ARC Research Hub for
Smart Fertilisers

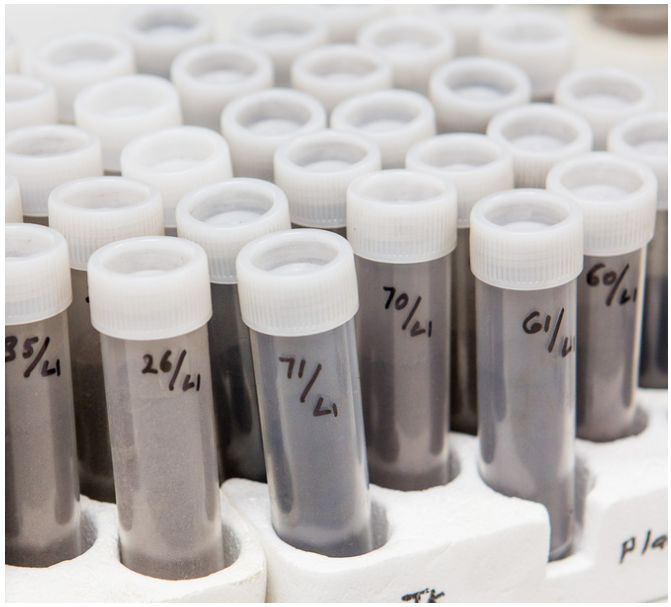
www.smartfertiliserhub.org.au

THEME 2 - UREASE AND NITRIFICATION INHIBITORS

Theme 2 is aimed at the design and synthesis of new compounds that enable inhibition of urease and ammonia monooxygenase (AMO) to overcome the problems with the current commercially available urease and nitrification inhibitors, such as low stability, difficult handling, and highly variable performance.

GOALS

- To develop new compounds that inhibit urease and ammonia monooxygenase (AMO) better than current commercial inhibitors to improve nitrogen use efficiency.
- To tailor the new generation of inhibitors to different soil conditions across Australia.
- To ensure that the eventual degradation of the inhibitors in soil will not lead to any additional environmental problems in Australian Agriculture Industry.



THE OPPORTUNITY

- Modifying the structure of the current commercially available inhibitors could lead to better performing materials.
- The enzyme urease can be targeted in several ways to block its activity
- The enzyme AMO has copper in its active site; developing compounds that can effectively bind to the metal centre may lead to potent inhibitors

INDUSTRY OUTPUT

New long-lasting urease and nitrification inhibitors tailored for intensive agriculture, which will reduce the needed quantity of N fertiliser to achieve the same yield, thereby increasing environmental sustainability by decreasing pollution of the atmosphere and waterways.

OUR PARTNERS

THE UNIVERSITY OF MELBOURNE

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LA TROBE UNIVERSITY

Australian Government
Australian Research Council

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RESEARCH ACTIVITIES

The development of next-generation inhibitors involves the design and synthesis of new compounds, testing of their performance in in vitro soil incubation studies in both the absence and presence of plants, and examining their stability through tracing in soils and degredation studies. The three work packages are closely intertwined, and results obtained in each of these will feedback and feedforward in an iterative fashion, as shown in the table below.

Research Activities	
Soil incubation studies	In vitro soil microcosm incubation studies are performed in soils from Australia's intensive production systems to test functional performance of the new classes of inhibitors to identify the role of the molecular structure on inhibitory activity in different environments. These soil testing studies will be performed in the absence and presence of plants with the new class of fertilisers involving MPN coatings (Theme 1), as well as a range of currently available controlled release fertilisers, and with standard granular urea fertilisers under conditions that simulate different agricultural production systems.
Development of urease and nitrification inhibitors	Synthetic organic chemistry is used to develop novel urease and nitrification inhibitors. The design process is supported by performing assays using Jack Bean urease (for the urease inhibitor development) and with pure bacterial cell cultures of ammonia monooxygenase (for the nitrification inhibitor development), which provide also new information of the mechanism of inhibition. In addition, in silico docking studies are also used to assist inhibitor design.
Inhibitor stability testing	Studies will be performed to test the stability in soils by tracking the new inhibitor compounds and their breakdown products extracted from soil at different timepoints of function. The stability to the atmospheric environment will be tested as well by studying the decomposition upon exposure to UV radiation, humidity, and elevated temperatures, using a range of state-of-the-art analytical techniques available at the UoM.

Research Team

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