The MPfN Program activities adjust through COVID-19

A somewhat belated edition 13 of Nitrogen Natters as alternative research, extension and communication methods for MPfN take priority during March and April of 2020.

The sub-projects of MPfN have been incredibly malleable during this period, with industry leaders working collaboratively with research organisations to continue to deliver upon milestones. Social distancing restrictions have seen some of our researchers scheduling their glasshouse, laboratory and field work around peers or host farmers to ensure adherence to isolation requirements. Furthermore, the capacity of testing laboratories has been greatly reduced, resulting in delayed analysis of soil and biomass samples. Extension events have moved online with researchers contributing to virtual field days. And of course, we have all been battling the delicate intricacies of sharing our home offices with our dearly beloved! 😊 Regardless, all projects have reported that upcoming milestones will still be achieved and no variations have been requested. Well done to all teams!

The 2020 MPfN Program Partner Forum was to be conducted in Hobart from the 21st to the 23rd of April, but has been postponed until October at this stage. We will have to remain open to further postponement though we will certainly see a final forum conducted at some stage! International travel restrictions also saw the 8th Global Conference of the International Nitrogen Initiative in Berlin (3rd-8th of May) cancelled, where eight team representatives were to present on MPfN Program research - now likely to take place in May 2021, all things considered.

The 2020 MPfN Program Research Update and Exchange was conducted via Zoom on the 22nd and 23rd of April in lieu of the forum. Heavily promoted by partners and Fertilizer Australia, this alternative platform resulted in 99 registered bookings for Session 1 (Dairy & Cotton), and 89 for Session 2 (Sugar & Horticulture). Overleaf, feedback from the event is provided. There was a mix of stakeholder groups with a third of attendees from research, one third from the agronomy/fertiliser industry, and the remainder from extension, technical and private farm consulting roles. A big thank-you to all project leaders who prepared well to address the varying needs of the multi-stakeholder audience.

Milestone Reporting

Milestone 8 Reports
Due May 31st.
All templates for final and milestone reporting have been distributed to project leaders.

MPfN Templates

Please ensure you are using the latest version of all Program templates.
The DAWE has pre-approved these templates but a reminder that all communications are to be reviewed by Marguerite prior to release.

USE OF THE EVENT EVALUATION IS ESSENTIAL PLEASE!
Click HERE to download all templates.

Partner Contacts

Keep the information exchanges happening! Click Here to access the MPfN Team Information Database for up to date contact details. Call upon others in similar roles as a sounding board!
If you have an update for the data-base, please contact Marguerite.
The two morning sessions held via Zoom to update teams and interested stakeholders in MPfN research activities and outcomes since our last meeting in September 2019 was considered highly worthwhile attending, with an average score of 4.6/5 from 52 respondents. A selection of the comments included:

“Great to see work from other regions…All presentations, I thought, were excellent!...Good presentations, well thought through. A credit to the presenters…Excellent info. Well prepared, relevant info. Grateful that I could attend these sessions from my office. ...The ability to keep abreast of the latest findings is awesome.”

Importantly, the average rating of 4.2/5 was achieved for belief that the MPfN research outcomes and outputs will provide opportunities for industries to increase NUE. This is a great indication that, whilst not yet at project end, there is confidence that MPfN will provide opportunity to make changes to current practices. Some of the presented strategies/tools that were considered to make a difference included: Industry guidelines, understanding of in-season N mineralisation and how to link this back to N application adjustments, predictive tools of when EEFs are most likely to result in a favourable response (NUE/profitability), relationship between mineralised N rate, moisture and temperature, new formulation encapsulated DMPP, budgeting and reducing N inputs and use of nitrogen inhibitors and EEF with decreased N application.

In addressing the MPfN Activity 1 Objective (increased knowledge and understanding of the interplay of factors that influence NUE), an average score of 3.9/5 was given. A selection of the comments included:

“Hmm...some interesting similarities in a lot of the projects- perhaps no great benefits from EENFs… All new research, and revised information contributes to more informed advise, and out comes… I already have a background in N research mainly in grains, but the presentations from the other industries were very instructive - showing similar issues to the grains industry…Reinforced what I have believed for some time, timing and if possible splitting of application of N should help achieve N use efficiency.”

In addressing the MPfN Activity 2 Objective (increased knowledge and understanding of the contribution of mineralisation to a crop of pasture N budget), an average score of 3.8/5 was given. A selection of the comments included:

“Estimating/determining in season N mineralisation for sugar is difficult because of the longer growing season, diverse climate and soils and different farming management practices…”

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…Yes, I need to follow up and look at these research projects and results more closely… I think that the spot measures discussed could have been better harmonised across the industries - I appreciate how difficult this can be but researchers should be using similar parameters that can then be modelled. “

In addressing the MPfN Activity 3 Objective (Increased knowledge and understanding of the factors that influence effectiveness of EEF technologies/blending to better match N supply with plant requirements), an average score of 3.6/5 was given. A selection of the comments included:

“The lack of response to EEF’s in cotton and sugar parallel the general observations in grains. I would counsel against using the term - the EEF’s did or did not WORK - the explanation should be couched in the effects on the particular processes that are being modified… Interesting to see that most of the current research in the EEF space is pretty consistent regarding yield effect… Perhaps helped to dispel some of misinformation that is present re EEF would be good to see some of the reports behind eef results… Interesting to hear from UQ how the products were made… Given my particular focus of interest presently is around the effectiveness of enhanced efficiency technology, I found those sessions quite good in helping to cut through the hype around some of the technology options.”

There was an overwhelming response to providing a key take-home messages from the attended session, primarily focused upon the role of mineralisation in N budgets (timing/rate), EEF effectiveness being dependent upon climatic conditions, seasonality and reducing N fertiliser application rates (but more work needs to be done) and the fact that MPfN will result in less guesswork around NUE considerations.

General feedback included:

“Brilliant research being undertaken by some outstanding researchers driven by innovation and new technologies… Good to see lots of excellent research happening with cooperation between the cropping segments… Really appreciate the opportunity to listen and be kept updated!!… Grateful that Fertcare brought this to my attention… great to have online formula - no chance of making Hobart. Going forward would love to see camera at back of all in person events & posted to you tube for those that can’t make it in person… Would have been nice to be in Hobart” ☺

Over the two sessions, 65 attended Session 1 in its live format, that allowed for participation in Q&A after each presentation, with 48 views so far of the You Tube recorded session, and 55 attending Session 2, with 43 views to date of the recorded session.

The link to recordings and all presentations was provided to all registered parties, the MPfN team partner list (124) and is now available from Fertilizer Australia’s website. You can also access via the links provided on the previous page.
Is there leaf N uptake from foliar spraying of potassium nitrate at mango flowering and fruit set?

Jo Tilbrook, Dallas Anson, Alan Niscioli & Tony Asis (NTDPIR).

Flowering in mango trees signifies the beginning of annual crop production. The timing and intensity of flowering greatly influences the time of harvest and quantity of fruit produced. It is generally accepted that crops need sufficient potassium (K) for fruit set, retention on the panicle and the development of high quality fruit.

We know that many mango growers use a 2% potassium nitrate (KNO$_3$) foliar spray twice during flowering for improved fruit set and retention. Foliar spraying provides about 5.5 kg nitrogen/ha to the orchard but it is not known how much spray is taken up across the leaf cuticles, rinses off the leaves with dry season dew, or adheres to leaves and ultimately becomes part of the decomposing litter on the orchard floor.

As a preliminary investigation to characterise the uptake of nutrients into mango leaves, Kensington Pride seedlings as rootstocks were grafted with B74, Kensington Pride and National Mango Breeding Program (NMBP) varieties 1243, 1201 and 4069 scions. A $^{15}$Nitrogen (N) labelled 2% KNO$_3$ solution was prepared with a surfactant added to improve adhesion of the liquid to the leaf. Mature, fully expanded leaves at the scion tips were dipped twice in control or $^{15}$N labelled 2% KNO$_3$ solutions one day apart to quantify how much N moves into leaves. Leaves were sampled one day after the final dip, washed and rinsed thoroughly then processed for analysis (Figure 1).

Results show that leaves take up nitrogen, with nitrogen use efficiency (NUE) varying among scions and ranging between 27% (NMBP 1201) and 42 % (NMBP 4069) (Figure 2). These foliar NUE are comparable to soil applied NUE. Also, it is known that leaf nitrogen content reduces as inflorescence development becomes a sink for nitrogen. The foliar spray is potentially replacing the nitrogen lost from leaves during that time. It is also possible that flowers can take up N applied this way. However, there are some limits with foliar applications of nitrogen, as concentrations of 3% KNO$_3$ and higher have the potential to cause necrosis around leaf margins, reducing photosynthetic capacity of the tree.

Overall this is useful knowledge for mango producers and forms part of the crop N budget. Excess application of nitrogen can result in significant post-harvest fruit quality problems and potential loss of income.

**Table 1**: Leaf NUE (%)

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<th>Mango variety</th>
<th>Leaf NUE (%)</th>
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<td>1201</td>
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**Figure 1.** Tony Asis & Dallas Anson sample the leaves of a range of grafted mango varieties after dipping in control and $^{15}$N labelled 2% KNO$_3$ solutions. Leaves were washed thoroughly before and processing.

**Figure 2.** Nitrogen uptake efficiency was calculated for leaves dipped twice into control and $^{15}$N labelled 2% KNO$_3$ solutions at either midday or early evening. One day after dipping, leaves were sampled, washed thoroughly and processed. Leaf NUE varied with variety used as scion but time of dipping made no difference. Bars represent standard error and means followed by the same letters are not significantly different at 5% level of significance using Tukey’s post-test.
The 2019–20 final cotton experimental season is fast heading towards a conclusion with only harvest (picking) and post-harvest soil coring to be done. After planting in late October, the main two trial paddocks were watered with between 8.4 and 14ML/ha, depending on the specific water deficit regime imposed. Due to the drought, the soil in the experimental fields was very dry pre-season and it took two days of initial irrigation to fully wet up the soil profile. Hot temperatures over summer added to the crops requirements, as in previous years. But, unlike previous years we received significant rainfall late in the season which kept the plant growing later than usual resulting in some very tall plants (some >2 metres).

This year the core site treatments included irrigation frequency, N timing, N rates, growth regulator intensity, water-run N efficiency and P fertiliser application, while minor treatments included cotton variety and tweaks to the proportion and timing of in-crop N application. During the irrigation events, runoff water quality was sampled in many of the plots to assess runoff N loss.

Cotton biomass peaked in late March 2020 and detailed sampling (Fig. 1), plant partitioning and plant growth mapping were carried out.

Off-site, grower demo sites near Narromine in central west NSW have been biomass-sampled and hand-picked to look for any indications of impacts from the simple N x P fertiliser and late-N fertiliser timing treatments.

In October, Graeme Schwenke, Guna Nachimuthu, Jon Baird and Clarence Mercer all presented project results to the 2019 Australian Cotton Research Conference in Armidale. In February 2020, Graeme, Jon Guna and Ben Macdonald also presented project data and discussions with local growers and advisor forums held at Moree, Gunnedah and Narromine.

In March, Dr Weijin Wang (QDES) and Dr Matt Redding (QDAF), of the MPfN team for sugar, were invited to present at a series of workshops conducted by Fertilizer Australia’s Fertcare Program and the Queensland Government’s Office of the Great Barrier Reef. Over ten days, from Cairns to Bundaberg, the pair travelled with a number of other guest speakers to extend the outcomes of their research directly to 166 regional agronomists and fertiliser resellers.

The evaluation of the workshops revealed that the two MPfN Program presentations were in the top 3 (out of 7) most highly regarded topics. A big effort from both researchers- well done! (Left: Dr Weijin Wang presents at Mackay)
The role of PCU and accounting for soil supplied N in NSW Sugarcane

Project Leader: Dr Lukas Van Zwieten, NSW DPI
Partners: Southern Cross University and Sunshine Sugar

The issue

The location of sugarcane farms near coastal areas in Australia necessitates the development and adoption of sustainable production practices. As sugarcane has a large production potential, N remains a key factor in driving productivity and profitability. However, crop NUE remains generally below 40-60% of applied fertiliser, with N loss pathways including nitrate (NO$_3^-$) leaching and run-off, and through gaseous losses by denitrification.

Objectives of the research

- To determine the extent of subsoil (deep) N reserves in northern NSW cane fields, both mineralised and potentially mineralisable N (PMN), to allow future refinement of the Six-Easy-Steps (6ES) application rates.
- To develop new tools (mid infra-red (MIR)/ near infra-red (NIR)) to rapidly and inexpensively predict PMN in sugarcane soil.
- To assess the potential of controlled release polymer coated urea (PCU) to better match soil N supply with crop demand, therefore benefiting yield in both one and two-year cane crops, by;
- delivering yield and N uptake response curves between urea and controlled release urea (5 rates) from 4 field trials.

Methods

- 1m cores (3 per field) taken from 27 cane fields in NSW and analysed for Carbon, N, pH and mineral N as well as PMN at 0-20cm and 20-40cm.
- N release measured from PCU 90 and PCU 270 mesh bags placed on row, at stool splitter fertiliser placement depth, in a non-fertilised area over a 24 month period to obtain an N release curve.
- Four field trials conducted at Stotts Creek (Tweed Catchment), Pimlico and Coraki (Richmond Catchment) and Woodford Island (Clarence Catchment) to investigate PCU blend effect on yield and N leaf content (%) over time versus standard practice urea application.
- Unmanned Aerial Vehicle (UAV) multi-spectral imaging used to monitor plot performance. Green Normalised Difference Vegetation Index (GNDVI) is a vegetation index for estimating photo-synthetic activity and is a commonly used vegetation index to determine water and N uptake into the plant canopy.

Outcomes for industry

- Some sugarcane farms in NSW have significant stores of N fertiliser (up to 300 units of N), being made up of mineral N and PMN prior to planting or the ratoon crop, allowing refinement of N fertiliser application.
- A rapid test based on MIR spectroscopy has been developed for NSW sugarcane soils that can reasonably predict PMN across 14, 56 and 300 days.
- Results suggest minimal benefits of slow release PCU (either 90 day or 270 day release) in the dry years that the field trials were conducted. Better climate forecasting (particularly in-crop rainfall predictions) would enable farmers to make decisions on N application.
- UAV based multispectral imaging has assisted research trials on assessing crop N uptake throughout the growing season. GNDVI shows promise at 160 days after ratoon emergence for estimating leaf N content (and possibly yield).

Recommendations

- Slow release PCU is likely to have an impact where high rainfall directly after fertilisation results in loss pathways for urea. This needs a modelling approach to predict best response based on season, and better climate forecasting.
- Deep soil N and mineralisable N should be considered in calculating soil N supply to crop, with considerations within the 6ES.
- A better quantification of residual N in soil (after harvest) from PCU is still required. This would be taken into consideration with the above point.
- Because 56 and 300 day PMN are much greater than 14 day PMN (standard method), it would be an important step for industry to start looking more in-depth at whole season soil N supply.
Smart blending of enhanced efficiency fertilisers to maximise sugarcane profitability

Project Leader: Dr Weijin Wang, QDES
Partners: QDAF, Farmacist Pty Ltd, T.R.A.P Services, HCPSL, ICL Specialty Fertilisers and Incitec Pivot Ltd

The issue

Poor NUE in sugarcane cropping is problematic for growers as losses are a wasted input cost and a hit to efforts to maximise yield potential. For the industry, it is associated with environmental impacts and, therefore, raises social licence concerns. Application rates of N fertiliser to sugarcane crops generally range from 130 to 250 kg N/ha, approximately half of which may be lost through gaseous emissions, leaching and/or runoff following large rainfall or irrigation events.

EEFs, such as PCU and nitrification inhibitor-impregnated urea, can increase NUE. However, the N release pattern of PCU may differ from crop N uptake dynamics and the high cost of EEFs can impede their use by farmers.

Objectives

- To assess the benefits of EEFs versus urea in terms of cane yield, sugar yield, NUE and profitability.
- To test if EEFs can significantly reduce fertiliser N application rates without yield loss.
- To determine the optimal blending ratio of PCU to urea in relation to site and weather conditions and evaluate whether there are associated input cost benefits.

Methods

Six field experiments were conducted at Bundaberg, Mackay, Ingham, Tully and Innisfail over three crop growing seasons from 2016 to 2019.

- Soil samples from the 0-20 cm or 0-90 depths were collected multiple times during each crop growing season to monitor soil mineral N dynamics under different fertiliser formulations and blends (PCU and urea) assessed at the recommended and sub-optimal 6ES rates.
- Plant samples from the treatments receiving urea and PCU at the recommended rates were also taken to measure whole-season crop N uptake dynamics.
- N release dynamics from PCU products were monitored for comparison with crop N uptake.

Outcomes for industry

- Soil mineral N (ammonium (NH$_4^+$) & Nitrate (NO$_3^-$)) contents generally declined to very low levels within 2-3 months after application of urea particularly in wet tropics following high rainfall events in summer, demonstrating the risk of substantial N loss during the early cropping season.
- Use of PCU consistently sustained higher mineral N contents in soil during the mid- to late season compared to normal urea and DMPP-coated urea treatments.
- N release dynamics of the PCU fertilisers did not differ significantly at different sites. So N supply from PCU to crops at different stages of the crop-growing season can be predicted with good accuracy.
- Substantial movement of fertiliser N into deep soil occurred following high rainfall events, but was significantly lower in the PCU treatments than in urea-only treatments.
- Nitrification inhibitor-coated urea effectively slowed down formation of NO$_3^-$ (more susceptible to loss) from NH$_4^+$ (more stable) in most circumstances and, based on separate studies, significantly reduced emissions of nitrous oxide (N$_2$O, a potent greenhouse gas) from soil.
- Applying N fertiliser in excess of the recommended rate seldom increased yield and thus can compromise profitability.
- Yield responses to EEFs and different blending ratios of PCU to urea varied with site and seasonal conditions.
Recommendations

Based on the findings to date, EEFs offer significant environmental benefits compared to normal urea, but their yield benefits vary substantially between different sites and from year to year at the same site. A farm profit benefit of using an EEF may therefore be limited to specific soil and climatic scenarios.

The project team are currently in a process of analysing the final data to identify possible regulating factors and to develop a decision support tool to help choose and manage EEFs.

Economic analysis of the impact of EEF use under certain climatic and farming scenarios is also underway and will be completed by the end of June.

A few images of the NSW DPI and QDAF sugar MPfN Program research activities from 2016 to 2020.
University of Melbourne’s Advanced Technologies also sums-up key outcomes for dairy…

**Project Leader: Dr Helen Suter, University of Melbourne**

A number of key outcomes from this project will guide the industry to improve N use efficiency in pasture based systems in southern Australia.

- Management of irrigation in the autumn is critical for good responses and efficient use of N. Maintaining adequate plant available water for plant growth throughout the whole root zone of the pasture (0-30 cm) was found to be important in the ability of pastures to respond to applied N. Management of irrigation to maintain this moisture whilst minimising the risk of waterlogged soils over winter will be key.

- Mineralisation supplies N throughout the year, estimated at around 1% of the total soil N pool, with peak supply through spring, summer, and into autumn under both dryland and irrigated systems. Knowledge of the climate leading into the N fertilisation time and for the subsequent growth cycle, and the effect on soil mineralization will help make decisions about N fertiliser requirements.

- In dryland systems, mineralisation of soil N over the summer will often result in the accumulation of good levels of mineral N by the time of the autumn break. However if there has been active pasture growth over the summer, this pool of plant available N in the soil will be lower and may require earlier applications of N fertiliser.

- Much of the N taken up by the plant comes from the soil, and N fertilisation builds soil N stores to sustain this supply. At times when N losses to the environment are not high (e.g. through leaching and volatilization), even though short term pasture responses to N fertiliser may be small, some of the fertilizer N will be incorporated into soil reserves and become available for plant use at other times more favourable for pasture growth.

- There was no clear benefit of using the enhanced efficiency fertilisers on pasture biomass productivity. Use of the nitrification inhibitor did lead to increased plant N uptake and pasture productivity but only at low N rates (e.g. 20 kg N/ha) and during winter, and not in all years, so the implications of this are not clear at this stage.

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**Dairy industry Fert$mart Best Management Practices and NUE Pocket Guide.**

The combined University of Melbourne, Tasmanian Institute of Agriculture and Queensland University of Technology teams, together with Dairy Australia Soil and Irrigation Leader, Cath Lescun, have been working tirelessly on the development of two collaborative outputs of the MPfN Program for dairy.

The updated version of the *Fert$mart N Guidelines* reflect key findings of research and modelling undertaken by the three collaborative projects of dairy within the MPfN Program. Dairy Australia are providing support to professionally design and print the A4 resource, in readiness for the final stages of the *MPfN Whole farm systems modelling project* of UoM that will spend its final six months presenting and discussing the guidelines with extension staff and industry across the major dairy regions of Australia.

Next is the preparation of an industry resource, the *NUE Pocket Guide*, to provide practical guidance to farmer decisions on the *right source, right rate, right time and right placement* of Nitrogen (N), underpinned by research outcomes, to maximise efficient and profitable use of N. The publication is being written by Graeme Ward (UoM) and Karen Christie (TIA), with review by the entire team, and will be designed as a published booklet with environmental call-outs and photos.

The pocket sized booklet can be kept in the glovebox of the farm ute- at easy reach for all dairy farmers as paddock decisions on N fertiliser applications are made. Dairy Australia is providing design support whilst the University of Melbourne’s communications budget will allow an initial 1500 booklets to be printed and distributed. The publication will also be available online to support other resources of Fert$mart.
Images of the UoM Advanced Technologies MPfN Program research activities from 2017 to 2020.
"Nitrogen Natters" is an activity of the MPfN Program, a cross-sector collaboration between Australia’s four major intensive users of nitrogenous fertilisers: cotton, dairy, sugar and horticulture, managed by the Cotton Research & Development Corporation. The Program is delivering outcomes from 10 research projects led by 8 research partners and involving twenty-three collaborating research and industry organisations. The MPfN Website provides a full overview of all participating partners.

This publication is prepared by Marguerite White, MPfN Science Coordinator. mwhite@icdprojectservices.com.au or phone 0447 500 415.