Seeking solutions for nitrogen management

IN A NUTSHELL

- The Australian Nuffield Scholars' Association offers scholarships for farmers to travel overseas and study a topic or topics of their choice
- A recent returning scholar came across the GreenSeeker™, a hand-held instrument that provides NDVI readings of a growing crop
- Using a nitrogen rich test strip in the field and software in the office, the technology can provide an instant recommendation for nitrogen requirements

Excerpt of Nuffield Scholarship Report, 2005, *Production and management of high yielding crops – disease management, stubble management & improving nitrogen use efficiency*, by David Cox, Esperance, WA

In my entire career as a farmer I have continually questioned why sometimes an application of nitrogen, whether it be an application of dairy effluent applied to a pasture, some ammonium sulphate on grass, or topdressing of urea on a wheat crop, will not seem to make much of a difference and other times the difference between the applied and control is chalk and cheese. We all stand around afterwards and come up with theories to do with the weather or management practices as to why the crop did or did not respond to the investment.

More recently our broadacre cropping enterprise has expanded and with increasing inputs I have been asking my consultants and agronomist to explain why they have recommended a certain rate of nitrogen. Their responses are usually based on simple nitrogen budgets that take into account yield goal and organic matter. These rates are generally the same across soil types, varying stubble loads and different yield potential. At the end of any season we will have fields that have been fertilised for a 5 t/ha yield and only do 3 t/ha, and vice versa.

How much nitrogen is needed?

Our local Department of Agriculture will show its annual nitrogen trial results and tell you that this year there was not a response to nitrogen above a certain rate and the next year's trials will say something totally different. At some sites in some years there have even been negative responses to applied nitrogen.

This information I believe is pointless because the money has already been spent. The fields have nearly all been over applied, costing money or under applied, costing lost yield. I compare this to entering a race track and betting on races that have already been run. We try to take into account as many things as possible when working out nitrogen rates but it still ends up being nothing more than a whole lot of educated guesswork and human emotion.

The obvious answer to this problem is to find a way to ask the plant how it is responding to bagged nitrogen in any given season and apply accordingly.

The next question after *How much nitrogen does the crop need? is How much of the calculated amount of product gets to the plant and can be turned into yield?* We ask the agronomists and the Department of Agriculture people and add in a few more estimations and off we go.

Finally, the timing of nitrogen applications. Rules for this are constantly changing. Best practice ten or even five years ago seem to be totally different to what we are doing today. Our soils are changing in depth, structure, fertility and organic matter therefore it is reasonable to suggest that our management practices must change too.

GreenSeeker™ answers the questions

The high point of my Nuffield Scholarship trip was spending time with Dr Bill Raun and PhD student Kyle Freeman at Oklahoma State University (OSU). The team at OSU is passionate about improving world nitrogen use efficiency. They are using a hand-held instrument, called a GreenSeeker, to measure the responsiveness of crops to nitrogen applications.

The GreenSeeker measures, using infra red and near-infrared technology, the NDVI (Normalised Difference Vegetative Index) which indicates the biomass of the crop. It is quite simple to use. After planting, a nitrogen-rich strip is added to each management zone of about 150% of the budgeted nitrogen for the crop. The nitrogen-rich strip only needs to be a couple of metres wide and long enough to be representative of the zone. The aim of the strip is to provide an area of comparison that has no nitrogen limitations.

Before every application of nitrogen, the difference between the nitrogen-rich strip and the remainder of the crop (farmer practice) is measured (Figure 1). Along with days from planting and maximum potential yield, the two NDVI readings are entered onto a web-based calculator. The calculator will give a nitrogen response index, an in-season yield prediction with and without added nitrogen and a recommended rate of nitrogen to apply (Figure 2).

Developing the technology

Oklahoma State University started using the GreenSeeker for optical sensing in 1991 to sense weeds for spraying. The system was then used to apply nitrogen, initially to turn the applicator on or off when plants were or were not present. In 1994, the sensors were used to vary the rate of nitrogen using an inverse n-rate, NDVI scale. Where the crop was poorest more nitrogen was applied and vice versa. In 1995, it was found that in-season treatment is necessary whereby the influence of the environment is integrated into treatment application.

Using the hand-held sensor NDVI, readings of wheat crops during the growing season were plotted against final grain yield and the in-season estimated yield (INSEY) index was developed.

In 2000, Dr. Gordon Johnson discovered that the nitrogen fertiliser rate needed to maximise yields varied widely over years and was unpredictable in several long-term experiments (OSU website 2005). This led to his development of the RESPONSE INDEX.

The response index (RI) was created by dividing the NDVI of the nitrogen-rich strip by the NDVI of the farmer practice.

Ensuing work by the Soil Fertility Project aimed to predict what the potential response to applied nitrogen would be using sensor measurements collected in-season. This approach allowed OSU to predict the magnitude of response to topdress fertiliser, and in time to adjust topdress nitrogen based on a projected 'responsiveness'.

Using the in-season response index (RINDV), OSU were able to project responsiveness to applied nitrogen, which changes from location to location based on climatic conditions specific to each parcel of land, and that changes on the same land from year to year.

Finally all the calculations (based on two sensor readings) were put together and the sensor based nitrogen rate calculator was developed. The calculator is available on the internet free of charge to anyone at www.soiltesting.okstate.edu (Figure 2).

Nuffield Scholarships for 2006

Applications for Nuffield Scholarships will open on 1 April 2006 and close on 30 June 2006. A recently returned scholar, Andrew Johnson from Tintinara SA, had this to say about the program.

"A Nuffield Scholarship is a life changing experience, which challenges one in personal development, and also interacting within a team of like minded colleagues. Being able to take myself away from the day to day issues of farming, gave me the opportunity to look at my business and Australian agriculture from another perspective. Though I have finished my study I feel in many ways my Nuffield experience is just beginning, with friendships made, lifelong participation within the Nuffield family, and a thirst for more knowledge, I can only recommend others to grab the opportunity."

Further information

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Application forms for 2006 scholarships may be downloaded from the Nuffield website: ***www.nuffield.com.au*** or are available from the Association's office.

Figure 1 *Measuring NDVIs at Esperance WA September 2005*

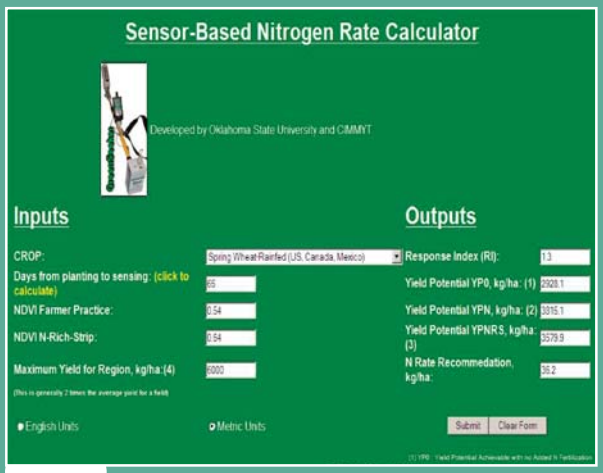

Figure 2 *Sensor based nitrogen rate calculator found on the website*