Advantages and disadvantages of controlled-release fertilizers

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Outline

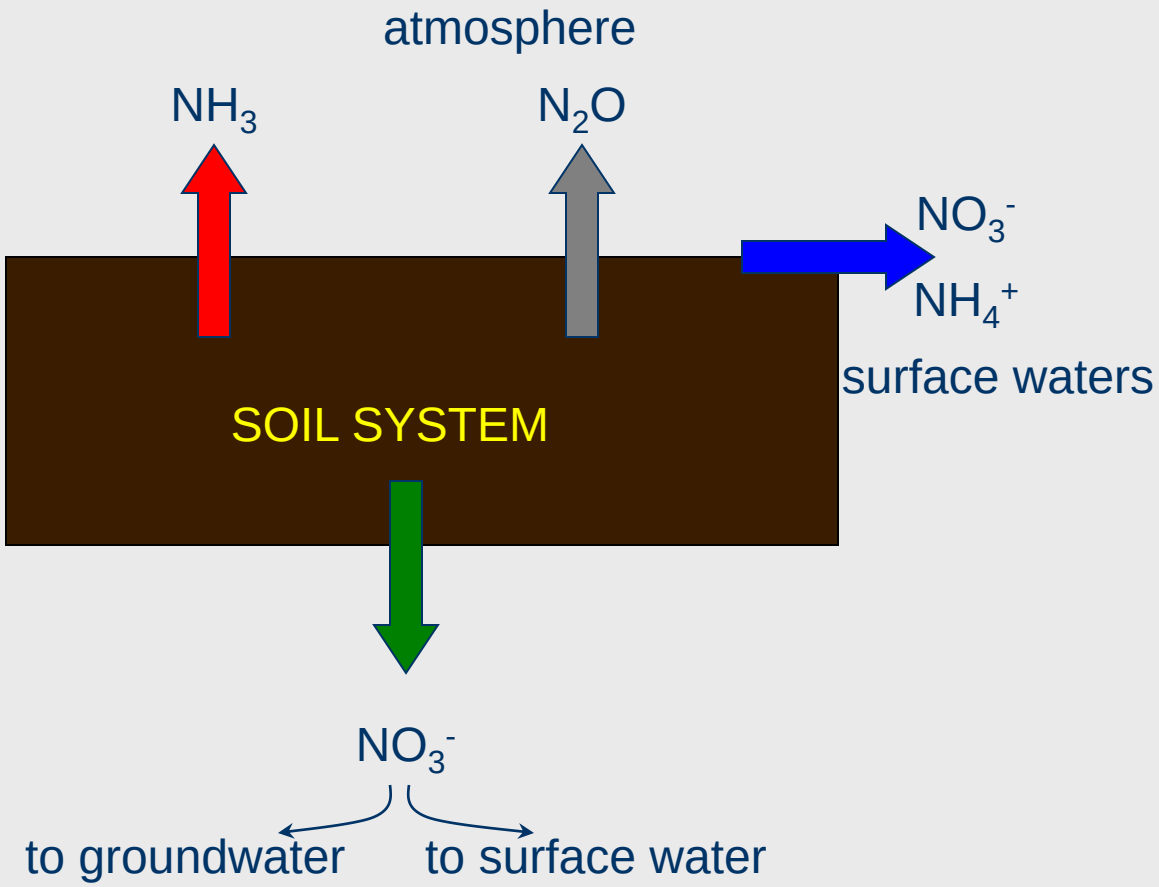
- Why consider slow-release N fertilizers?
- Defining “slow-release”
- Types of slow-release N products
  - Mechanisms
- Evaluating your need for slow-release

Why consider slow-release N

- There is a fundamental flaw in how we apply N fertilizer – we don’t apply N as the crop needs it.
- In some cases, applying all N at preplant does not result in optimal use of N
- N is subject to environmental losses

Environmental losses of N

- Volatilization
- Denitrification
- Leaching
- Runoff



Why consider slow-release N

- Consider slow-release N when attempting to reduce environmental losses
- Slow-release fertilizer is becoming more cost effective
- Consider your soil system and cropping system and evaluate which N losses may be occurring and hindering efficiency

The value of increasing efficiency

Efficiency = more N applied taken up by the crop

#1 – Increase in yield with same fertilizer rate

#2 – Maintain yield with reduction in rate

#3 – Increase in yield with decrease in rate

#4 – Large increase in yield with increase in rate

(in each case more N is taken up per unit applied!)

Disclaimer

- Products mentioned in this presentation to not reflect an endorsement of that product.
- Likewise, a lack of mention does not imply that a product is not recommended or available for use.

What does “controlled-release” mean?

Terms sometimes used synonymously

- Slow-release
- Controlled-release
- Delayed-release

Preferred term that encompasses all types of products: *Fertilizer technologies*

Fertilizer Technologies

Three general categories:

- Uncoated, controlled-release
- Coated, controlled-release
- Bio-inhibitors
  - Not really “slow-release” per se
  - Inhibit microbial processes that convert N into plant available forms (and thus making the N susceptible to environmental losses)

Slowly (or relatively slowly) parse N into soil environment

Uncoated, slow-release

- Urea-formaldehyde reaction products
  - Decompose in soil by chemical processes, biological processes, or a combination of both
- Isobutylidene diurea (IBDU)
  - Relies solely on soil chemical processes to breakdown product.
- Inorganic salts
  - Magnesium ammonium phosphate

Coated, slow-release

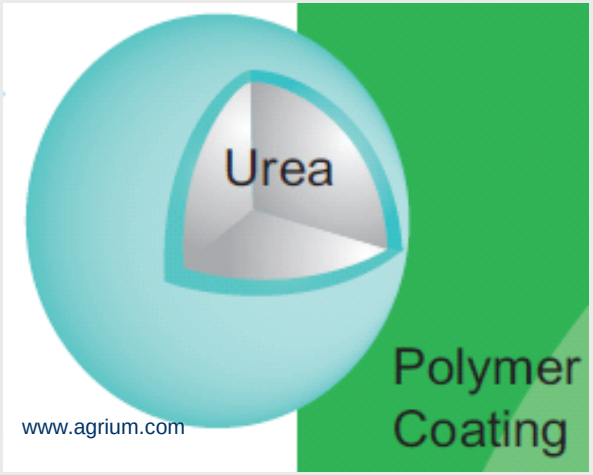
- Sulfur-coated urea
  - Releases N through oxidation of S coating
  - Used for turf fertilization
- Polymer-coated (or Poly-coated) urea

www.nugrotech.com

Coated, slow-release N

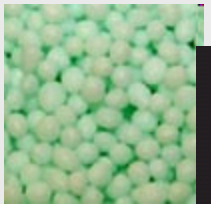
Polymer-coated

- Urea is coated with special polymer coating – special to each manufacturer.
- Water moves in through coating to dissolve urea
- N diffuses out through porous polymer membrane



Coated, slow-release

- Popular for conventional agriculture systems
- ESN ® (Environmentally Smart Nitrogen, Agrium, Calgary, AB)
- Polyon ® (Agrium, Calgary, AB)
- Nutricote ® (Chisso-Ashahi Fertilizer Co., Ltd., Tokyo, Japan)



ESN

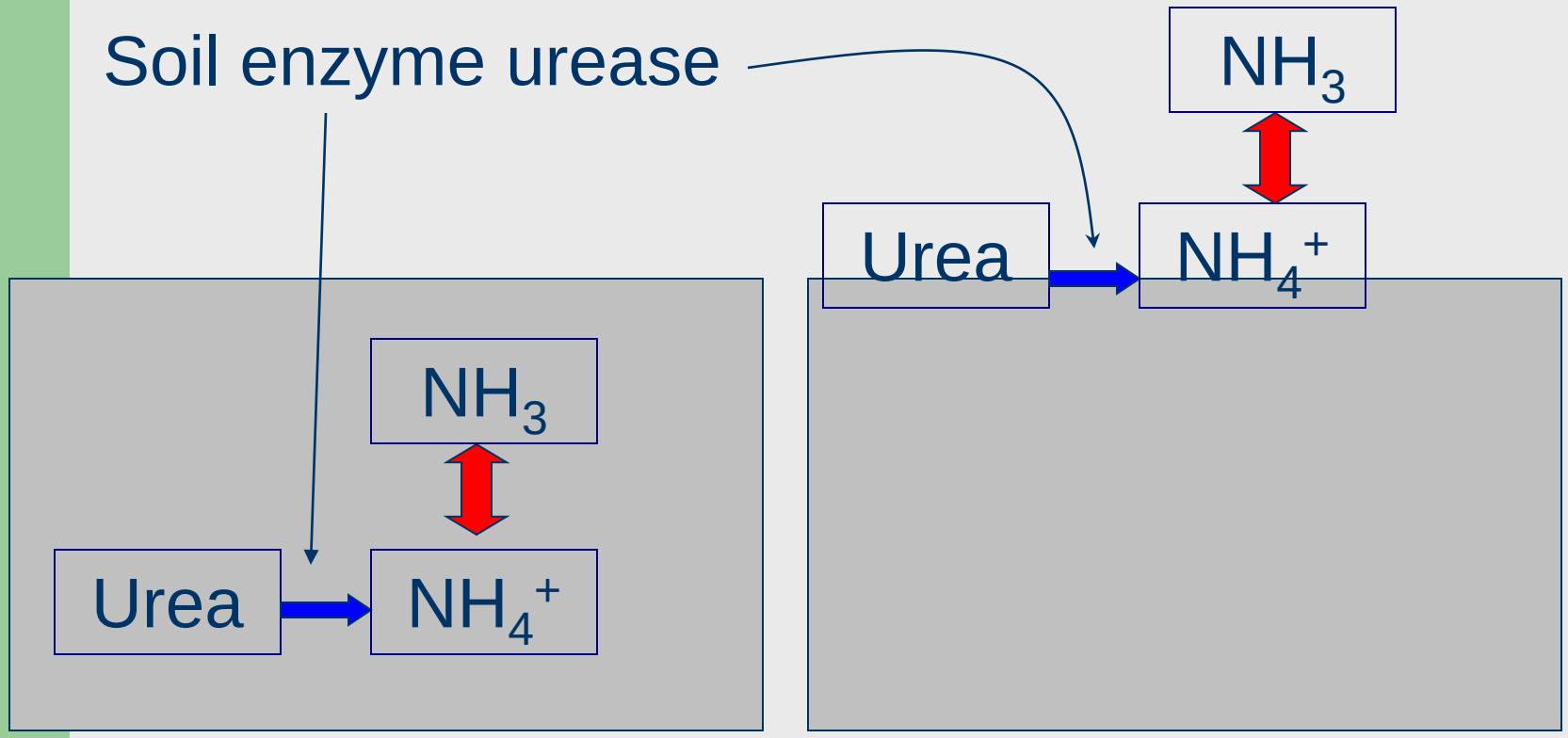
Coated, slow release (PCU)

- Beneficial in reducing split applications in sand soils / potato (Wilson et al., 2009) MN
- Greater utilization of N in corn, barley, and potato (Shoji et al., 2001) CO
- Reduction in N leaching loss (Pack et al., 2006) on sandy soils. FL
- PCU increased corn yields on low-lying areas (subject to denitrification losses) (Noellsch et al., 2009) MO
- Good alternative to split application on corn in sandy soils (Bundy – 2004) WI

Bio-inhibitors

- Urease inhibitors
- Nitrification inhibitors

Urease Inhibitors – Volatilization



Soil pH effects on percent N

	Ammonia-based N	
Soil pH	Ammonia (NH_3)	Ammonium (NH_4^+)
	----------%----------	
6	0.06	99.94
7	0.6	99.4
8	5.4	94.6
9	36.5	63.5

Options for controlling volatilization

- Incorporate into soil
- Irrigate into soil
- Rainfall occurs with 2-3 days
- Apply urease inhibitor

- If not, volatilization losses can be 15-20% of the N applied.
- Maximum of 30% loss

Urease inhibitors

- N-(n-butyl) triophosphoric triamide (NBPT)
- Agrotain ® (Agrotain, Inc., LLC, Corydon, KY)
- Can be added to urea or mixed with UAN

AGROTAIN®
Improved Nitrogen Efficiency

Urease inhibitors

- Urease inhibitors kill or chemically inhibits the activity of the soil enzyme urease
- This causes the urea to not breakdown as quickly, providing time for rainfall to move urea into the soil
- Can inhibit for 2 weeks or more depending on conditions
- Warm temps and wetter conditions cause urease to repopulate faster

Urease inhibitors

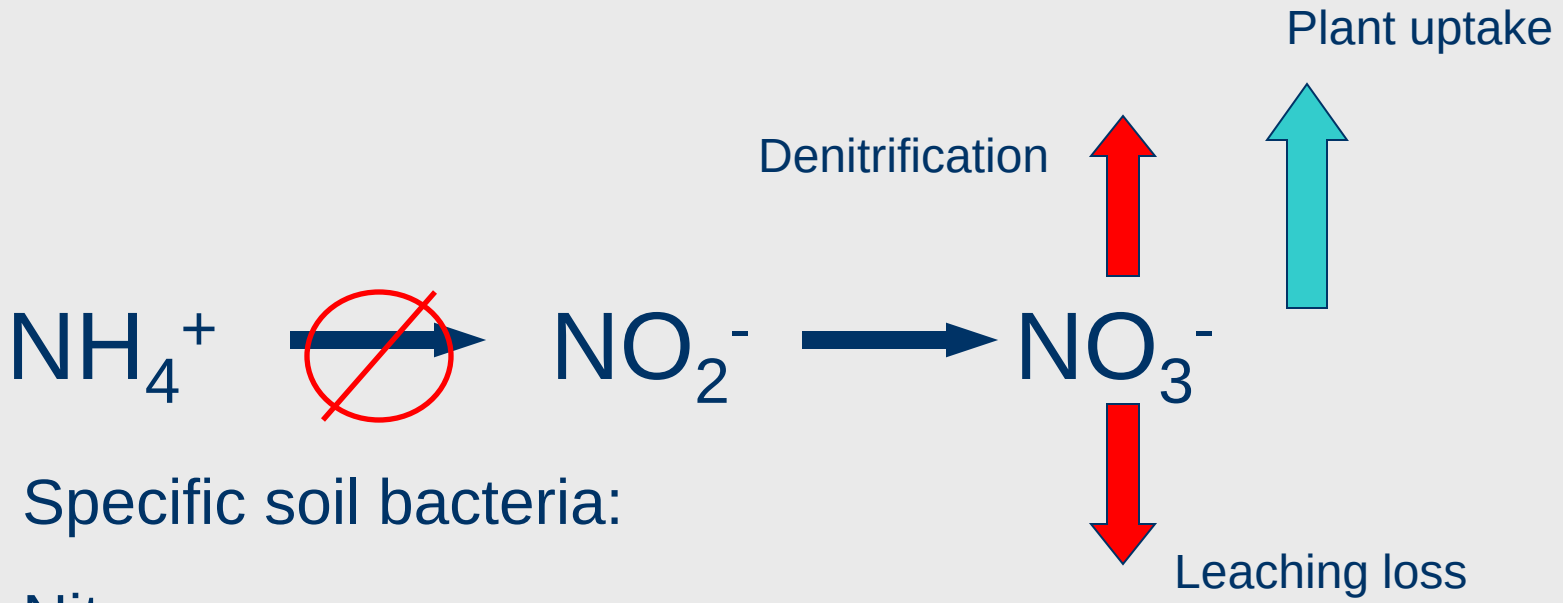
Potential benefits:

- On no-till or reduced tillage systems with surface application of N
- Allows flexibility for application timing
- On soils that have factors that favor ammonia loss

However, when there are not conditions for volatilization, urease inhibitors have little to no value

Nitrification inhibitors

- Delay conversion of NH_4^+ to NO_3^-



Specific soil bacteria:

Nitrosomonas

Delays conversion 2-4 weeks depending on pH and temp

Nitrification inhibitors

Value occurs when NO_3^- losses are high – from leaching or denitrification

- Tile drained soils (when leaching potential is high)
- Wet soils / poorly drained soils
- Fall applications
- Fertilizers containing NH_4^+
- No-till systems

Table 3. Effects on Grain Yields of Corn Grown with Conventional and No-Till Systems from Addition of Nitrification Inhibitors to Fall- and Spring-Applied Ammoniacal Fertilizers.[1]

Location	Time of application	No. of experiments	No. of yield increases from NI_2	% Yield increase from NI_3
Indiana	Fall	24	17	12.5
	Spring	51	29	5.8
	Spring (no-till)	12	9	10.0
No. Illinois	Fall	12	5	5.0
	Spring	14	2	-1.0
So. Illinois	Fall (NH_3)	7	7	4.6
	Spring (NH_3)	9	7	4.6
	Spring (no-till)	2	2	8.5
	Fall (N solution)	5	4	3.3
	Spring (N solution)	5	2	-1.2
Kentucky	Spring (no-till)	8	7	14.3
Wisconsin	Fall	2	1	4.7
	Spring	2	0	1.5

[1] Adapted from R. G. Hoeft 1984. Current status of nitrification inhibitors. In R. O. Hauck (ed.) Nitrogen in Crop Production. Am. Soc. of Agronomy, Madison, Wi.

[2] Significant at 95% probability level.

[3] Average percent yield increase across all N rates and locations.

Nitrification products

Nitrapyrin [2-chloro-6-(trichloromethyl)-piridine)]

- N-Serve® (Dow AgroSciences LLC, Indianapolis, IN) – only labeled for corn, sorghum, and wheat.
- Instinct™ (Dow AgroSciences)

Dicyandiamide (DCD)

- SuperU® (Agrotain) – contatins Agrotain and DCD

Nitrification inhibitors

- Not necessary for above optimum levels of N
- Not necessary when applying sidedress
- Do not work well on coarse textured soils
- With the low CEC, NH_4^+ can leach out of zone containing inhibitor

Fertilizer technologies

- Uncoated, slow-release
  - specialty crops
- PCU
  - Sandy soils, prolonged saturated soils
- Urease inhibitor
  - Surface applied urea, no till systems
- Nitrification inhibitor
  - High potential for nitrate loss (leaching, denitrification), no till, fall applications

Some quick economics

- Based on data from mid-March, 2011
- Urea = $481 ton (46% N)
- Agrotain =$78 gallon = $559 ton (46% N)
- SuperU = $620 ton (46% N)
- ESN = $650 ton (44% N)

How to choose an enhanced-efficiency fertilizer

- Dr. Tom Bruulsema, International Plant Nutrition Institute.
- IPNI Plant Nutrition Today, Winter 2009-2010, No. 1

How to choose an enhanced-efficiency fertilizer

#1 - Do you know the mode of action and is it relevant to your crop, soil and climate?

- All the things we discussed here today

#2 - How as the product performed in your region/cropping system?

- Look for regional data
- University conducted research

How to choose an enhanced-efficiency fertilizer

#3 - How does the product perform in your fields?

- On-farm tests, replicated strip trials

#4 - Does the product enhance your ability to plant at the optimum time?

- Can this product allow for improvements to management?

How to choose an enhanced-efficiency fertilizer

#5 - Do you have the opportunity to improve?

- How much N are you removing?
- What the ratio of N removed from the system (in fruit or plant material) to the amount of N you apply?

#6 - What opportunities exist for innovation?
(i.e. what haven't we thought of yet?)

Questions? Thoughts? Concerns?