Yield Prophet® for N Fertiliser Decisions

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Summary

APSIM simulations, accessed through the Yield Prophet® web interface, were evaluated for their ability to forecast nitrogen fertiliser responses at the canopy management trial in the Wimmera.

Yield Prophet accurately simulated crop yield and protein for a range of nitrogen fertiliser application rates and timings.

Yield Prophet was able to estimate likely nitrogen fertiliser responses and dollar returns during the season.

For accurate simulations Yield Prophet requires good soil characterisation data (crop lower limit, drained upper limit and bulk density) and pre-sowing measurements of soil water and available nitrogen.

Background

Deciding whether a crop needs more nitrogen has never been easy. The decision to top-dress nitrogen has historically been based on:

- Experience – "We got a response last year so we will use it again this year".
- Looks – "The crop is going yellow it needs nitrogen".
- Soil testing – soil testing to depth ('deep N') and working out a nitrogen budget based on an expected yield.

APSIM computer simulations of crop growth, accessed through the Yield Prophet web interface, are proving to be a very useful tool for managing nitrogen. Yield Prophet provides an objective indication of the likelihood that a crop will respond to nitrogen fertiliser. It can also be used to objectively assess the likely dollar return from applying nitrogen fertiliser.

The canopy management work undertaken by Nick Poole (FAR, New Zealand) has clearly demonstrated for wheat, that nitrogen applications later in the season result in similar or better yields in comparison to up-front applications of nitrogen (pre-drilling). An additional benefit of late nitrogen application is that protein levels are usually higher and screenings lower, compared to pre-drilled application.

Later application of nitrogen provides an opportunity for Yield Prophet to assist farmers in making nitrogen application decisions at a time when more is known about how the season is unfolding in relation to rainfall, and how well the crop is growing. This paper uses data collected by Nick Poole at Lubeck and shows how Yield Prophet performed during the season and how it can be used to make better nitrogen top-dressing decisions.

Methods

The trial site was located at Lubeck and site details are described by Nick Poole in this manual ('Wheat Canopy Management Trial – Wimmera').

Yield Prophet was set up at the start of the season with the required data provided for soil characteristics (crop lower limit, drained upper limit and bulk density), starting soil water and available soil nitrogen, crop variety and sowing date. The model was used to determine likely nitrogen response at the time of pre-drilling, and at the appearance of the first node (GS31), which coincided with the times at which nitrogen applications took place. The same rates of nitrogen were tested in the simulation as were used in the trial (control with no nitrogen fertiliser, and 50 and 100 kg of N/ha as urea).

Results

Final yield comparison

Yield Prophet was able to simulate the growth of the crop during the season, and at crop maturity the simulated yields were similar to the actual yields for all rates and timings of nitrogen fertiliser (Figure 1).

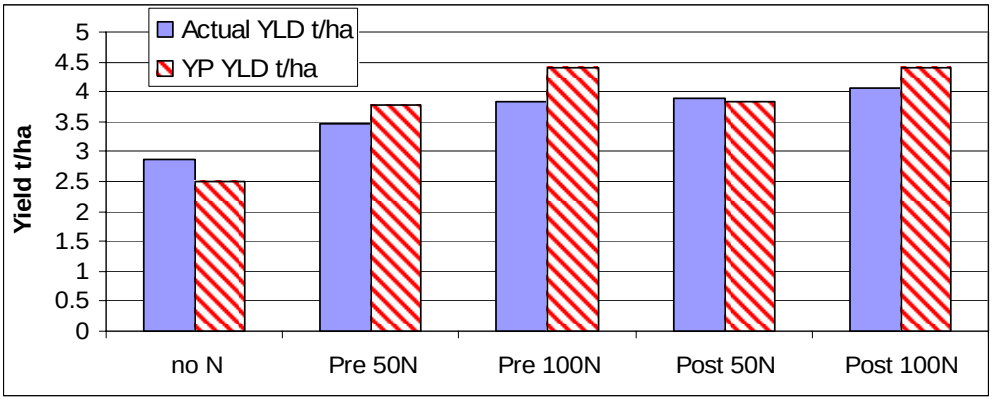

Figure 1: Actual and simulated yield for the nitrogen trial at Lubeck with various N applications.

Protein comparison

As with yield, actual and simulated grain protein contents were very similar (Figure 2).

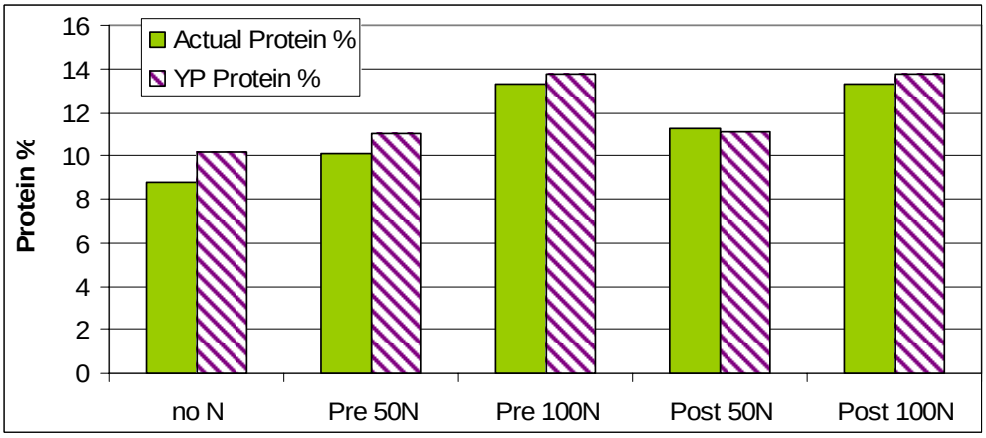

Figure 2: Actual and simulated grain protein content for the N trial at Lubeck with various N applications

Predictive performance of Yield Prophet

At both pre-drilling and GS31 Yield Prophet indicated that there was a high probability of a large yield increase in response to nitrogen fertiliser application (Figure 3). At both times there was a 50% chance of a yield increase exceeding 0.6 t/ha.

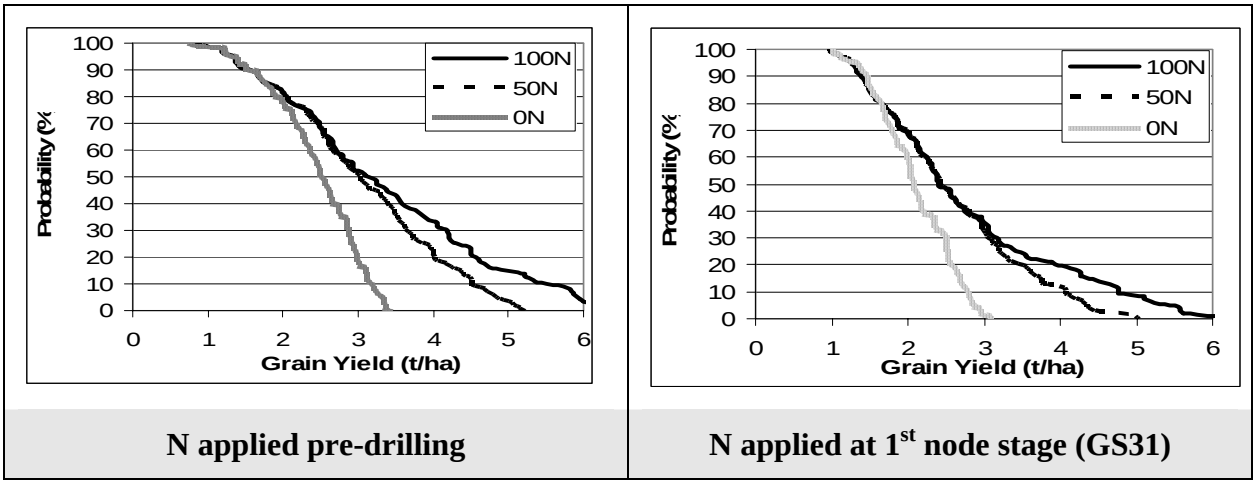

Figure 3: The probabilities of yield outcomes for three different nitrogen applications (0, 50, 100kg N/ha) at sowing (pre-drilled) and at appearance of the first node (GS31)

Dollar return estimate at the end of tillering

Yield Prophet can calculate the profit that is likely to result from the application of nitrogen fertiliser. It does this by subtracting the expense of nitrogen fertiliser and its application from the income from wheat, based on likely yield, protein and price (Figure 4).

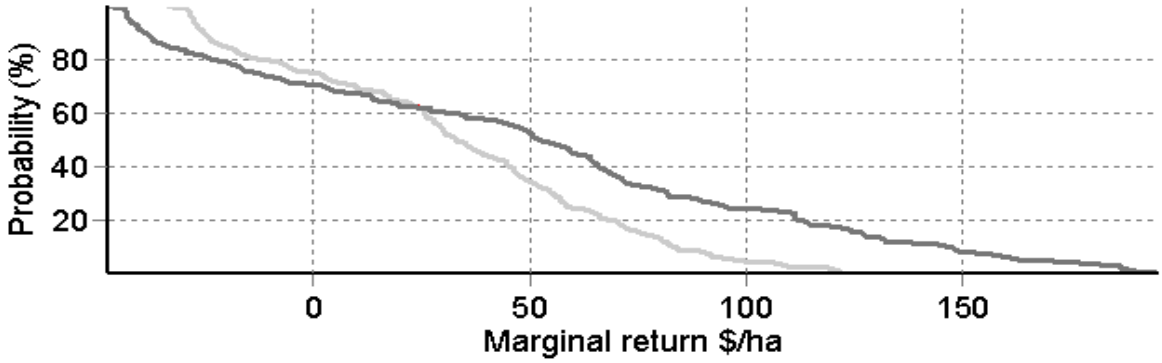

Figure 4: Marginal return for two nitrogen fertiliser applications (50 and 100kg of N/ha) at the end of tillering. The lightly shaded line is the marginal return between applying 50kg N/ha and no further nitrogen, the dark line is the marginal return between applying 100kg N/ha and no further nitrogen.

In the example of dollar returns presented in Figure 4 for the 100kg N/ha (dark line) there is a:

- 30% chance (1 in 3 years) that no return on investment or a loss is made from applying nitrogen.
- 50% chance (1 in 2 years) that a $50/ha or more return on investment can be made.
- 30% chance (1 in 3 years) that a $80/ha or more return on investment can be made.

For the 50kg N/ha option there was a lower chance of losing money (1 in 4 years) but also a lower chance (1 in 10 years) of making an $80/ha return on investment.

Other outputs useful for making N decisions.

- Plant Available Soil Water: Yield Prophet also shows the current plant available soil water content within the rooting depth of the crop. This graph is a useful aid to see how much plant available water is in the profile and when the crop is likely to become drought stressed (without rain or irrigation).
- Seasonal forecasts: Yield Prophet uses the decile technique, SOI phase system and the GESS (Global ENSO Sequence System) forecasting system from the Agriculture Department in WA.

Commercial Practice

For sites where there is good information on soil water characteristics (crop lower limit, drained upper limit and bulk density), and soil water and available nitrogen content prior to sowing, Yield Prophet is a very useful tool which:

- accurately 'grows' a crop during the season using computer simulation.
- presents information on likely crop yield responses from additional nitrogen fertiliser.
- makes an assessment of the likely dollar return in comparison to no further application of fertiliser.
- allows users to 'see' how much plant available soil moisture is still in the profile and whether the crop is likely to run out of water soon.
- provides several seasonal forecasts of rainfall.