Nitrogen management in wheat at Tarlee

This trial was funded by GRDC (SFS 00017) in collaboration with Nick Poole (Foundation for Arable Research NZ) and the Mid-North High Rainfall Group (Mick Faulkner and Jeff Braun).

Key findings

- With a soil nitrogen (N) content of 103 kg N/ha at sowing, Mace wheat yielded 3.1 t/ha with no N fertiliser applied and contained 6.6% protein.
- Optimum gross margins were recorded with 75 kg N/ha, though none of the N levels up to 100 kg N/ha reached 9% protein.
- Yield response was greatest for N application timings at sowing, GS31, or a split application between GS31 and GS39.
- A crop sensor was used to measure in season nitrogen responsiveness and was able to predict the optimal N rate.

Why do the trial?

To compare how different nitrogen strategies effect crop growth, grain yield and protein.

To maintain yield and quality, while reducing the risks associated with excess early crop growth.

To evaluate the performance of crop sensors for measuring crop growth and predicting crop responsiveness to N.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	Triple super phosphate (0:20:0) @ 60kg/ha
Seeding date	13th May 2010		Urea applied as per treatment
Available soil moisture 13th April (0-90cm)	35mm	**Soil nitrogen 13th April (0-90cm)**	103 kg/ha
Location	Mid North High Rainfall Site, Tarlee		

The trial was a randomised complete block design with 4 replicates.

The treatments included:

- 4 nitrogen timings by 5 nitrogen rates
    - N timings: incorporated by sowing (IBS, 13th May), 1st node (GS31, 31st July), flag leaf fully emerged (GS39, 7th Sept) and a split application with 50% applied GS31 and 50% applied GS39.
    - Nitrogen rates: 0, 25, 50, 75, 100 kg N/ha (0, 54, 109, 163, 217 kg urea/ha)
- 2 nitrogen rates (25 and 50 kg N/ha) applied at flowering (GS65, 12th Oct)
- 1 treatment with 25 kg N/ha applied at GS31, GS39 and GS65 (total 75 kg N/ha)
- A strategic N application based on in season crop measurement using crop sensors. Nitrogen response was predicted as a ratio from measurements in the unfertilised treatment referenced against the measurements from the 100 kg N/ha IBS treatment. This resulted in 50 kg N/ha applied at GS31 and 25 kg N/ha applied at GS39.

All plots were assessed for biomass, nitrogen uptake, crop reflectance using crop sensors (NDVI), green area index (GAI), tiller and head number, grain yield, protein, test weight, screenings (<2mm) and grain weight. Edge rows were removed prior to harvest.

NDVI is a comparison of reflectance of red and near infra red wavelengths [(NIR-Red)/(NIR+Red)] and is a good indicator of the green leaf area of the crop.

Results

At all N timings there was a significant grain yield response to N up to 75 kg N/ha. The maximum rate of 100kg N/ha did not produce a significant yield response (Figure 1). Yield response was greatest for N application timings at sowing, GS31 or a split application between GS31 and GS39. Delaying all of the N application until GS39 reduced the yield response, however this was not significant. N application delayed until flowering resulted in significantly lower grain yields compared to earlier applications (Figure 1).

Delaying N application until GS65 reduced the nitrogen use efficiency to 6 kg grain/kg N, whereas N applied at sowing or stem elongation had an efficiency of 29-37 kg grain/kg N at the rates of 25 and 50 kg N/ha (Figure 2). Calculating the nitrogen use efficiency shows that there is a declining rate of return with increasing N rate (Figure 2).

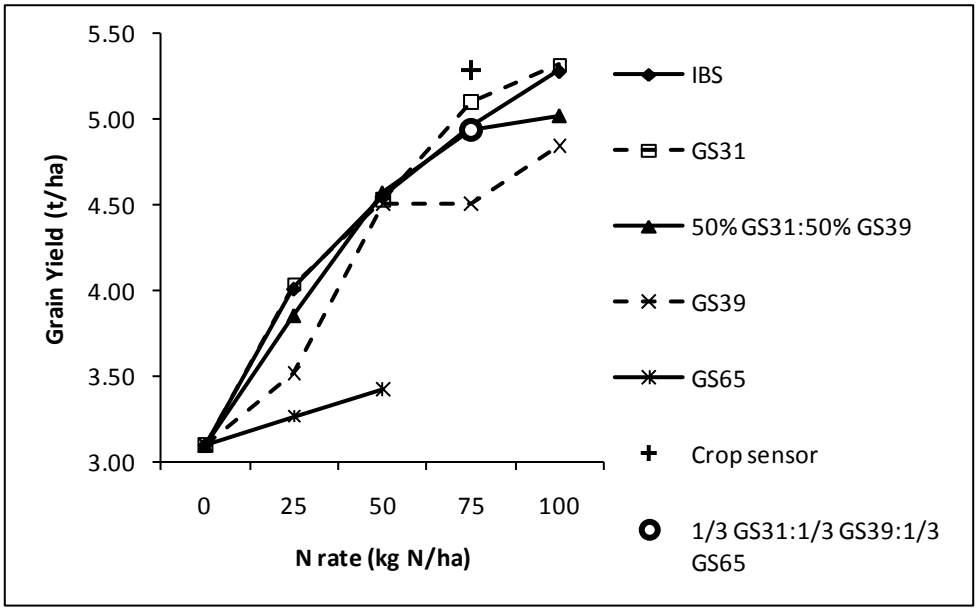

Figure 1: Grain yield (t/ha) for different N rates and application timings. (l.s.d. rate = 0.31, l.s.d individual treatments = 0.67).

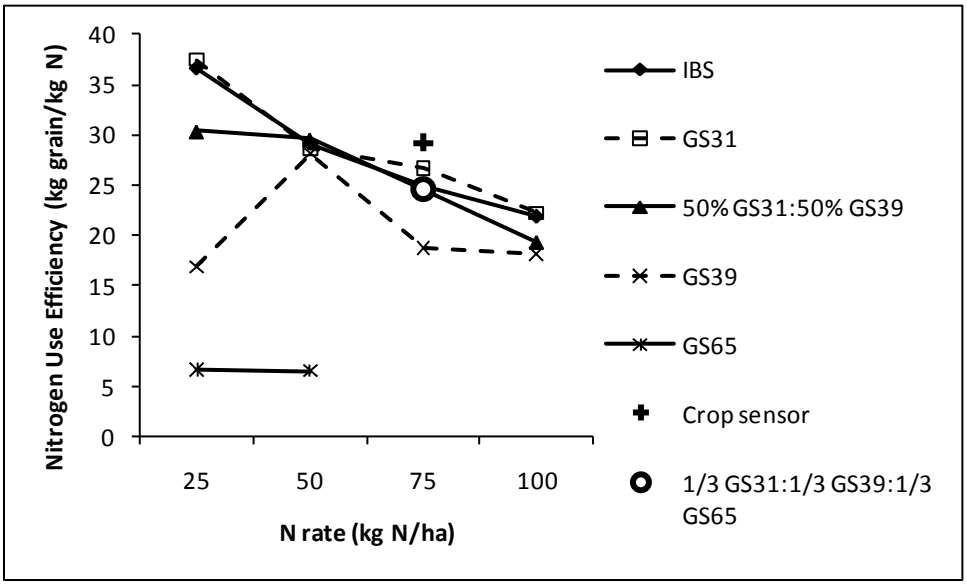

Figure 2: Nitrogen use efficiency (kg grain/kg N) for different N rates and application timings.

Delayed N application resulted in higher grain protein levels, as did higher N rates (Figure 3). No treatments produced protein levels greater than 9%, therefore all treatments would have been classed ASW. With earlier N applications (IBS or GS31), there appears to be a slight reduction in protein with low rates of N, this can be attributed to the increasing yield associated with those treatments diluting the protein concentration and offsetting any gains in total N uptake.

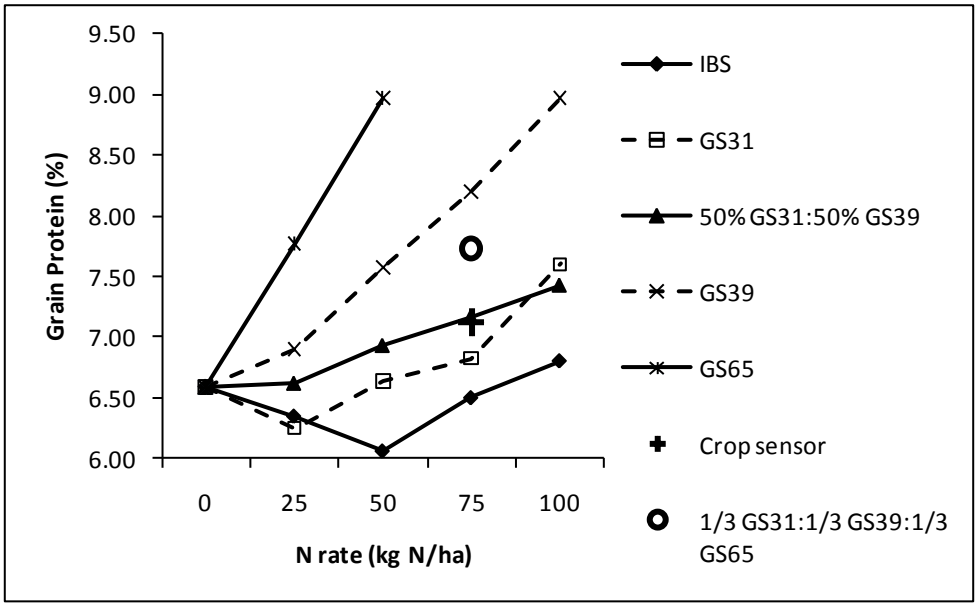

Figure 3: Grain protein (%) for different N rates and application timings. (l.s.d. rate = 0.23, l.s.d. timing = 0.21, l.s.d individual treatments = 0.59).

Nitrogen recovery is a measure of what percentage of N that is applied is recovered in the grain. Nitrogen recovery is highest for N applications delayed up until GS39, however for later N applications (GS65) the nitrogen recovery is reduced to levels similar to GS31 applications (Figure 4).

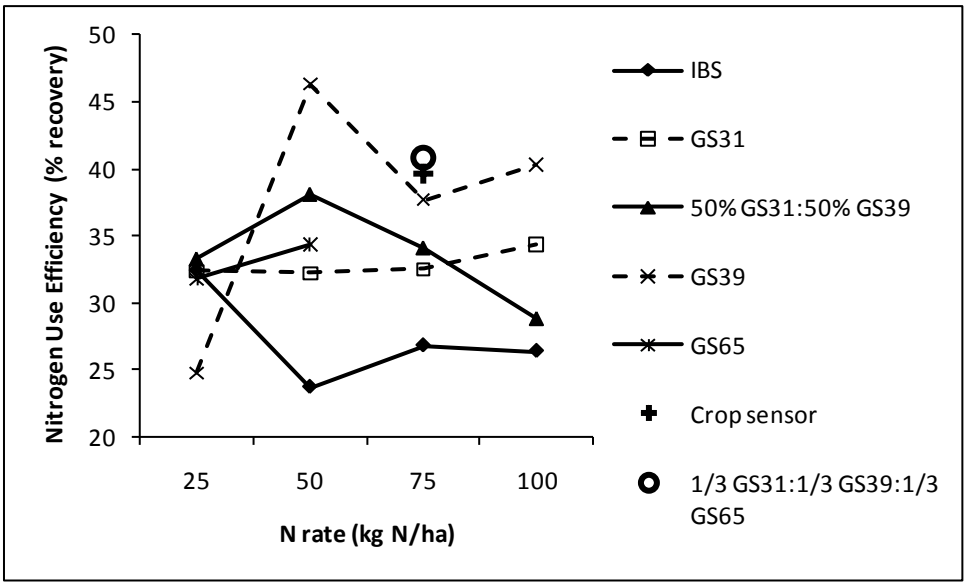

Figure 4: Nitrogen use efficiency (% recovery) for different N rates and application timings. Percent recovery indicates how much of the N that was applied is recovered in the grain.

Three applications of 25 kg N/ha at GS31, GS39 and GS65 did not result in a significant yield difference to other treatments with 75 kg N/ha applied, however the late application did increase protein levels, although not to the level of 75 kg N/ha applied at GS39. The late application did improve yield compared with just 25 kg N/ha applied at GS31 and GS39 (total 50 kg N/ha). Provided that yield potential is not limited too severely during stem elongation, both yield and protein can still be gained with N applications as late as flowering.

The crop sensor treatment predicted a yield response to N at GS31 based on comparison of measurements in the nil and 100 kg N/ha IBS treatment. The suggested N rate was 75 kg N/ha and this was applied in two applications, with 50 kg N/ha applied at GS31 and 25 kg N/ha applied at GS39. This treatment produced a yield of 5.29 t/ha, which was equivalent to the highest yields in the trial, including those treated with 100 kg/ha.

Increasing applied nitrogen rate had the biggest affect on gross margins up to 75 kg N/ha. Time of N application had a smaller effect, however using crop sensors for an in season prediction of N response was able to optimise the gross margin in this trial.

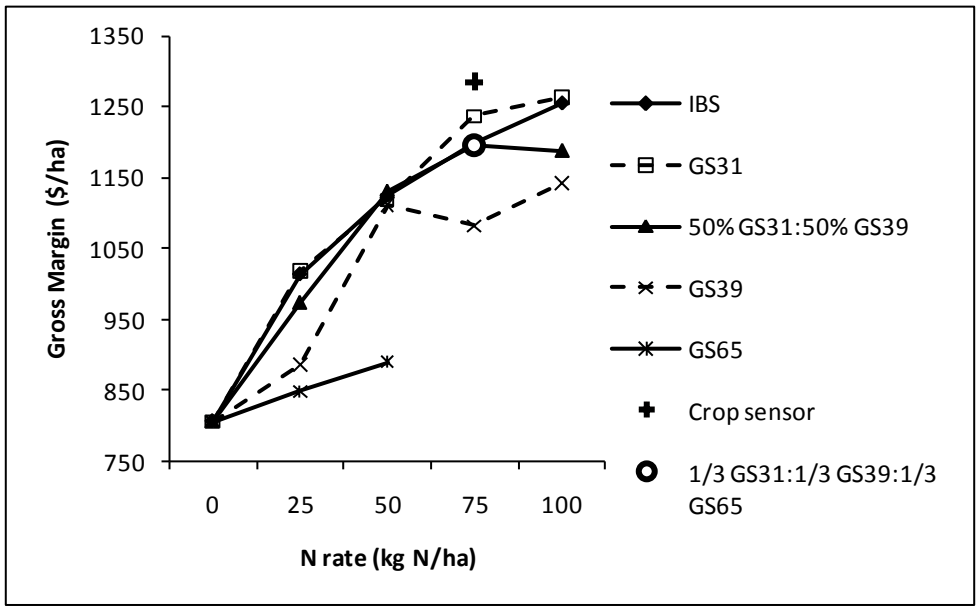

Figure 5: Gross margin ($/ha) for different N rates and application timings. Indicative prices used were ASW = $260/t and urea = $550/t. (l.s.d. rate = 81, l.s.d individual treatments = 164).