GRDC Regional Cropping Solutions Network
Report Structure for Final Reports

Introduction — Improving the Understanding of Nitrogen Use Efficiency and Soil Water Interactions, 2014.04.19

Background to the project

The research aimed to demonstrate the concept of utilizing a range of technologies for monitoring and improving Nitrogen use efficiency on four of the major soil types in the Northern Agricultural Region (NAR).

The project and trial component of the research involved collaboration between MIG and Agrarian Management (AM) and the grower groups NAG, YFIG, MFIG, MDFI and NEFF to characterize the major soil types of this region. The second component involved building an understanding of the current Nitrogen use efficiency of the four soil types and measuring how efficiently applied nitrogen is being utilized. Growers can take this information and use it to make more confident and accurate decisions on nutrient application and grain marketing during the growing season.

The research proposed to develop a concept for growers to implement and access during the growing season, providing them with real time information and improved confidence in crop performance and yield potential. The information allows growers to allocate nutritional inputs and market their grain based on informed knowledge.

By testing soil nitrogen levels to depth close to sowing, accurate soil profile nitrogen is known at seeding and plant available nitrogen can be calculated. Plant available nitrogen at sowing can then be modelled to develop a Nitrogen response curve that provides growers with information they can be used to tailor nitrogen applications to a range of estimated yields. The result is an increased level of risk management and reduced risk of under or over fertilizing a particular soil type.

The next piece of the jigsaw is to knowing what the final yield is likely to be. The yield estimation tools Yield Prophet, iPaddock Yield and the old water use efficiency calculators such as French & Shultz equations are all useful tools in predicting final yield. An evaluation of these tools has been conducted and included in the results of this research. The models were run retrospectively based on the previous 10 years of rainfall and paddock yield data for each research paddock in the project.

Objectives of the project

To build an understanding of the current nitrogen use efficiency of four soil types in the NAR.
To understand how efficiently applied nitrogen is used in the soil.
To educate growers and advisors on how to improve nitrogen use efficiency through a greater understanding of the soil water interactions and how to use this information in reducing production risk by identifying what the final yield is likely to be.

Trial location (if trial)		
	Morawa: (Ag College)	-29.225371, 116.006134
	Cosgrove: (Yarragadee)	-29.148490, 115.385140
	Messina: (West Casuarina's)	-28.754821, 115.284774
	Cripp's: (Ogilvie)	-28.134653, 114.808465

Methodology

The field component of this project included four replicated small plot trials on four of the most common soil types in the northern agricultural region. The trials aimed to utilize and demonstrate how real time soil moisture monitoring (using soil moisture probes) combined with pre and in season soil nitrogen testing can be integrated with seasonal forecasting to predict likely responses to applied nitrogen. This will enable grain growers to better match their fertiliser applications to crop demand and manage the associated risks of application during the season.

Achieving this involved investigating the use of multiple integrated decision support tools that demonstrate the implementation of seasonal risk management to achieve maximum nitrogen use efficiency. Each small plot trial

consisted of six treatments replicated four times and one trial was placed on each of the four soil types in low, medium and high rainfall parts of the NAR. The treatments included:

A) Nil Nitrogen
B) 20 units N
C) 40 units N
D) 60 units N
E) 80 units N
F) 100 units N

The following took place for each site:

a) Installation of a soil moisture probe.
b) Soil particle size analysis to allow for full soil characterisation, determination of crop lower limit (CLL) and soil drained upper limit (DUL).
c) Plant available soil water (PAW) monitoring in real time presented live on a web based platform, Crop Manager.
d) The data interpretation platform Crop Manager monitored both present PAW and current soil moisture usage rates in real time. It also used current seasonal forecast rainfall deciles to predict future rainfall and hence seasonal PAW throughout the growing period.
e) This information was used in combination to give a daily yield prediction from the available yield prediction tools used in the project.

A nitrogen response curve has been developed for each site to identify the most economic rate of nitrogen for each soil type. The curve for the Cosgrove site is included in the results (Attached).

The project monitored variation between treatments at each site at regular intervals during the growing season. A correlation can be drawn between crop vegetative growth, timing and rate of nitrogen application, soil water use and final grain yield. On the lower PAWC soils, we hypothesize strategies that increase early crop vigour and growth result in a greater early drawdown of soil water and result in increased moisture stress during the grain fill period.

Results — Included in Attachment

Discussion of Results — Included in attachment

Implications

The yield estimation tool iPaddock yield looks at long term water use efficacy, using a line of best fit analysis to predict yield based on rainfall received to date against previously achieved yields with a range of soil moisture levels at the same period within the season. The yield predictions are based on actual farmer / paddock performance, taking into account current management, soil constraints and rainfall patterns. The more historical yield and rainfall information a grower enters into the model, the greater the accuracy will be. Essentially, past performance is utilized to predict the future yield estimates. In this project iPaddock Yield has shown to have the least variation of all models between predicted and actual yield achieved in the paddock, thus delivering the highest level of yield prediction accuracy.

A yield estimate was produced as at the 31st July for each of the 10 years of historical data collated from each site. Yield estimate accuracy was calculated against grower actual yield. Below are estimate accuracy figures from the Cosgrove site.

1. Yield Prophet (APSIM) — 68% accuracy
2. French & Shultz (Brocken Stick) — 74% accuracy
3. iPaddock Yield — 77% Accuracy

The more accuracy and confidence we have in final yield estimates, the greater the ability of the grower to play the season with Nitrogen applications and use these to maximize grain yield and profitability in any given season. Every season is different so an understanding of soil water holding capacity and plant available moisture in the soil throughout the season is essential for estimating yield and tailoring nitrogen applications. The knowledge and accuracy, thus confidence, that we have in this area is increasing rapidly.

Unfortunately 2015, well below average rainfall (decile 1) at all sites resulted in soil moisture, rather than nitrogen supply, being the major limitation to grain yield. The nitrogen response curve was developed with rates from 0 units to 100 units of applied N. In a number of cases though, soil nitrogen at sowing was adequate and there was little response to applied nitrogen due to grain yield being limited by moisture.

Assessment of the impact of the outcomes on industry in Australia

- Improved management of in crop expenses – reducing grower expenditure
- Improved yield and total grain production forecasts from Australian grain growers
- Growers want to improve yield prediction accuracy, the implementation of soil moisture probes and the data interpretation platform Crop Manager increases the likelihood of improvement in this area.
- An increased efficiency in use of resources – physical inputs, time/labour, machinery

(where possible provide a statement of costs and benefits).

Recommendations

Growers were very positive about the implications of this research on their cropping systems and requested that future research includes more information from further down the soil profile, the installation of permanent probes, the recording of accumulated heat units during the growing season and a greater understanding of the plants responses when subsoil constraints (eg acidity and compaction) are removed. These requests have been included in a project proposal currently under evaluation for 2016.

With an improved knowledge of soil water interactions, rainfall and accumulated heat units, grain growers can confidently and accurately identify their crop growth stage, the nutritional requirements of the plant at that growth stage and the crop yield potential. The proposed project will bring the total number of soil moisture probes under MIG management to 19 and build on MIG's goal to improve grower's knowledge of soil water interactions and their ability to react and make confident decisions that improve gross margins during variable seasons.

Further evaluation will also increase the confidence in the accuracy of each yield prediction model currently available, crucial for maintaining profitable farming systems in a challenging environment.

Appendices

- Four regional workshops were held in July to extend the research objective and findings to date to local growers and industry. Events were held in Mingenew, Morawa, Tenindewa and Ogilvie, averaging 20 participants at each location. The workshops were presented by Debbie Gillam (MIG), Craig Topham (AM), Wayne Pluske (Equii), Dr Yvette Oliver (CSIRO).
- A presentation on the concepts being developed within the data management platform "Crop Manager" was presented by Craig Topham and Debbie Gillam at the MIG Spring field day with 25 participants in the session consisting of growers and industry.
- The complete trial results were presented by Craig Topham at the MIG Regional Updates and Trials Review with over 70 participants. Questions were received from the audience and answered.

Glossary	Optional
References	Footnotes/References/Cross-references

As part of the Research Report (please see following page), authors need to provide a one page, plain English summary along with each Research Report in electronic format. If there were any trial booklets produced throughout the year then these may be included as part of the Research Report. We are also very keen for publishable photos to be included in your report.

Please remember to take photos throughout the life of the trial/project. GRDC are very keen to see what you have been doing, and photos may be used for reporting purposes (with appropriate credits). Always use the highest definition and save it without attempting to reduce file size; or send photos in a separate email as an attachment.

Questions: Julianne Hill (08) 97261307, 0447261607, regionalcroppingsolutions@gmail.com

Additional Information:

Grower participant feedback:

Participating growers said that they would definitely like to continue using soil moisture probes in the future and would be very happy to participate in another project with our team. All rated having an accurate yield prediction as a high priority. They felt the trial layout was done well and fitted with their paddock system. Unfortunately an external collaborator assisted with installation of the probes and one of the probes was placed not directly within the crop row. This affected the interpretation of the Crop Manager information for this site. This collaborator would not be used in the future for assistance with this work. All other sites were installed and monitored correctly.