

GOA trial site report

Improving confidence in high wheat plant populations as a weed control tool in lower rainfall environments, Tottenham.

Grain Orana Alliance

Trial code:	GAWE06322-1
Season/year:	Winter 2022
Location:	Tottenham
Trial partners:	Greg Radford
Trial establishment date:	24/05/2022

Keywords

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

Key findings

- Increasing sowing rates increased crop populations and assumedly weed competition. Varieties that reach peak biomass earlier may be better choices in paddocks where weeds are a problem.
- Higher sowing rates did not cause any decrease in yields.
- Increasing sowing rates and crop populations did not result in higher screenings.
- Some varieties (such as Condo^{db}) had 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 done via several practical measures such as decreasing row spacing and increasing plant populations. A key barrier to adoption, particularly in marginal, lower rainfall environments, is the perceived yield instability and risks of increasing screenings at harvest time. Growers are also reluctant to decrease row spacing as this can impede trash flow with tyne planters, particularly in minimum tillage farming systems. Moving to narrower row spacing usually requires an additional investment in machinery and moving to higher sowing rates can also increase costs.

GOA trial site report

Recent research, such as US00084 ¹, has also demonstrated changes in crop competitiveness through variety, population, spacing and crop choice, require 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 for grower adoption.

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

Aims

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

Methodology

Trial design	
Sowing date	24/05/2022
Harvest date	15/12/2022
Sowing equipment	Knife point press wheel
Fertiliser	P: 75 kg/ha MAP (with seed) N: 100 kg/ha Urea (IBS) N: 140 L/ha UAN
Varieties	8 varieties commonly grown in the region (see below)
Target populations	30, 70, 110 and 150 plants/m ²
Replications	4
Analysis	ANOVA (ASREML)
Confidence interval	95%
Design	Randomized complete block

Site Selection:

¹ <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/>

GOA trial site report

The site was selected in the western area of the GOA 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: Tottenham rainfall for 2022 and the long-term average (LTA).

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2022	54	36	53	114	98	5	38	87	81	212	106	22	906
LTA	48	48	43	35	37	36	33	32	30	42	41	45	470

Treatments

A combination of 4 target populations and 8 varieties (Table 1).

Table 1: Varieties (earliest to latest recommended sowing times), target plant populations and actual sowing rates used at Tottenham 2022^{3^} (growth habit descriptions: NSW Winter Crop Variety Sowing Guide 2022).

Variety	Growth habit	Target population (plants/m ²) and sowing rate (kg/ha)			
		30	70	110	150
Coolah	Tall plant type	13	33	57	88
LRPB Flanker	Tall plant type	11	28	48	74
LRPB Lancer	Short-medium plant height	12	31	54	82
Beckom	Short plant type	11	29	50	77
Condo	Tall plant type	11	29	51	78
LRPB Mustang	Medium plant type	11	28	49	75
LRPB Spitfire	Medium plant type	12	31	55	84
Vixen	Short-medium plant height	14	37	64	98

³ Growth habit adapted from NSW Winter crop variety sowing guide 2022, https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1454188/Winter-crop-variety-sowing-guide-2023.pdf

GOA trial site report

Results

Plant populations:

Growers generally target ~50 plants/m² i.e. sowing rates of 25-35 kg/ha, in the low rainfall GOA areas. Some research into row spacing suggests that increasing the population results in decreased plant establishment, possibly due to competition between germinating seeds in the row. The establishment percentage (i.e. the percent of seed sown that emerges) declined with increasing plant populations, even though the establishment was higher than targeted (Table 2).

Table 2: Target populations, establishment factor, actual establishment and the establishment %.

Target population (plants/m ²)	Establishment factor	Actual establishment (%)	Establishment as a percentage of target (%)
30	0.90	113	130
70	0.82	87	109
110	0.74	75	105
150	0.66	68	106

Plant establishment:

The plant establishment was close to the targeted population, and for each variety the established populations were different except for the 2 middle populations of Coolah^d and the 2 highest populations of LRPB Flanker^d (Figure 1). These differences give confidence that any subsequent differences in yield (and other variables) between populations are because of treatment effects.

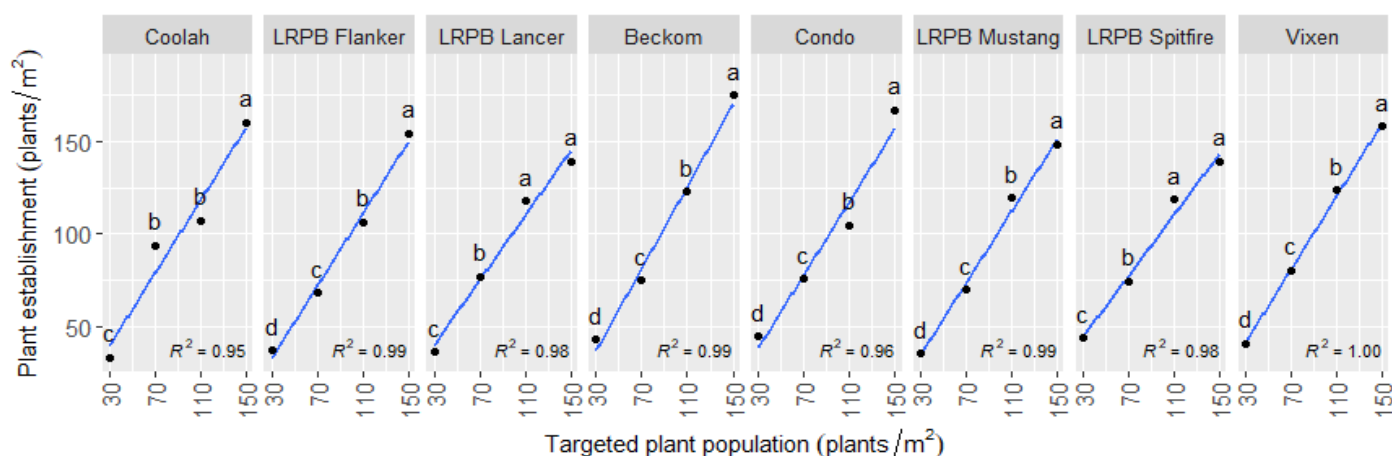


Figure 1: Plant establishment (plants/m²) by variety and targeted plant population. Treatments with the same letter within a variety are not significantly different.

Vegetation index :

GOA trial site report

The VI was measured with a handheld 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 are an indicator of crop competition. VI was assessed 84 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[Ⓛ], Beckom[Ⓛ], Mustang[Ⓛ] and Vixen[Ⓛ] was the same for each variety at the 3 higher populations.
- The VI for Flanker[Ⓛ], Lancer[Ⓛ], Condo[Ⓛ] and Spitfire[Ⓛ] was the same at the 2 higher populations.
- At the highest population Condo[Ⓛ] had the highest VI of all varieties (except for Spitfire[Ⓛ] @ 110 plants/m²).

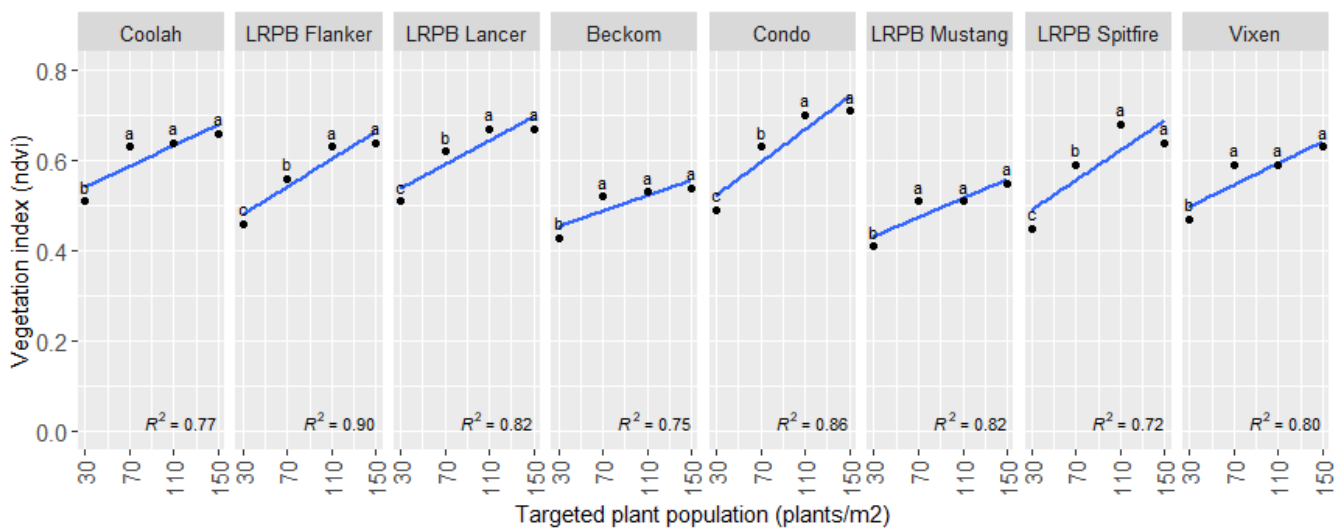


Figure 2: Vegetation index on the 16/8/2022 (84 days after sowing) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Yield:

- Yields were high, with several treatments yielding well over 4 t/ha (the long-term average wheat yield for NSW is 1.93 t/ha⁴).
- For 3 of the 8 varieties, yields at the target population of 30 plants/m² were lower than the higher plant populations.
- The higher sowing rates did not cause any decrease in yields (Figure 3).

⁴ <https://research.csiro.au/digiscape/digiscapes-projects/wheat-yield-forecasts/>

GOA trial site report

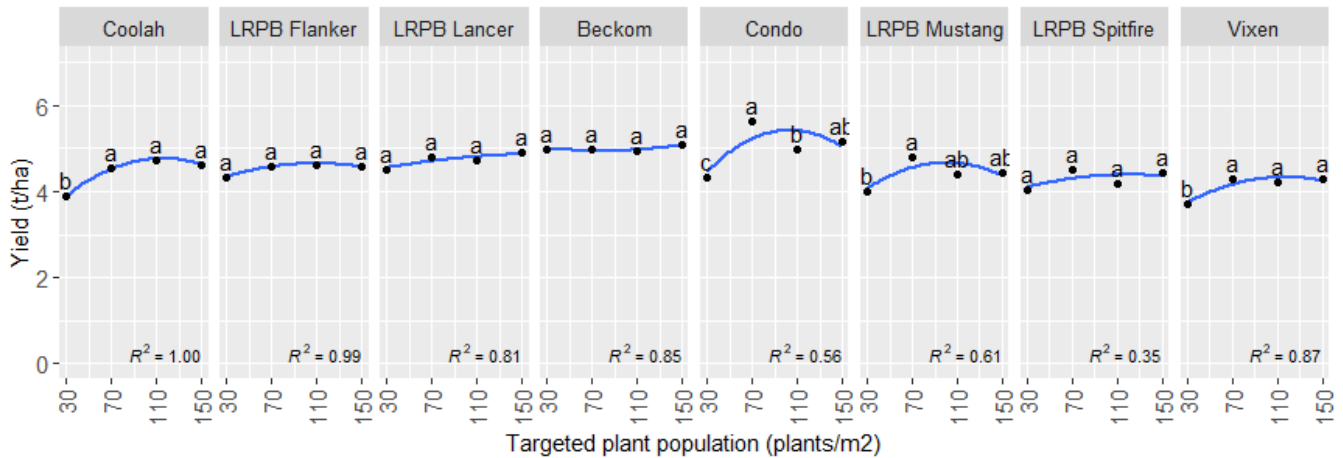


Figure 3: Wheat yield (t/ha) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Protein:

Protein levels declined with increasing populations in all varieties except LRPB Mustang[Ⓛ]. This may be due to yield dilution effects (Figure 4).

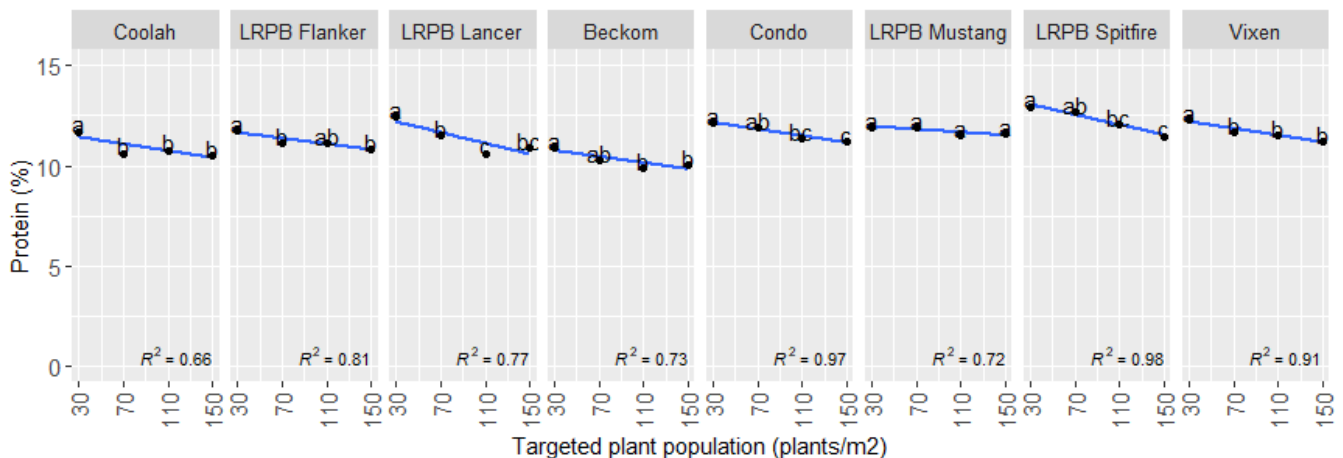


Figure 4: Wheat protein (%) by variety and targeted plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Screenings:

For 7 of the 8 varieties, population had little or no effect on screenings. LRPB Spitfire[Ⓛ] had higher screenings at the lowest population (Figure 5). Five of the 8 varieties were <5% screening threshold (across all populations) which may see them obtaining a higher binned grade.

GOA trial site report

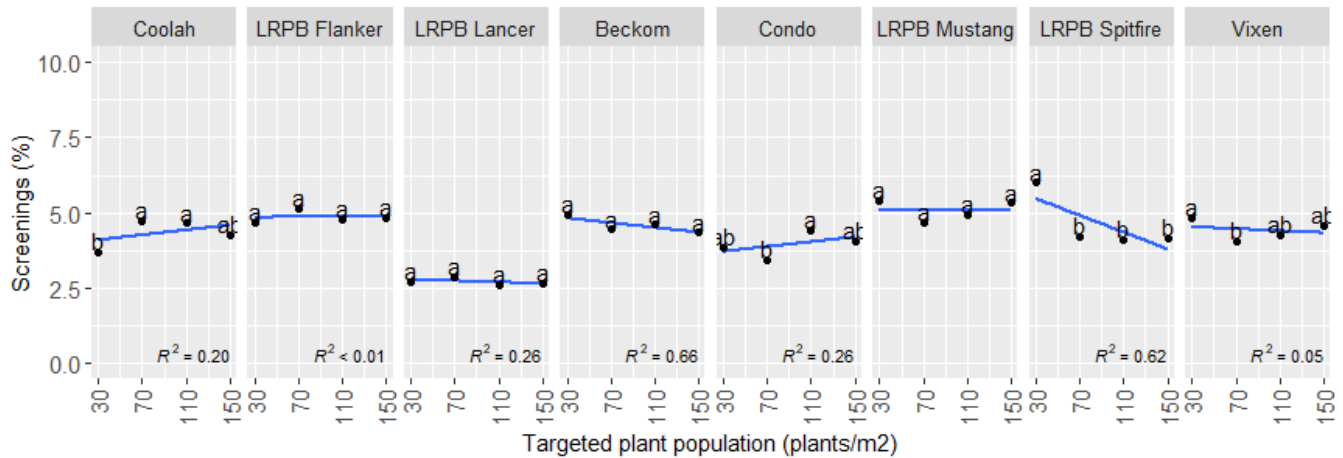


Figure 5: Wheat screenings (%) by variety and target plant population (plants/m²). Treatments with the same letter within a variety are not significantly different.

Discussion

2022 was a very wet year, with an in-crop rainfall of 542.3mm, more than double the long-term average of ~210mm. This resulted in an above average yielding wheat crop. The average site yield was 4.6 t/ha (Figure 3), and average protein was 11% (Figure 4).

As sowing rates increased, the percentage of seed sown that emerged declined. In this trial the decline was close to 20%. Consequently, growers looking to achieve higher populations may need to increase sowing rates using an ‘establishment factor’.

At mid-season there was a clear indication that the lowest populations had the lowest VI (a measure of crop competition), regardless of variety. There were considerable VI varietal differences, for example Condo^(d) had 19% higher NDVI reading than Mustang^(d) where the target population was 70 plants/m². These results support using higher sowing rates as a crop competition tool and consideration could be given to selecting varieties that display vigorous early season growth.

There was a substantial yield response to both variety and population, with close to 2.3 t/ha difference between the highest (5.6 t/ha) and lowest (3.3 t/ha) yielding treatments. While all varieties had lower VI at the lowest plant population, only 3 had decreased yields, indicating that some varieties were able to compensate to maintain yields. For the varieties that had lower yields (at the lowest populations: Condo^(d), Mustang^(d) and Vixen^(d)) this could have been because of lower tiller numbers (not measured) or because of lower water use efficiency (a more open canopy resulting in greater ratio of evaporation to evapotranspiration (not assessed)).

Increasing plant populations, even to the very high levels of ~150 plants/m² (roughly 3 times the district average), did not reduce yields regardless of variety, nor was there any effects on grain quality that would result in a downgrade in the ‘binned grade’. The fact that yields and quality did not decline at higher sowing rates suggests that experiences of yield instability may be due to other factors, such as diseases including crown rot. Other factors that may contributed to this yield stability may be related earlier row closure allowing for a better water use efficiency (less surface evaporation).

GOA trial site report

These results may 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 above average rainfall year 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 Greg Radford who hosted this trial.

DISCLAIMER — TECHNICAL

This report has been prepared in good faith based on information available at the date of publication without any independent verification. The GRDC, and Grain Orana Alliance (GOA) do not guarantee or warrant the accuracy, reliability, completeness of currency of the information in this publication nor its usefulness in achieving any purpose.

Readers are responsible for assessing the relevance and accuracy of the content of this publication. The GRDC and GOA will not be liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on the information in this publication.

Products may be identified by proprietary or trade names to help readers identify types of products but this is not, and is not intended to be, an endorsement or recommendation of any product or manufacturer referred to. Other products may perform as well or better than those specifically referred to.

GOA trial site report

Appendix

Table 3: Trial results 2022

Target population (plants/m2)	Variety	Yield (t/ha)		Test weight (kg/hl)		Protein (%)		Screenings (%)		Vegetation index		Plant establishment (plants/m2)	
										NDVI (10/8/22)			
30	Beckom	4.99	bcd	75.2	defg	10.9	jklmn	4.93	bcde	0.43	pq	42.8	j
70		4.97	bcd	75.1	defgh	10.3	nop	4.45	defghi	0.52	lm	74.8	gh
110		4.94	bcd	74.3	h	9.9	p	4.60	cdefghi	0.53	klm	122.8	de
150		5.08	bc	74.2	h	10.0	op	4.35	efghij	0.54	kl	174.8	a
30	Condo	4.34	fghijk	77.0	a	12.1	bcde	3.87	ijk	0.49	mno	44.4	ij
70		5.64	a	76.8	a	11.9	cdefg	3.45	kl	0.63	defg	75.6	gh
110		4.99	bcd	76.4	abc	11.4	ghijk	4.42	defghij	0.70	ab	104.8	ef
150		5.17	ab	76.4	abc	11.2	hijkl	4.08	ghijk	0.71	a	166.7	ab
30	Coolah	3.90	kl	74.4	gh	11.7	defghi	3.70	jk	0.51	lmn	33.2	j
70		4.55	defgh	75.0	defgh	10.6	lmno	4.75	bcdefgh	0.63	efg	93.6	fg
110		4.73	bcdefg	74.8	efgh	10.8	klmn	4.65	cdefgh	0.64	cde	107.2	ef
150		4.63	cdefgh	75.4	def	10.5	mnop	4.28	efghij	0.66	bcde	160.0	abc
30	LRPB Flanker	4.34	fghijk	75.2	defg	11.8	defgh	4.70	bcdefgh	0.46	op	36.8	j
70		4.59	defgh	75.6	cde	11.1	ijklm	5.13	bcd	0.56	ijk	68.0	hi
110		4.63	cdefgh	75.8	bcd	11.1	hijkl	4.80	bcdefg	0.63	efg	106.4	ef
150		4.57	defgh	75.4	def	10.8	klmn	4.85	bcdef	0.64	def	154.4	abc
30	LRPB Lancer	4.52	defgh	76.8	a	12.4	abc	2.73	lm	0.51	lm	36.0	j
70		4.78	bcdef	77.2	a	11.5	efghij	2.87	lm	0.62	efgh	76.8	gh
110		4.73	bcdefg	77.1	a	10.6	lmno	2.60	m	0.67	bcd	117.6	de
150		4.89	bcde	77.1	a	10.9	jklmn	2.67	m	0.67	bcd	139.2	cd
30	LRPB Mustang	3.99	jkl	74.6	fgh	11.9	cdefg	5.40	ab	0.41	q	35.2	j
70		4.79	bcdef	75.1	defgh	11.9	cdefg	4.68	bcdefgh	0.51	lm	69.6	h
110		4.41	fghij	75.0	defgh	11.5	efghij	4.93	bcde	0.51	lm	119.2	de
150		4.44	efghij	74.6	fgh	11.6	efghi	5.33	abc	0.55	jkl	148.4	bc
30	LRPB Spitfire	4.03	ijkl	76.7	ab	12.9	a	6.00	a	0.45	opq	43.6	j
70		4.50	defghi	77.0	a	12.6	ab	4.22	efghij	0.59	hij	74.4	gh
110		4.18	hijkl	76.8	a	12.0	bcdef	4.12	fghijk	0.68	abc	118.4	de
150		4.42	efghij	77.0	a	11.5	fghij	4.17	fghijk	0.64	cde	139.2	cd
30	Vixen	3.71	l	72.7	ij	12.3	bcd	4.85	bcdef	0.47	nop	40.4	j
70		4.28	ghijk	72.8	i	11.6	efghi	4.05	hijk	0.59	ghi	80.0	gh
110		4.21	hijk	71.9	j	11.5	efghij	4.25	efghij	0.59	fghi	123.6	de
150		4.28	ghijk	72.0	ij	11.2	hijkl	4.57	defghi	0.63	defg	157.9	abc
lsd	lsd	0.48		0.9		0.6		0.73		0.04		23.9	