Wheat versus Barley– managing nitrogen for profitability following canola and wheat

Christine Zaicou-Kunesch, Blakely Paynter, Brenda Shackley, Raj Malik, Mohamad Amjad.
Department of Agriculture and Food, Western Australia

Key messages

Barley was higher yielding than wheat at six of the nine sites, similar at two sites and lower yielding at one other site. Biomass and head numbers were higher in barley than wheat.

Averaged across all varieties, both crops were responsive to added nitrogen at either 20 or 40 kg/ha. Higher rates of nitrogen reduced barley yields in some environments in 2014.

At current prices of >$300/t, barley is a more profitable option at sites suitable for barley production (note grain quality data was not available at the time of printing).

Aims

- compare the responses of six barley (feed and malt) and six wheat (APW and AH) varieties to changes in nitrogen application,
- provide information on the responsiveness of new varieties to management and the consequences for grain yield, grain quality and overall agronomic performance,

Method

Ten cereal type x variety x nitrogen experiments were conducted in the wheat belt of Western Australia. Six were sown into wheat stubble (wheat/barley on wheat) and four were sown into canola stubble (wheat/barley on canola) from the previous season. The wheat/barley on wheat trials were located at Binnu, Buntine, Wongan Hills, Merredin and Pingrup. The wheat/barley on canola trials were located at Wongan Hills, Cunderdin, York and Pingrup. The trial at Merredin was abandoned due to site variability.

Each experiment consisted of 24 treatments in a split plot cyclic design with 3 replications. The 24 treatments consisted of 12 cereal varieties (6 barley and 6 wheat) and 4 nitrogen rates.

The cereal varieties were sown as whole plots and nitrogen randomised as subplots. Treatments were sown with a 7 row cone seeder. Plot size was 10 x 1.54 metres. The barley varieties sown were Compass, Flinders, Granger, IGB1337, La Trobe and Scope CL. The wheat varieties Cobra, Corack, Mace, Magenta and Wyalkatchem were sown at all trial sites. Emu Rock was sown at the wheat/barley on wheat trials which were located in the low rainfall zone, while Trojan was sown at the wheat/barley on canola trials which were located in the medium rainfall zone.

The nitrogen treatments were N0 = nil nitrogen; N20 = 20kg/ha of nitrogen applied at seeding; N40 = N20 + 20 kg/ha N top dressed three to four weeks after seeding; N80 = N20 + 60 kg/ha N top dressed three to four weeks after seeding. Details on growing season rainfall and sowing date are listed in Table 1

At each site plant establishment was recorded 4 to 6 weeks after sowing. Head number, lodging and plant height were recorded at maturity. NDVI readings were undertaken at 6, 10 and 14 weeks to measure biomass during the season (data not presented). Grain yields were measured at harvest from an 8 metre length of plot. A subsample of grain was retained at harvest and cleaned using a dockage tester to enable grain quality testing. (Note: grain quality assessments are not available at time of print).

Results

Plant establishment

Target plant density was 120plants/m^2. However at the 2 Cunderdin locations and at York, establishment was more efficient and averaged around 140plants/m^2 (Table 2) At Pingrup, establishment averaged 95plants/m^2 at the grey shallow sandy duplex site and 78plants/m^2 at the grey shallow loamy duplex site (Table 2). Visual observations indicate non-wetting had an influence on plant establishment at Pingrup.

Table 1 Paddock rotation, sowing date and growing season rainfall (May- Oct) at nine trial locations.

Location:	Binnu	Buntine-E	Wongan Hills	Wongan Hills	Cunderdin	Cunderdin	York	Pingrup	Pingrup
Stubble:	wheat	wheat	wheat	canola	wheat	canola	canola	wheat	canola
Sown:	9 May	12 May	16 May	16 May	14 May	14 May	15 May	19 May	19 May
GSR (mm)	188	162	276	276	259	259	294	294	294
Total N (0-50cm)	32	39	19	15	54	39	30	17	29
Soil pH ($CaCl_2$) at 20-30cm	4.3	4.7	4.2	4	4.5	6.1	6.4	5.2	4.6

Head numbers

Nitrogen influenced head numbers at all sites (P>0.001). There were significantly more heads of barley than wheat at each nitrogen treatment at all sites except Binnu (data not provided) which had a soil pH at 20-30cm of 4.3 (Table 1). Heads per plant for barley increased from 2.5 to 4 heads per plant at 0 and 80kg/ha nitrogen respectively (averaged across all trials – data not shown). In contrast wheat head numbers only increased from 1.5 to 2.2 heads per plant at 0 and 80 kg/ha nitrogen respectively (averaged across all trial sites -data not shown).

Grain yield

When sown on cereal stubble, barley was significantly higher yielding than wheat (averaged across all varieties and nitrogen treatments) at Buntine, Wongan Hills, and Cunderdin. At Binnu wheat was higher yielding than barley but there was no difference in yield between the cereals at Pingrup.

When sown on canola stubble, barley was significantly higher yielding than wheat (averaged across all varieties and nitrogen treatments) at Wongan Hills, York and Pingrup but there was no difference at Cunderdin.

Grain yields of the highest yielding variety (at 20kg/ha of nitrogen) ranged from 3.5t/ha (La Trobe barley) at York to 1.69t/ha (Corack wheat) at Binnu (Table 2). Compass barley was a consistently high yielding variety (wheat or barley) across all sites. Scope CL, La Trobe and Flinders were significantly lower yielding than the highest yielding variety at four trials sites. Corack was the only wheat variety that ranked highest at a trial site. When comparing wheat varieties only, no one variety was a consistently high yielding variety (at 20kg/ha of nitrogen) across trial sites.

Table 2 Average grain yield (t/ha) summary of barley and wheat varieties at 20kg/ha of applied nitrogen at nine trials (w- wheat stubble, c- canola stubble) in 2014.

Location	Binnu (W)	Buntine (W)	Wongan Hills (W)	Wongan Hills (C)	Cunderdin (W)	Cunderdin (C)	York (C)	Pingrup (W)	Pingrup (C)
Plant establishment (#/m2) Barley / Wheat	135 / 126	119 / 103	124 / 113	126 / 118	149 / 133	149 / 136	144 / 138	100 / 91	78 / 77
Barley Yield (t/ha)									
Compass	1.45	**2.02**	**2.61**	**3.10**	**2.55**	**3.28**	3.21	2.27	2.66
Flinders	0.97	1.75	2.19	2.94	2.13	3.08	3.42	2.15	2.41
Granger	0.99	1.77	2.50	3.02	2.36	3.01	3.31	2.36	**2.87**
IGB1337	1.43	1.98	2.43	2.96	2.02	2.99	3.29	2.19	2.53
La Trobe	1.34	1.89	2.29	2.89	2.04	3.10	**3.50**	2.14	2.67
Scope CL	1.34	1.85	2.09	2.88	2.30	3.00	3.24	2.11	2.51
Wheat Yield (t/ha)									
Cobra	1.56	1.73	1.86	2.46	2.05	2.92	3.48	2.18	2.42
Corack	**1.69**	1.56	2.07	2.68	2.17	2.92	3.04	2.07	2.44
Emu Rock	1.29	1.81	2.02	-	1.88	-	-	2.42	-
Mace	1.52	1.85	2.01	2.72	2.03	2.70	3.04	2.28	2.26
Magenta	1.30	1.66	1.85	2.50	1.81	2.95	3.18	2.27	2.54
Trojan	-	-	-	2.61	-	2.82	3.42	-	2.62
Wyalkatchem	1.48	1.74	1.93	2.39	1.75	2.80	2.95	2.19	2.10
LSD(0.05)	*0.32*	*0.34*	*0.21*	*0.15*	*0.21*	*0.36*	*0.44*	*ns*	*0.52*

Bold = highest yielding and underlined = not significantly different from highest yielding variety

The response to added nitrogen differed between sites and rotation. At Wongan Hills wheat yields (averaged across variety) increased with addition of 40 kg/ha of nitrogen on the wheat stubble and only 20 kg/ha following canola (Figure 1). There was no yield penalty at 80kg/ha of nitrogen. In contrast, barley yields increased with addition of 20

kg/ha of nitrogen on the wheat stubble and up to 40 kg/ha following canola but there was a yield penalty at 80kg/ha of nitrogen. The trials at Wongan Hills were in adjacent paddocks and classified as sandy earth soils. The growing season rainfall was 276mm (Table 1). Barley biomass (as indicated by NDVI readings) was significantly greater than wheat 6 and 10 weeks after seeding. However, by week 14 after seeding, barley biomass was significantly less than wheat (data not provided)

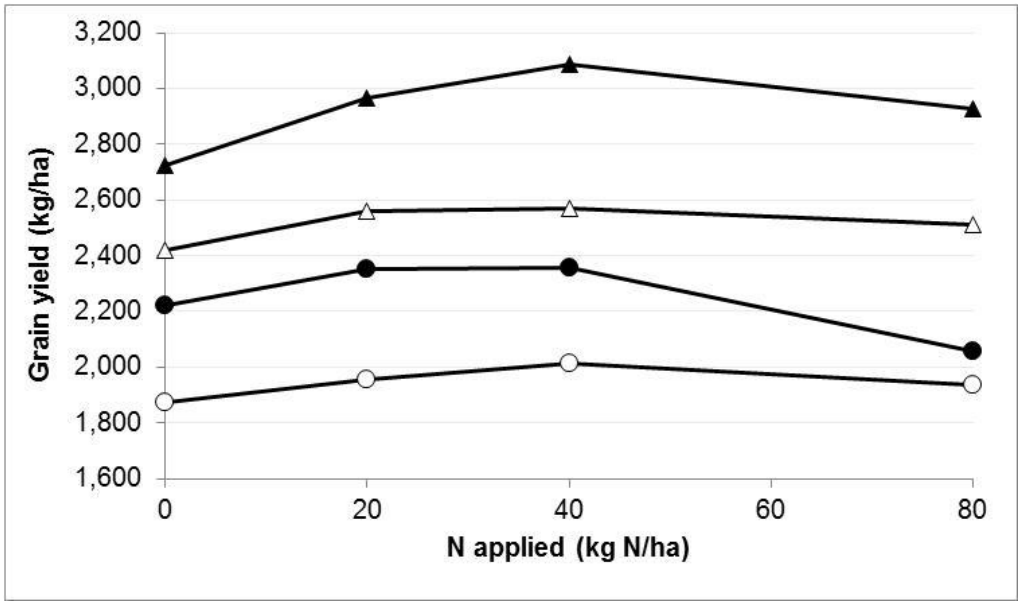

Figure 1 Effect of increasing nitrogen on grain yield (closed symbols -barley, open symbols -wheat) at Wongan Hills on canola stubble (triangles) and wheat stubble (circles). On cereal stubble, LSD (0.05) = 117kg between cereals, 96kg within each cereal. On canola stubble, LSD(0.05) = 93kg between cereals, 84kg within each cereal.

At Cunderdin on the wheat stubble, barley and wheat yields (averaged across varieties) increased significantly with added nitrogen up to 80kg/ha (Figure 2). On the canola stubble site at Cunderdin wheat responded similarly. In contrast, barley yields increased up to 40kg/ha of added nitrogen but there was no benefit of 80kg/ha of nitrogen (Figure 2). Although both sites were shallow sandy duplex soils the canola wheat site was classified as a better soil. On these duplex soils, the depth to the 'B' horizon was 10cm on the wheat stubble and 20cm on the canola stubble. In addition soil pH at 15-20cm depth was 6.1 at the canola stubble site and 4.5 at the wheat stubble site.

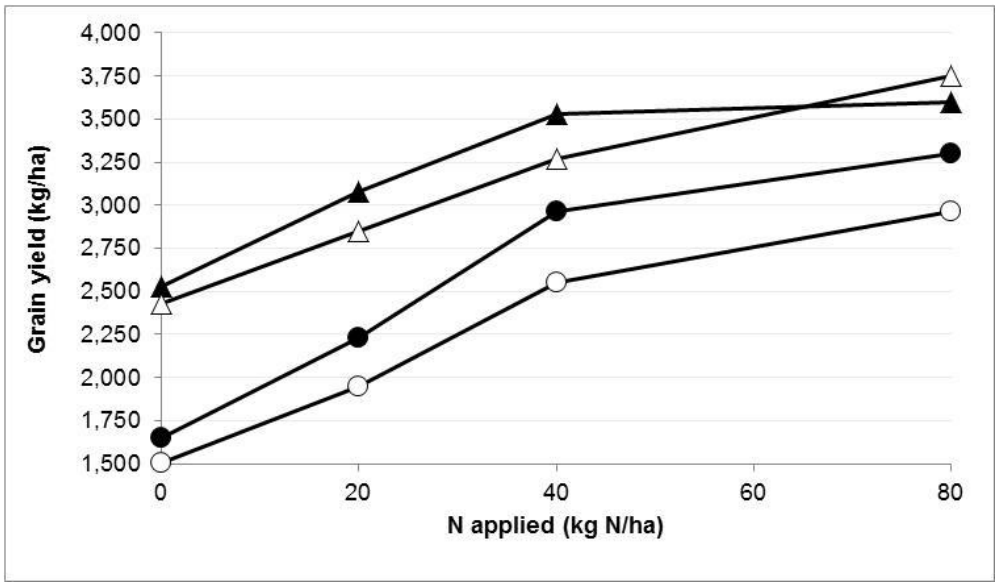

Figure 2 Effect of increasing nitrogen on grain yield (closed symbols -barley, open symbols -wheat) at Cunderdin on canola stubble (triangles) and wheat stubble (circles). On cereal stubble, LSD (0.05) = 213kg between cereals, 209kg within each cereal. On canola stubble, LSD(0.05) = 265kg between cereals, 299kg within each cereal.

Conclusions

Which cereal is more productive?

Based on yield alone, barley was more productive than wheat at a larger number of trial sites on both wheat and canola stubble. Yield differences between barley and wheat averaged across all varieties and nitrogen treatments ranged from 123 to 411 kg/ha. The higher barley yields were achieved through greater head number compared to wheat.

Influence of nitrogen on production

Nitrogen is important component of agronomy of wheat and barley in both canola and wheat rotations. Yields did respond to added nitrogen. However, high rates of nitrogen were a greater risk to barley than wheat. One explanation is the increased tillering capacity and biomass of barley relative to wheat may increase water use and reduce its availability for grain fill if spring rains are limited.

When is wheat more profitable than barley

Barley and wheat each have different grain quality specifications. Although barley is more productive than wheat at a large number of trials sites, the price of each commodity will influence its profitability and hence the choice of crop and agronomy following wheat or canola.

In today's market, barley commodity prices are high relative to wheat. Feed barley was priced at $300/t on 15th Dec 2014 compared to $270 for AGP wheat. Price for malting barley and milling wheats are similar. In this series of trials, barley productivity ranged from 123kg/ha to 411 kg/ha higher than wheat (except at Binnu where wheat was 200kg/ha better than barley). Given the current prices and yield advantage of barley, it is likely that barley will be more profitable than wheat (assuming milling and malting grades are achieved). The yield potential of the site will influence the wheat grain price needed to offset improved barley yields. For example where barley yields 1.5t/ha and wheat is likely to yield 1.3t/ha (yield difference 0.2t/ha), at a current price for barley of $300/t and $150/t, the break even wheat prices are $346/t and 173/t respectively (Table 3). The yield difference between wheat and barley will also influence prices. At a barley yield of 3.5t/ha at $250/t, when the yield differences between barley and wheat is 0.2t/ha and 0.4t/h, the break even wheat price is $265/t and $282/t respectively. So in today's market, barley may have been more profitable assuming production costs are similar for both crops. However, barley is less tolerant to acid soils and Malt grade can be hard to achieve so site selection is important, as is a good understanding of grain quality and the end price.

Table 3 Wheat grain price ($/t) needed to offset the yield increase of barley at four barley price levels ($/t) at 1.5 t/ha and 3t/ha of barley.

Barley price ($/t)	At Barley 1.5t/ha and Yield difference Barley-wheat = 0.2t/ha	At Barley 3.5t/ha and Yield difference Barley-wheat = 0.2t/ha	At Barley 1.5t/ha and Yield difference Barley-wheat = 0.4t/ha	At Barley 3.5t/ha and Yield difference Barley-wheat = 0.4t/ha
150	**173**	159	205	169
200	231	212	273	226
250	288	**265**	341	**282**
300	**346**	318	409	339

Key words

Wheat, barley, nitrogen, agronomy

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