Managing your fertiliser dollar in wheat, barley and canola

Sarah Noack, Hart Field-Site Group

Key Findings

- In wheat an application rate of 20 kg N/ha in-season was sufficient to achieve the highest yield at Hart in 2017. However, it was the 80 kg/ha treatment which maximised yield and protein to achieve the best return on nitrogen fertiliser invested.
- For barley an application of 40 kg N/ha was adequate to produce the highest yield and quality within the trial.

Why do the trial?

The two main grower questions with nitrogen management are how much nitrogen needs to be applied and when should it be applied. While there are a variety of approaches to nitrogen management, the basis of most is a nitrogen budget. However, in reality nitrogen management decisions are often 'reactive' to the season and based on previous season's experiences and attitude to risk.

The key components to nitrogen budgeting are target yield and protein, as crop yield potential is the major driver of nitrogen requirement. This trial is designed to look at simple nitrogen management strategies in wheat, barley and canola across multiple seasons. The specific aims were to:

- Assess simple nitrogen management strategies to determine the best return on investment from fertiliser nitrogen applications.
- Determine within a crop rotation (wheat, barley and canola) where was your fertiliser dollar best spent over a number of seasons.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) @ 60 kg /ha at seeding (equivalent to 10 kg N/ha)
Seeding date	3rd May 2017		In-season nitrogen rates Table 1.

Each trial was a randomised complete block design. Trials were blocked separately by crop type (Mace wheat, Spartacus CL barley and 44Y90 canola). Prior to sowing the trial area was assessed for available soil nitrogen (0-10, 10-30, 30-60 cm) and gravimetric water content. All plots were assessed for grain yield and quality (protein or oil content %, test weight kg/hL, screenings % and retention %).

Table 1. Nitrogen rates applied to the wheat, barley and canola nutrition trials at Hart in 2017.

Wheat	Barley	Canola
1. Nil	1. Nil	1. Nil
2. 80 kg N/ha @ seeding	2. 80 kg N/ha @ seeding	2. 100 kg N/ha @ seeding
3. 20 kg N/ha @ GS31	3. 20 kg N/ha @ GS31	3. 50 kg N/ha @ seeding + 50 kg N/ha @ late cabbage
4. 40 kg N/ha @ GS31	4. 40 kg N/ha @ GS31	4. 50 kg N/ha @ seeding + 50 kg N/ha @ late cabbage + 100 kg N/ha @ bolting
5. 80 kg N/ha @ GS31		5. 200 kg N/ha @ bolting
6. 100 kg N/ha @ GS31		
7. 200 kg N/ha @ GS31		

Results and discussion

Soil available nitrogen pre-seeding

Starting available soil nitrogen was 57 kg N/ha. This low figure is not unexpected given the previous crop rotation of oaten hay (2016), canola (2015) and barley (2014).

Barley

The nitrogen rates trialed in Spartacus CL barley showed 40 kg N/ha was sufficient to achieve the highest yield and protein (Table 2). While Spartacus CL is currently pending malt accreditation if approved, in this trial it would have meet malt classification (9-12%) for the 40 kg N/ha rate at 9.7%. All other nitrogen rates of 80 kg N/ha at seeding, GS31 or GS65 did not improve yield or protein. In comparison to the nil treatment, the application of 40 kg N/ha was 0.4 t/ha higher yielding and also shifted the receival grade from feed to malt.

Test weight was unaffected by nitrogen application and all treatments fell above 65 kg/hL (minimum required for maximum grade). Grain retention did vary among nitrogen treatments, however was of little consequence as all values were above 70% for malt classification.

Table 2. Spartacus CL grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Treatment	Yield t/ha	Protein %	Screenings %	Test weight kg/hL	Retention %
Nil	3.59^{b}	8.8^{b}	1.71^{c}	72.05	88.0^{a}
80 kg N/ha @ seeding	4.07^{a}	10.1^{a}	2.40^{bc}	71.84	83.3^{b}
40 kg N/ha @ GS31	3.95^{a}	9.7^{a}	3.13^{ab}	71.85	79.9^{cd}
80 kg N/ha @ GS31	4.00^{a}	10.1^{a}	3.76^{a}	71.53	77.8^{d}
80 kg N/ha @ GS65	3.91^{a}	10.3^{a}	2.93^{ab}	71.63	81.6^{bc}
LSD (P≤0.05)	0.27	0.72	0.91	ns	2.26

Wheat

In 2017, an application of 20 kg N/ha was sufficient to achieve the highest yield at Hart. If the nitrogen rate had been increased to 40, 80 or 100 kg/ha there was no yield benefit and a negative impact was observed at 200 kg N/ha rate. There was also no difference in grain yield if nitrogen was applied upfront at seeding or in-season (GS31).

As expected with increasing nitrogen application rate, grain protein also increased. Unfortunately, even the 200 kg/ha rate was unable to achieve 13% required for H1. This can be attributed to the season. The in-season N rates were applied in late July and while sufficient rainfall was received to wash the nitrogen into the soil, the surface soil remained relatively dry (reduced plant root access to the nitrogen) due to below average rainfall in August, September and October.

Three treatments produced grain protein levels which met the receival grade H2 (>11.5%) which were the 80, 100 and 200 kg N/ha rates applied at GS31. An additional 60 kg N/ha (130 kg urea/ha) to achieve the higher grade would have cost approximately $60/ha and provided a better return given the lower protein in the 20 or 40 kg N/ha would have only achieved ASW. The results show that applying 80 kg/ha upfront was not able to maintain protein in comparison to the equivalent rate at GS31. The optimum nitrogen rate for wheat in this trial was 80 kg N/ha at GS31 to achieve maximum yield and quality in 2017.

Grain screenings and test weight were excellent across the trial with all treatments falling below 5% screenings and test weights above 76 kg/hL.

Breaking down the nitrogen budget

There are many variations and figures for developing your nitrogen budget. Here we show one example:

Assume 40 kg N/ha* required per tonne of grain to achieve protein level of 11% in wheat. We require 160 kg N/ha to achieve a 4.0 t/ha crop at Hart in 2017.

Starting soil N (0 - 60 cm)	=	57 kg N/ha
**Mineralisable N	=	35 kg N/ha
Starting fertiliser	=	10 kg N/ha
Fertiliser required	**=**	**60 kg N/ha**

**Assumes 50 % nitrogen fertiliser use efficiency*
***Mineralisable N = 0.15 × OC% × GSR (for in Hart 2017 = 0.15 × 1.3% × 191 mm)*

Table 3. Mace wheat grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Nitrogen rate	Yield t/ha	Protein %	Screenings %	Test weight kg/hL
Nil	3.55^{c}	8.8^{e}	0.66	81.0^{a}
80 kg N/ha @ seeding	4.13^{a}	9.9^{d}	0.84	80.8^{ab}
20 kg N/ha @ GS31	4.02^{a}	9.9^{d}	0.71	80.8^{ab}
40 kg N/ha @ GS31	3.99^{a}	10.8^{c}	0.64	80.6^{bc}
80 kg N/ha @ GS31	3.88^{ab}	11.7^{b}	0.61	80.3^{cd}
100 kg N/ha @ GS31	3.88^{ab}	11.8^{b}	0.71	80.0^{d}
200 kg N/ha @ GS31	3.64^{bc}	12.5^{a}	0.65	80.2^{d}
LSD (P≤0.05)	0.33	0.69	ns	0.39

Canola

The addition of 100 kg N/ha was sufficient to achieve the highest yield in the trial at 1.4 t/ha. This was on average 0.3 – 0.4 t/ha higher compared to the nil applied and did not differ to where 200 kg N/ha was spread. The oil content data shows the 100 kg N/ha treatments maintained oil at > 42% similar to the nil. However, the 200 kg N/ha rate applied at bolting or a triple split across seeding, late cabbage and bolting contained the lowest oil contents on average 39.9%. For the 2017 season 100 kg N/ha spread post seeding or split was the best treatment in terms of yield and oil content.

Table 4. 44Y90 canola grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Nitrogen rate (kg N/ha)	Yield t/ha	Oil content %
Nil	1.07^{c}	44.3^{a}
50 kg N/ha seeding + 50 kg N/ha late cabbage	1.31^{b}	42.8^{ab}
100 kg N/ha seeding	1.40^{ab}	43.9^{a}
50 kg N/ha seeding + 50 kg N/ha late cabbage + 100 kg N/ha bolting	1.31^{b}	41.1^{bc}
200 kg N/ha @ bolting	1.52^{a}	38.5^{c}
LSD (P≤0.05)	0.2	2.7

Summary / implications

Developing your own nitrogen fertiliser budgets is the best way to determine nitrogen rate at seeding and in-season. Some key points to remember:

- Taking account of available soil nitrogen reserves prior to the main applications of nitrogen fertiliser in wheat is a key measure to improve nitrogen fertiliser management, N efficiency and avoiding losses to the atmosphere.
- Whilst nitrogen needs to supplied to growing wheat crops throughout the growing season, it is important to recognise that 20-30% of a wheat crop's needs are required prior to stem elongation.
- Targeting the majority of nitrogen to the wheat crop just prior to early stem elongation is the best way of matching N supply to crop demand.
- Predictive models such as Yield Prophet® can more accurately determine yield potential and therefore the N fertiliser requirement.
- Seasonal climate forecasts are also more accurate later in the season i.e. July- August for determining yield potential and therefore calculating the correct amount of nitrogen fertiliser to apply.