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Understanding the variability in performance of the nitrification inhibitor 3,4-Dimethylpyrazole phosphate in Australian agricultural soils.

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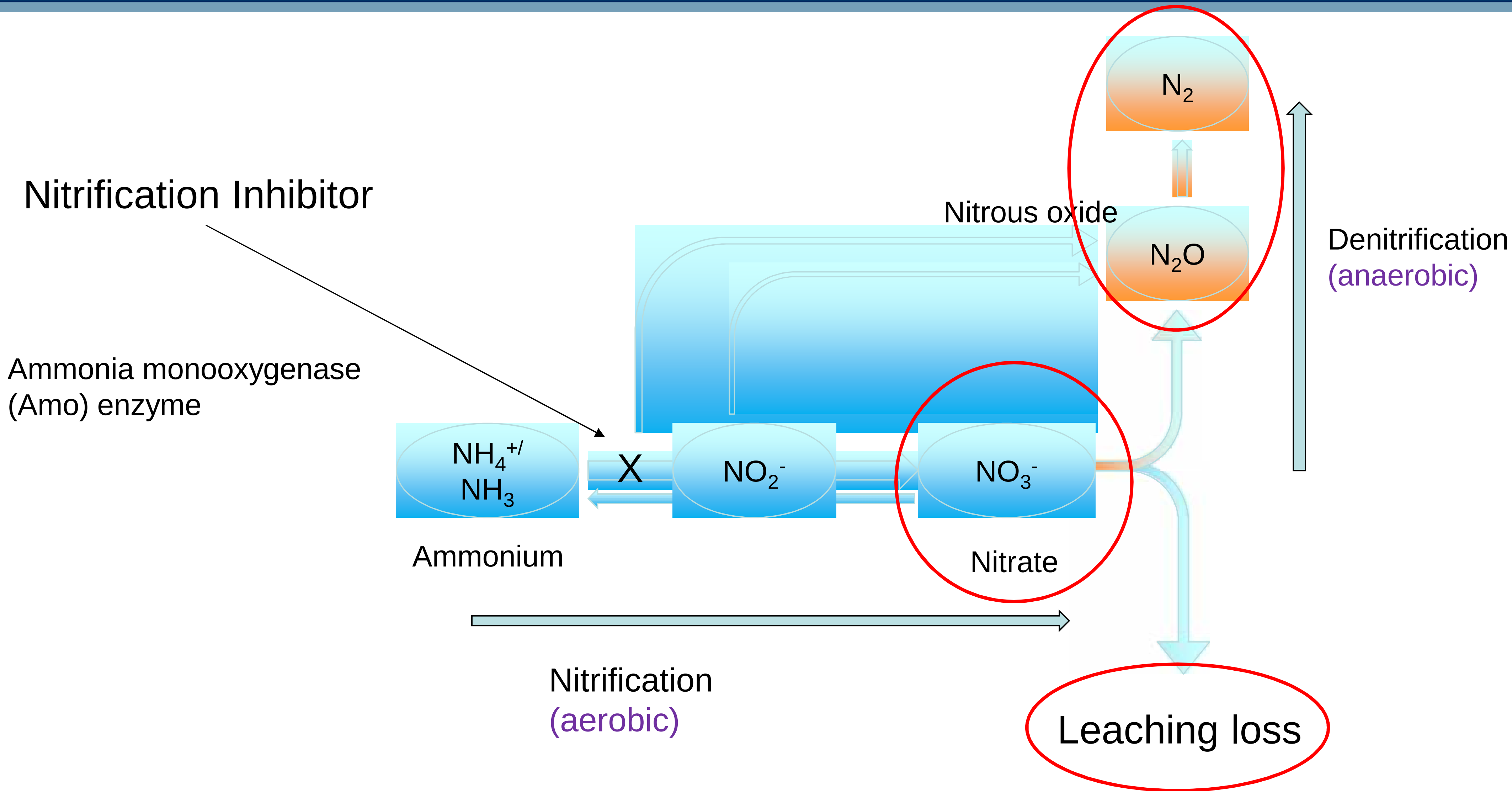
Incitec Pivot Fertilisers

N_2O Network

Australian Government
Department of Agriculture

Role of Nitrification Inhibitors



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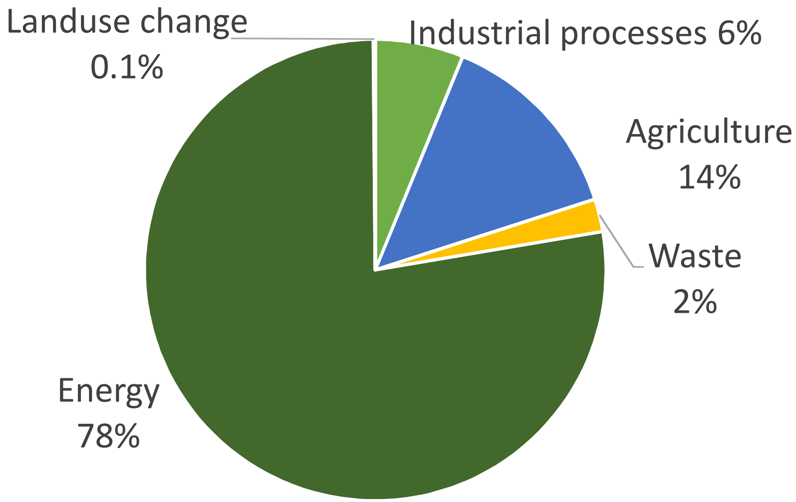
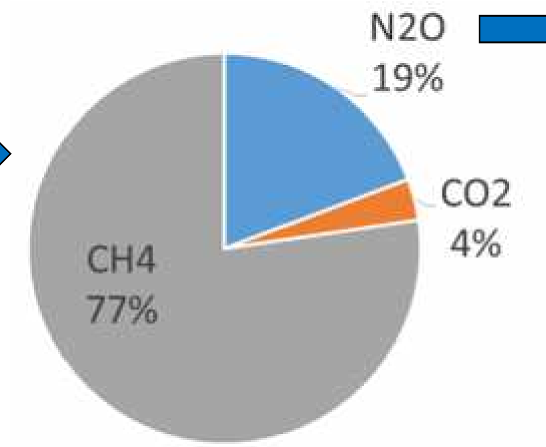
Background : Why Focus on Nitrification inhibitors?

- Reduce N_2O emissions





93% = agricultural soils

= 18% of agricultural emissions

Fertiliser inputs significant contributor to N_2O

Australia's National GHG inventory (2014) (total CO_2-e)

- Reduce nitrate leaching
- Improve nitrogen use efficiency

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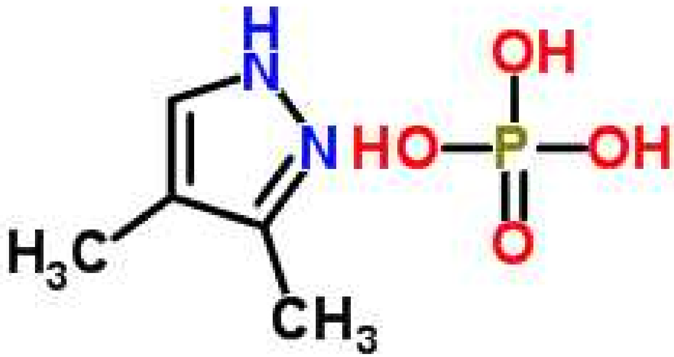
Background : Why Focus on 3,4-Dimethylpyrazole phosphate?

- Commercially available in Australia
- Potential for use across broad range of climates



3,4-Dimethylpyrazole phosphate

BUT

- Inconsistent results observed
- Reasons for this are unclear

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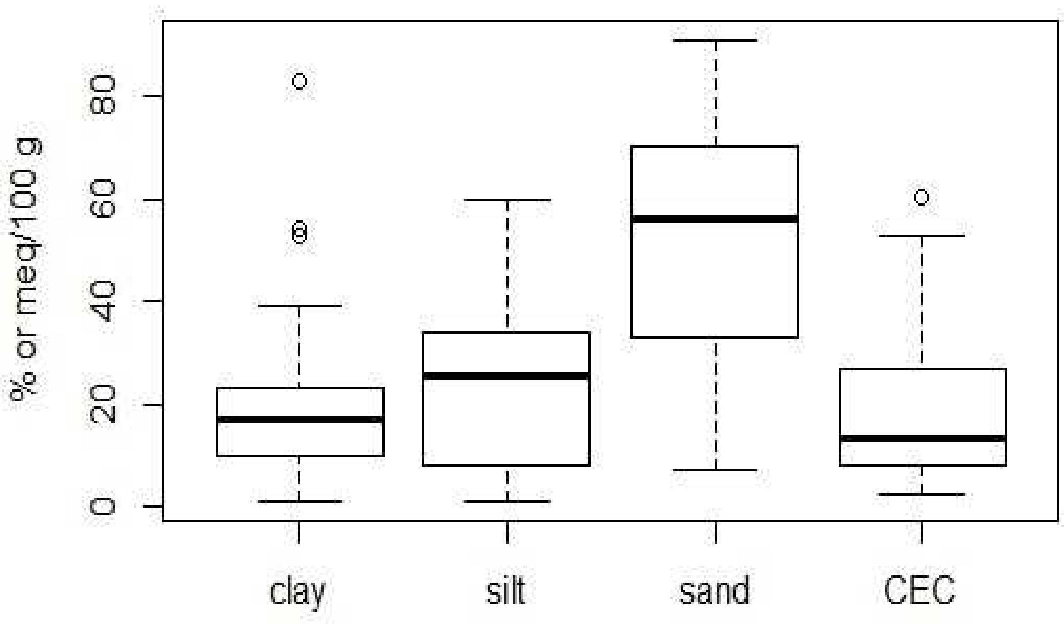
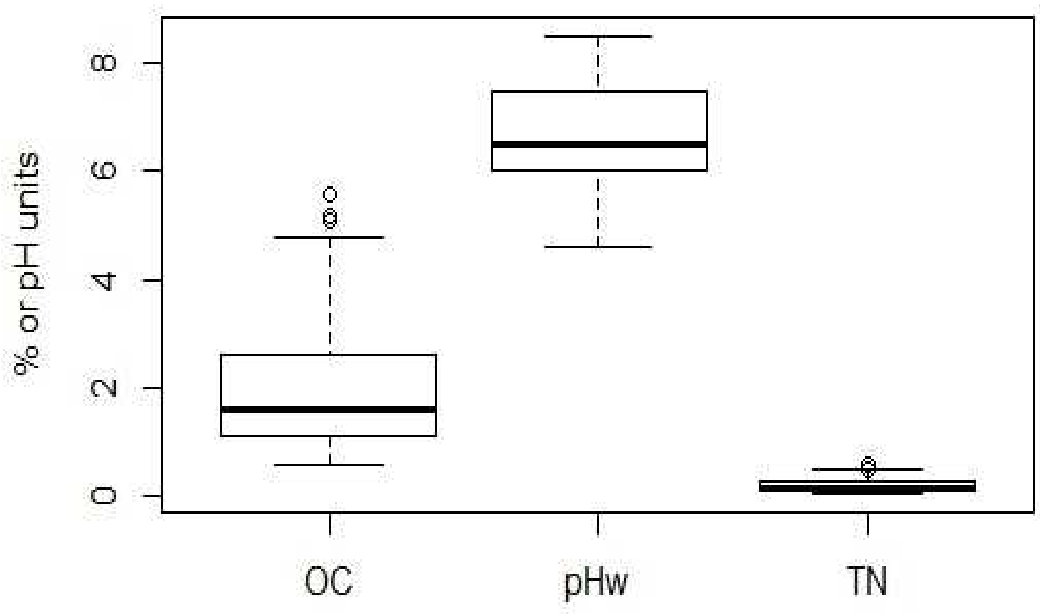
How to address this? Experimental Methodology

- Laboratory Incubation experiment
- 30 soils, < 2 mm
- Treatments
  - Control (no N)
  - Fertiliser (NH_4^+-N)
  - Fertiliser + DMPP
- 100 µg NH_4^+-N / g soil + 50 µg NO_3^--N / g soil
- 25°C, 60% WFPS, 28 days,
- Mineral N (2 M KCl 1:5) and N_2O collected





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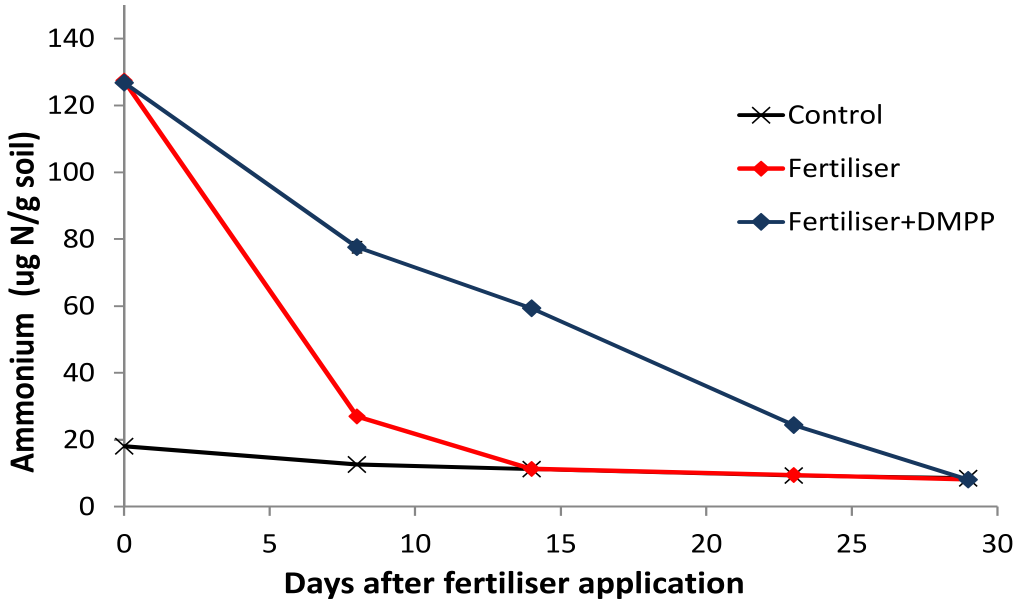
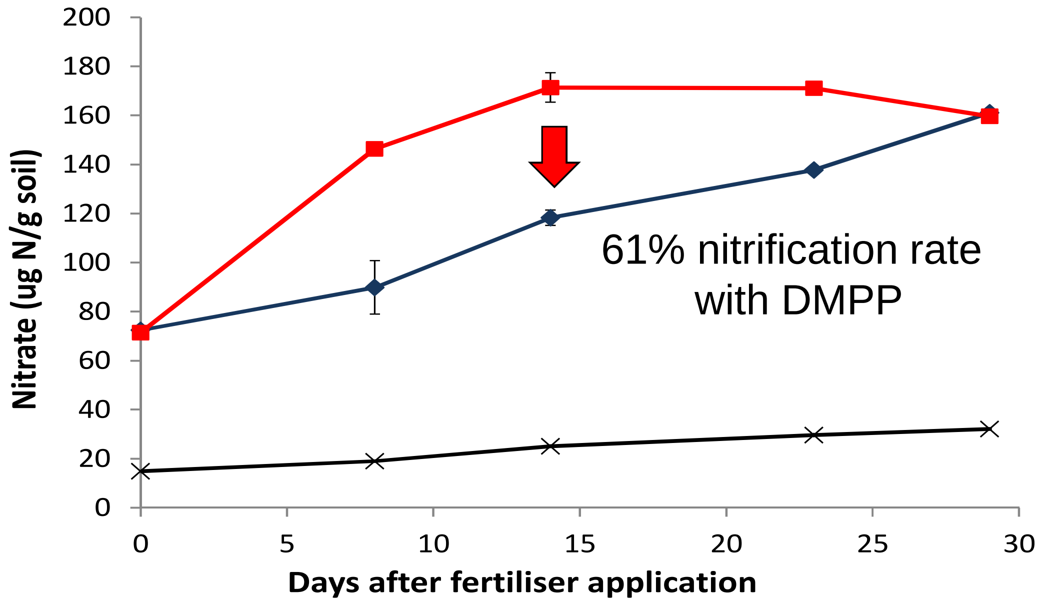
Results : Nitrification rate

Example of mineral N dynamic



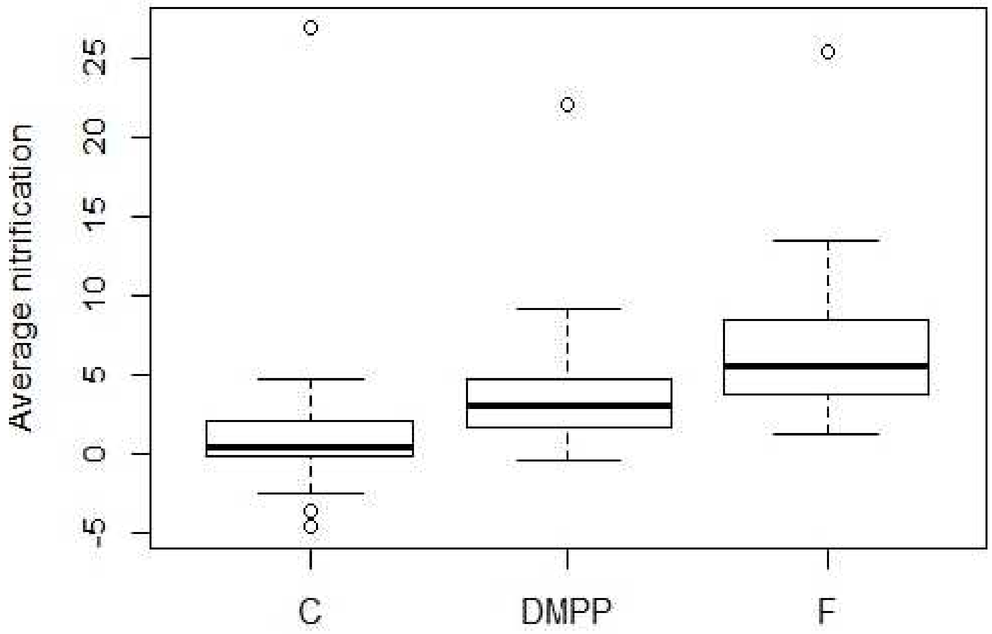


Horsham soil (cropping) : 23% clay, 34% silt, 44% sand, pHw 8.5, OC 0.82%, N 0.08%

Results : Nitrification rate

Treatment	Average nitrification rate (14 days) (μg NO_3^-N produced/g soil/day) Range	Average ± standard error
Control	-4.61-26.89	1.37±0.99[a]
Fertiliser	1.33-25.45	6.47±0.93[b]
DMPP	-0.43-22.02	4.00±0.78[ab]

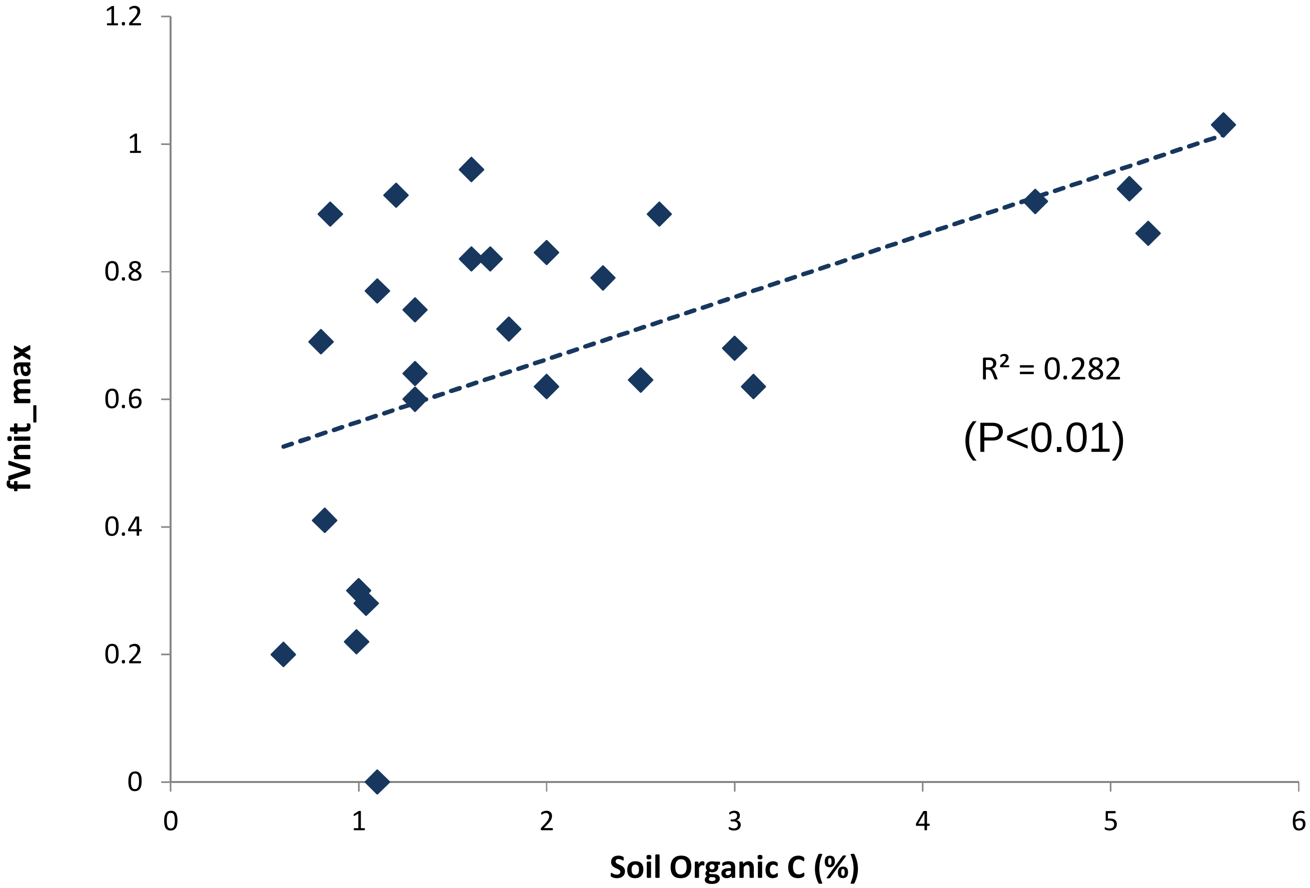
Treatment	Average net-nitrification rate (14 days) (μg NO_3^-N produced/g soil/day) Range	Average ± standard error
Fertiliser	-1.44-12.63	4.82±0.55[b]
DMPP	-4.86-8.02	2.39±0.45[a]



- Addition of fertiliser increases nitrification rate
- DMPP nitrification rate = control (no fertiliser)

- **Average 38% reduction in fertiliser induced nitrification rate with DMPP (range 9-100%)**

Results : Soil properties and DMPP efficacy to reduce nitrification



Other soil properties

- Clay (-ive) (P<0.05)
- Mn (-ive) (P<0.1)
- DTPA Cu (+ive)

fVnit_max: fraction of nitrification achieved with DMPP relative to the fertiliser only treatment

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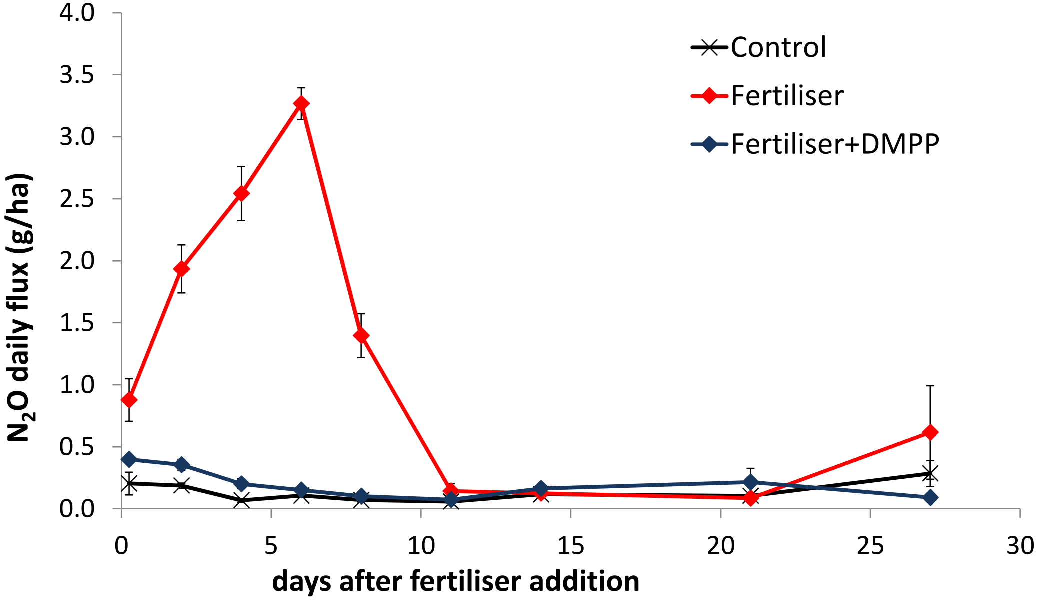
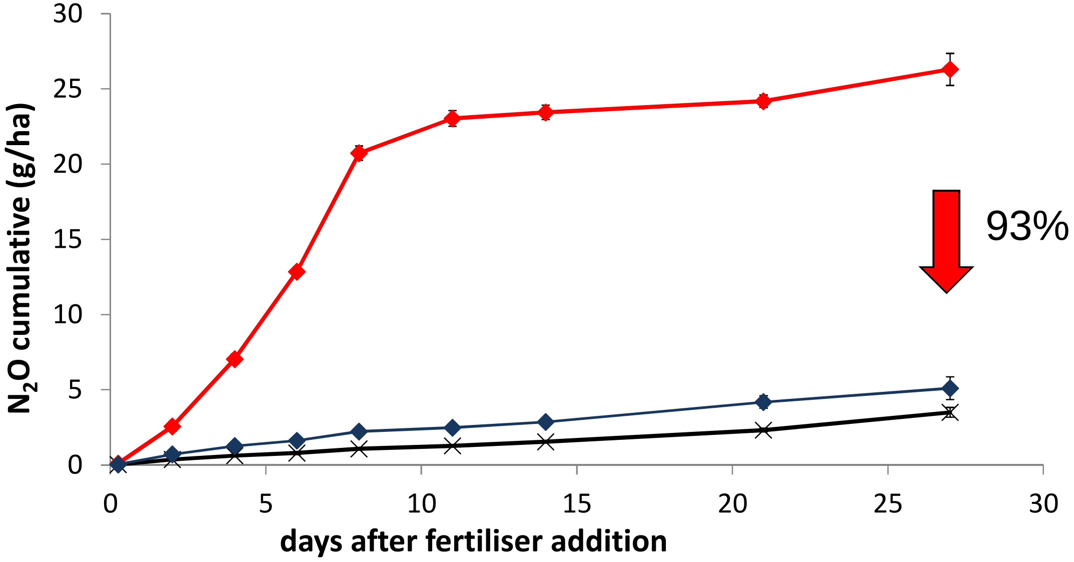
Results : N_2O emissions

Example of N_2O emission





Horsham soil (cropping) : 23% clay, 34% silt, 44% sand, pHw 8.5, OC 0.82%, N 0.08%

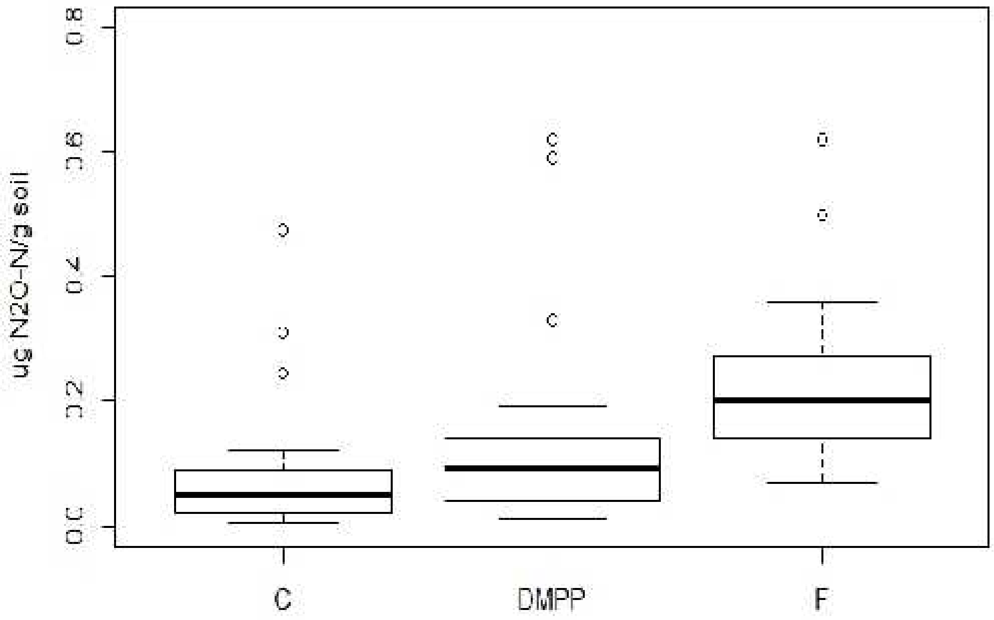
Results : N_2O emissions

Cumulative N_2O emissions (28 days)
(µg N_2O-N/g soil)

Treatment	range	Average ± standard error	Log_{10}
Control	0.01-1.1	0.06±0.30	-1.20±0.64[a]
Fertiliser	0.07-7.74	0.62±0.28	-0.59±0.45[b]
DMPP	0.01-6.96	0.49±0.26	-0.92±0.64[ab]

Cumulative Net-N_2O emissions (28 days)
(µg N_2O-N/g soil)

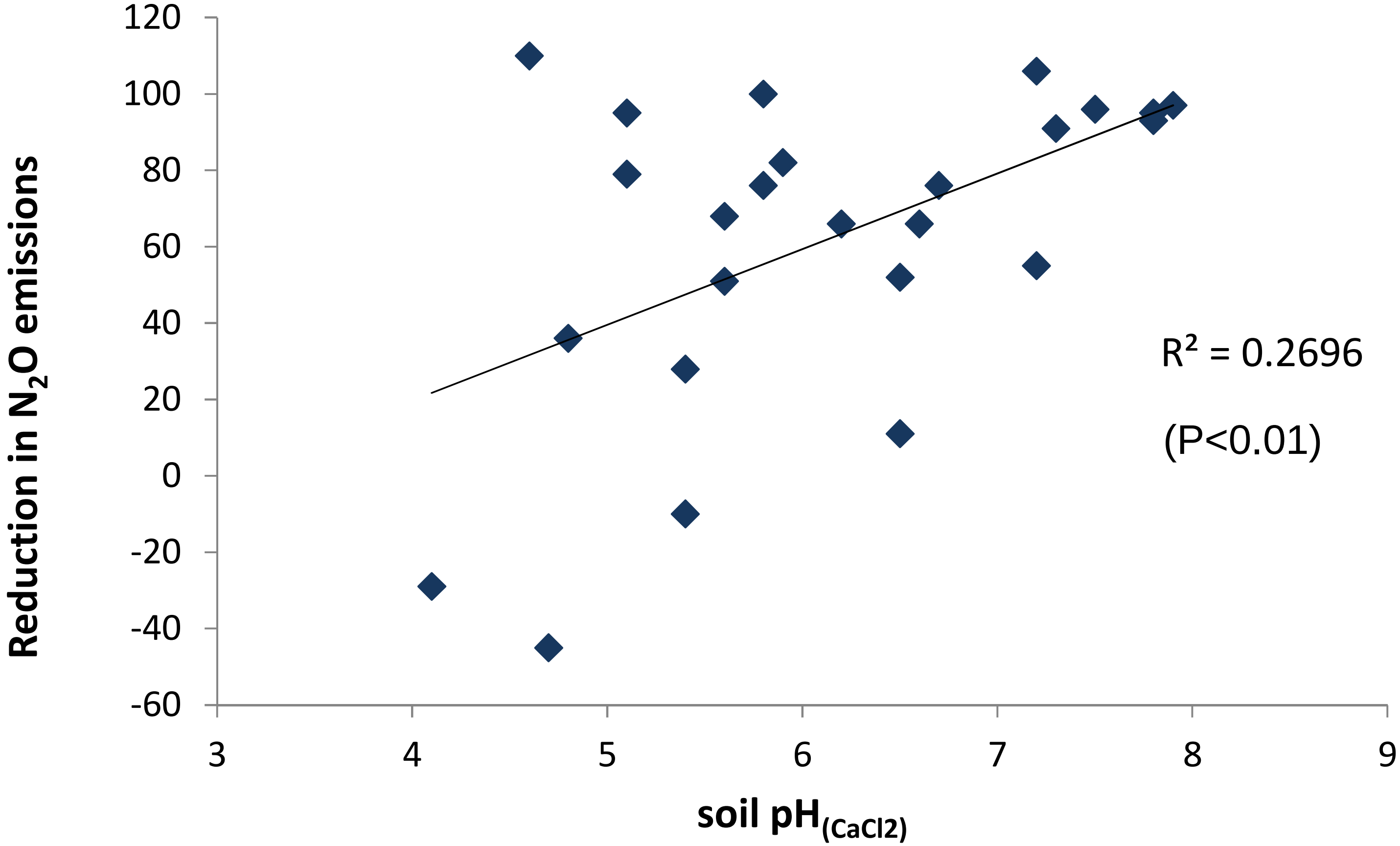
Fertiliser	-0.10-9.54	0.71±0.39	-0.57±0.48 [a]
DMPP	-0.01-10.75	0.52±0.35	-1.17±0.78 [b]



- Addition of fertiliser increases N_2O emissions
- DMPP nitrification rate = control (no fertiliser)

- **Average 55% reduction in fertiliser induced N_2O emissions with DMPP (range 0-100%)**

Results : Soil properties and DMPP efficacy in reducing N_2O emissions



Other soil properties

- Mn (+ive) ($P<0.05$)
- DTPA Zn (+ive) ($P<0.05$)
- DTPA Fe (-ive) ($P<0.01$)

Conclusions on DMPP efficacy and soil properties

- Effective tool for reducing nitrification and N_2O emissions across Australian agricultural soils
- High range of responses
- OM significantly (P<0.01) affected the DMPP inhibition of nitrification
- pH significantly (P<0.01) affected the DMPP inhibition of N_2O emissions
- Further investigation of the importance of properties other than organic matter and pH, and the role of soil trace elements and metals for their interactions with the inhibitor.
- The significant of the soil microbial community requires investigation
  - e.g. Bacterial versus archaeal responses

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Thankyou

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