Table 1: Varieties (sorted from earliest to latest recommended sowing times), target plant populations and actual sowing rates[4].

| Sowing rate (kg/ha) | Target population (plants/m$^2$) | | | | | |
|---|---|---|---|---|---|---|
| **Variety** | **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 was selected in the western areas of the GOA region where the adoption of higher sowing rates as a weed control tool is lower. Trials were placed in paddocks with a good rotational history to minimise disease risk.

**Rainfall:**

The 2024 season was above average in Tottenham, with an in-crop rainfall of ~178 mm (Table 2).

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

Table 2: Monthly rainfall[5] (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** | 82 | 49 | 46 | 54 | 100 | 25 | 42 | 37 | 19 | 28 | 70 | 68 | **620** | 178 |
| **LTA** | 47 | 46 | 42 | 34 | 37 | 35 | 30 | 30 | 28 | 40 | 38 | 45 | **452** | - |

## 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 t |
|---|---|---|---|
| **30** | 0.90 | 78 | 90 |
| **70** | 0.82 | 74 | 93 |
| **110** | 0.74 | 67 | 94 |
| **150** | 0.66 | 61 | 95 |

**Plant establishment**

- Plant establishment was close to the targeted population, and for each variety the established populations were different from each other (Figure 1).

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

# GOA trial site report

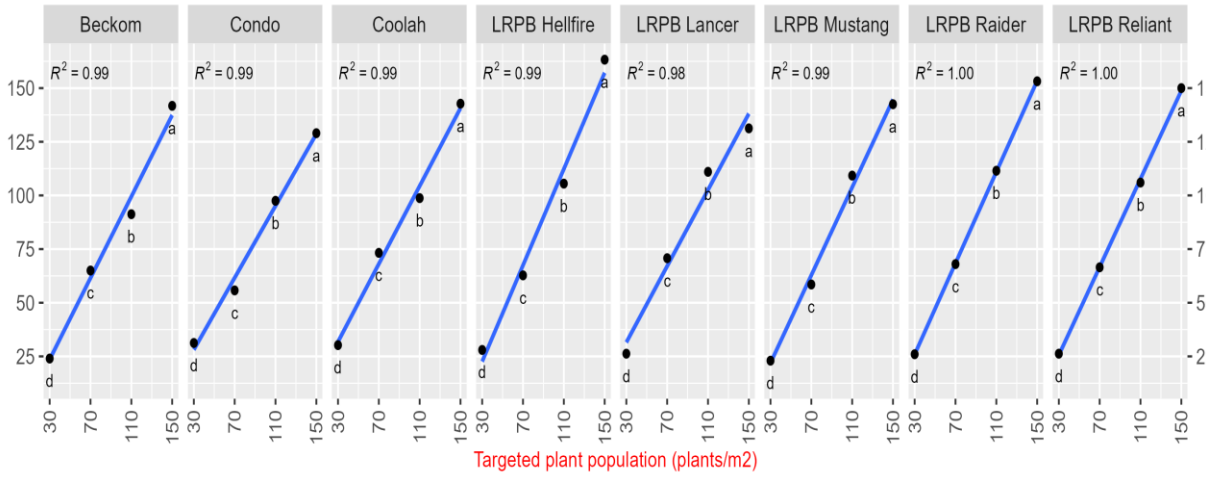


Figure 1: Plant establishment (plants/m$^2$) by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

**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. The higher numbers indicate a greater green material density and is an indicator of crop competition. VI was assessed 96 days after sowing, when most of the treatments were at canopy closure.

- The VI was lowest for all varieties at 30 plants/m$^2$ target population (Figure 2).
- The VI increased or remained the same as the population increased for every variety tested.
- The VI was lower at 70 plants/m$^2$ than the 2 highest populations for Condo$^A$, LRBP Mustang$^A$, and LRBP Reliant$^A$.
- The VI for Coolah$^A$ and LRBP Lancer$^A$ was the same at 70, 110, and 150 plants/m$^2$.
- The VI for Beckom, Coolah$^A$, LRPB Hellfire$^A$, and LRBP Lancer$^A$ was the same at 70 and 110 plants/m$^2$
- The VI for all varieties was the same at the 2 higher populations.
- The highest population of Condo$^A$ and Lancer$^A$ had the highest VI of all varieties.

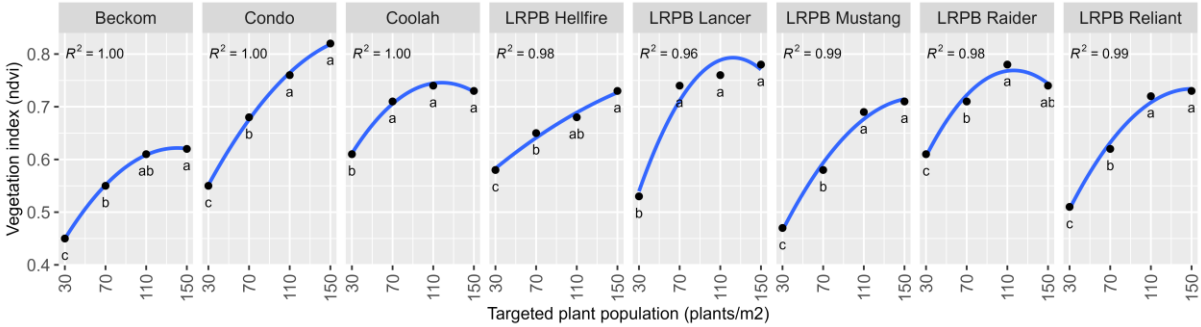


Figure 2: Vegetation index (NDVI) 96 days after sowing by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

# GOA trial site report

**Yield:**

- The yields were high. Most treatments yielded over 4 t/ha (the long-term average wheat yield for NSW is 1.93 t/ha (Figure 3)).
- The lowest population resulted in the lowest yield for all varieties tested.
- There was no yield difference between the 3 highest populations of Beckom[A], Condo[A], Coolah[A], LRPB Hellfire[A], LRBP Lancer[A], and LRPB Raider[A].
- LRBP Mustang[A] and LRBP Reliant[A] yields increased as population increased from 70 to 110 plants/m$^2$.

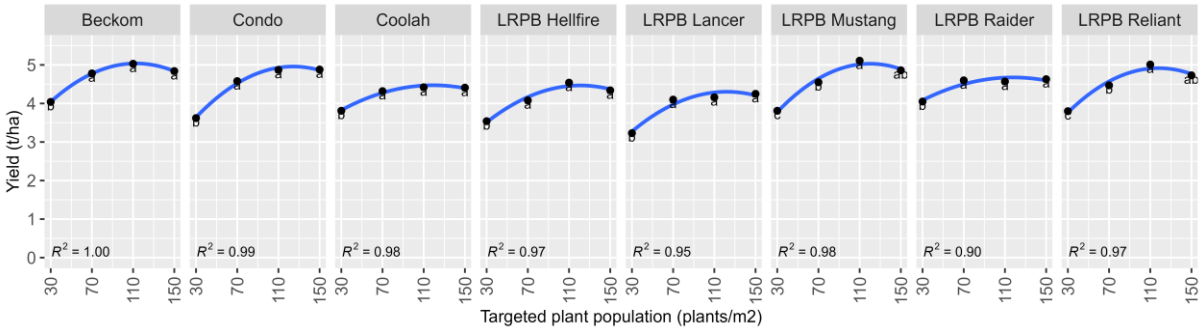


Figure 3: Yield by variety. Treatments with the same letter are not significantly different.

**Protein**

- Protein levels were not influenced by population for LRPB Mustang[A] and LRBP Reliant[A] (Figure 4).
- Protein levels decreased marginally with increasing populations for the remaining 6 varieties, except for LRPB Hellfire[A] which had the same protein at the lowest and highest populations.

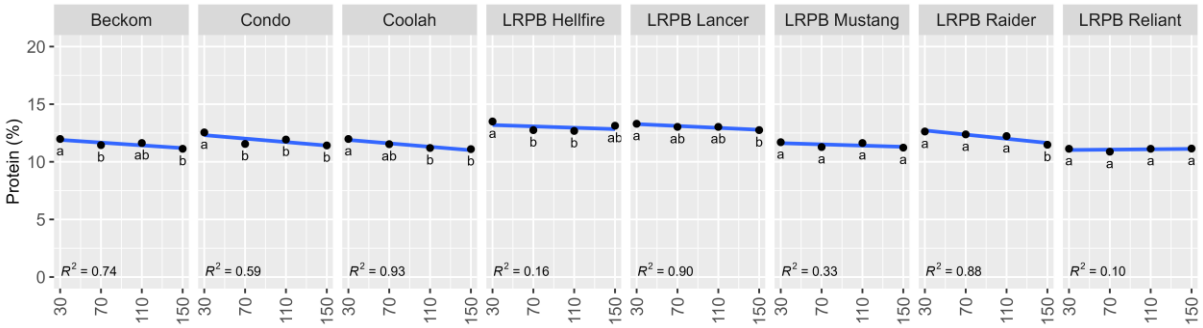


Figure 4: Wheat protein (%) by variety and targeted plant population (plants/m$^2$). Treatments with the same letter within a variety are not significantly different.

**Screenings**

- All screenings were below 5%, the quality threshold before moving to a lower bin grade (Figure 5).
- For all varieties except for Beckom[A], increasing the population had no effect or marginally decreased screenings.
- Beckom had higher screenings at the highest population.

# GOA trial site report

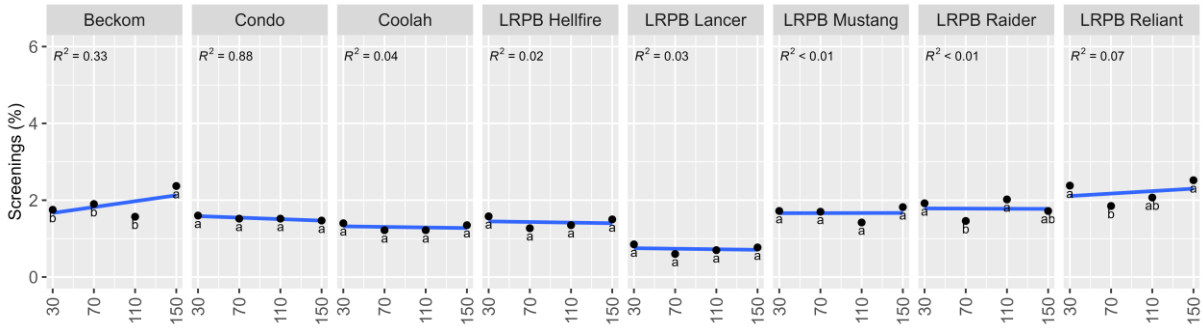


Figure 5: Wheat screenings (%) by variety and targeted plant population (plants/m$^2$). Treatments with the same letter within a variety are not significantly different.

## Discussion

2024 was a wet year and the in-crop rainfall at this site was in the order of 178 mm, resulting in an above average yield for 2024. The mean site yield was 4.4 t/ha (Figure 3)) and mean protein levels were 12% (Figure 4).

Generally, growers target ~50 plants/m$^2$ i.e. sowing rates of 25-35 kg/ha in low rainfall environments. Some of the research into row spacing suggests that increasing the plant population decreases plant establishment, possibly due to inter-row competition between germinating seeds.

Germination rates can be reduced at higher sowing rates. A 90% establishment aimed at a target population of 30 plants/m$^2$ and 66% establishment at 150 plants/m$^2$. The fact that plant establishment was close the target populations support 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 close to 2.5 t/ha difference between the highest (5.1 t/ha) and lowest (2.6 t/ha) yielding treatments.

At mid-season there was a clear indication that the lowest populations had the lowest VI regardless of variety. There were considerable varietal differences in VI, for example Condo$^A$ had 24% higher NDVI reading than Beckom$^A$,where both had a target population of 70 plants/m$^2$. This supports the use of higher sowing rates 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/m$^2$ (roughly 3 times the district average), did not reduce yields when compared to the lowest target population regardless of variety. There was also no effect on grain quality 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 perceptions of yield instability may have occurred where other factors were at play, such as the presence of 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).

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 fact, evidence from this trial showed that yields and screenings were the same or better at higher sowing rates as low sowing rates.

## Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the Grains Research and Development Corporation (GRDC), the authors would like to thank them for their continued support. Special thanks go out to Paul Adams who hosted this trial.

## DISCLAIMER — TECHNICAL

# GOA trial site report

## Appendix

| | | Plant establishment | | | Vegetation index | | | Yield | | | Screenings | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variety | Target population | (plants/m2) | | | (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 | 24.00 | h | d | 0.45 | m | c | 4.00 | lmn | b | 1.80 | cdefghi | b |
| | 70 | 65.00 | fg | c | 0.55 | jkl | b | 4.80 | abcdefg | a | 1.90 | cdef | b |
| | 110 | 91.20 | e | b | 0.61 | hij | ab | 5.00 | ab | a | 1.60 | efghijk | b |
| | 150 | 141.70 | bc | a | 0.62 | fghi | a | 4.80 | abcdef | a | 2.40 | ab | a |
| Condo | 30 | 31.30 | h | d | 0.55 | jkl | c | 3.60 | nop | b | 1.60 | defghijk | a |
| | 70 | 55.70 | g | c | 0.68 | defg | b | 4.60 | bcdefghi | a | 1.50 | efghijk | a |
| | 110 | 97.50 | de | b | 0.76 | abc | a | 4.90 | abcde | a | 1.50 | efghijk | a |
| | 150 | 129.00 | c | a | 0.82 | a | a | 4.90 | abcd | a | 1.50 | fghijk | a |
| Coolah | 30 | 30.30 | h | d | 0.61 | hij | b | 3.80 | mno | b | 1.40 | hijk | a |
| | 70 | 73.20 | f | c | 0.71 | cde | a | 4.30 | ghijkl | a | 1.20 | kl | a |
| | 110 | 98.70 | de | b | 0.74 | bcd | a | 4.40 | efghijkl | a | 1.20 | kl | a |
| | 150 | 142.80 | bc | a | 0.73 | bcd | a | 4.40 | fghijkl | a | 1.30 | ijk | a |
| LRPB Hellfire | 30 | 28.00 | h | d | 0.58 | ijk | c | 3.50 | op | b | 1.60 | efghijk | a |
| | 70 | 62.70 | fg | c | 0.65 | efgh | b | 4.10 | klm | a | 1.30 | jkl | a |
| | 110 | 105.50 | de | b | 0.68 | def | ab | 4.50 | defghijk | a | 1.30 | ijk | a |
| | 150 | 163.20 | a | a | 0.73 | bcd | a | 4.30 | ghijkl | a | 1.50 | efghijk | a |
| LRPB Lancer | 30 | 26.30 | h | d | 0.53 | kl | b | 3.20 | p | b | 0.80 | lm | a |
| | 70 | 70.70 | fg | c | 0.74 | bcd | a | 4.10 | jklm | a | 0.60 | m | a |
| | 110 | 111.00 | d | b | 0.76 | abc | a | 4.20 | ijklm | a | 0.70 | m | a |
| | 150 | 131.20 | c | a | 0.78 | ab | a | 4.20 | hijklm | a | 0.80 | m | a |
| LRPB Mustang | 30 | 23.00 | h | d | 0.47 | m | c | 3.80 | mno | c | 1.70 | cdefghi | a |
| | 70 | 58.50 | fg | c | 0.58 | ijk | b | 4.60 | cdefghij | b | 1.70 | cdefghij | a |
| | 110 | 109.20 | d | b | 0.69 | de | a | 5.10 | a | a | 1.40 | ghijk | a |
| | 150 | 142.50 | bc | a | 0.71 | cde | a | 4.90 | abcdef | ab | 1.80 | cdefgh | a |
| LRPB Raider | 30 | 26.00 | h | d | 0.61 | hij | c | 4.10 | lmn | b | 1.90 | cde | a |
| | 70 | 68.00 | fg | c | 0.71 | cd | b | 4.60 | bcdefghi | a | 1.50 | fghijk | b |
| | 110 | 111.50 | d | b | 0.78 | ab | a | 4.60 | cdefghi | a | 2.00 | bcd | a |
| | 150 | 153.20 | ab | a | 0.74 | bcd | ab | 4.60 | bcdefgh | a | 1.70 | cdefghi | ab |
| LRPB Reliant | 30 | 26.30 | h | d | 0.51 | lm | c | 3.80 | mno | c | 2.40 | ab | a |
| | 70 | 66.50 | fg | c | 0.62 | ghi | b | 4.50 | defghijkl | b | 1.80 | cdefg | b |
| | 110 | 106.00 | de | b | 0.72 | cd | a | 5.00 | abc | a | 2.10 | abc | ab |
| | 150 | 150.00 | ab | a | 0.73 | bcd | a | 4.70 | abcdefgh | ab | 2.50 | a | a |
| lsd | lsd | 16.30 | na | na | 0.06 | na | na | 0.50 | na | na | 0.40 | 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