Does it pay to use nitrification and urease inhibitors?

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The situation:

- N prices are high
- Growers considering reducing N rates
- N losses a concern
- In the past, some growers applied extra N as insurance
- Which is a better and cheaper insurance policy in today's economic climate?
  - Nitrification & urease inhibitors
  - Extra N

Urease Inhibitors

Urea hydrolysis and N volatilization

N loss from urea

- Urease is ubiquitous in soil
  - Urea hydrolysis can be complete within 2-3 days
- Up to 20 % of N can be volatilized
  - If urea not incorporated
    - Mechanically *or*
    - With rain/irrigation (0.5 – 0.75”)
- Stopping urea hydrolysis until rainfall washes urea into soil will reduce N loss

Urease inhibitors - Agrotain

- Effective in reducing conversion of surface applied urea and UAN

Corn yield increase from NBPT with surface applied urea and UAN. Yield increase sig. ($P<0.01$)

Sites	Number of sites	Yield Increase	
		Urea	UAN
		------- bu/a -------	
All	78	4.3	1.6
N responsive	64	5.0	2.8
With sig. NH_4^+ loss	59	6.6	2.7

Hendrickson, 1992

Urease inhibitors - Agrotain

- Yield decreases also occur
- Consistent yield increases not expected every year/field
- Benefits likely occur 30 – 40 % of the time
  - Negative impacts 5-10 % of time

Decision to use Agrotain

- Knowing when significant losses of N are likely
  - Surface application of urea containing material
    - Dry conditions
    - High pH soils
- Cost-benefit

Cost-Benefit of Agrotain Example

- Used actual corn yield response data
  - Agrotain was not a treatment
  - High yield potential soil
  - Previous crop = soybean
  - Max yield achieved is 214 bu/a
  - Yield was maximized at 120 lb N/a
- Price of corn is $2.20/bu
- Agrotain application rate of 5 qt/T urea
  - 14 days of control
  - $50/gal Agrotain
- When Agrotain applied, no N loss
  - Yield the same as when no Agrotain and no N loss
    - Realistically may not occur in all fields

Cost-Benefit of Agrotain with Surface Applied Urea

	No N Loss	
N rate	Yield	Return
lb N/a	bu/a	$/a
If N costs $0.22/ lb N		
140	214	440.00
115	213	443.30
100	211	442.20
90	208	437.80
If N costs $0.38/ lb N		
140	214	417.60
115	213	424.90
100	211	426.20
90	208	423.40

Cost-Benefit of Agrotain with Surface Applied Urea

	No N Loss		— Assume 20 % N Loss —			
N rate	Yield	Return	N Loss	Yield	Return	Lost Return
lb N/a	bu/a	$/a	lb N/a	bu/a	$/a	$/a
If N costs $0.22/ lb N						
140	214	440.00	28	212	435.60	4.40
115	213	443.30	23	209	434.50	8.80
100	211	442.20	20	205	429.00	13.20
90	208	437.80	18	201	422.40	15.40
If N costs $0.38/ lb N						
140	214	417.60	28	212	413.20	4.40
115	213	424.90	23	209	416.10	8.80
100	211	426.20	20	205	413.00	13.20
90	208	423.40	18	201	408.00	15.40

Cost-Benefit of Agrotain with Surface Applied Urea

	No N Loss		— Assume 20 % N Loss —				With Agotain	
N rate	Yield	Return	N Loss	Yield	Return	Lost Return	Agrotain Cost	Return
lb N/a	bu/a	$/a	lb N/a	bu/a	$/a	$/a	$/a	$/a
If N costs $0.22/ lb N								
140	214	440.00	28	212	435.60	4.40	9.51	430.49
115	213	443.30	23	209	434.50	8.80	7.81	435.49
100	211	442.20	20	205	429.00	13.20	6.79	435.41
90	208	437.80	18	201	422.40	15.40	6.11	431.69
If N costs $0.38/ lb N								
140	214	417.60	28	212	413.20	4.40	9.51	408.09
115	213	424.90	23	209	416.10	8.80	7.81	417.09
100	211	426.20	20	205	413.00	13.20	6.79	419.41
90	208	423.40	18	201	408.00	15.40	6.11	417.29

Nitrification Inhibitors

Nitrification

- Can occur in 2 – 3 weeks in most soils
  - Temperature > 50 °F
  - Soil pH > 5.5
  - Soil is aerated (not waterlogged)
- Nitrate loss
  - Leaching
  - Denitrification

Denitrification

- Maximized in soils when:
  - Temperature > 60 °F
  - pH near 7.0
  - Large concentration of nitrate
  - Carbon compound is available
- Up to 100 lb N/a can be lost in 5 days
  - Conditions need to be favorable
  - In cold soils (40 °F) with low pH (near 5.0), denitrification is slower

Nitrification Inhibitors

- Interfere with nitrification process
  - Kill or impede metabolism of *Nitrosomonas*
- Advantage
  - Maintains N in NH_4^+ form
    - Held by CEC
    - Less likely to be lost
- Effective for 3 to 6 weeks depending on environmental conditions

Nitrification Inhibitors

- Fall N applications
  - Hold N in NH_4^+ form until it is < 40 °F and denitrification potential is reduced
- Spring preplant applications
  - Hold N in NH_4^+ form when crop demand is low and denitrification potential is high
- Highest probability of yield increase with nitrification inhibitors
  - Sandy soils
  - Poorly drained fine-textured soils

Sandy soils and NServe

Four year average effect of N timing and use of N Serve on corn yield at Hancock (Wolkowski, 1995)

N Timing†	NServe	Yield	Income	N Cost	NServe Cost	Return‡
		bu/a	$/a	$/a	$/a	$/a
PP	No	116	255.20	47.60		207.6
SD	No	134	294.80	47.60		247.2
PP	Yes	121	266.20	47.60	8	210.6
SD	Yes	134	294.80	47.60	8	239.2

† 140 lb N/a was applied spring preplant (PP) or sidedressed (SD). NServe was applied at a rate of 2 pt/a.

‡ Calculations were based on $2.20/bu corn, $0.34/lb N, and $32/gal of NServe.

Impact on N application timing and use of NServe on corn yield, seven year average on a poorly drained Mollisol in Waseca, MN (Randall et al., 2003)

N Timing†	NServe‡	Yield	Income*	N Cost	NServe Cost	Return
		bu/a	$/a	$/a	$/a	$/a
Fall	No	131	288.2	45.90		242.3
Fall	Yes	139	305.8	45.90	8	251.9
Spring	No	139	305.8	45.90		259.9
Split	No	145	319	45.90		273.1
LSD (0.01)		4				

† 135 lb N/a was applied as anhydrous ammonia in all treatments. Split application had 40% of the N applied in the spring and 60% sidedressed at V8.

‡ NServe was applied at a rate of 2 pt/a.

* Calculations were based on $2.20/bu corn, $0.34/lb N, and $32/gal of NServe.

Effect of time and rate of N application and NServe on corn yield in Illinois (Hoeft, 1984).

N rate	NServe	Yield	N cost	NServe cost	Return†
		Fall Appl.			Fall Appl.
lb N/a		bu/a	$/a	$/a	$/a
0		66	0		144.86
100	No	100	34		185.47
100	Yes	124	34	8	230.13
150	No	124	51		221.13
150	Yes	154	51	8	278.98
200	No	142	68		243.63
200	Yes	158	68	8	270.76

† Calculations were based on $2.20/bu corn, $0.34/lb N, and $32/gal of NServe.

Effect of time and rate of N application and NServe on corn yield in Illinois (Hoeft, 1984).

N rate	NServe	Yield	N cost	NServe cost	Return†
		Spring Appl.			Spring Appl.
lb N/a		bu/a	$/a	$/a	$/a
0			0		
100	No	144	34		282.04
100	Yes	134	34	8	252.10
150	No	161	51		302.34
150	Yes	159	51	8	289.93
200	No	173	68		311.66
200	Yes	172	68	8	301.49

† Calculations were based on $2.20/bu corn, $0.34/lb N, and $32/gal of NServe.

Effect of time and rate of N application and NServe on corn yield in Illinois (Hoeft, 1984).

N rate	NServe	Yield		N cost	NServe cost	Return†	
		Fall Appl.	Spring Appl.			Fall Appl.	Spring Appl.
lb N/a		bu/a	bu/a	$/a	$/a	$/a	$/a
0		66		0		144.86	
100	No	100	144	34		185.47	282.04
100	Yes	124	134	34	8	230.13	252.10
150	No	124	161	51		221.13	302.34
150	Yes	154	159	51	8	278.98	289.93
200	No	142	173	68		243.63	311.66
200	Yes	158	172	68	8	270.76	301.49

† Calculations were based on $2.20/bu corn, $0.34/lb N, and $32/gal of NServe.

Summary

- Both urease and nitrification inhibitors are tools to manage N loss
  - Profitable in today's economic climate
- Insure greatest probability of economic return
  - Know if environmental or management practices increase risk of N loss
- If N rates are reduced because of high fertilizer prices, inhibitors may be insurance against yield loss