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Effect of nitrogen rate and sowing rate on the grain yield and quality of barley

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Key findings

- La Trobe and Compass displayed the best combination of yield and quality traits for achieving malt specification.
- The environment, or experiment site, had a greater effect on yield than variety, nitrogen (N) rate or sowing rate. Low rainfall at Condobolin resulted in significantly lower yields than at Parkes.
- The sowing rate did not significantly affect yield above 150 plants/m^2 at Condobolin or Parkes.
- Nitrogen (N) applications, in the absence of adequate rainfall, can have a negative effect on yield.

Introduction

Eight barley varieties were sown at Condobolin and Parkes to assess the varietal response to N application and seeding rate on grain yield and quality.

Site details

Location	Condobolin	Parkes
Sowing date	25 May 2015	14 May 2015
Soil type	Red chromosol	Red dermosol
Previous crop	Wheat	Canola
Rainfall	198 mm Apr–Sep.	326 mm Apr–Oct.
Fertiliser	MAP 70 kg/ha	Granulock 90 kg/ha
Available N	60.7 kg/ha	42.6 kg/ha

Treatments

N rates	0, 30 and 90 kg/ha at sowing
Sowing rates	75, 150 and 300 seeds/m^2 *
Varieties	Bass$^{\Phi}$ Buloke$^{\Phi}$ Commander$^{\Phi}$ Compass$^{\Phi}$ Flinders$^{\Phi}$ GrangeR$^{\Phi}$ La Trobe$^{\Phi}$ Wimmera$^{\Phi}$

*Seeding rates of 75, 150 and 300 seeds/m^2 is equivalent to 34, 68 and 135 kg seed per ha, assuming a grain size of 45 mg.

Results

Parkes was the highest yielding site, with significant differences between sowing rate, N rate and variety (tables 1 and 2). La Trobe yielded the highest at 30 kg/ha of N and a sowing rate of 150 plants/m^2. Higher sowing and N rates had no significant effect on any variety. At Condobolin, there were significant effects from seeding density and N rate, although there was no varietal interaction between the two variables (tables 3 and 4).

Table 1. Grain yield (t/ha) of eight barley varieties with three nitrogen rates applied at sowing at Parkes, 2015.

Variety	N applied (kg/ha)		
	0	30	90
Bass	4.94	5.11	5.15
Buloke	5.04	5.18	4.91
Commander	5.35	5.27	5.20
Compass	5.49	5.79	5.56
Flinders	5.19	5.20	5.11
GrangeR	5.34	5.60	5.38
La Trobe	5.64	5.80	5.60
Wimmera	5.29	5.30	4.72
l.s.d. (P = 0.05)	26		

Table 2. Grain yield (t/ha) of eight barley varieties sown at three sowing rates at Parkes, 2015.

Variety	Sowing rate (plants/m^2)		
	75	150	300
Bass	5.01	5.10	5.09
Buloke	5.05	5.05	5.04
Commander	5.16	5.41	5.25
Compass	5.45	5.61	5.78
Flinders	5.11	5.17	5.22
GrangeR	5.18	5.50	5.64
La Trobe	5.52	5.78	5.74
Wimmera	5.10	5.09	5.12
l.s.d. (P = 0.05)	0.21		

Table 3. Grain yield (t/ha) of eight barley varieties with three nitrogen rates at Condobolin, 2015.

Variety	N rate (kg/ha)		
	0	30	90
Bass	1.06	0.88	0.58
Buloke	1.04	0.95	0.69
Commander	0.60	0.52	0.37
Compass	1.25	1.12	0.86
Flinders	0.70	0.59	0.52
GrangeR	0.73	0.57	0.36
La Trobe	1.33	1.43	0.90
Wimmera	0.636	0.79	0.41
l.s.d. (P = 0.05)	0.22		

Table 4. Grain yield (t/ha) of eight barley varieties sown at three sowing rates at Condobolin, 2015.

Variety	Sowing rate (plants/m^2)		
	75	150	300
Bass	0.82	0.86	0.84
Buloke	0.83	0.90	0.95
Commander	0.41	0.55	0.53
Compass	1.07	1.07	1.09
Flinders	0.56	0.66	0.60
GrangeR	0.46	0.60	0.59
La Trobe	1.19	1.26	1.21
Wimmera	0.50	0.71	0.61
l.s.d. (P = 0.05)	0.64		

Varieties

Compass and La Trobe were the highest yielding varieties, with significant yield increases over all other varieties at Parkes, and all but Buloke at Condobolin (Figure 1). The lowest yielding varieties were Commander at Condobolin (0.50 t/ha) and Buloke at Parkes (5.04 t/ha).

Effect of sowing rate

There was a significant yield improvement at both sites when sowing rate was increased from 75 to 150 plants/m^2, but there was no significant difference when sowing rate was increased from 150 to 300 plants/m^2 (Figure 2).

There was a significant difference in ear number between all sowing rates at both sites as shown in Figure 3. This implies grain number per head was affected by sowing rate.

Nitrogen effect

At the Condobolin trial there was a significant yield decrease (P=0.05) at N rates of 90 kg/ha, while the Parkes trial did not demonstrate significant differences in yield from any N treatment (Figure 4). Low rainfall during the grain-filling period at Condobolin decreased yield relative to Parkes. This increased available N per plant, concentrating the impact of N on overall yield.

Grain quality

The Parkes protein and screenings data is presented in this paper as the site was more representative of the conditions in southern NSW in 2015 (Figure 5). Malting barley must have a grain protein concentration of 9%–12% to meet malt specifications. By adding 90 kg/ha N at Parkes, all varieties exceeded that limit, with the lowest concentrations being La Trobe (12.2%) and Compass (12.3%). Compass displayed significantly lower N accumulation at 30 kg/ha (9.6%) than any other variety, and at 0 kg/ha of N, also had the lowest protein concentration, possibly due to its high yield distributing N across a greater sink.

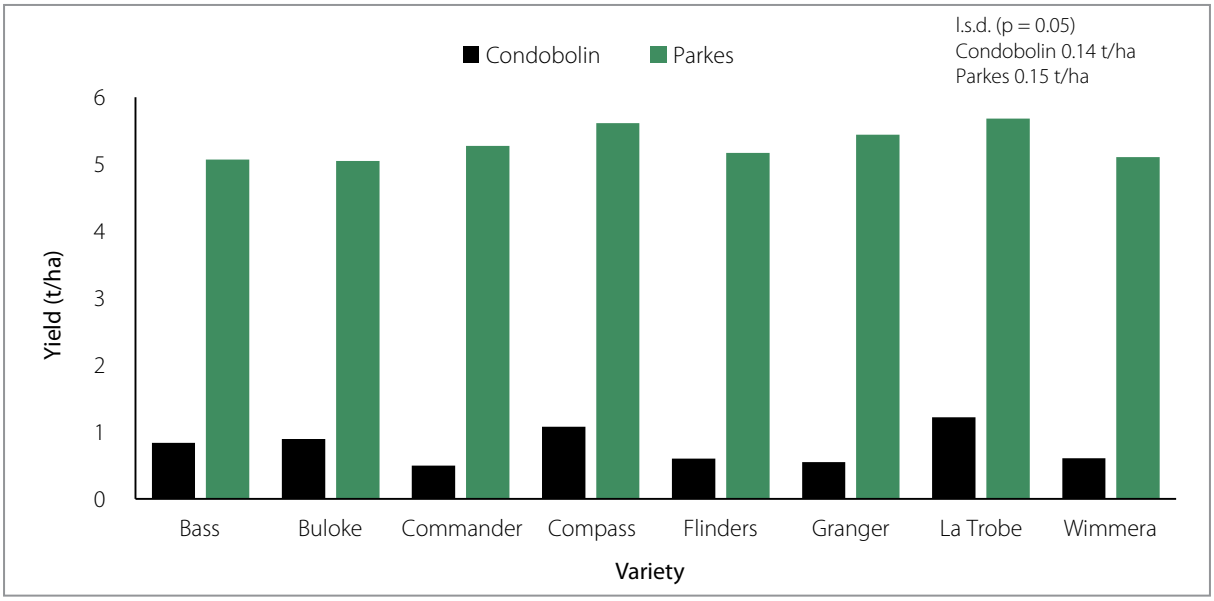

Figure 1. Yield of eight barley varieties at Condobolin and Parkes across all sowing and nitrogen rates.

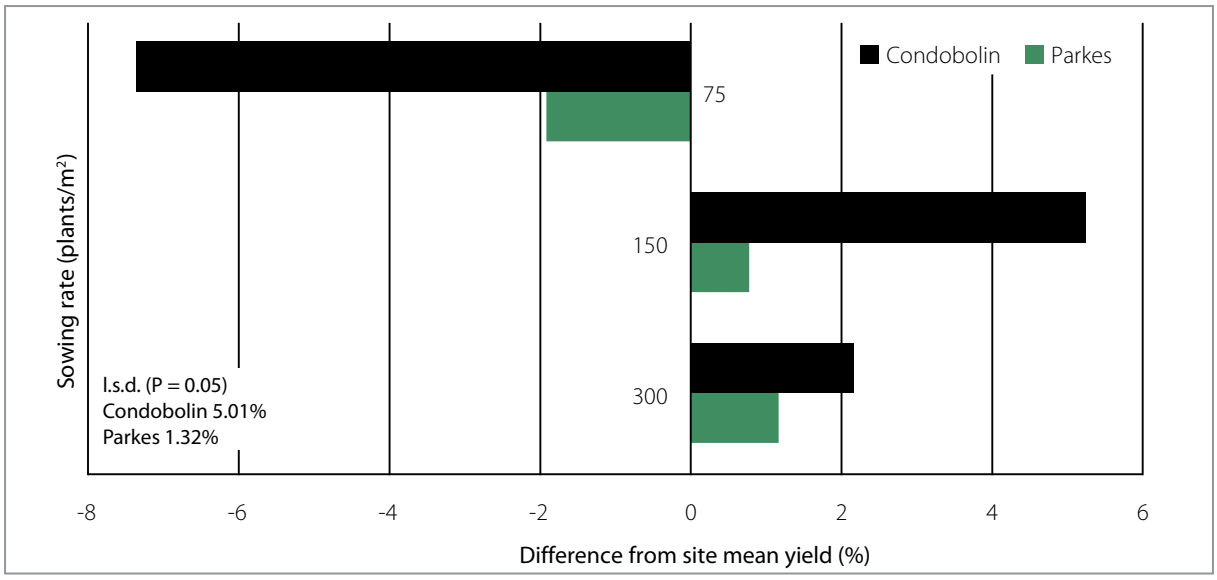

Figure 2. Yield differences at different sowing rates of barley across two sites in 2015. The site mean for Parkes was 5.30 t/ha and the site mean for Condobolin was 0.79 t/ha.

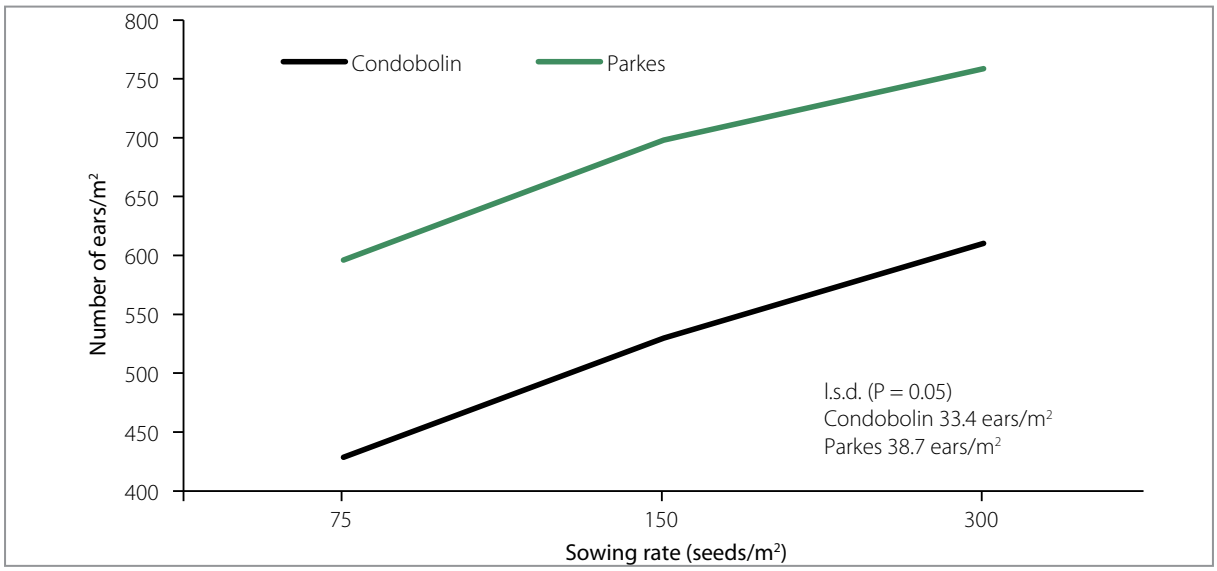

Figure 3. The effect of sowing density on number of ears/m² at anthesis across two sites in 2015.

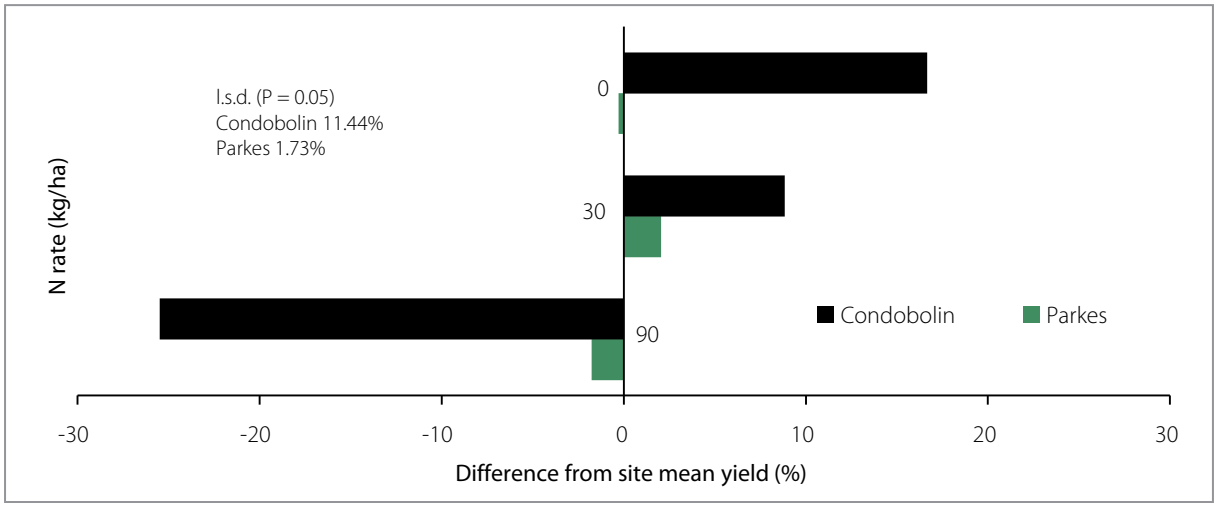

Figure 4. Yield difference under different N rates across two sites in 2015. The site mean for Parkes was 5.30 t/ha and the site mean for Condobolin was 0.79 t/ha.

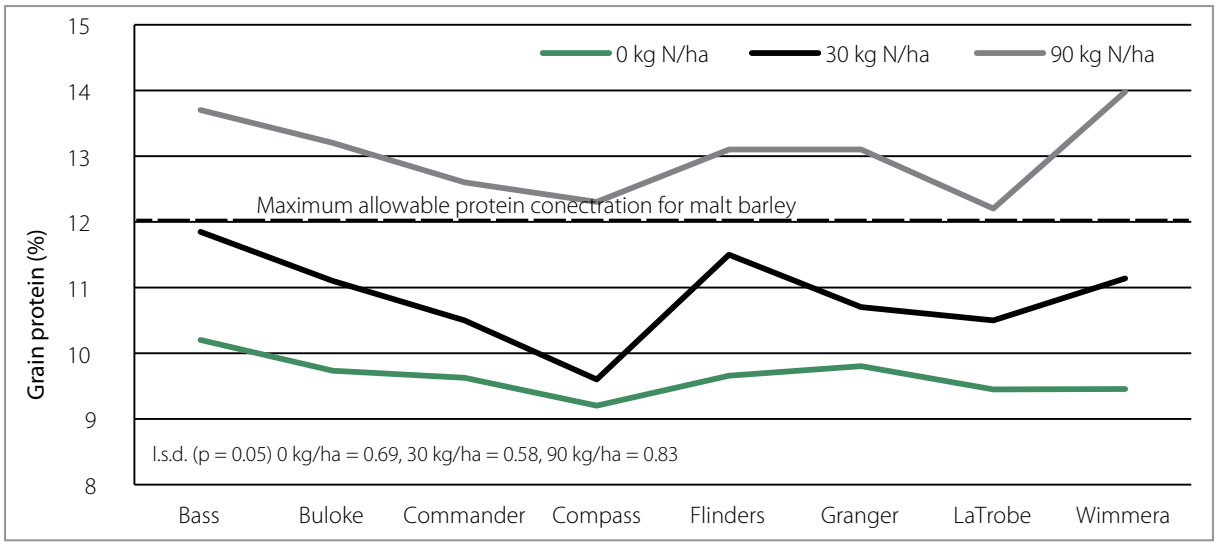

Figure 5. Grain protein concentration of eight barley varieties sown at Parkes and treated with 0, 30 and 90 kg/ha of N at sowing.

Screenings data indicated that seed rate had no significant effect on grain weight. Seed rate did not cause any significant difference to screenings above 2.5 mm, or below 2.2 mm sieve.

Nitrogen rate significantly decreased (P <0.001) the material that was retained above the 2.5 mm sieve. As N rate increased from 0 to 90 kg/ha, retention decreased from 91.6% to 70.0%.

As N rates increased, the percentage of grain plumper than 2.5 mm decreased from 91.6% to 70.0%, while grain below 2.2 mm plumpness increased from 0.94% to 4.9% (P<0.0001). In order to achieve malt standard, a barley sample must contain more than 70% of grain plumper than 2.5 mm and less than 7% of grain smaller than 2.2 mm.

Summary

The agronomic characteristics of both La Trobe and Compass made them the standout varieties at both Condobolin and Parkes in 2015. La Trobe, a successor and sister line to Hindmarsh, was malt accredited in 2015, and has demonstrated consistently competitive yields in both medium and low rainfall environments. Compass significantly out-yielded its predecessor Commander, at both sites, and has entered the malt accreditation process with its earliest accreditation date estimated as 2018. Compass and La Trobe demonstrated the lowest grain protein concentrations under all three N rates.

Seed and fertiliser are two of the most expensive inputs in sowing a crop. Understanding varietal responses to both sowing rates and nitrogen are vital in order to best tailor sowing rates and N fertiliser rates to particular varieties. Increased sowing rates did not have a significant effect on yields above 150 plants/m^2. N applied at 90 kg/ha significantly reduced yield at Condobolin, however at Parkes, there was no significant difference in yield when N rate was increased from 30 to 90 kg/ha. N rates of 90 kg/ha at Parkes did significantly decrease retention above 2.5 mm or increase screenings, demonstrating the necessity to properly manage N fertiliser applications. High rates of N need to be carefully managed when targeting malting grades. Sowing density did not affect grain plumpness, screenings or retention at Parkes.

Acknowledgements

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