New technologies and managements: transforming nitrogen use efficiency in cane production

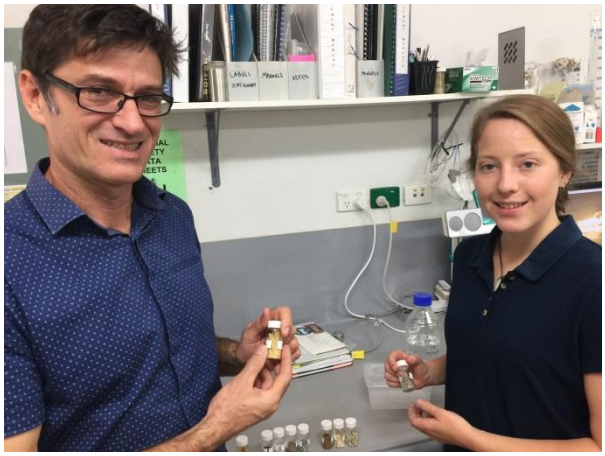
Fertiliser is a major determinant of profit margin for cane growers. This project, led by the Queensland Government Department of Agriculture and Fisheries, seeks to investigate new novel formulations and management techniques to optimise nitrogen (N) application to cane crop requirements.

Past research has found uptake of fertiliser nutrients to crops is extremely poor, with only 50% efficiency across many production systems. Mass balances indicate annual N inputs consistently exceed harvested exports by 40% to 60%, resulting in substantial loss to the environment. Impacts of poor nitrogen use efficiency (NUE) are being closely monitored in the Great Barrier Reef (GBR) catchment, where a major source of nutrient discharge is from agriculture, including the sugar industry.

This project has commenced with "proof of concept" laboratory based studies devised to economically test the characteristics of a large range of N fertiliser formulations, under varying simulated management and environmental conditions, prior to narrowing the selection to those considered most appropriate for more costly field based trials. The aim is to develop more targeted N formulations to better match N release to cane crop demands, throughout seasons, by controlling N transformation and solubility, and combating N "leakiness" to the environment. To do so, the research team has designed innovative equipment to rapidly test characteristics influencing optimal N application for cane crops of singular or combinations of enhanced efficiency fertilisers (EFFs).

The Research Questions

- Through novel fertiliser formulations is it possible to deliver nitrogen to meet ideal crop requirements throughout the season without excess soluble nitrogen during periods of low requirement?
- Is it possible to intercept runoff nitrogen losses close to sources of nutrient intensive crop production, prior to flow convergence, and significantly decrease the magnitude of these losses?



Methodology

The project is conducting research through these key activities:

- Laboratory component: The application of innovative micro-scale dialysis techniques, in addition to batch processes, is providing real time investigation of process kinetics in 'typical' sugar farming systems, with and without plants. Other loss pathways are being monitored in real-time and on-line using a custom-automated suite of Cavity Ring-Down Spectrophotometers, Fourier Transform Infra-Red Spectrometers and Quantum Cascade Lasers.
- Growth accelerator trials: Rapid growth pot trials and cost-effective screening is being undertaken of a wide range of prototype fertiliser formulations using advanced mechatronics technologies to carefully control the environment of the experiments. Robotics are used to schedule and apply water whilst taking 3D images to measure growth rates and N soil and plant content.
- A purpose built off-site rainfall simulator and flume has been constructed to carry-out evaluation of transport mitigation managements.
- Field investigations (final year): Focus will be on completing field trials with a limited number of evidence-based EEF formulations from laboratory and simulation studies. Production system representative fertiliser field-trials will be established in the GBR catchments of Herbert / Wet Tropics and Burdekin to undertake nutrient capture and formulation research. System nutrient losses will be monitored.
- Supporting mathematical modeling and evaluation will use an over-arching conceptual framework to compare fertiliser formulation performances and to place the research data into context with previous sugar agronomic studies.

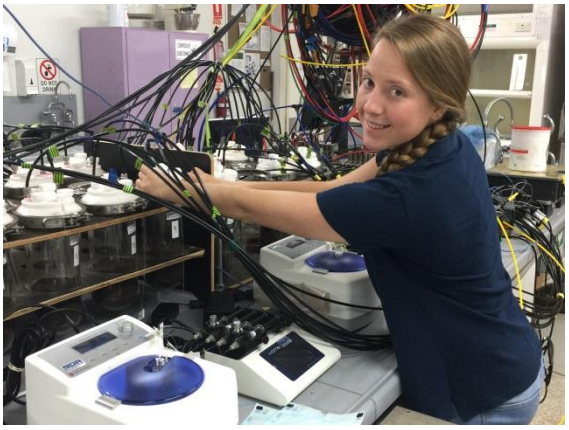
Project Achievements

- New laboratory based experimental processes have been developed to rapidly test a large number of EFF formulations using a cutting edge ensemble including computer integration and automated 32 channel manifolds, reaction vessels plumbed with gas lines, probes previously used to measure brain fluid chemistry, a robot controlled plant growth accelerator (with 3D cameras), a rainfall simulator with automated sampling, and a bank of spectrophotometers.
- Initial studies have commenced on testing the characteristics of over 30 EEF formulation possibilities.
- Planning has commenced in collaboration with the MPfN project conducted by the Queensland Department of Environment and Science to collocate field based studies.

Initial Outcomes

Already producing results, to date this approach has identified:

- An inhibitor treatment that can decrease runoff nitrate losses from the rainfall simulator by about 50%.
- Two inhibitor formulations that can increase plant nitrogen uptake after 12 weeks under highly leached but otherwise controlled conditions. This is a good early success as decreased initial fertiliser vulnerability to loss followed by mid-season availability is one of the key research targets.
- A novel inhibitor formulation that increases plant nitrogen uptake for the period from germination to 20 weeks in a model plant.
- Six novel inhibitor formulations capable of significantly decreasing nitrogen leaching losses.



Extending the outcomes

The project is already providing a number of opportunities for sugar farmers, service providers and extension staff to connect with ongoing findings and has plans for future activities, including:

- Demonstration days conducted at field trial locations
- Workshops aimed at early adopters of new technology
- Preparation of fact sheets on formulation options resulting from project findings
- Articles and videos for Sugar Research Australia (SRA) avenues, including the industry's CaneConnection magazine.
- Conference presentations and proceedings at key events, including the 2017 Fertiliser Australia Conference.
- Peer reviewed journal publications on both field experiments and laboratory work.

For more information contact: Dr Matt Redding, Principal Soil Chemist/Geochemist, AgriScience Queensland, Queensland DAF
T: +61 7 45294172 E: Matthew.Redding@daf.qld.gov.au

www.crdc.com.au/more-profit-nitrogen

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, Queensland Government (Department of Agriculture and Fisheries) and Sugar Research Australia. It is also supported by research collaborators, University of Queensland and AgResearch New Zealand.

Australian Government
Department of Agriculture and Water Resources

Queensland Government

AGRICULTURE: Top University in Australia Top 20 University in the World
The University of Queensland

agresearch