Stabilised nitrogen fertilisers to reduce greenhouse gas emissions and improve nitrogen use efficiency in Australian agriculture

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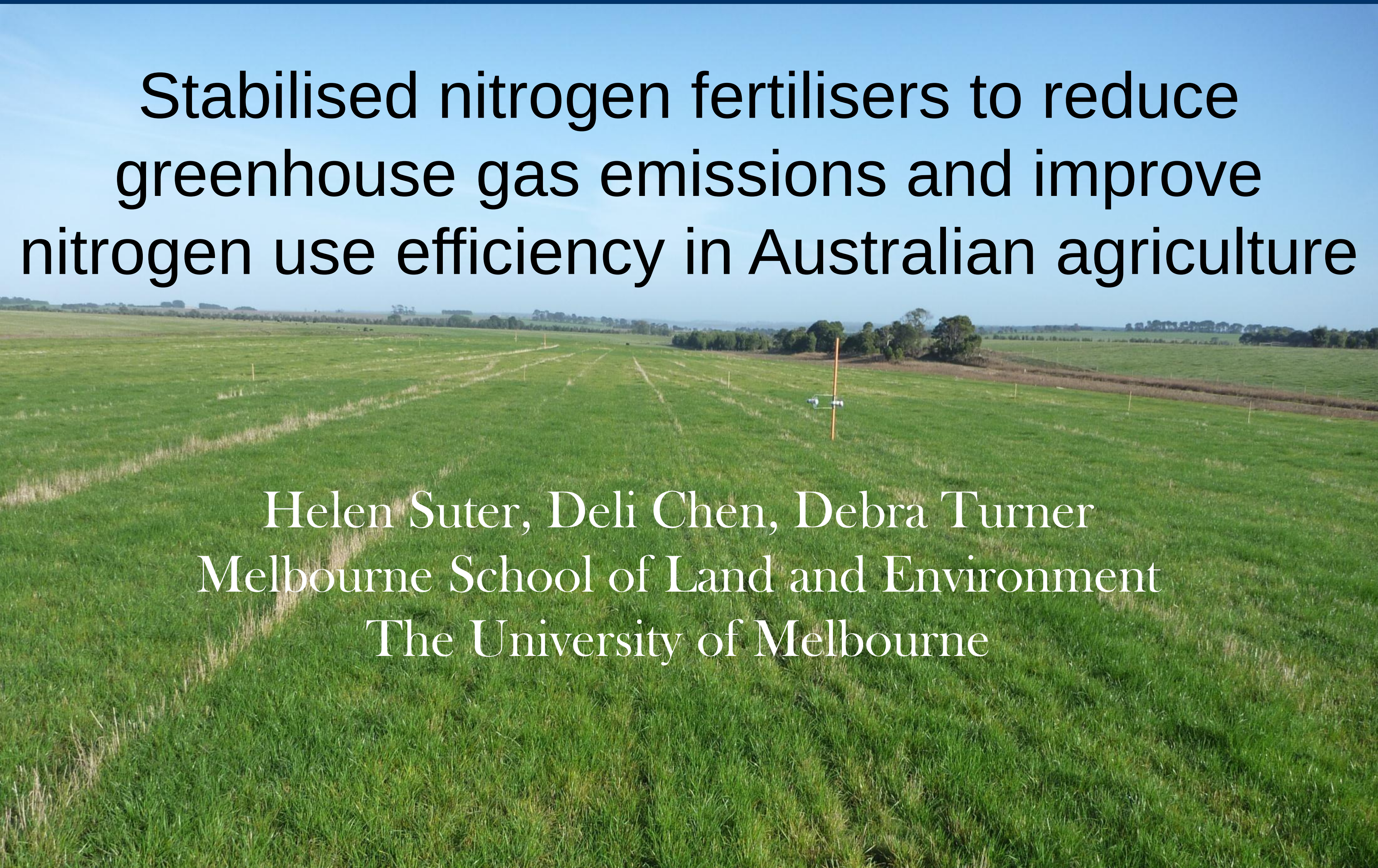

Background

- Nitrogen Use Efficiency
  - 6-60% plant N uptake
  - Losses
    - NH_3
    - Leaching (NO_3^-)
    - Other gases (N_2O, NO_x)

Urea consumption Australia = 1.1 million tonnes/ yr

Variable and potentially large losses;
up to 57%
economics, environment, health

Indirect GHG
N_2O EF; 1.0%
environment

Background

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  - 6-60% plant N uptake
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Lost nutrient
Indirect GHG;
N_2O EF; 1.0%
environment
economic

•EF; 0.05 – 2.8%

Australian total (25 Mt CO_2-e)
•76% = agriculture
•~38% = mineral fertiliser use
environment
economic – C trading

Background

- Stabilised fertilisers
  - Urease inhibitor (Part 1)
    - NH_3 loss
  - Nitrification inhibitor (Part 2)
    - N_2O
    - NO_3^-

Greatest benefit?

- Variable outcomes
  - emissions
  - productivity gains

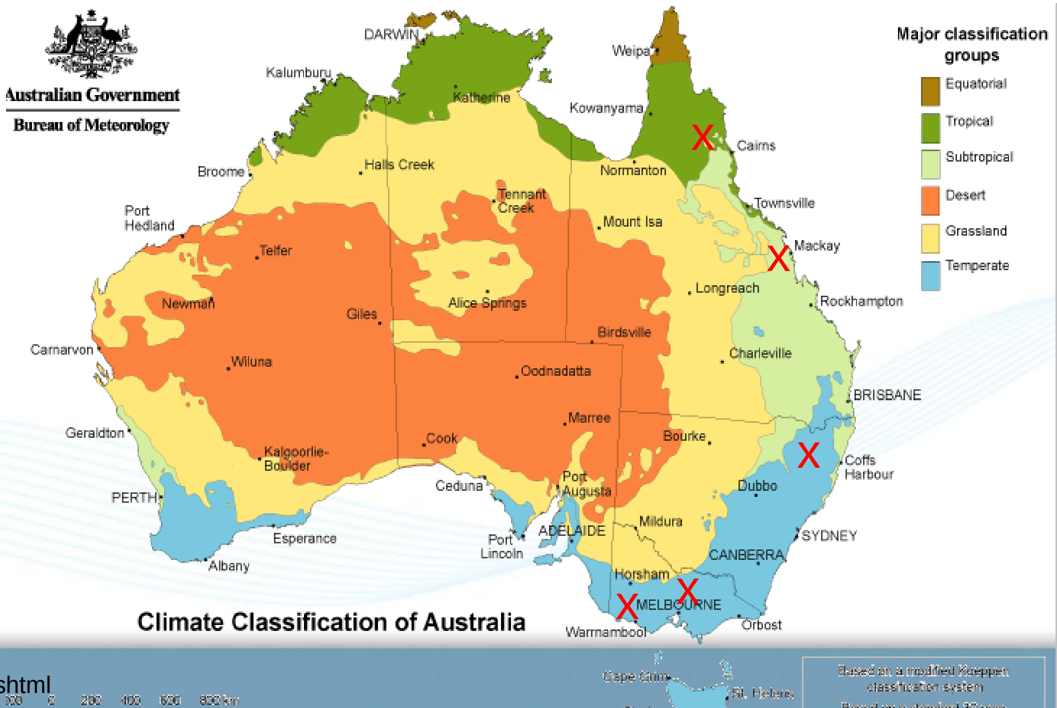
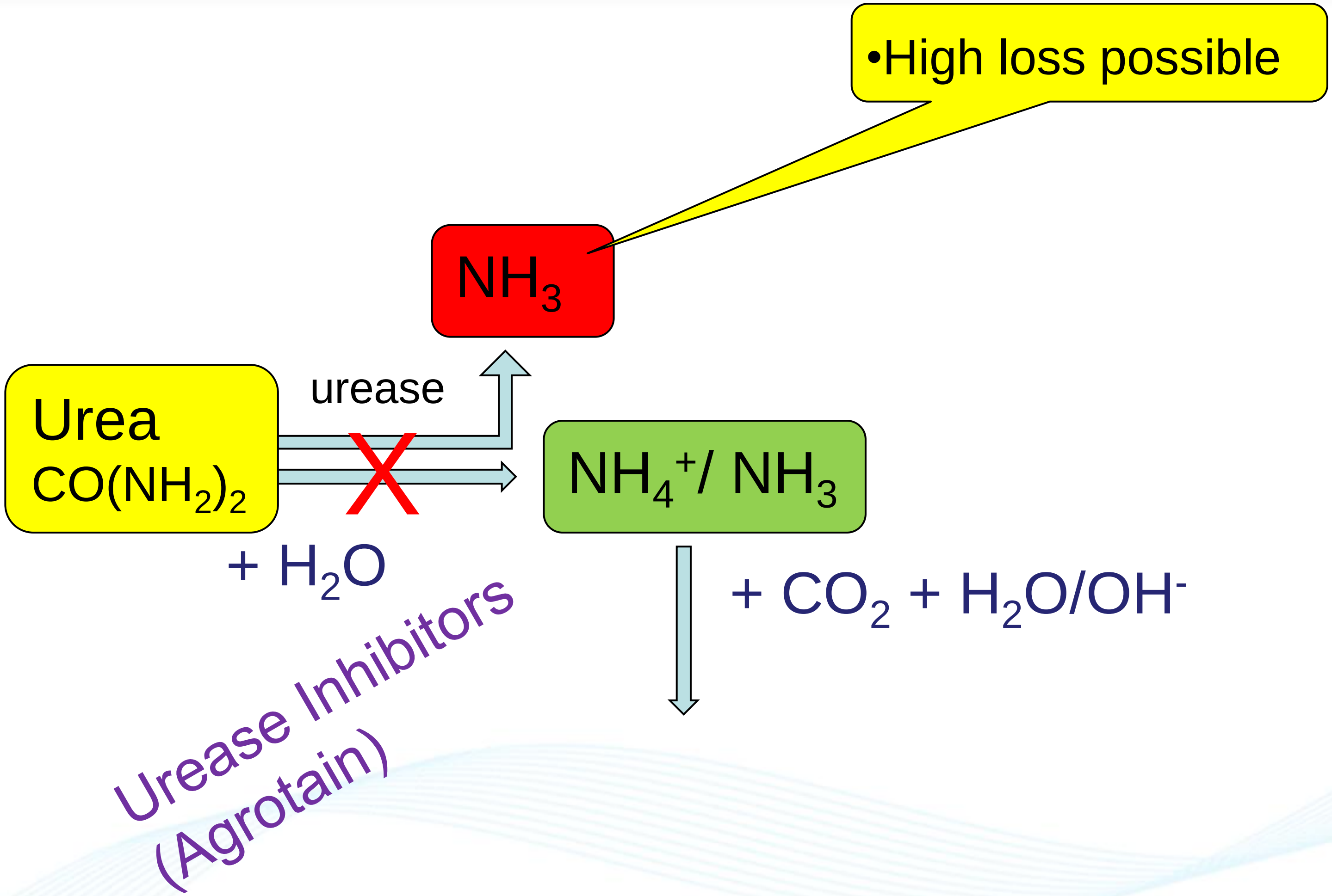


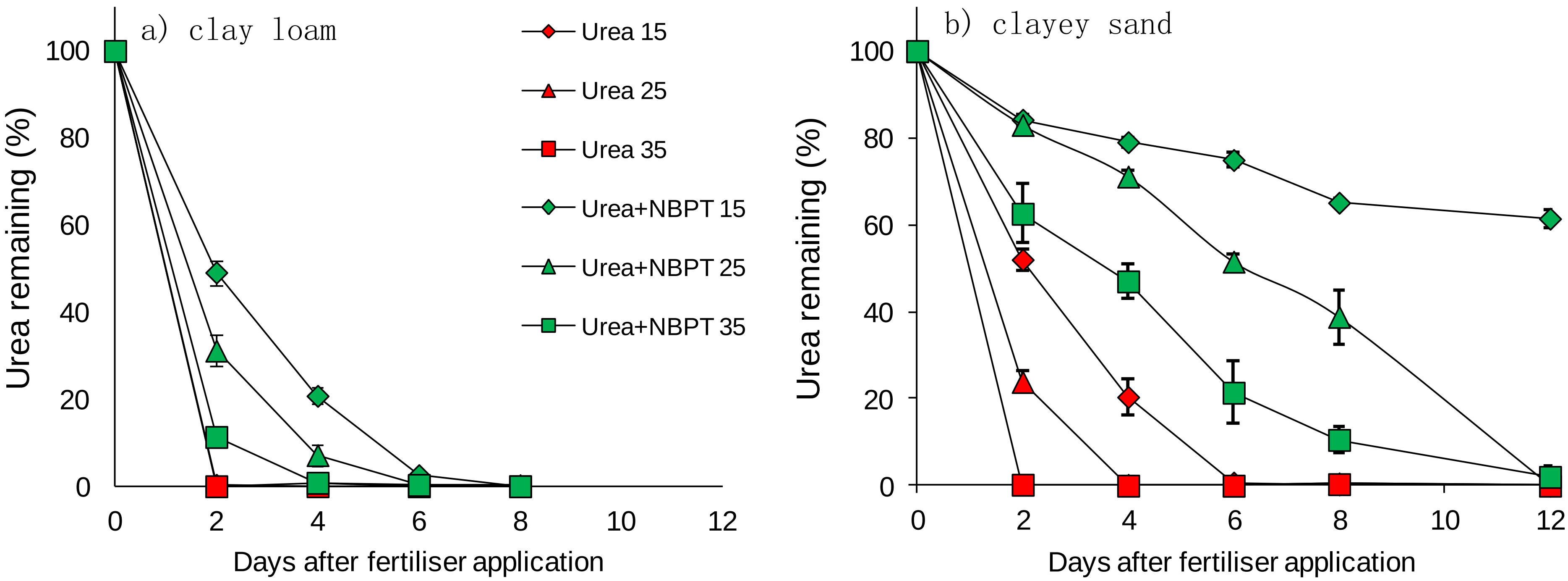
Image source: http://www-cluster.bom.gov.au/climate/environ/other/kpn_group.shtml

Part 1 : Urease Inhibitors

Reducing ammonia (NH_3) loss



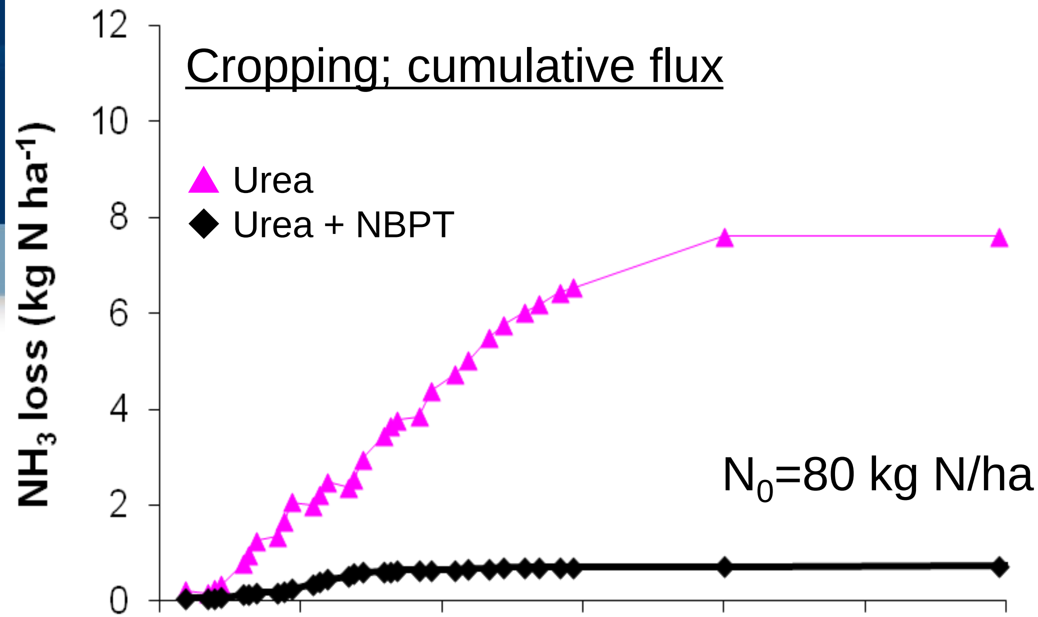
Urea hydrolysis

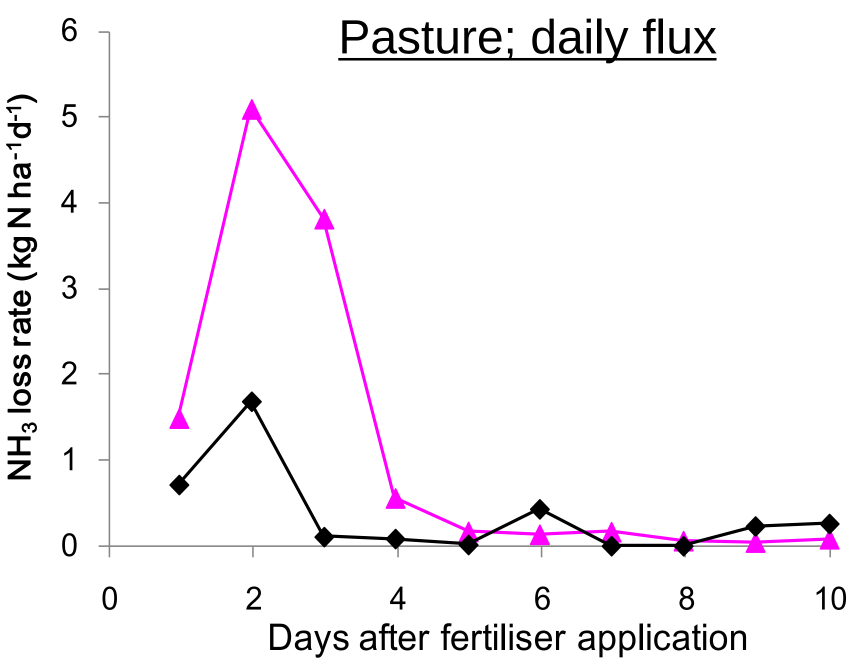


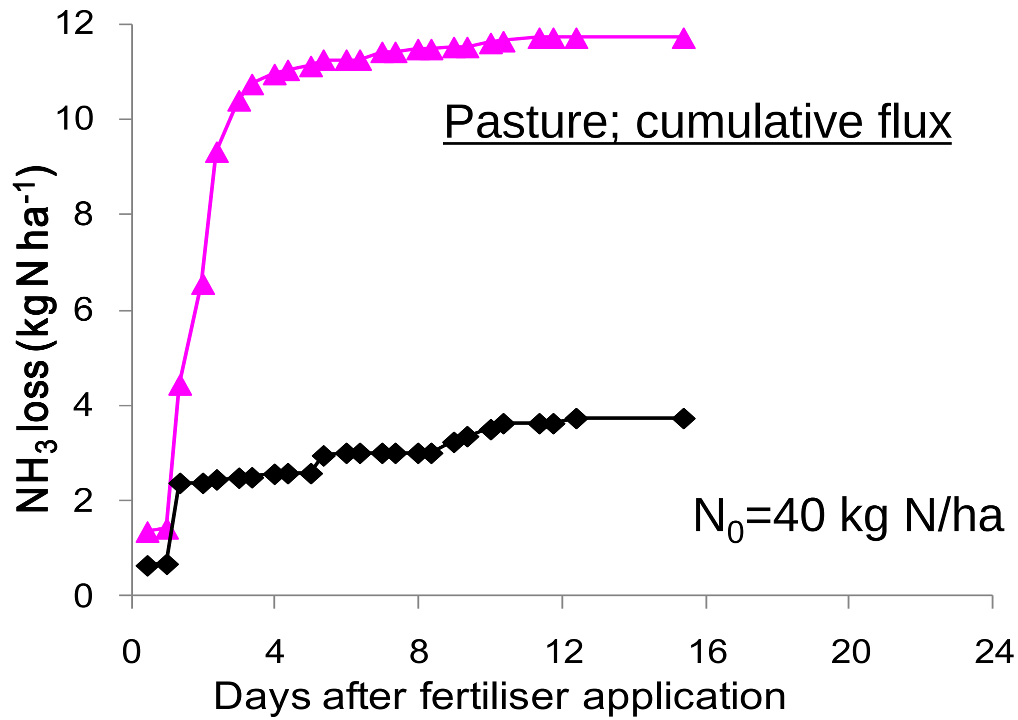
	Clay loam	Clayey sand
pH	5.5	7.3
Clay	20	9
Organic C (%)	3.9	0.5
Urease activity (mg urea-N/g soil/hr)	134	43

NH_3 loss

	cropping	pasture
pH	7.3	5.5
Organic C (%)	1.3	2.4
Clay (%)	33	22







NH_3 loss

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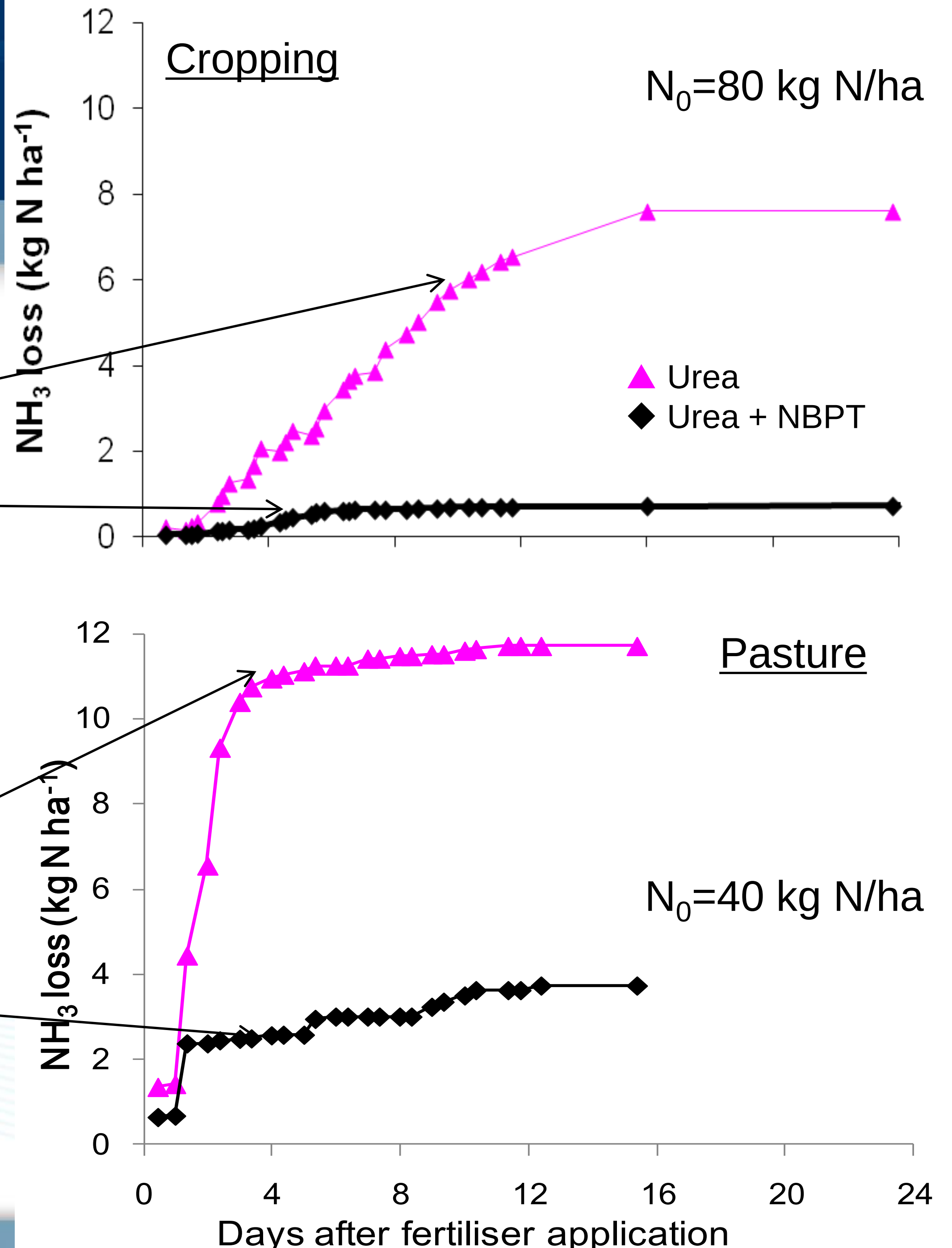


89% reduction

9.5%

1%

70% reduction

30%

9%

{Pasture, spring: 2% loss with urea}

N use efficiency

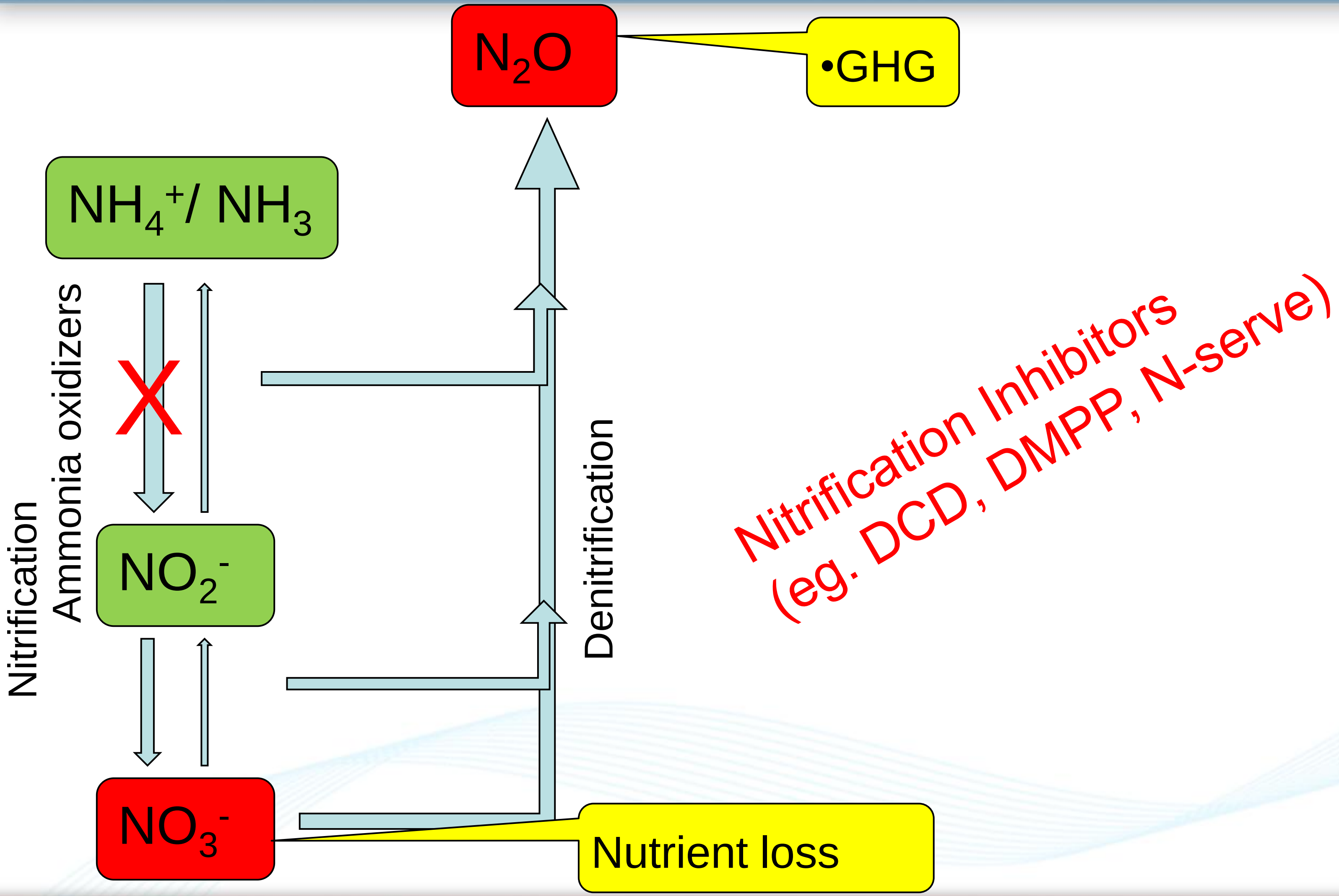
- ^{15}N – 73% recovery
  - Plant: 42%
  - Soil: 31%

  (H. Sultana, UoM)

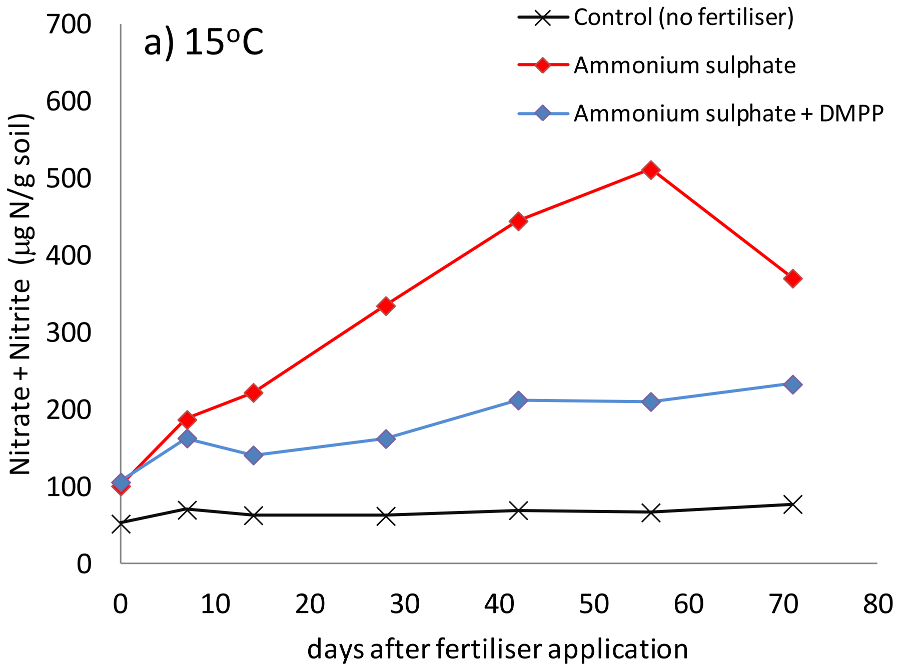
- Dry matter production (kg/ha) increase per unit N (kg) addition (autumn);
  - 8 (urea)
  - 7 (urea + NBPT)

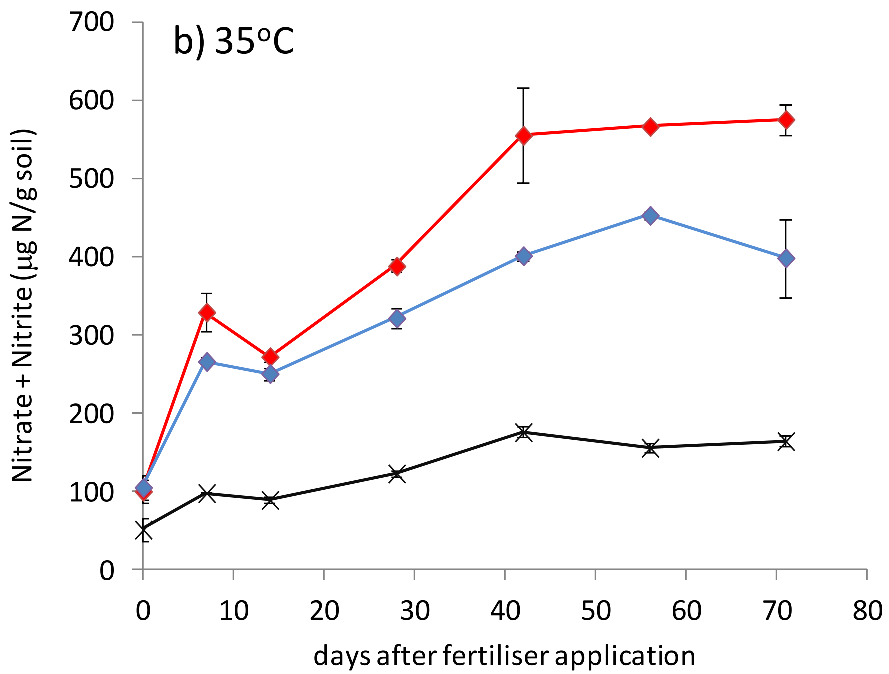
Part 2. Nitrification Inhibitors

Reducing N_2O emissions and NO_3^- leaching



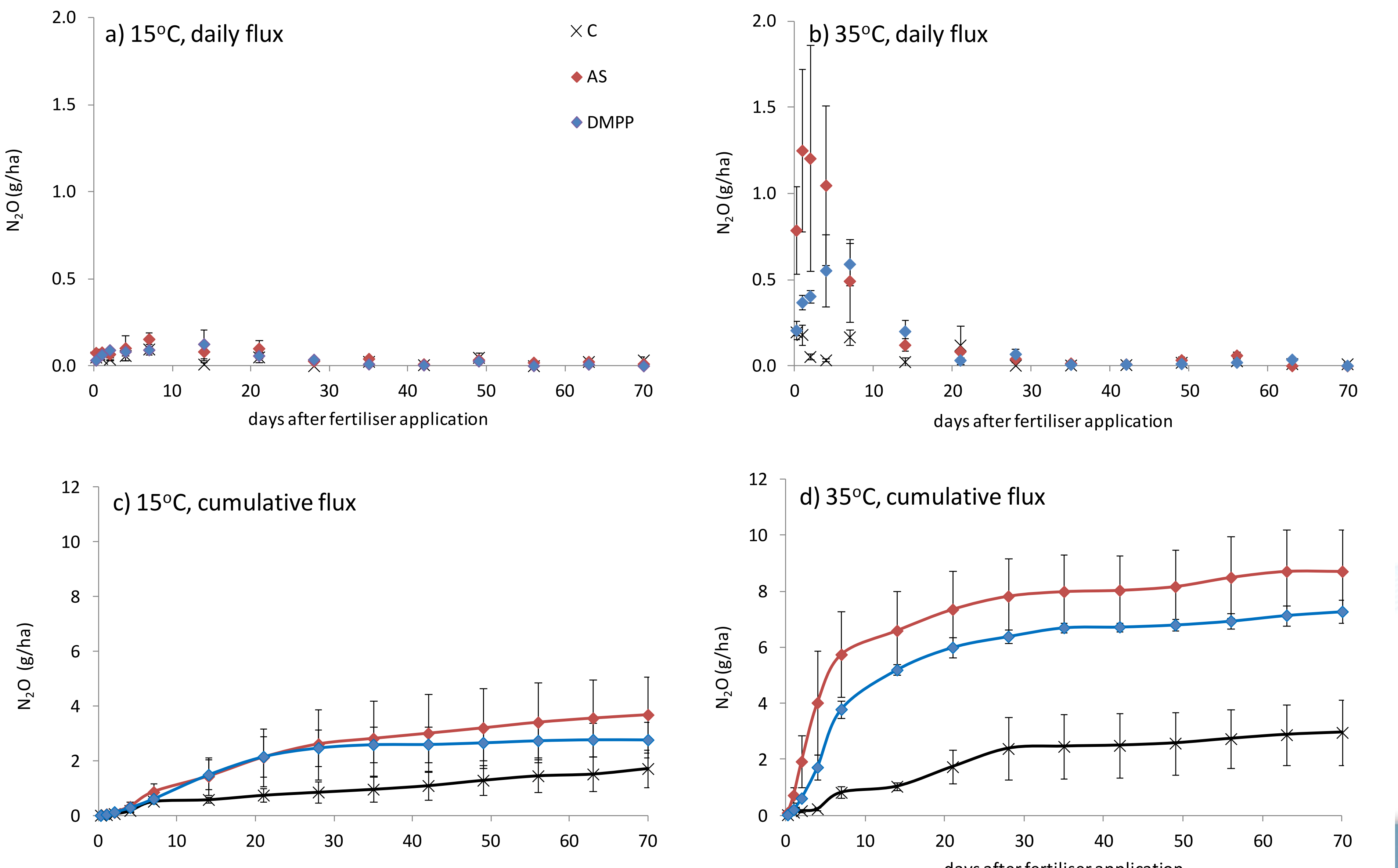
Nitrification Inhibitors : Nitrate production





– temperature

Nitrification Inhibitors : N_2O



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Soils used in laboratory experiments

Summary of selected soil properties

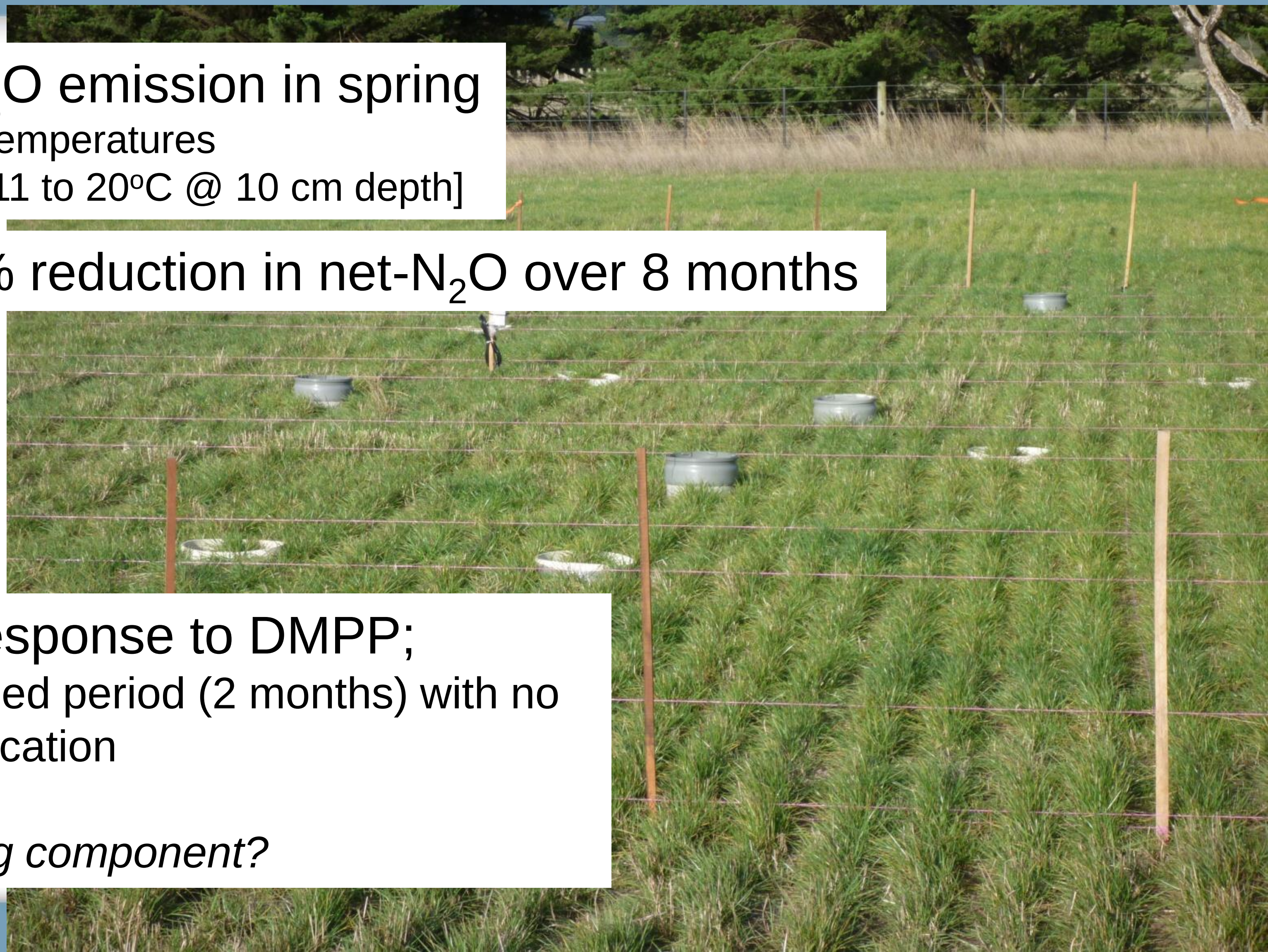
Location	Use	Clay (%)	pH_w	Org. C (%)
NSW	grains	39	8.0	1.5
Qld	sugarcane	13	4.8	1.5
Qld	sugarcane	13	5.5	0.7
Qld	sugarcane	39	5.3	3.1
Vic	dairy pasture	21	5.4	10
Vic	dairy pasture	33	5.5	2.4
Vic	conversion	24	5.5	6.2
Vic	conversion	21	5.5	7.3
Vic	cropping	30	7.8	1.3

Nitrification Inhibitors

N_2O emissions and temperature

- Inhibitory effect
  - N_2O reduction: 0-95%
    - Soil
      - ? pH
      - ? Clay content
      - ? Organic C
      - ? Nitrification rate
    - Temperature: reduced inhibition
      - Soil
      - Inhibitor

Nitrification Inhibitors



Greatest N_2O emission in spring

- warming soil temperatures

[increase from 11 to $20^{o}C$ @ 10 cm depth]

DMPP; 64% reduction in net-N_2O over 8 months

Biomass response to DMPP;

- After extended period (2 months) with no fertiliser application
- Over winter
  - *Leaching component?*

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Conclusions : potential for inhibitors in Australian agriculture

Inhibitor	NH_3	N_2O	Nitrogen use efficiency	Drivers of performance
Urease inhibitor	✓	x / ?	?	•Soil (pH, urease activity, organic C) •Climate (*rainfall) •Temperature
Nitrification inhibitor	?	✓	✓ / ?	•Temperature • Soil (pH, clay %, organic C)

Conclusions : benefits from inhibitors in Australian agriculture

Inhibitor	Greatest benefit
Urease inhibitor	•Surface applied urea •High emission environments organic low moisture windy
Nitrification inhibitor	•High losses as - N_2O - leaching

- Considerations
  - environment
    - soils, climate
  - N savings potential
    - industry, nutrient management

Thank you

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- http://www.piccc.org.au/
- http://www.n2o.net.au/