SOUTHERN AUSTRALIA FOCUS

COVERING CROPPING SYSTEMS OF SOUTHERN NSW, VICTORIA, TASMANIA, SOUTH AUSTRALIA & WESTERN AUSTRALIA

THE RESEARCH VIEW

Crop sensors, canopy management and better decisions

By Nick Poole, Foundation for Arable Research (FAR)

For most growers canopy management has been the adoption of delayed nitrogen, where based on trial results, they have had greater confidence to delay expenditure on inputs such as nitrogen and fungicides and to respond more effectively to seasonal climatic and growing conditions. The approach has been valuable to not only take account of deteriorating spring conditions but also in making greater use of crop models such as *Yield Prophet*.

There are a number of ways of estimating nitrogen requirement for a crop, for example, soil nitrogen testing and budgeting. But one of the reasons for exploring whether tractor-mounted crop sensors have a role in better N management is that they have a number of potential advantages. They could:

- Give an immediate result of canopy nitrogen status;

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Nick Poole.

Consultants' Corner

Consultants' Corner is an initiative by *Australian Grain* highlighting current GRDC-funded research with a particular focus on the commercial implications of adopting cutting-edge research.

This article relates to a GRDC funded project on disease and canopy management taking place across Australia. Preliminary studies carried out as part of the project last season, sought to establish whether crop reflectance readings could be related to crop size and plant nitrogen uptake at the key timings for in-crop nitrogen application tillering to flag leaf emergence (GS22–GS39). The project links the Australian farmer groups from NSW to WA, CSIRO, University of Tasmania, NSW DPI with the New Zealand levy organisation, FAR.

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- Give an indication of nitrogen status across the whole paddock;
- Be relatively quick in comparison to soil nitrogen testing;
- Give a better indication of nitrogen supply to the plant than soil testing, since the plant is the indicator not the soil; and,
- Be more easily linked to variable rate fertiliser application.

Are we practicing canopy management?

Though the process of delaying nitrogen clearly influences canopy size and duration, it is difficult to consider it canopy management. We have no quick or easy means of measuring the canopy size or its water, nitrogen or disease status. So how could we measure canopy size and status quickly in order to make better decisions in the key period of stem elongation GS30–59?

Role of crop reflectance sensors – what can we visualise?

Ask the majority of growers how they make decisions on crop inputs and they will tell you it is based on experience and the visual appearance of the crop.

Over the past season, a GRDC project has been examining the role of crop reflectance sensors – such as the Crop Circle and GreenSeeker – to assess whether we can use them to visualise canopy size and nitrogen status.

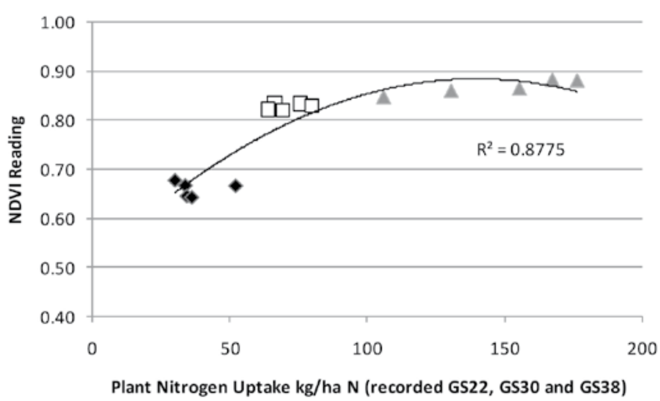
These tractor or boom mounted sensors measure light reflectance from the crop canopy at different wavelengths of light. We are particularly interested in the red and near infrared wavelengths – the readings of which are strongly influenced by the biomass and chloropyhll content of the canopy. From calculations on reflected wavelengths it is possible to get a measure of crop canopy greenness.

One of the standard indices from crop sensors, such as the GreenSeeker, for estimating canopy greenness is NDVI (normalised difference vegetative index), which is calculated by the simple equation:

NDVI = [reflectance at the red – near infrared (NIR) wavelength]÷[reflectance at red + near infrared (NIR) wavelength]

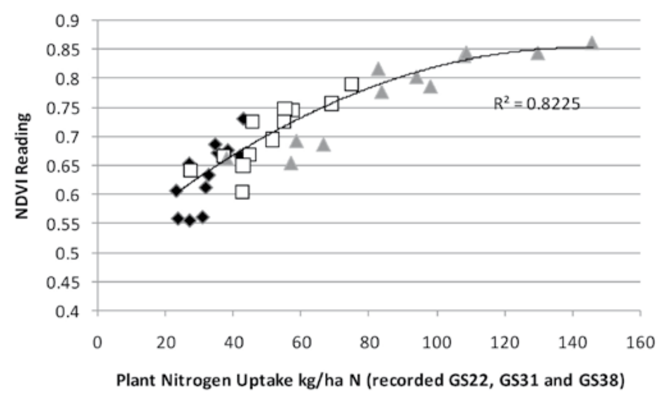
At project trial sites in the 2008 season different crop canopies were established using a range of nitrogen rates. We examined whether NDVI can be used to better

FIGURE 1: NDVI and plant nitrogen uptake, Lubeck, Victoria



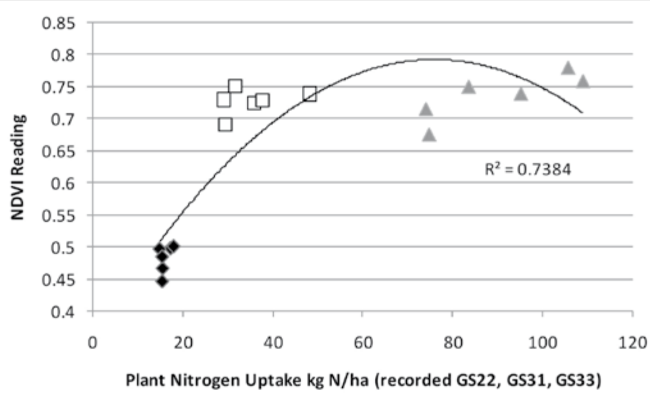
NDVI readings taken with the Greenseeker at GS22 ◆ (main stem and two tiller); GS30 □ (pseudo stem erect); and, GS38 ▲ (50% flag leaves emerged on the main stem) and the relationship with plant nitrogen uptake (in above ground biomass) in wheat. Cv Derrimut with 0, 25, 50, 75 & 100kg N/ha applied at sowing (Soil Nitrogen Reserve 253kg N/ha (0–100cm)).

FIGURE 2: NDVI and plant nitrogen uptake, Tarlee, SA



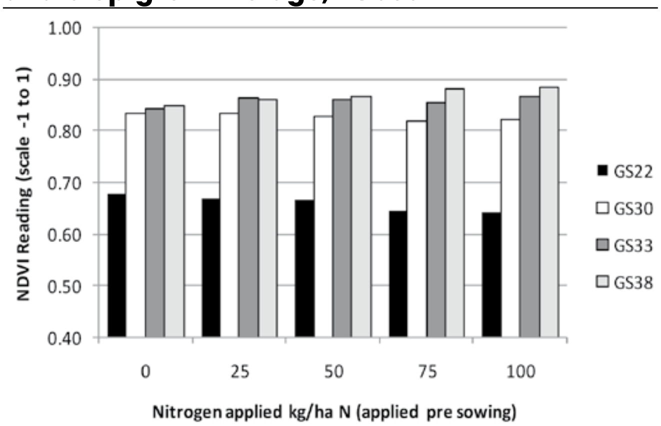
NDVI readings taken with the Greenseeker at GS22 ◆ (main stem and two tiller); GS30 □ (1st node); and, GS38 ▲ (50% flag leaves emerged on the main stem) and the relationship with plant nitrogen uptake (in above ground biomass) in wheat. Cv mean of Wyalkatchem & Correll at two populations with 0, 50 & 100kg N/ha applied at sowing (Soil Nitrogen Reserve 133kg N/ha (0–60cm)).

FIGURE 3: NDVI and plant nitrogen uptake, Hart, SA



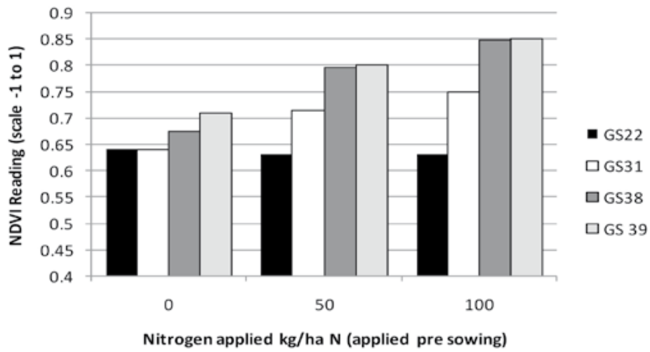
NDVI readings taken with the Greenseeker at GS22 ◆ (main stem and two tiller); GS31 □ (1st node); and, GS33 ▲ (3rd node) and the relationship with plant nitrogen uptake (in above ground biomass) in wheat. Cv mean of Wyalkatchem & Correll with 0, 30 & 60kg N/ha applied at sowing (Soil Nitrogen Reserve 113kg N/ha (0–60cm)).

FIGURE 4: NDVI reading, pre-sowing N rates and crop growth stage, Lubeck



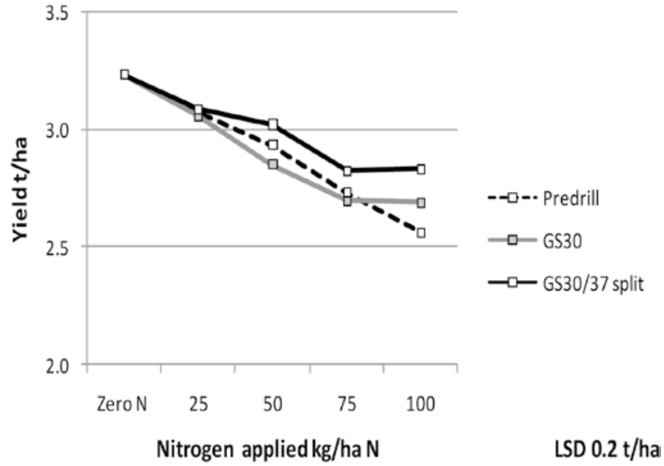
NDVI readings taken with the Greenseeker at GS22 (main stem and two tiller) – GS30, (pseudo stem erect) and GS38 (50% flag leaves emerged on the main stem) for different rates of pre sown nitrogen (0, 25, 50, 75 & 100 kg/ha N) in wheat.

FIGURE 5: NDVI reading, pre-sowing N rates and crop growth stage, Tarlee



NDVI readings taken with the Greenseeker at GS22 (main stem and two tiller) – GS30, (pseudo stem erect), GS38 (50% flag leaves emerged on the main stem) & GS39 (flag leaf emergence on the main stem) for different rates of pre sown nitrogen (0, 50, & 100 kg/ha N) – cv Mean of Wyalkatchem & Correll at two populations with 0, 50 & 100kg N/ha applied at sowing (Soil Nitrogen Reserve 133kg N/ha (0–60cm)).

FIGURE 6: Influence of nitrogen timing and rate on yield (t/ha) of Derrimut wheat, Lubeck



estimate canopy size and nitrogen status in the plant.

The sites were subject to a range of different climatic and agronomic conditions. Wheat was established at all sites with different rates of applied nitrogen at seeding and in-crop.

To determine whether there was a relationship between plant nitrogen uptake and crop reflectance, above ground dry matter was assessed at key growth stages in the spring to determine dry matter and percentage N content. Key growth stages were from tillering (GS22) through to flag leaf emergence (GS38–39). This period is regarded as the key timing window for in-crop nitrogen application.

Crop sensors which measure canopy reflectance can give very useful readings of in-crop nitrogen levels.

What we found

Although data is still being processed, preliminary results have been collected from the three sites: Lubeck; Tarlee; and, Hart.

The three trials indicated that under different levels of soil nitrogen reserve, NDVI measured by the GreenSeeker gave a good guide to the amount of nitrogen uptake in the key period from tillering to flag leaf emergence (Figures 1, 2 and 3).

Though there was evidence that beyond GS31 NDVI readings were beginning to saturate (smaller differences in NDVI as crop canopy NDVI scores approached the upper range of measurement), it was clear that at Tarlee – where soil nitrogen reserve was lower and crop canopies more restricted by nitrogen availability (rather than water availability which was the case at Hart) – NDVI still gave a useful guide to plant nitrogen uptake at flag leaf emergence.

At the Lubeck site there was no significant difference in NDVI between the five rates of pre applied nitrogen until GS38 when higher rates of nitrogen gave slightly higher NDVI compared to the zero N control (Figure 4).

In other words, it was not until flag leaf that the GreenSeeker was able to detect small differences in NDVI which also corresponded to differences in plant uptake of nitrogen.

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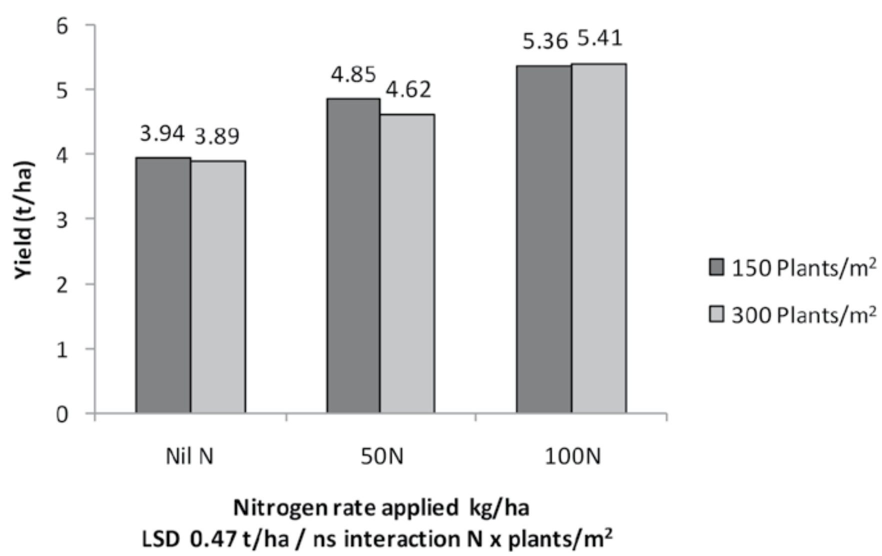
FIGURE 7: Influence of nitrogen rate and plant population on the yield (t/ha) of wheat (mean of two varieties, Correll and Wyalkatchem), Tarlee



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At the sites with a lower soil nitrogen reserve such as Tarlee, differences in NDVI between the different rates of nitrogen applied at seeding were larger and obvious far earlier in the season. This indicated an earlier exhaustion of the nitrogen in the soil profile and a greater need for applied N (Figure 5).

Early indications suggest that where NDVI readings showed no difference (due to different rates of sowing applied nitrogen) through tillering and early stem elongation, there was no positive yield response to applied nitrogen. In fact yield was reduced (Lubeck, Figure 6).

In contrast at Tarlee there was a significant response to nitrogen application which coincided with significant differences in NDVI from GS31 onwards.

TO SUM UP

Crop reflectance at the red and infrared wavelengths (calculated using NDVI) showed good correlations with plant nitrogen status at the key timings for in-crop nitrogen application (GS22 – GS38).

It is hoped that these relationships, in conjunction with knowledge of soil water availability, can be used to optimise in-crop nitrogen treatments on a variable rate N application basis.

I would like to acknowledge all the input of my co-workers on this part of the project: Hart & Tarlee (Peter Hooper & Mick Faulkner), Cropfacts & Birchip Cropping Group (Brooke Thompson & Simon Craig), NSW DPI (Guy McMullen and Alan Bowring), and the funding of GRDC.

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THE CONSULTANT'S VIEW

By Brooke White, CropFacts Pty Ltd

Canopy management is essentially seen by many growers as nitrogen management.

From the 1990s to the early 2000s in the Victorian Wimmera, standard practice was to pre-drill all nitrogen up front prior to sowing. A typical application was about 100 kg per hectare of urea. If it turned out to be a good season, a grower might top up nitrogen levels in-crop to achieve higher yields.

The main problem with this system was risk. Growers applying nitrogen up front did not know if the season would be good, bad or average, and therefore didn't know if there would be a return on their nitrogen investment.

More recently, Wimmera farmers have completely moved away from applying nitrogen up front to cereal crops. Particularly with wheat, all nitrogen is now applied post seeding, usually just one application after the end of tillering (GS30). The majority of nitrogen applied is still urea, although in some cases growers are also using UAN.

Brook White: "When and how much nitrogen to apply in-crop causes a lot of farmer angst."

There are several benefits of this practice in addition to better risk management. These include savings on nitrogen and pre-drilling costs, conserving soil moisture for when the crop needs it more, and more efficient photosynthesis through better canopy structure. Growers are no longer pleased to see lush canopies.

Making the decision to apply nitrogen, and when to do it, causes the most concern for growers working with this system, and a few sleepless nights too. Many growers have agonised over the decision, although in recent seasons their angst has been exacerbated by the dry finishes to the season.

Determining how much nitrogen is required is highly important. In the Wimmera, growers generally rely on a pre-sowing soil nitrogen and moisture test, and in some cases an in-crop soil test for nitrogen and soil moisture, to formulate their nitrogen budget. Decision support tools, such as *Yield Prophet*, that determine the likelihood of getting a response to applying extra nitrogen can help a grower avoid sleepless nights.

The use of crop sensors to determine nitrogen levels is still in its infancy in Australia, but it promises to add another tool to support nitrogen decision-making. In trials we are currently using hand-held active sensors, although commercial systems will use vehicle-mounted sensors so that every time a grower makes a pass over the paddock they can get a nitrogen reading, which can be used to formulate a fertiliser plan.

AT A GLANCE…

- Up to now, canopy management for most growers has revolved around delaying nitrogen application – but unless there are easy ways of measuring a crop canopy, it is difficult to see how it can be managed.
- Crop sensors measuring the reflectance from the cereal crop canopy, may offer a better opportunity for defining the size and status of the canopy, and better information for making in-crop input decisions.
- From preliminary studies, crop reflectance showed good correlations with nitrogen in the above ground biomass of the plant.
- The correlation between plant N uptake and NDVI was very strong when different growth stages between tillering and flag leaf emergence were compared.
- Where different nitrogen rates were applied at sowing, the correlation between NDVI and plant nitrogen uptake was dependent on the level of soil nitrogen present at sowing.
- Lower soil nitrogen reserves resulted in greater differences in NDVI when different levels of applied seedbed nitrogen were compared. The NDVI differences also showed up earlier in plant development indicating that NDVI would be the basis of a useful guide for predicting soil nitrogen reserve.
- It is hoped that these relationships – in conjunction with knowledge of soil water availability – can be used to optimise in-crop nitrogen applications on a spatial basis.