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 15N 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.
- 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.

For more information contact: Lukas Van Zwieten, Senior Principal Research Scientist, Soils. NSW Department of Primary Industries, Wollongbar
T: +61 2 6626 1126 E: lukas.van.zwieten@dpi.nsw.gov.au