Compass and La Trobe: head to head from 25 to 400 plants/m^2 at York in 2014

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Key messages

- Sowing barley at very low seed rates (<50 plants/m^2) reduced the yield potential at this site by nearly 20%.
- Sowing barley at very high seed rates (>200 plants/m^2) did not reduce the grain yield at this site. There was however an impact on grain quality with a reduction in both the hectolitre weight and brightness of the grain.
- Despite large differences in their plant type Compass and La Trobe responded similarly to increasing seed rate.
- The optimum plant population for grain yield in this study was 129 plants/m^2, which is in line with the suggested target density for barley in Western Australia of 120 to 150 plants/m^2.
- The agronomic performance of Compass and La Trobe was not influenced by sowing in a narrow (2 to 3 cm) or a wider seeding band (4 to 5 cm).

Aims

The barley varieties Compass and La Trobe are likely to dominate Western Australia's barley production area in coming years, especially if Compass becomes an accredited malting variety just like La Trobe. Compass and La Trobe have a comparable grain yield when grown in Western Australia but differ in their phenology and plant architecture (Paynter *et al.* 2015). Compass is +3 to +4 days later to awn peep (Z49) than La Trobe when sown in May. Compass is best described as a medium spring variety with an erect early growth habit (with no dwarfing genes), a leafy plant architecture and of a tall height. La Trobe is best described as an early spring variety with an erectoides plant architecture (due to the semi-dwarfing gene *ari.GP*) and of medium height.

The purpose of this study was to compare the response of Compass and La Trobe to increasing seed rate when sown at two different row widths at the same row spacing. Can tillers compensate for low density and as such does Compass (being slightly later to flower) have more chance to compensate? How different are the inter-plant interactions due to sowing in a single or a twin row configuration? Do Compass and La Trobe react similarly to increasing seed rate even though their above ground plant architecture is different?

Method

The barley varieties Compass and La Trobe were sown in a small plot trial at York (red deep sandy duplex, sown 15 May 2014) in 2014 (May-Oct rainfall = 335 mm). The two barley varieties were evaluated for their response to six different seed rates (25, 50, 100, 150, 200 and 400 plants/m^2) with two different splitter boots (single row tail versus a twin row tail with a 65 mm splitter) over three replicates. The actual seed rates used ranged from 16 to 295 kg/ha in Compass and 13 to 231 kg/ha in La Trobe between the lowest and highest seed rate. 100 plants/m^2 was equivalent to 69 kg/ha in Compass and 54 kg/ha in La Trobe, with differences in seed rate due to differences in their kernel weight. The trial was sown as a split plot cyclic design with splitter type as whole plots and variety by seed rate randomised as subplots.

The trial was direct-drilled with a small plot air-seeder using Primary Sale coil tynes with Superseeder points at a row spacing of 22 cm and on-row press wheels. Barley seed was placed at 2 to 3 cm depth. A Summit NPK compound fertiliser was banded below the seed at 180 kg/ha and the plots were topdressed with CSBP NPK Blue at 250 kg/ha in front of the seeding bar. Weeds and diseases were controlled as required and the plots were harvested with a small plot harvester. Plots were assessed for establishment at 3 weeks after sowing (WAS) (plants/m^2), NDVI index (0-1) at 6, 10, 14 and 18 WAS, biomass (kg/ha) at maturity, head number (heads/m^2), grain number (grains/ear), harvest index (0-1), plant height (cm, base of ear) at maturity, lodging score (9–0) close to harvest, grain yield (t/ha), kernel weight (mg, db), hectolitre weight (kg/hL), screenings (% < 2.5 mm), grain protein concentration (%, db) and grain brightness (Minolta 'L*').

Data was analysed within Genstat (VSN International 2013) with a block structure of (rep+colrep)/splitter type/(variety x seed rate) and a treatment structure of splitter type x variety x seed rate.

The optimum plant population (actual establishment versus grain yield) was estimated using GenStat to fit an inverse polynomial model (LDL or QDL) forced through the origin as in Anderson *et al*. (2004). The optimum population for grain yield was defined as the point when the slope of the curve was 1.5 kg/ha of grain for each extra established plant/m^2.

Table 1. Analysis of variance of plant establishment and NDVI scoring of plots, plus average data for Compass and La Trobe.

ANOVA	Plant counts (plants/m^2)	NDVI – 6 WAS (0-1)	NDVI – 10 WAS (0-1)	NDVI – 14 WAS (0-1)	NDVI – 18 WAS (0-1)
Splitter (SP)	n.s.	n.s.	n.s.	n.s.	n.s.
Variety (V)	n.s.	<0.001	<0.001	0.002	<0.001
Seed rate (SR)	<0.001	<0.001	n.s.	0.023	0.005
SP x V	n.s.	n.s.	n.s.	n.s.	n.s.
SP x SR	n.s.	n.s.	n.s.	n.s.	n.s.
V x SR	n.s.	0.022	0.015	0.033	0.007
SP x V x SR	n.s.	n.s.	n.s.	n.s.	n.s.
Compass	187	0.515	0.684	0.578	0.486
La Trobe	184	0.385	0.599	0.545	0.443
LSD (p=0.05)	**n.s.**	**0.018**	**0.024**	**0.020**	**0.018**

Table 2. Analysis of variance of maturity cuts, plant height and lodging scores, plus average data for Compass and La Trobe.

ANOVA	Head no. (heads/m^2)	Grain no. (grains/ear)	Grains no. (grains/m^2)	Harvest index (0-1)	Plant height (cm)	Lodging (9-0)
Splitter (SP)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Variety (V)	<0.001	0.004	<0.001	0.024	<0.001	<0.001
Seed rate (SR)	<0.001	<0.001	<0.001	<0.001	<0.001	n.s.
SP x V	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
SP x SR	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
V x SR	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
SP x V x SR	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Compass	485	23.0	10,930	0.585	61	6.6
La Trobe	545	23.8	12,749	0.595	57	7.8
LSD (p=0.05)	**25**	**0.5**	**657**	**0.009**	**2**	**0.4**

Table 3. Analysis of variance of grain yield and grain quality, plus average data for Compass and La Trobe.

ANOVA	Grain yield (t/ha)	Kernel weight (mg, db)	Hectolitre weight (kg/hL)	Screenings (% < 2.5 mm)	Grain protein (%, db)	Grain brightness (Minolta 'L*')
Splitter (SP)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Variety (V)	n.s.	<0.001	<0.001	<0.001	<0.001	<0.001
Seed rate (SR)	<0.001	<0.001	<0.001	0.003	<0.001	<0.001
SP x V	n.s.	n.s.	0.036	n.s.	n.s.	n.s.
SP x SR	n.s.	n.s.	n.s.	0.014	n.s.	n.s.
V x SR	n.s.	n.s.	n.s.	0.019	n.s.	n.s.
SP x V x SR	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Compass	3.33	48.2	69.9	1.9	7.8	59.0
La Trobe	3.34	41.7	71.2	5.4	8.2	59.8
LSD (p=0.05)	**n.s.**	**0.3**	**0.2**	**0.3**	**0.1**	**0.2**

Results

The plots sown with the single row tail achieved an average plant row width of 2.3 ± 0.1 cm and the twin row tail 4.7 ± 0.1 cm. Establishment was above target being 36, 66, 124, 198, 267 and 441 plants/m^2 respectively when measured at 3 weeks after sowing. There were no differences in establishment due to variety or due to splitter type (Table 1).

Varietal differences

Compass produced more biomass than La Trobe at 6, 10, 14 and 18 WAS as indicated by the NDVI index (Table 1). At 6 WAS, Compass reached its maximum NDVI index at a lower plant density than La Trobe (Figure 1a). By maturity Compass plants were taller than La Trobe plants with a higher degree of lodging observed (Table 2).

Compass and La Trobe did not differ in their grain yield response to increasing seed rate or due to splitter type (Table 3). They achieved the same grain yield averaged across all treatments. The biological pathway in which they delivered their grain yield however differed. La Trobe achieved the same grain yield as Compass by producing 60 more tillers/m^2 and had nearly one more grain per ear than Compass. Compass compensated for the fewer tillers and the fewer grains pre ear by producing grains that were 16% heavier than La Trobe grains (Tables 2 and 3).

Compass and La Trobe did not differ in their grain quality response to increasing seed rate, except for screenings, or due to splitter type, except for hectolitre weight (Table 3). In both Compass and La Trobe there was a slight decrease in screenings followed by a slight increase as seed rate increased. In Compass the lowest screenings was achieved at the target seed rate of 50 plants/m^2, whereas in La Trobe it was achieved at the target seed rate of 150 plants/m^2

(Figure 1g). The hectolitre weight of Compass was slightly lower in the twin rows than in the single row plots, whereas the hectolitre weight in La Trobe was the same regardless of splitter type (data not shown).

Seed rate responses

Increasing seed rate (differences between 25 and 400 plants/m^2 treatments):

1. increased biomass at 6 WAS then plateaued, although response varietal dependent (Figure 1a),
2. produced more ground cover at lower seed rates, although response varietal dependent (Figure 1b),
3. increased tillers per m^2 by 86% or 312 tillers (Figure 1c),
4. decreased grains per ear by just under 8 grains per ear (Figure 1d),
5. increased grains per m^2 by 36% (data not shown),
6. decreased harvest index (Figure 1e),
7. decreased plant height by 7 cm (Figure 1f),
8. had no effect on straw strength or lodging resistance (data not shown),
9. increased grain yield by 19% before plateauing after 200 plants/m^2 (Figure 1g),
10. decreased kernel weight by just over 4 mg per grain (Figure 1h),
11. decreased hectolitre weight by 1.6 kg/hL (Figure 1i),
12. decreased screenings before increasing slightly with different varietal responses (Figure 1j),
13. decreased grain protein before increasing slightly above 200 plants/m^2 (Figure 1k), and
14. reduced grain brightness by just under 2 Minolta 'L*" units (Figure 1l).

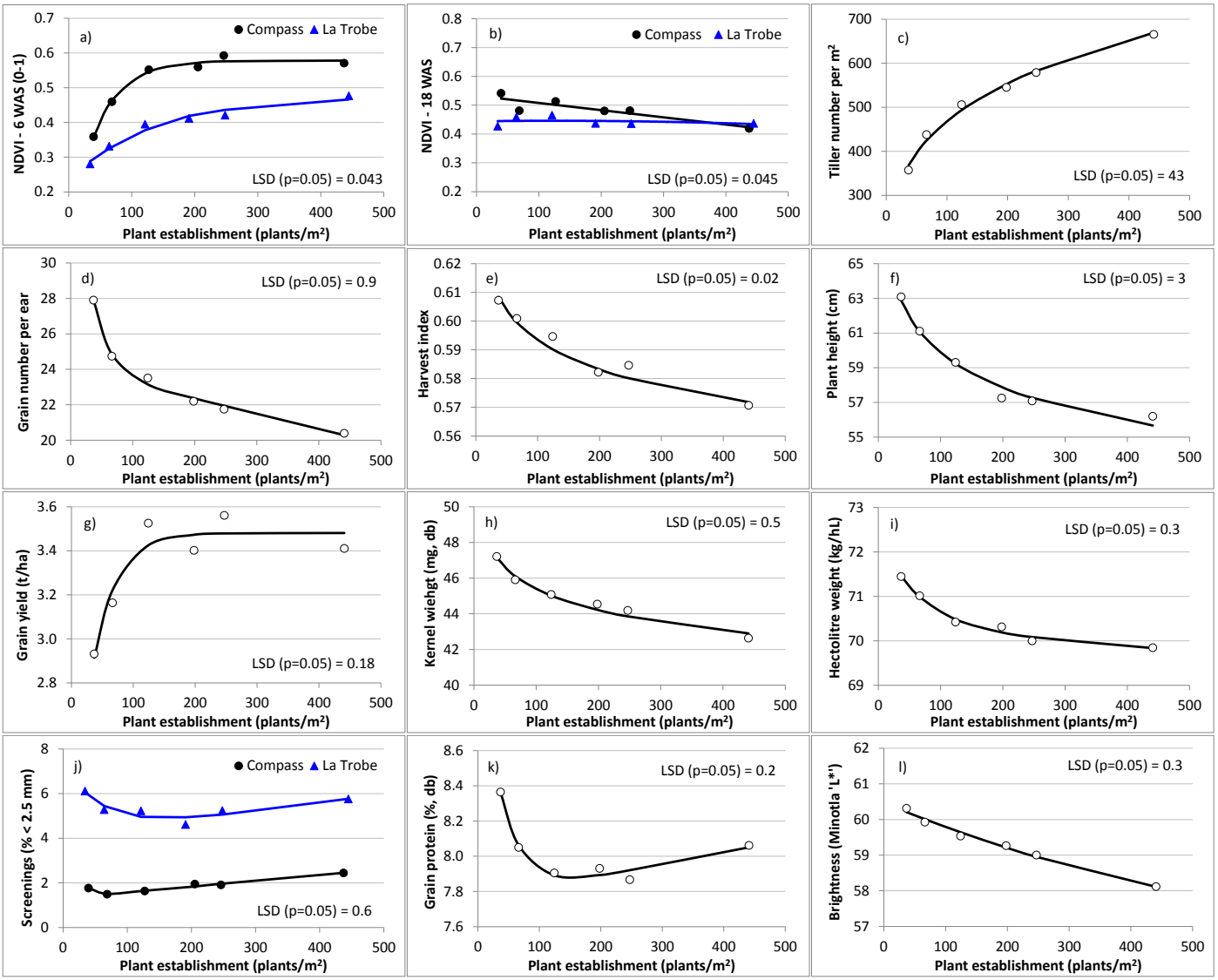

Figure 1. Response of Compass and La Trobe to increasing seed rate, a) NDVI – 6 WAS, b) NDVI – 18 WAS, c) tiller number per m^2, d) grain number per ear, e) harvest index, f) plant height, g) grain yield, h) kernel weight, i) hectolitre weight, j) screenings, k) grain protein concentration and l) grain brightness. Open symbols represent average data for Compass and La Trobe, whereas closed symbols represent data for Compass and La Trobe individually.

Conclusion

The plant architecture of Compass and La Trobe is significantly different (Tables 1 to 3; Figure 1). Despite those differences in plant type Compass and La Trobe produced the same grain yield in this study. This result is consistent with their relative performance in National Variety Trials in Western Australia (Paynter *et al*. 2015). They also did not differ in their grain response to increasing seed rate or due to splitter type. Despite having fewer tillers and slightly less grains per ear, Compass was able to yield the same as La Trobe by producing larger grains. La Trobe grain had a higher hectolitre weight, higher screenings and was brighter with a higher grain protein concentration than the Compass grain.

Paynter *et al*. (2016b) has suggested that in order to maximise grain yield establishment densities above 120 plants/m^2 need to be achieved. A similar observation was found in this study, Paynter and Hills (2009) and Paynter *et al*. (2016a and 2016b). There was a yield penalty of nearly 20% by sowing barley at less than 50 plants/m^2 (compared to maximum yield) and the optimum plant population for grain yield in this study was 129 plants/m^2.

Increasing the plant establishment from 25 to 100 plants/m^2 increased grain yield by nearly 10% but with only a 0.6 kg/hL reduction in hectolitre weight, a 0.1% drop in screenings, a 0.3% drop in grain protein and a 0.4 Minolta 'L*' units drop in grain brightness. Increasing plant establishment further from 100 to 200 plants/m^2 increased grain yield by nearly another 5% with only a further 0.4 kg/hL fall in hectolitre weight, a 0.1% decrease in screenings, no change in grain protein and a 0.6 Minolta 'L*" unit drop in brightness.

The grain quality response of Compass and La Trobe to increasing seed rate was similar for all quality traits except screenings, even though their hectolitre weight, screenings, grain protein concentration and grain brightness was different. In a more stressful environment the differences in grain quality may have been larger and the grain plumpness advantage of Compass more pronounced with increasing seed rate.

This study (based on one trial) suggests that Compass and La Trobe do not need different seed rate strategies, although more research is needed. Paynter *et al*. (2016b) proposed that La Trobe should be sown to achieve a target establishment of 150 plants/m^2 in the more than 1 t/ha environments. If both Compass and La Trobe are to be sown to achieve 150 plants/m^2, the actual seed rate (kg/ha) will differ as Compass has heavier seed. A target density of 150 plants/m^2 would be equivalent to sowing ~90 kg/ha of Compass and sowing ~80 kg/ha of La Trobe, assuming a 5 mg difference in kernel weight, 80% emergence and 98% germination.

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Key words

Barley, seed rate, plant establishment, grain yield, grain quality, plant population

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