Making better fertiliser decisions for Western Australian cropping systems

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KEY MESSAGES

- The current calibration curves between a particular soil test and crop grain yield responses are based on a large body of past research. However, cropping systems in WA have changed. For example, there is now a wider range of crop species growing in rotations, increased adoption of zero-till, increased crop yield, and more nutrients need to be managed for optimal crop grain yield. Thus there is a need to improve the current soil test-crop response calibrations to maximise returns from fertiliser investment in cropping.

- Minimising on-farm nutrient losses is an increasingly important aspect of fertiliser decision making, in response to public concern about the environment, changing climate and high fertiliser prices.

- The GRDC newly funded project ‘Making Better Fertiliser Decisions in the WA Cropping Systems’ aims to improve current fertiliser recommendation systems through the main activities:
  - Compiling fertiliser experiments for the national database and defining and improving soil test-crop response relationships for the major nutrients and crops.
  - Developing a user-friendly Decision Support System (DSS) to minimise on-farm nutrient (N and P) losses.

- The project is part of a national GRDC project starting in July 2009.

- This paper provides an overview of the project with a view to obtain feedback from grains industry stakeholders that will improve the value of project outcomes.

PROJECT OVERVIEW

Improving soil test-crop response relationships

The GRDC Nutrient Management Initiative (NMI) review identified the need for improved soil test interpretation (Chen et al. 2009). Chen et al. (2009) indicates that with changing farming practices and deficiencies of nutrients with different soil mobility, there is an increased need to address soil sampling practices (sampling depth, sampling position in relation to seeding row, etc.) and improve soil test-crop response relationship interpretation for making fertiliser recommendations.

Fertiliser requirement is often calculated from the information on soil nutrient supply, crop potential yield and the relationship between soil test and crop response. The shape of crop response curve to applied nutrients can be described by the Mitscherlich function:

\[ \text{Yield} = A \ast \{1-B \ast \text{exp}\{-c \ast x\}\} \]

Where A is the potential yield (PY), B is the scaled yield response to the applied nutrient, c is the curvature of the response curve which is a measure of nutrient efficiency, and x is the rate of the applied nutrient. The above function is also widely used to make commercial fertiliser recommendations to growers in WA (Chen et al. 2009). Hence, the key requirements for making better fertiliser recommendations are realistic estimates of potential yield (A), knowledge of the maximum yield response to fertiliser input for a given nutrient status of the soil (B) and estimates of nutrient use efficiency or the curvature of the response curve (C). Estimating site-specific plant available water capacity together with the record of growing season rainfall to predict crop yield potential (PY) and integrating this knowledge when defining soil test-crop response relationships will be important to improve the current fertiliser recommendation systems. The maximum crop yield response (B) will depend on crop yield potential and the capacity of the soil to supply specific nutrients. The capacity of the soil to supply specific nutrients is often measured by soil testing based on the standard procedures.
This project will compile experimental data and critically analyse soil test-crop response relationships. Key factors affecting the soil test-crop response relationships such as seasonal rainfall and its impact on crop yield potential (thus nutrient demand), soil nutrient distribution down the soil profile and its influence on soil test interpretation will be considered. The data analysis will also link with the DAFWA soil landscape database to locate soil groups with different nutrient distribution down the profile. This work will provide important information on the locations (or soil groups) where deep soil sampling is necessary when interpreting soil test results.

**Decision Support System (DSS) to minimise nutrient losses**

Nitrogen (N) and Phosphorus (P) are essential nutrients for crop production. These nutrients can lead to eutrophication of water ways. As a result agriculture is coming under increasing pressure to develop management practices which will reduce N and P losses.

P loss from agricultural watersheds is mainly derived from a small part of the landscape associated with a few relatively large storms. These storms result in areas of a watershed contributing to surface runoff. When these areas have high soil P or recent fertiliser or manure applications there can be significant P runoff. In Australia, Mathers et al. (2007) states P losses from cropping systems have not been systematically investigated to the same extent as those from other agricultural sectors such as dairy pasture (Melland et al. 2007).

Assessment of P loss is both consuming and expensive. Therefore models are often seen as a more efficient and feasible means of evaluating management alternatives on the amount of P loss. For example, Soil and Water Assessment Tool (SWAT) (Neitsch et al. 2005) has proven to be an effective tool for assessing water resource and nutrient losses (P and N) over a wide range of scales and environmental conditions. Sharpley (2007) argues that model selection is critical. The model selected must meet the user’s needs in terms of level of predictive accuracy, input data availability, over a defined scale (field, watershed or basin) and defined time period (flow event, annual or multiyear).

Surface applied fertiliser and manure P is particularly vulnerable to removal by overland flow. Incorporation of applied P into the soil by cultivation can decrease P losses. But cultivation can increase site vulnerability to particulate P loss. Surface applied P (fertiliser or manure) can have an overwhelming impact on the amount of dissolved P loss by overland flow and can temporarily overwhelm the relationship between the soil P test and P overland flow. Type, method of application, timing of application and rate of P application must be accounted for when modelling the effect of applied P (fertilisers and manures).

This component of the project aims to develop nutrient loss (P and N) routines which can be included in Decision Support System (DSS) to quantify the amount of P and N loss associated with various cropping practices under different environmental conditions.

**REFERENCES**


**KEY WORDS**

soil test-crop response calibration, nutrient use efficiency, modelling, phosphorus, leaching, runoff

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