Managing your fertiliser dollar in wheat and barley – a study across three seasons

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Key findings

- Across three seasons the N application rate to maximise returns in barley was different each year, for 2017 40 kg N/ha; 2018 80 kg N/ha and nil N applied in 2019.
- Nitrogen response in wheat was variable. In general, 80 kg N/ha applied at seeding or GS31 has resulted in the highest yield and protein level for maximum grade.
- It is important to look at seasonal climatic forecasts and Yield Prophet® to help assist in accurately determining potential yield and make decisions on nitrogen application rates and timing.

Why do the trial?

The two main grower questions regarding nitrogen (N) management are 1) how much N needs to be applied and 2) when should it be applied? An N budget is the most common way to manage N fertiliser inputs. However, decisions can often be 'reactive' to the season and based on previous season's experiences and attitude to risk.

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

- Assess simple N management strategies to determine the best return on investment from fertiliser N applications.
- Determine within a crop rotation (wheat and barley) where your fertiliser dollar was 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	June 5, 2019		In season N rates: Table 1

Each trial was a randomised complete block design. The trials were blocked separately by crop type (Scepter wheat and Spartacus CL barley).

Prior to sowing (May 23, 2019) the trial area was assessed for available soil N (0-10, 10-30 and 30-60 cm). The total available soil N pre-seeding was 28 kg N/ha. All plots were assessed for grain yield and quality (protein, test weight kg/hL, retention % and screenings %).

Table 1. Nitrogen rates applied to wheat and barley nutrition trials at Hart in 2019.

Wheat	Barley
1. Nil	1. Nil
2. 80 kg N/ha @ seeding	2. 80 kg N/ha @ seeding
3. 20 kg N/ha @ GS31*	3. 20 kg N/ha @ GS31
4. 40 kg N/ha @ GS31	4. 40 kg N/ha @ GS31
5. 80 kg N/ha @ GS31	5. 80 kg N/ha @ GS31
6. 100 kg N/ha @ GS31	
7. 200 kg N/ha @ GS31	

*GS31 = first node can be seen 1 cm or more above the base of the shoot and the internode above it is less than 2 cm.

Results and discussion

Barley

Nitrogen rates trialed in Spartacus CL barley in 2019 showed applying nil N fertiliser was adequate to achieve the highest yield and protein to meet malt specifications (Table 2). The N supply for the crop in this treatment came from the soil (low starting soil available N of 28 kg N/ha) plus 10 kg N/ha applied at seeding. Increasing the N rate to 20 kg N/ha or above did not increase grain yield. However, grain protein was increased (14.5%) where 80 kg N/ha was applied at seeding. The increase in grain protein was not beneficial as it exceeded 12% protein (the maximum required for malt 1). This result was not consistent with 2017 and 2018 where 40 kg N/ha and 20 kg N/ha were required to maximise grain yield and protein to meet malt specification (Table 2). Both these seasons had either more growing season rainfall or some stored soil moisture increasing their yield potential and N requirement.

Across all three seasons screening levels were below 5% and test weight was > 65 kg/hL for all N rates and timings trialed. The only quality parameter to be affected by N treatment was grain retention. In 2017 and 2018 all retention levels were above 70 kg/hL. However, in 2019 applying a large amount of N upfront at seeding (80 kg N/ha) reduced retention to 50%. This treatment also had high protein and highlights the high early application of N set the crop up for a high yield and the dry finish resulted in smaller grains (lower retention).

Wheat

In 2019 at Hart, application of 20 kg N/ha at GS31 was sufficient to achieve the highest wheat yield (Table 3) of 1.4 t/ha. There was no yield benefit from increasing the N rate to 40, 80, 100 or 200 kg N/ha. However, an increased N rate was needed to achieve higher protein levels. The application of 80 kg N/ha at seeding provided enough N to achieve H1 grade. Even where 80 kg N/ha had been applied in-season or higher it did not achieve the same protein as the upfront N application. This can be attributed to the dry seasonal conditions favouring greater N uptake from early applications compared to holding off in-season where there was limited rainfall and soil moisture for N uptake.

The 2017 and 2018 seasons had higher growing season rainfall and/or starting soil moisture. It is not surprising that higher N rates were required to achieve maximum grain yield. In general, the data shows there is a trade-off between fertiliser rate (i.e. cost) and maximising grain yield and protein.

Other quality factors to affect the wheat receival standard are grain screenings and test weight. Across three seasons screening levels were largely unaffected by N rates from 0 – 200 kg N/ha. The 2019 season was the only year where wheat screening levels were above 5% (ranged from 5-9%) for all treatments. Grain test weights were all above the minimum of 76 kg/hL for all N treatments across three years.

Table 2. Barley grain yield and quality for the N treatments at Hart with varieties Spartacus CL (2017, 2019) and La Trobe (2018). Treatments shaded grey are not significantly different from the highest yielding/quality treatment.

Year	Treatment	Yield t/ha	Protein %	Screenings %	Test Weight kg/hL	Retention %	Receival grade	Net return* $/ha
2017 GSR: 191 mm Starting soil N: 57 kg/ha	Nil	3.6^{b}	8.8^{b}	1.7^{c}	72.0	88.0^{a}	F1	477
	80 kg N/ha @ seeding	4.1^{a}	10.1^{a}	2.4^{bc}	71.8	83.3^{b}	Malt 1	699
	40 kg N/ha @ GS31	4.0^{a}	9.7^{a}	3.1^{ab}	71.8	79.9^{cd}	Malt 1	718
	80 kg N/ha @ GS31	4.0^{a}	10.1^{a}	3.8^{a}	71.5	77.8^{d}	Malt 1	669
	80 kg N/ha @ GS65	3.9^{a}	10.3^{a}	2.9^{ab}	71.6	81.6^{bc}	Malt 1	666
	LSD(P≤0.05)	**0.3**	**0.7**	**0.9**	**ns**	**2.3**		
2018 GSR: 160 mm Starting soil N: 78 kg N/ha	Nil	2.6^{a}	9.0^{a}	0.8	71.6^{c}	92.3^{b}	Malt 1	347
	80 kg N/ha @ seeding	3.0^{b}	12.2^{c}	2.1	70.0^{a}	70.3^{a}	F1	652
	20 kg N/ha @ GS31	3.0^{b}	9.7^{ab}	1.3	71.1^{bc}	88.5^{b}	Malt 1	442
	40 kg N/ha @ GS31	3.0^{b}	10.7^{b}	1.5	70.6^{b}	81.5^{ab}	Malt 1	418
	80 kg N/ha @ GS31	3.1^{b}	12.4^{c}	2.3	70.5^{bc}	70.9^{a}	F1	254
	LSD(P≤0.05)	**0.2**	**1.5**	**ns**	**0.7**	**12.1**		
2019 GSR: 162 mm Starting soil N: 28 kg N/ha	Nil	1.4	10.5^{a}	0.8	69.7^{bc}	89.7^{c}	Malt 1	-13
	80 kg N/ha @ seeding	1.7	14.5^{d}	2.6	68.8^{a}	50.2^{a}	F1	-96
	20 kg N/ha @ GS31	1.6	11.6^{b}	1.1	69.9^{c}	81.3^{bc}	F1	-47
	40 kg N/ha @ GS31	1.7	12.3^{bc}	1.4	69.2^{abc}	75.1^{bc}	F1	-47
	80 kg N/ha @ GS31	1.9	12.9^{c}	1.7	68.9^{ab}	69.7^{b}	F1	-46
	LSD(P≤0.05)	**ns**	**1.1**	**ns**	**0.9**	**15.7**		

*Cost of urea fertiliser based on 2019 prices. Net return based on production costs of $433 for malting barley or $423 of feed barley + fertiliser application and returns on grain of $300/t for malting barley or $250/t for feed barley.

Table 3. Wheat grain yield and quality for the N treatments at Hart with varieties Scepter (2018, 2019) and Mace (2017). Treatments shaded grey are not significantly different from the highest yielding/quality treatment.

Year	Treatment	Yield t/ha	Protein %	Screenings %	Test Weight kg/hL	Receival grade
2017 GSR: 191 mm Starting soil N: 57 kg/ha	Nil	3.6^{c}	8.8^{e}	0.66	81.0^{a}	ASW
	80 kg N/ha @ seeding	4.1^{a}	9.9^{d}	0.84	80.8^{ab}	ASW
	20 kg N/ha @ GS31	4.0^{a}	9.9^{d}	0.71	80.8^{ab}	ASW
	40 kg N/ha @ GS31	3.9^{a}	10.8^{c}	0.64	80.6^{bc}	APW
	80 kg N/ha @ GS31	3.9^{ab}	11.7^{b}	0.61	80.3^{cd}	H2
	100 kg N/ha @ GS31	3.9^{ab}	11.8^{b}	0.71	80.0^{d}	H2
	200 kg N/ha @ GS31	3.6^{bc}	12.5^{a}	0.65	80.0^{d}	H2
	LSD(P≤0.05)	**0.3**	**0.7**	**ns**	**0.4**	
2018 GSR: 160 mm Starting soil N: 78 kg N/ha	Nil	2.2^{c}	8.4^{ab}	0.9^{b}	80.1	ASW
	80 kg N/ha @ seeding	2.5^{bc}	11.6^{de}	0.9^{b}	79.6	H2
	20 kg N/ha @ GS31	2.7^{abc}	9.3^{bc}	1.1^{b}	80.3	ASW
	40 kg N/ha @ GS31	2.5^{bc}	9.6^{c}	1.1^{b}	78.1	ASW
	80 kg N/ha @ GS31	3.1^{a}	10.7^{d}	0.6^{a}	80.7	APW
	100 kg N/ha @ GS31	3.0^{ab}	11.8^{e}	0.7^{ab}	80.5	H2
	200 kg N/ha @ GS31	3.0^{ab}	13.2^{f}	0.8^{ab}	79.9	H1
	LSD(P≤0.05)	**0.5**	**1.0**	**0.3**	**ns**	
2019 GSR: 162 mm Starting soil N: 28 kg N/ha	Nil	1.1^{a}	8.8^{e}	8.9^{d}	77.9	AGP1
	80 kg N/ha @ seeding	1.4^{b}	13.3^{a}	4.9^{a}	77.3	H1
	20 kg N/ha @ GS31	1.2^{b}	9.5^{de}	6.8^{c}	79.2	AGP1
	40 kg N/ha @ GS31	1.3^{bc}	10.2^{d}	6.1^{bc}	78.0	AGP1
	80 kg N/ha @ GS31	1.2^{bc}	11.4^{c}	5.8^{ab}	77.7	AUH2
	100 kg N/ha @ GS31	1.3^{bc}	11.5^{c}	5.6^{ab}	77.6	AUH2
	200 kg N/ha @ GS31	1.3^{c}	12.4^{b}	5.8^{b}	76.0	AUH2
	LSD(P≤0.05)	**0.1**	**1.5**	**0.9**	**ns**	

Summary / implications

The results observed from 2017, 2018 and 2019 show the effect of rainfall, yield potential and N uptake of crops. It is important to look at seasonal climatic forecasts and Yield Prophet® to help assist in accurately determining potential yield and make decisions on N application rates and timing. In drier seasons results indicate that using lower N fertiliser (e.g. 20 kg N/ha (2018) and nil (2019) for barley and 20 kg N/ha for wheat for both years) was the best use of your fertiliser dollar.

Some key points to remember:

- Taking account of available soil N reserves prior to the main applications of N fertiliser in wheat is a key measure to improve N fertiliser management, N efficiency and avoiding losses to the atmosphere.
- Whilst N needs to be supplied to growing wheat crops throughout the growing season, it is important to recognise that 20 – 30% of a wheat crops needs are required prior to stem elongation.
- Targeting the majority of N to the wheat crop just prior to early stem elongation is the best way of matching N supply to crop demand.
- 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 N fertiliser to apply. Refer to Figure 2 of the article 'Yield Prophet® performance in 2019' (page 16, Hart Trial Results 2019).