

Urease Inhibitors

by

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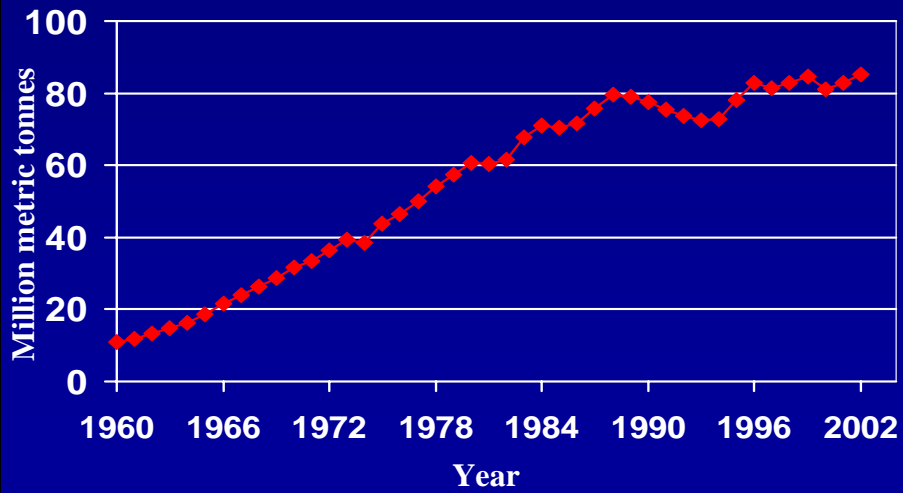
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Outline of presentation

- Agronomic importance of urea
- Urease activity and ammonia volatilisation
- Urease inhibition / Urease inhibitors
- Economics and future considerations
- Conclusions

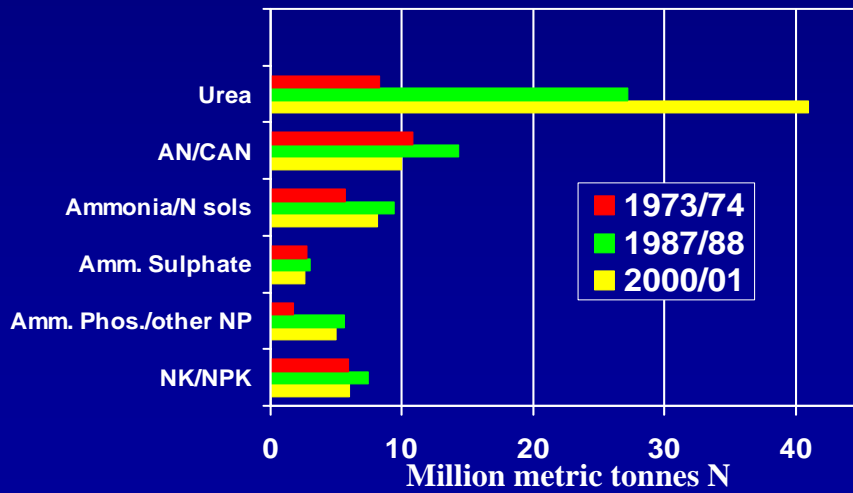
World N fertiliser consumption



N fertiliser consumption Developed vs Developing countries

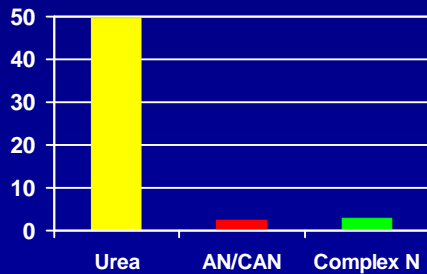


World N consumption by product

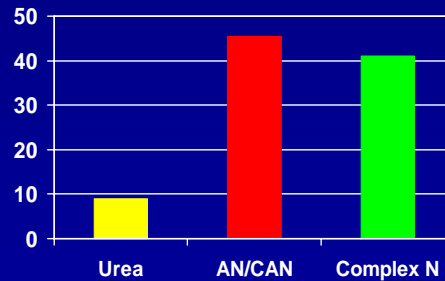


% of total N consumption

CHINA (23.3 mt)



UK (1.25 mt)



Advantages of urea

- **Most concentrated N fertiliser available (46% N)**
- **Offers transportation advantages over other sources**
- **Less expensive to manufacture**

Disadvantages of urea

- **Loss of N by ammonia volatilisation**
- **Yield response is often lower than that to AN/CAN**
- **Can adversely affect seed germination and seedling growth**

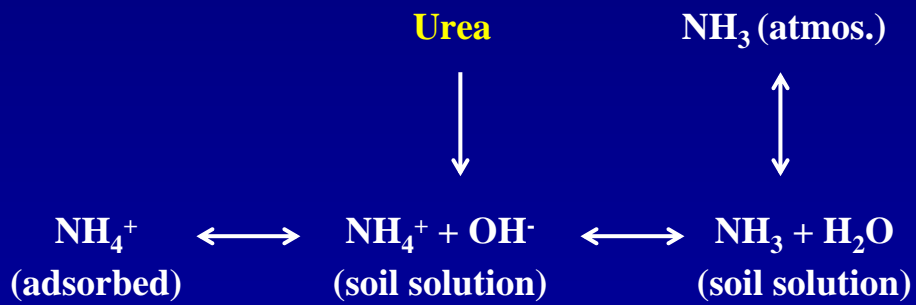
Urea hydrolysis



Factors affecting urea hydrolysis

- Temperature
- Urea concentration
- Soil water
- Soil pH
- Soil organic matter content

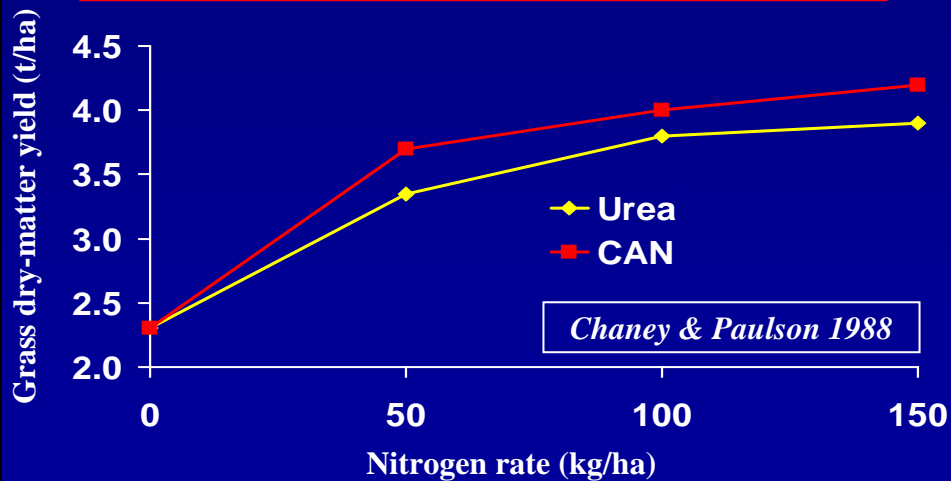
Equilibrium reactions



Factors controlling ammonia volatilisation

- Rate of urea application
- Soil properties
- Soil temperature
- Soil water content
- Air exchange rates

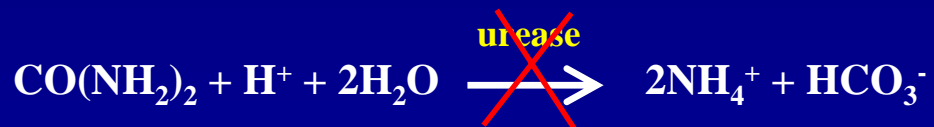
Urea vs (C)AN



Opportunities for increasing the efficiency of urea

- Slow release systems
- Chemical additives
 - acidic materials
 - inorganic salts
- Granule size and placement
- Urease inhibitors

Urease inhibitors



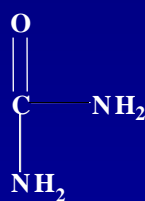
Requirements for a successful urease inhibitor

- Non toxic
- Stable
- Effective at low concentrations
- Inexpensive
- Compatible with urea

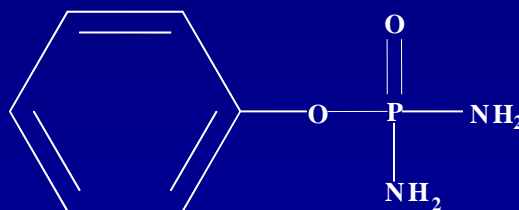
Major classes of urease inhibitors

- Interact with a key functional group
 - eg. Sulphydryl reagents
- Non competitive inhibitors
 - eg. Hydroxamates
- Competitive inhibitors
 - eg. Structural analogues of urea

Structural analogues of urea Phosphoramidate inhibitors

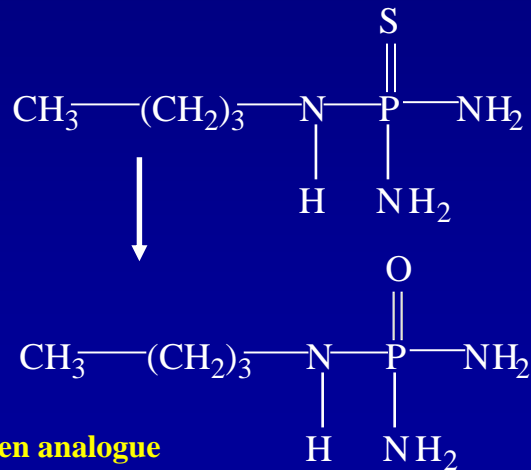


Urea

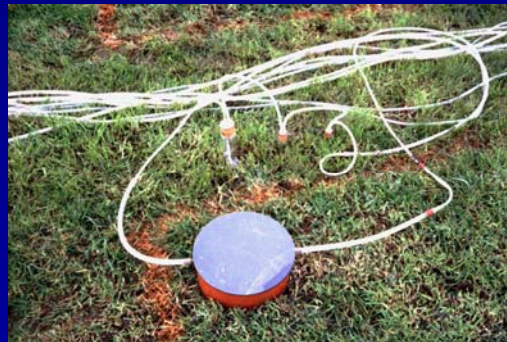


Phenylphosphorodiamidate (PPD)

N-(n-butyl) thiophosphoric triamide (nBTPT)



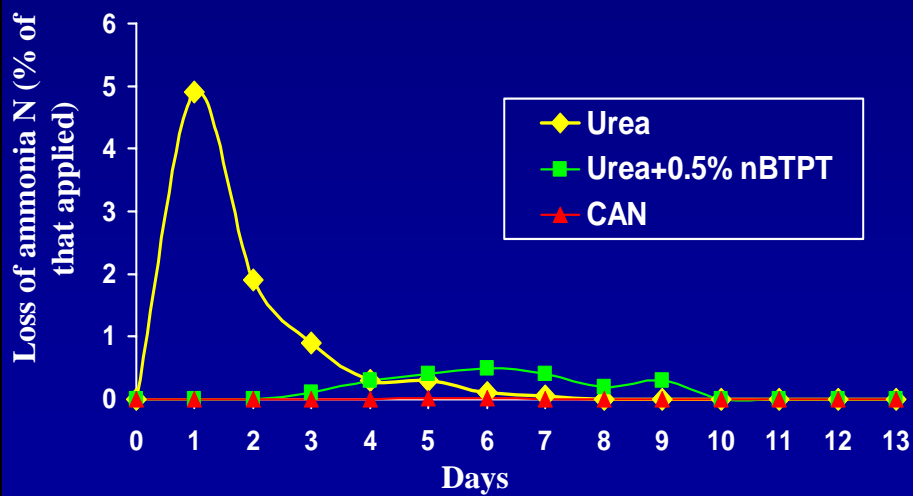
Measuring NH₃ volatilisation



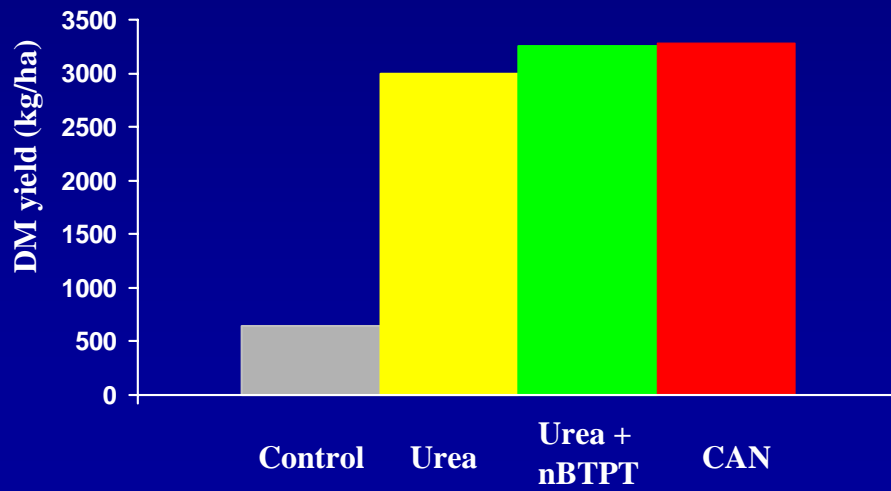
Measuring NH_3 volatilisation in the field



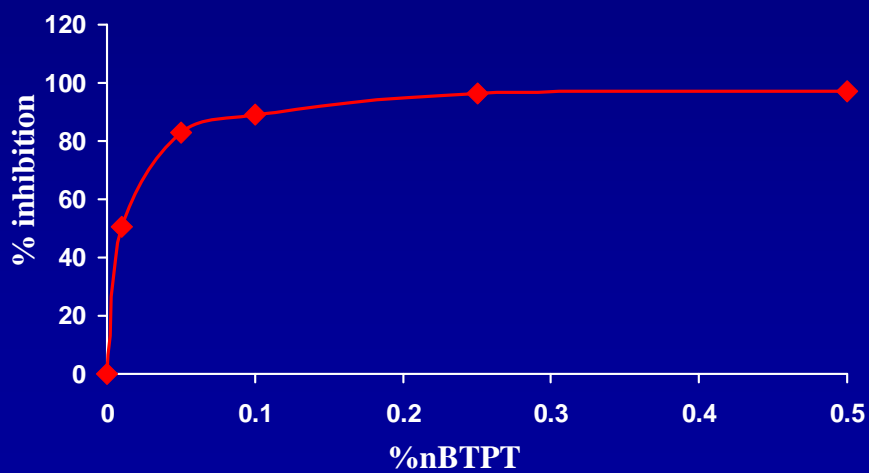
Daily loss of $\text{NH}_3\text{-N}$ (%)



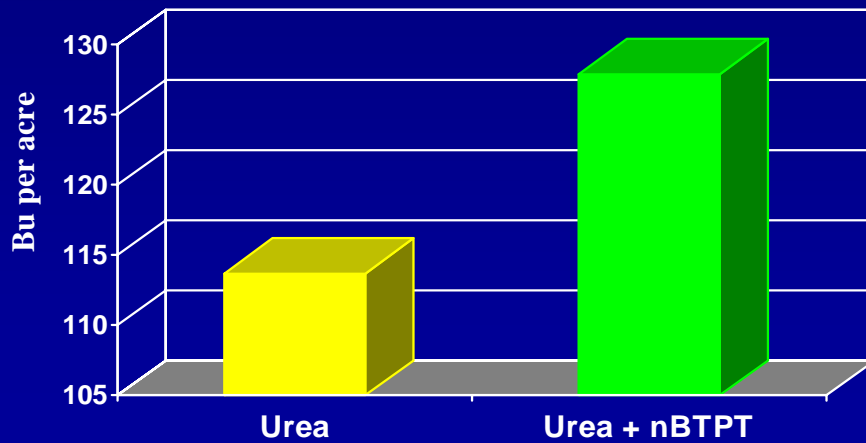
Dry-matter yield of ryegrass (kg/ha)



% inhibition in $\text{NH}_3\text{-N}$ volatilisation



Maize response to nBTPT in USA **(average 316 sites and 14 years testing)**



Other advantages of nBTPT

- **Reduces adverse effect of ammonia and nitrite toxicity on seed germination and seedling growth following rapid urea hydrolysis**
- **Reduces NH_3 loss from livestock waste**

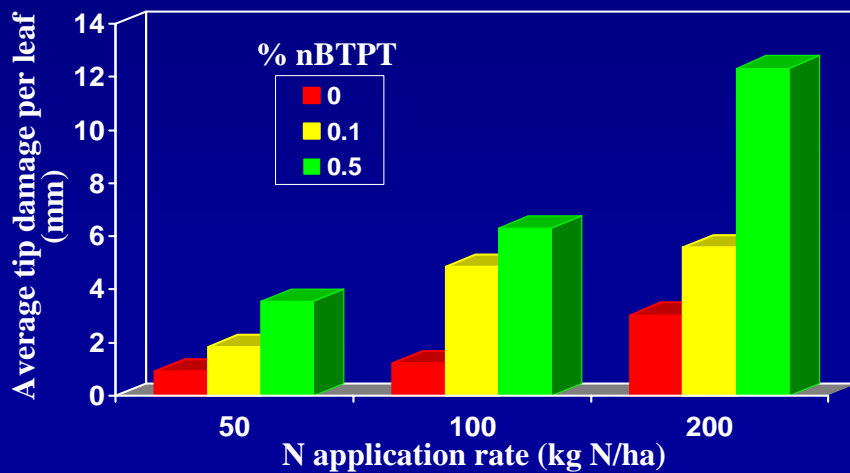
**Urease inhibitors can cause
transient leaf tip scorch**



Leaf tip necrosis



Leaf tip necrosis



nBTPT is the only commercially available urease inhibitor

Tradename is AGROTAIN

AGROTAIN is a clear green solvent containing 20-25% nBTPT. This can be :-

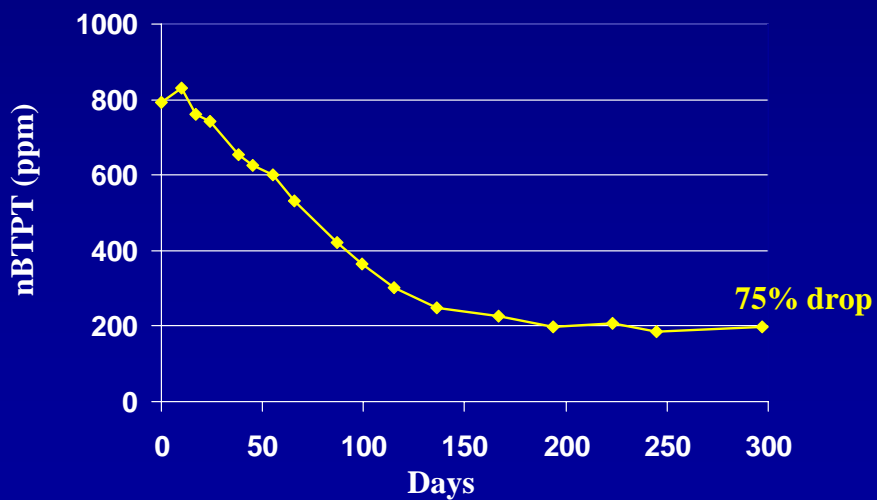
- Used to Impregnate urea granules
- Added to the urea melt during manufacture
- Added to UAN solutions prior to surface spreading in the field

Recommended rate for spray impregnation is 0.11 to 0.14% (w/w)

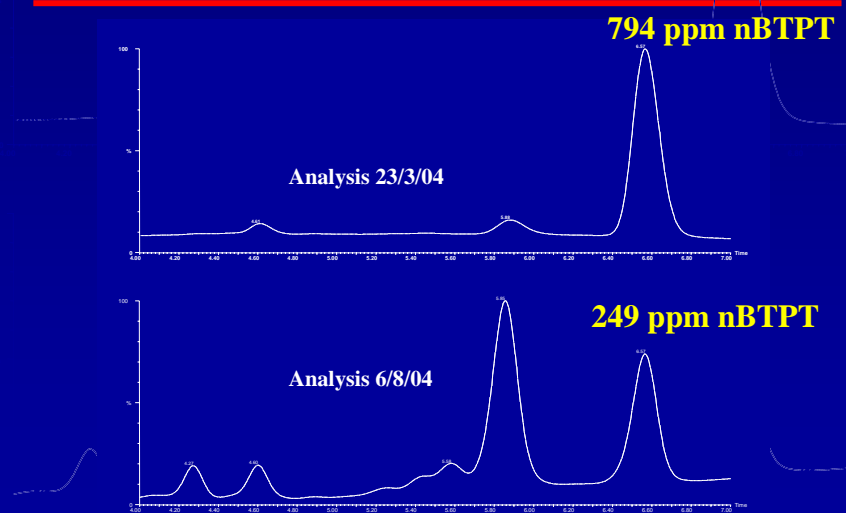
AGROTAIN

- Has successfully passed extensive toxicological and environmental tests
- Degrades into fertiliser elements N, P & S
- Compatible with most agricultural chemicals

Stability of urea coated with nBTPT



HPLC trace of coated product



Super U, UFLEXX & UMAXX

Granular products containing:

- Urea +
- N-(n-butyl) thiophosphoric triamide +
- Dicyandiamide (DCD)

Economic benefit of urease inhibitors

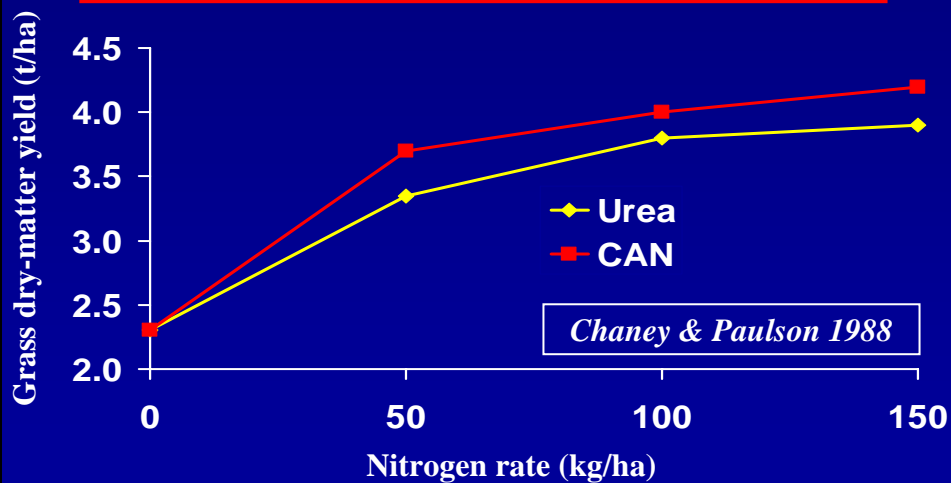
Depends on:

- Price differential between urea and AN or CAN
- Additional cost of amendment
- Amount of N saved from ammonia loss
- Value of the additional crop yield

Further work is required on the effect of urease inhibitors on:

- Losses of nitrate by leaching
- Gaseous emissions (eg. N_2O , CH_4)
- Urea loss to surface waters
(156 $\mu\text{g NH}_4^+\text{-N/l}$ is EC guideline for freshwater fish)
- Plant nutrition and physiological aspects

Urea vs (C)AN



Conclusions

Maximum benefits of urease inhibitors will occur when:-

- Crop yield potential is high
- Soil N levels are low
- Incorporation of urea is difficult
- Soil and environmental conditions promote extensive volatilisation

Conclusions contin.

The development and introduction to the market of new effective, low price and non toxic urease inhibitors is a time-consuming process requiring years of data collection for registration purposes.