GETTING NITROGEN TIMING RIGHT TO OPTIMISE YIELD AND PROTEIN IN BARLEY

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TAKE HOME MESSAGES

- Nitrogen (N) timing had no effect on yield or grain quality in 2017, when sown into a lentil stubble with a high amount of available N.
- RGT Planet produced higher harvest biomass, more grains per head and higher yield than La Trobe and Compass.
- N applied during tillering increased lodging in Compass, compared to later N application at flag leaf sheath extension, but it didn't affect grain yield.

BACKGROUND

Barley varieties with different genetics vary in their phenology, plant architecture and growth patterns. Some varieties have rapid early vigour, are slower, or tiller more than others. These differences may impact on their demand for nitrogen (N) and the specific timing that they require N, in relation to development.

The key limitation for N fertiliser application at the correct development stage is rainfall for fertiliser uptake. However, if the season was favourable, would different barley varieties benefit from nitrogen applied at specific timings?

RGT Planet is a new variety that is commonly grown in Europe. It was first trialled in 2016 in Australia through the National Variety Trials program, yielding extremely well in low and higher rainfall areas. It hasn't however, been tested to see if it benefits from a specific N management package. As part of the GRDC-funded 'Barley agronomy for the southern region' project, new varieties are agronomically tested so management packages can be built around them, to provide further information to growers (besides yield performance) to enable better decision making and adoption.

AIM

To determine if barley varieties show responses in grain yield and quality to nitrogen applied at different plant growth stage timings.

PADDOCK DETAILS

Location:	Longerenong
Crop year rainfall:	424mm
GSR (Apr-Oct):	303mm
Soil type:	Clay
Paddock history:	Lentil

TRIAL DETAILS

Crop type:	Barley: RGT Planet, Compass and La Trobe
Treatments:	Refer to Table 1
Target plant density:	130 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	15 May 2017
Replicates:	Four
Harvest date:	28 November 2017
Trial average yield:	6.8t/ha

TRIAL INPUTS

Fertiliser:	Granulock Supreme Z + Impact @ 60kg/ha at sowing Refer to Table 1 for N treatments	
Herbicide:	15 May	Trifluralin @ 1.5L/ha + Avadex Xtra® @ 2L/ha + glyphosate @ 2L/ha
	28 June	Velocity® @ 670mL/ha + MCPA LVE @ 400mL/ha + Lontrel® @ 300mL/ha + Hasten 1%
Insecticide:	9 September	Lorsban® @ 600mL/ha
Fungicide:	20 July	Prosaro® @ 300mL/ha + BS1000 @.25%
	9 September	Prosaro @ 300mL/ha + BS1000 @ .25%
Seed treatment:	Systiva® @ 150mL/100kg seed + Gaucho® @ 240mL/100kg seed	

METHOD

The trial was sown as a two-way randomised block design, including four replicates. The trial consisted of three barley varieties and six N timings, all comprising of 70kg N/ha in split or whole applications, aimed at being relevant to farmer practice rates in the region. N timings were targeted for yield, at early tillering and later tillering to first node stage, with a later timing applied (flag leaf sheath

extension) to determine the impact on both yield and grain quality. Due to differences in growth rates between varieties, not all varieties were at the exact same growth stage when the N was applied (Table 1). All N treatments were applied as urea (46% N) and then broadcast with a garden spreader, prior to rainfall events.

Assessments included normalised difference vegetation index (NDVI - measure of canopy greenness), maturity biomass cuts, harvest index (measure of biomass:grain ratio), heads/m^2 (counted at maturity), lodging scores and grain yield and quality parameters.

Harvest index was calculated from biomass cuts taken at maturity. The samples were threshed and then the amount of grain weighed.

The head counts were calculated by taking a subsample from the biomass cut, weighing and counting the number of heads and then calculating into heads/m^2.

Table 1. N treatment rates and timings applied for each variety. Growth stage upon application of N changed, dependant on variety. For further information on growth stage identification see Appendix 9, pp. 246.

Treatment	N rate (kg N/ha)	Timing (growth stage)
1	70	Applied at sowing
2	70	Applied at early tillering (GS22)
3	70	Applied at late tillering to first node (RGT Planet GS25, Compass GS30 and La Trobe GS30.5)
4	70	Applied at flag leaf emergence to flag leaf sheath extension (RGT Planet GS33, Compass GS41, La Trobe GS37)
5	35 35	Applied at early tillering (GS22) Applied at late tillering to first node (RGT Planet GS25, Compass GS30 and La Trobe GS30.5)
6	35 35	Applied at early tillering (GS22) Applied at flag leaf emergence and flag sheath extension (RGT Planet GS33, Compass GS41, La Trobe GS37)

RESULTS AND INTERPRETATION

The trial was sown into a moist soil bed and all varieties established well. Starting soil N at the site was 77kg N/ha (0-100cm), combined with starting soil fertiliser of 5kg N/ha, N treatments of 70kg N/ha and an estimated 54kg N/ha available through mineralisation by the end of the growing season (due to a high lentil stubble load and high rainfall during the growing season). This is approximately enough to grow 5.9t/ha of barley (based on a rule of thumb that 35kg/ha of N produces 1 tonne of barley).

The average trial yield was 6.8t/ha which was high given the amount of N available. As the trial set out to mimic common farmer N fertiliser practice for an average year, the trial may not have received enough N to realise the yield potential at the site.

How was yield and grain quality influenced by nitrogen timing?

Generally with barley, N applications applied during tillering contribute to yield (through additional tiller production). The amount of barley heads and potential grain number is already set before GS30, therefore not having the ability, like wheat, to fill wider. Barley can potentially abort tillers if there is not adequate N or moisture to convert tillers to heads.

Nitrogen that is applied later (post GS30) can still contribute to yield, but it is more likely to be converted into protein content. This however, wasn't the case for this trial, there were no differences in yield between N timing in the barley varieties tested (and no N timing alone effect). Possibly, the residual effect from the previous lentil crop (starting soil N and mineralisation) may have diluted the effect of any N rate application, therefore the N timing too.

In terms of overall variety performance (average of N timings) RGT Planet yielded exceptionally well, 0.9t/ha above La Trobe and Compass (Table 2).

Protein and other grain quality parameters were not affected by N timing. Treatments four and six with later applications of nitrogen (around flag leaf sheath extension) had no significant effect on grain quality, including grain protein (data not shown). The only significant differences in quality noted, were when comparing varieties (average of all N timings). All varieties had excellent quality with La Trobe (accredited Malt variety) and Compass (undergoing Malt accreditation) meeting Malt standards (Table 2). RGT Planet however, fell slightly down in retention (>65kg/hL) meaning for some treatments, it fell out of Malt specification. This variety is currently undergoing Malt accreditation.

Table 2. Variety yield and grain quality parameter results.

Variety	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Retention (%)	Screenings (%)
Compass	6.5	11.8	65.5	89.7	2.5
La Trobe	6.5	11.5	66.2	80.4	4.4
RGT Planet	7.4	10.8	64.8	83.6	3.0
Sig. diff.	P<.001	P=0.002	P<.001	P<.001	P<.001
LSD (P=0.05)	0.10	0.53	0.69	2.86	0.65
CV%	2.5	8	1.8	5.8	34.5

Did nitrogen timing have an effect on NDVI, head number, lodging, harvest index and maturity biomass?

There was no variety by N timing interaction (or timing alone) effect for maturity biomass, harvest index and heads/m^2 (Table 3). There was a difference between varieties (average of all N treatments), with RGT Planet having the highest biomass at maturity and harvest index. RGT Planet was also the highest yielding variety in the trial and this corresponded to biomass and harvest index assessments. A variety with a higher harvest index indicates that it is more efficient at converting biomass into grain yield, which was seen in RGT Planet. Compass had the lowest harvest index, indicating it was slightly less efficient at converting biomass into grain yield.

La Trobe had the greatest number of heads/m^2 and RGT Planet, though yielding the highest, had less than La Trobe. For both varieties, thousand seed weight (TSW) was not significantly different (La Trobe - 36g, RGT Planet - 35g), therefore the greater yield achieved by RGT Planet was driven by grain number (more grains per head) not grain size. Compass also had a lower head number (but yielded the same as La Trobe), this can be explained by the higher TSW in Compass contributing to yield (40g per 1000 grains).

Table 3. The difference between the three varieties biomass at maturity, harvest index and heads/m^2.

Variety	Biomass at maturity GS99	Harvest index	Heads/m^2
Compass	14.5	0.46	887
La Trobe	14.7	0.52	1015
RGT Planet	15.8	0.55	833
Sig. diff.	P<0.001	P<0.001	P<0.001
LSD (P=0.05)	0.63	0.01	62.30
CV%	7.2	4.3	11.7

In terms of lodging, there was no variety by N timing effect. There was a variety alone difference, with Compass lodging significantly more (average 68% lodging observed) than La Trobe (very minor) and RGT Planet (no lodging). Differences between N timings (average of varieties), indicated that late N applications at GS41 (treatment four and six) had less lodging. Given that there were no differences in biomass at maturity and harvest index (between varieties and N timings), a possible explanation could potentially be early N applications caused an increase in plant height, which had a greater influence on plant lodging later in the season. This however was not measured and only speculative.

There were no differences in NDVI. Earlier NDVI can't be compared within all treatments, as not all N timings had been applied.

COMMERCIAL PRACTICE

In this season, no N timing treatment, whether applied earlier or later, appeared to produce yield or grain quality differences, therefore no financial benefit. This is likely a reflection on the position this trial was placed in the rotation and that there was adequate N available to the crop throughout the growing season.

This provides strong evidence that it is beneficial to know the starting nitrogen levels leading into growing a cereal crop on the back of a pulse, as it can help limit unnecessary expenditure on nitrogen inputs, or better tailor them to timings that offer more benefits. Growers should utilise services such as soil sampling to know the status of their paddock and manage inputs accordingly.

Previous research has shown, that generally, to achieve yield responses, early N applications during the tillering stage (before stem elongation) provides the best opportunity to increase tiller number and ultimately yield. If there are reservations that low protein (below Malt specifications) may be a risk, later N timings (stem elongation or later) can increase protein in barley. This trial was only looking at one year, with set N rates, so following a nitrogen strategy and knowing correct growth stages is still an important practice.

RGT Planet has a good fit for the Wimmera, yielding exceptionally well, although was slightly lower in test weight than other varieties (something to watch if it becomes an accredited Malt variety). La Trobe and Compass also performed well, however lodging was evident in Compass, particularly in the earlier N applications. It would be recommended as a good N regime for Compass, to not apply large amounts of N upfront or at once if possible. This has the potential to increase the bulkiness of the plant and possibly lead to greater lodging (in favourable environments).

REFERENCES

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