More Profit from Nitrogen

Improved nitrogen use efficiency through accounting for deep soil and mineralisable N supply, and deployment of enhanced efficiency fertilisers (EEF) to better match crop N demand

NSW Department of Primary Industries (NSW DPI) leads this project which seeks to advance fertiliser technologies that enable subtropical sugar farmers to better match nitrogen (N) supply with crop N demand to improve N use efficiency (NUE) and reduce N loss to the environment. To achieve this, the project is assessing N stores in soil to improve understanding of N supplied from soil organic matter (mineralisation) and is investigating optimal use of EEFs, such as poly coated urea (PCU), to better match N demand from the crop with N supply. A dose response model for urea and PCU, considering soil type and soil organic N supply, will develop improved practice management options leading to better environmental outcomes and grower profitability.

The research questions

- Can the quantification of mineral N from soil and N from organic matter be used to lower application rates of fertiliser N?
- Does slow release N fertiliser (PCU) increase N supply in soil, reduce N losses and increase fertiliser use efficiency?
- Is there potential for PCU to extend the supply of fertiliser N later into the crop cycle (ie. second year) resulting in greater yields?

Methodology

1. 30 representative paddocks in northern NSW were sampled to determine the extent of subsoil (deep) N reserves. The soils were used in incubation studies to determine the rate of N mineralisation, with data being used to develop new tools (MIR/NIR) to rapidly predict soil mineralisable N
2. An assessment of the potential of PCU to better match soil N supply with crop demand is currently being assessed at three field sites in the Tweed, Richmond and Clarence catchments, NSW.
3. Results will be used to:
    a. Derive N response curves for urea and PCU to enable the development of a simple model to predict the economic returns of using an EEF product based on the differential pricing of each product at any given time in the future.
    b. Determine N leaching losses on the lighter textured soils to demonstrate benefits of PCU in maintaining N levels in surface soils.
    c. Inform ^{15}N stable isotope studies to assess the contribution of fertiliser vs native soil N to crop N uptake in soils that differ in base soil N levels, and to derive NUE indices.

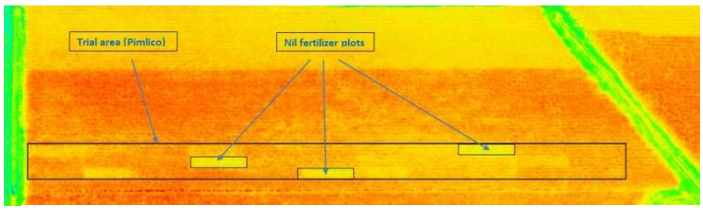
Project achievements

- Two field trials were established in October 2016 (Tweed Valley & Richmond Valley, NSW) to evaluate an N-response curve from urea and PCU (9 month product). The sites are laid out in a randomised complete block design of 6 rates of each fertiliser, with 3 replicates (33 plots with controls).
- The Tweed Valley field site was harvested as 1 year sugarcane in October 2017, while the Ballina field site is continuing as 2-year cane.
- Residual N from deep soil cores (1m) (control, 300 units urea and 300 units PCU cores to 1m at 0-20, 20-40, 40-60, 60-80 and 80-100cm) were taken post- harvest to assess the role of residual N from PCU vs urea at the Tweed Valley site in 2017.
- Nitrification assays of the cores have been undertaken using the Queensland Department of Environment and Science (QDES) 14 day N mineralisation method and have also been analysed by NSW DPI's MIR/NIR equipment to develop algorithms for estimating N-mineralisation potential.
- UAV/ NDVI/ red edge evaluation of the plots is continuing at a higher frequency (every 6 months) than first anticipated, now by NSW DPI's internal capacity.
- 27 sugarcane paddocks have been sampled and analysed in NSW, at varying depths, for deep soil N.

Initial outcomes

Tweed and Richmond Valley sites:

- Some soils have significant stores (ca 200 kg ha^{-1}) of ammonium-N to 1m depth, with little evidence of nitrification.
- Sugarcane roots were also detected in these cores to depth suggesting plants can access deep N stores.
- Both field sites showed a leaf-N response curve to N fertiliser (using 6 fertiliser doses), with more N in biomass from matching doses of N coming from PCU.
- Mineralisable N assay data, completed for the deep soil N cores, are being used to inform an MIR/NIR algorithm for predicting potentially mineralisable N in soils. To date, variation was observed between soil types and field locations.



UAV collected multispectral imaging is being used to develop an algorithm for 14 day and 6 month mineralisable N. Above: Richmond Valley trial site aerial and NDVI image with nil fertilizer plots clearly visible.

- Year 1 findings demonstrated that nearly 50 kg ha^{-1} of mineralisable N was released from the 0-40cm soil profile at the Richmond Valley site, while the much heavier soil at the Tweed Valley site released less at 22 kg ha^{-1}.

Extending the outcomes

- Workshops/field days/briefings with advisors, extension officers (eg Sunshine Sugar Agricultural Services), and farmer groups.
- A model is being developed for incorporation into the industry "Six-Easy Steps Guidelines" and will contribute to the development of a Decision Support Model for the use of EEFs in sugarcane production.
- Rapid mineralisable N methodologies will be made available for commercial adoption.
- Scientific outputs including results for the stable isotope methodologies will be presented in Industry workshops, science conferences, and journal publications.

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This project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program, NSW Department of Primary Industries and Sugar Research Australia. It is also supported by research collaborators Southern Cross University and Sunshine Sugar Agricultural Services.

Australian Government
Department of Agriculture and Water Resources

Sugar Research Australia

NSW Department of Primary Industries

Sunshine Sugar

Southern Cross University