

# **Effective Additives for Improving Fertilizer Use Efficiency**

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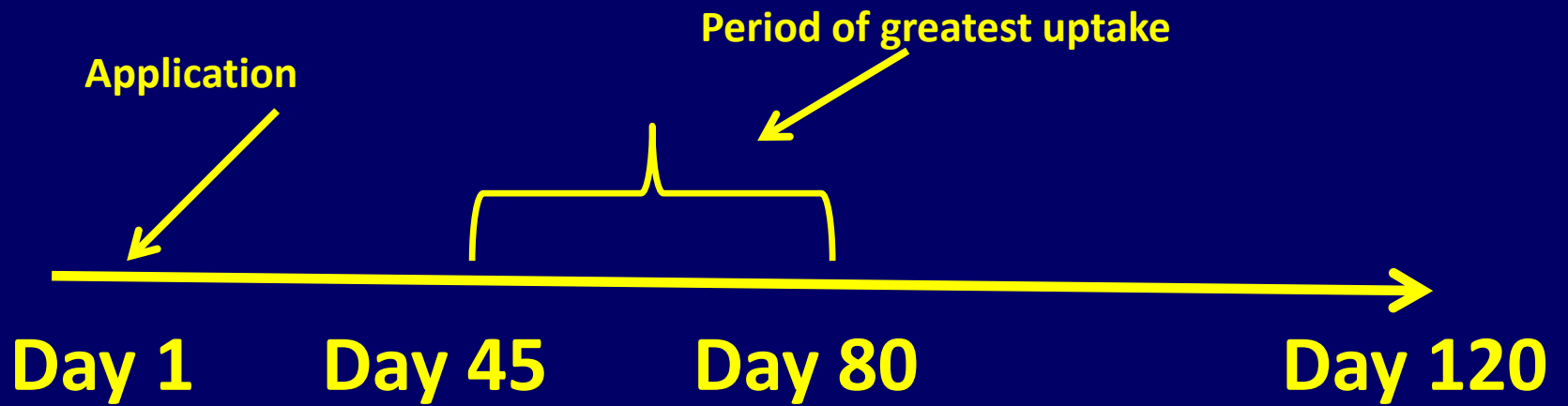
# **Three main avenues for N loss**

**Ammonia volatilization from urea**

**Nitrification**

**Denitrification**

# Corn N timeline



**-Nitrification inhibitors**

**-Urease inhibitor additives**

**-Nitrification and urease inhibitor**

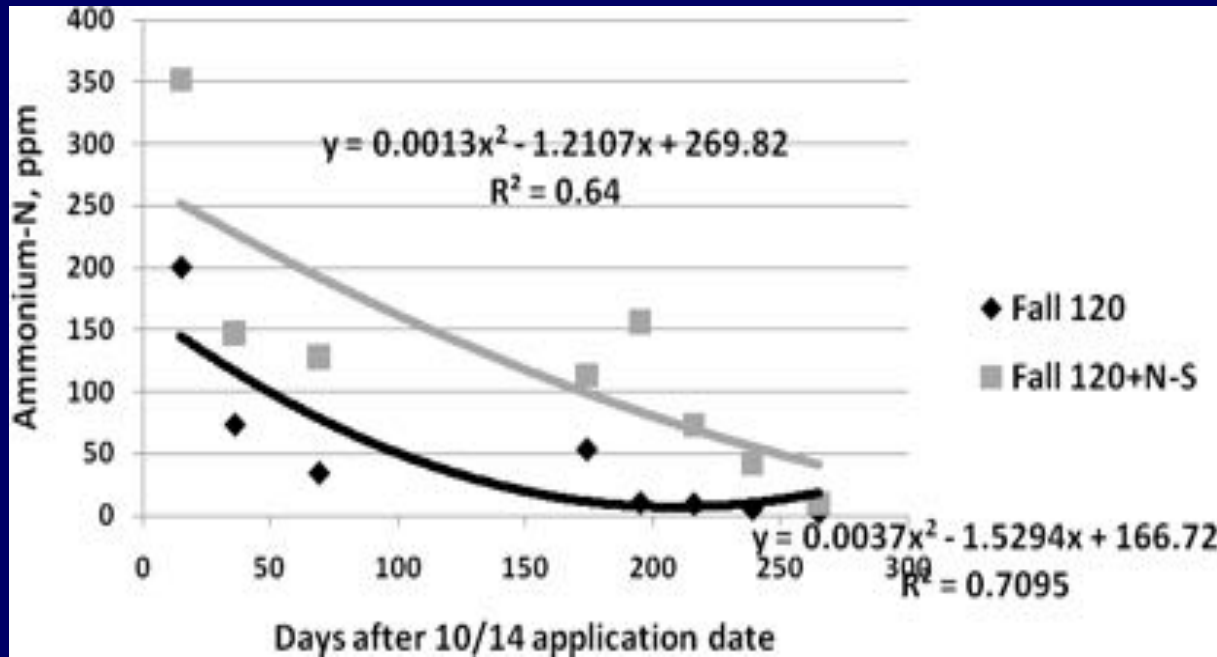
## **Nitrification inhibitors-**

**N-Serve<sup>®</sup> /Instinct<sup>®</sup>**

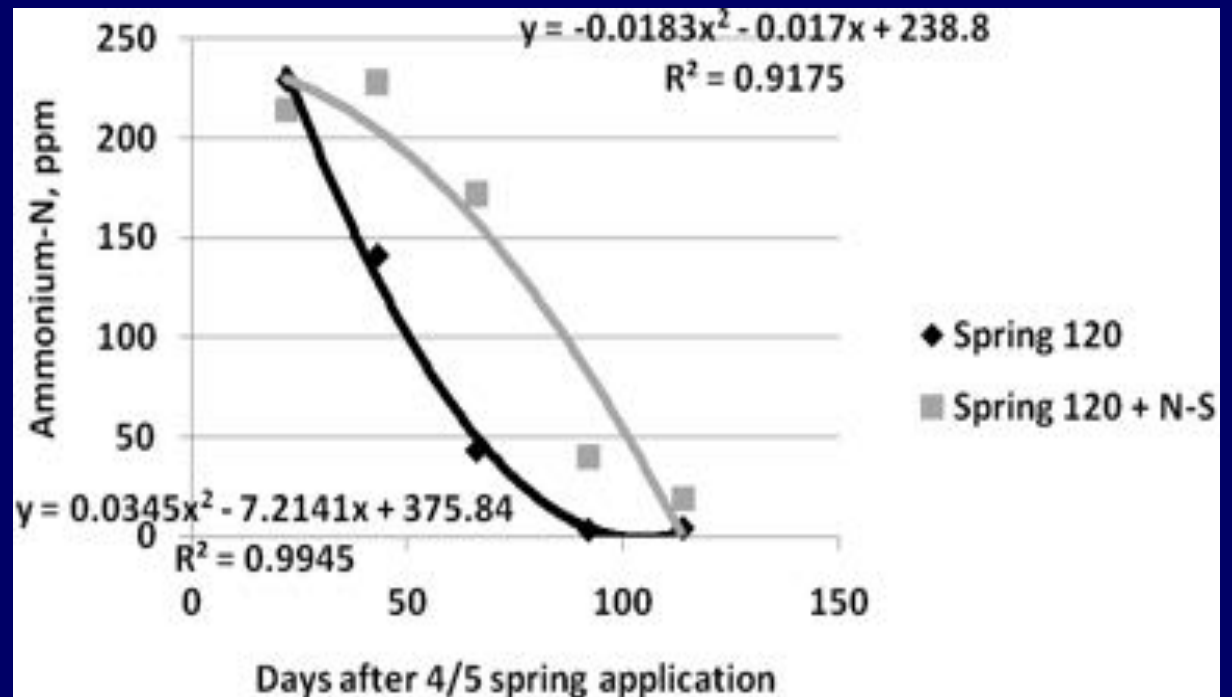
**nitrapyrin (2-chloro-6-[trichloromethyl] pyridine)**

**DCD, dicyandiamide**

Fall N, Touchton et al., 1978



Spring N, Touchton et al., 1978



**Some studies showed a yield increase with N-Serve, while others showed no yield increase. Yield increases were more a result of weather between application and N uptake rather than performance of the product.**

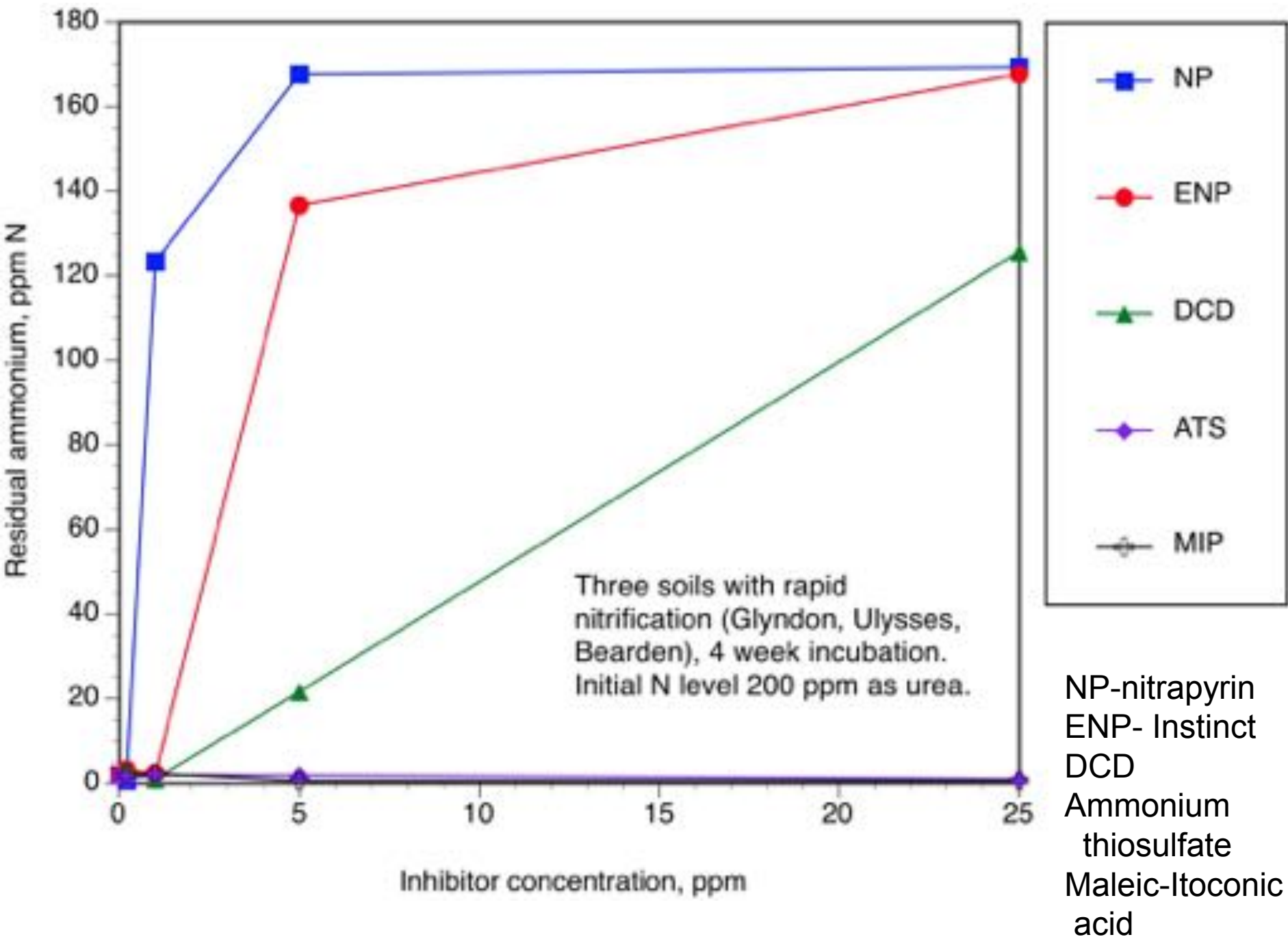
**Yield increases over the seven years in Minnesota were 15 bushels per acre more for fall anhydrous ammonia + N-Serve over fall anhydrous ammonia alone, and 27 bushels per acre more for spring anhydrous ammonia compared to fall anhydrous ammonia (Randall et al., 2008).**

**Instinct<sup>®</sup> is a new formulation of nitrapyrin that can be mixed with ammonium fertilizers and can stay on the soil surface without incorporation.**

**Research at several Universities has found a very low frequency of yield benefits to its use, although the product inhibits nitrification.**

**(Kentucky, Schwab, unpublished data)**





# **DCD- a nitrification inhibitor (dicyandiamide)**

## **Found in**

**AgrotainPlus (Agrotain, Int.) (10 lb DCD per ton U)**

**SuperU (Agrotain, Int.)**

**Guardian DF (Conklin)**

**Guardian DL (Conklin) (2% solution, roughly)**

	DCD		
	No. of comparisons		
	Total	With significant advantage	Average response
			%
<b>Timing</b>			
Fall	4	1	+1.6
Spring	15	3	+3.4
Sidedress	3	1	+1.4
<b>N Source</b>			
Ammonium sulfate	2	0	-1.0
Anhydrous ammonia	6	1	+3.6
Urea	4	4	+2.2

From Malzer et al., 1989

**Yield increases in potato with DCD  
were more consistently achieved  
with potato in the Malzer survey.**

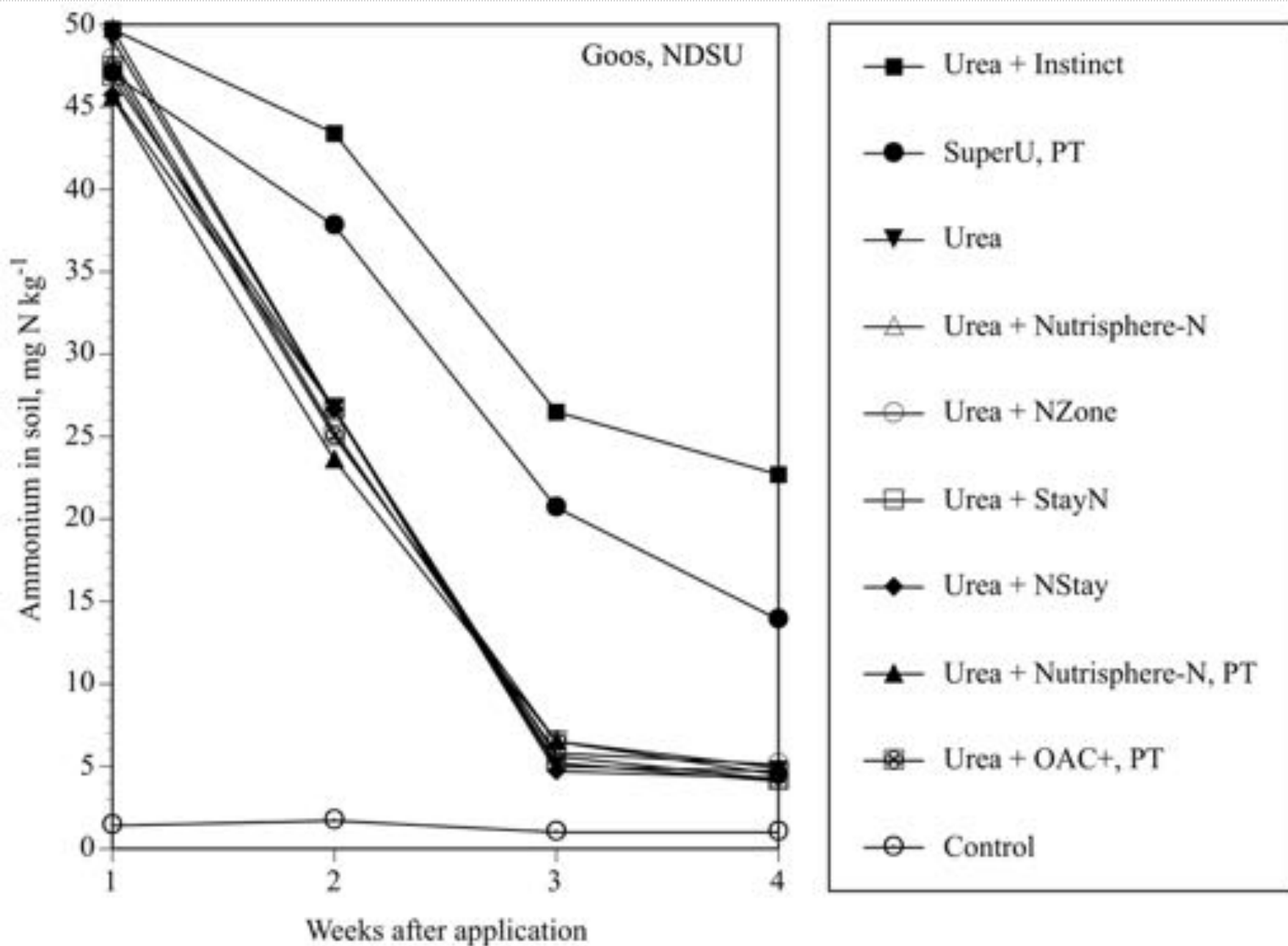
**Trace amounts of DCD have recently been found in dry milk from some New Zealand farms.**

**The fallout from this paper is still on-going.**

**Is the amount a problem?**

**Is there a way to prevent contamination?**

**What are the alternatives to DCD to avoid future contamination and still limit N contamination of ground/surface water?**



- Goos, unpublished

**Use of a nitrification inhibitor does not stop nitrification.**

**Use of a nitrification inhibitor tends to slow down the process, never eliminates it.**

**Use of Best Management Practices of timing is essential, with a nitrification inhibitor used to help with unanticipated weather/soil wetness conditions.**

# **UREASE Inhibitors**

**NBPT (N-(n-butyl) thiophosphoric acid triamide)**

**Agrotain and private label NBPT's**

**Competes for active sites on the urease enzyme and ties up activity for about 10 days, depending on weather conditions.**



# Limus<sup>®</sup>

## Nitrogen Management

A nitrogen management product that is applied to granular urea fertilizer to minimize nitrogen losses by reducing ammonia volatilization

### CONTAINS NONPLANT FOOD INGREDIENTS

#### Active Ingredient:

16.88%	.....	N-(n-butyl) thiophosphoric triamide (NBPT) (CAS No: 94317-64-3)
5.63%	.....	N-(n-propyl) thiophosphoric triamide (NPTT) (CAS No: 915609-14-8)
77.49%	.....	<b>Total Other Inert Ingredients:</b> (solvent, colorant, fragrance)
100.00%	.....	<b>Total</b>

Density = 9.055 pounds per gallon (1.065 grams per cubic centimeters) at 68° F

GHS Signal Word: **DANGER**  
**FOR PROFESSIONAL USE ONLY**  
Keep Out of Reach of Children

**Net Contents: 2.5 Gallons (9.46 Liters)**      91560919 10/11/2014 05:00:00 Product of Switzerland

BASF Corporation  
20 Davis Drive  
Research Triangle Park, NC 27709



**Directions for Use**

Limus is suitable for use with all crops. This product is recommended for surface application of granular urea and can be used on any fertilizer banding system it is not recommended as a fertilizer substitute and is not recommended for soil application. (See label for toxic to freshwater shell organisms)

**Application Instructions**

1. Wear proper personal protection including eye protection and chemical resistant gloves.
2. Use only under adequate ventilation with high volume of air movement if conditions in buildings, machinery, premises is required.
3. Weigh the urea and transfer into the mixing or blending equipment.
4. Measure the desired quantity of Limus.
5. Apply the product to the urea in the blender. Blend with enough urea to uniformly distribute. Stop after 5 minutes intervals only after uniform blend coverage is achieved.
6. Under conditions of high temperature and high humidity, particles may become sticky. Addition of other fertilizer materials, such as pellet or the dry carriers, may reduce sticking.

**Application Rate**  
3 quarts of Limus per 1,000 pounds of urea or 2.5 lbs per acre 907 kilograms of urea

**Storage and Disposal**

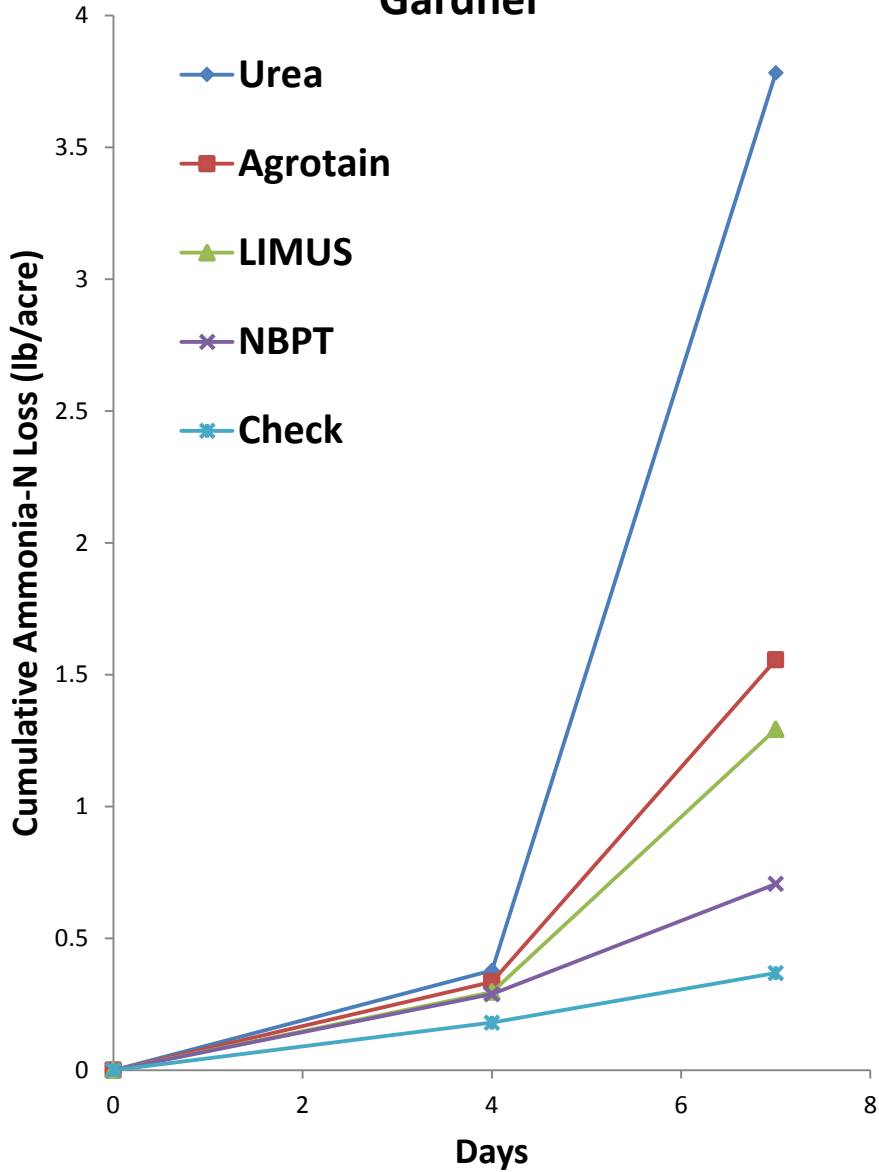
Prevent access to hot concentrated acid, heat, or water. Do not allow the acid contact drains, surface water, or groundwater.  
Product and Container Disposal: Dispose of container and unused contents in accordance with federal, state, and local provisions for hazardous waste.

# Yield for side-dressed no-till corn in Hardin County, KY. (From Schwab and Murdock, 2009)

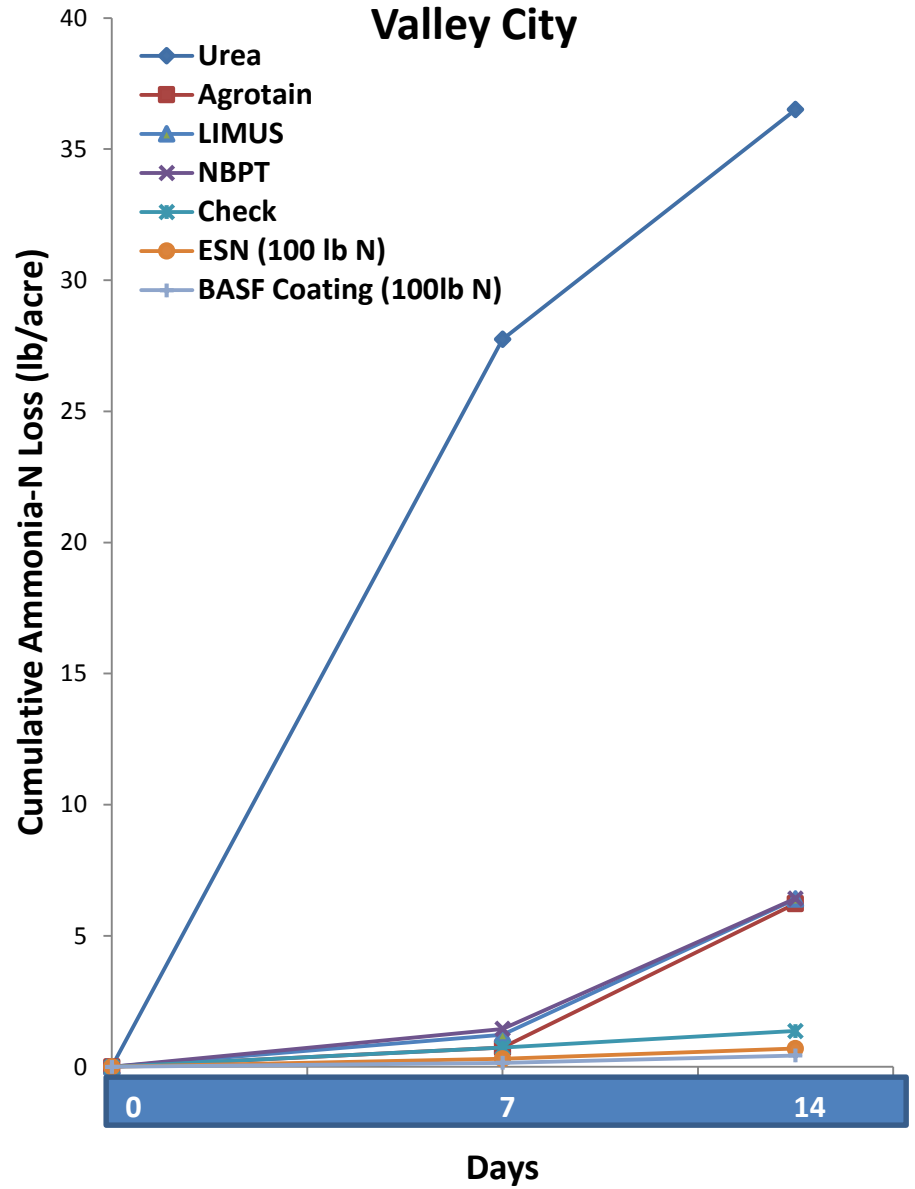
Treatment	Yield, bushels per acre
Check (50 lb N/acre preplant N only)	117d*
Urea	158c
Urea + Agrotain	201b
SuperU	201b
UAN	150c
UAN + Agrotain	179bc
UAN + Agrotain Plus	175bc
Ammonium nitrate	239a



### Gardner



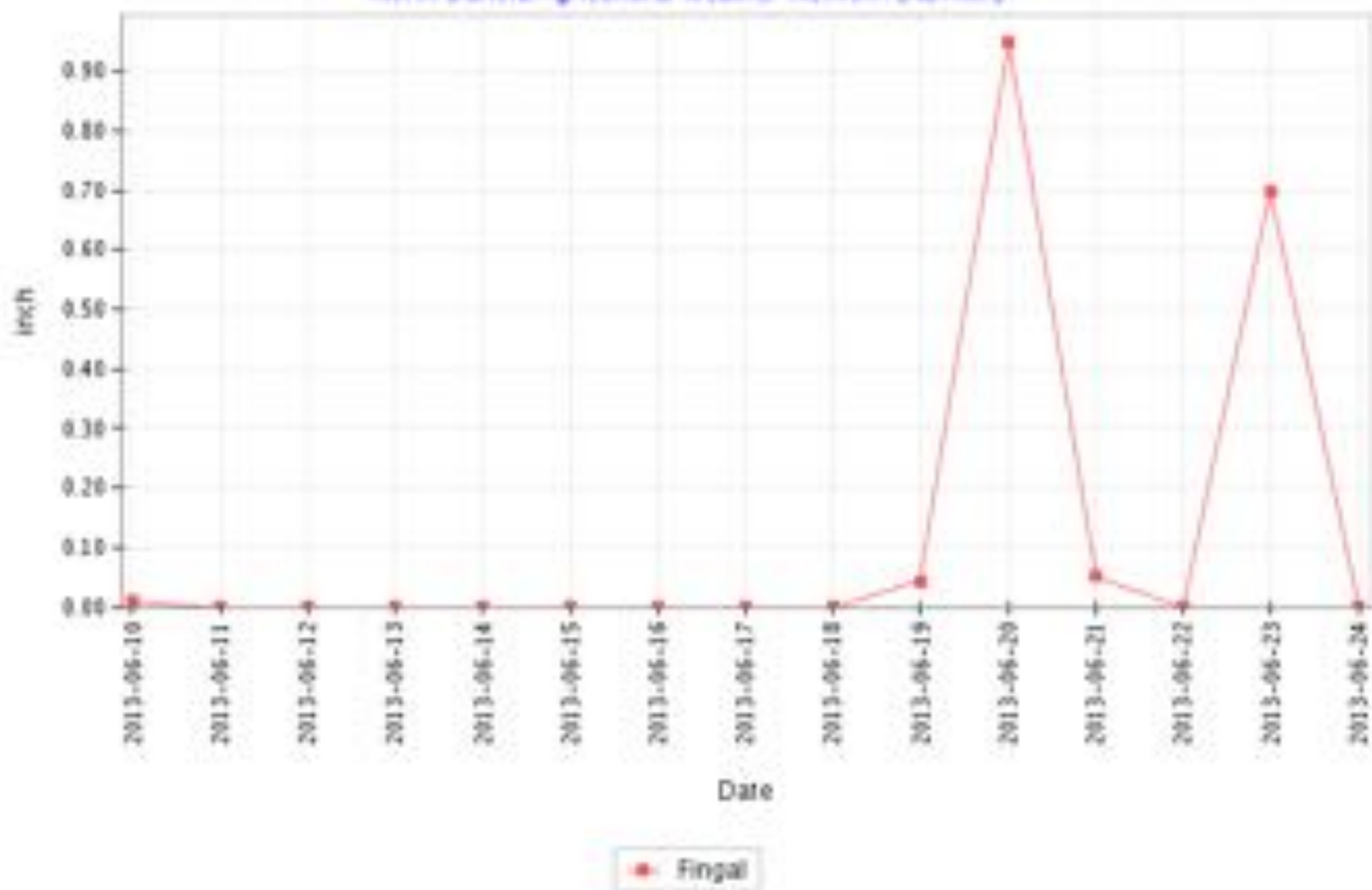
### Valley City



# Total Rainfall

(2013-06-10 - 2013-06-24)

North Dakota Agricultural Weather Network (NDAWN)



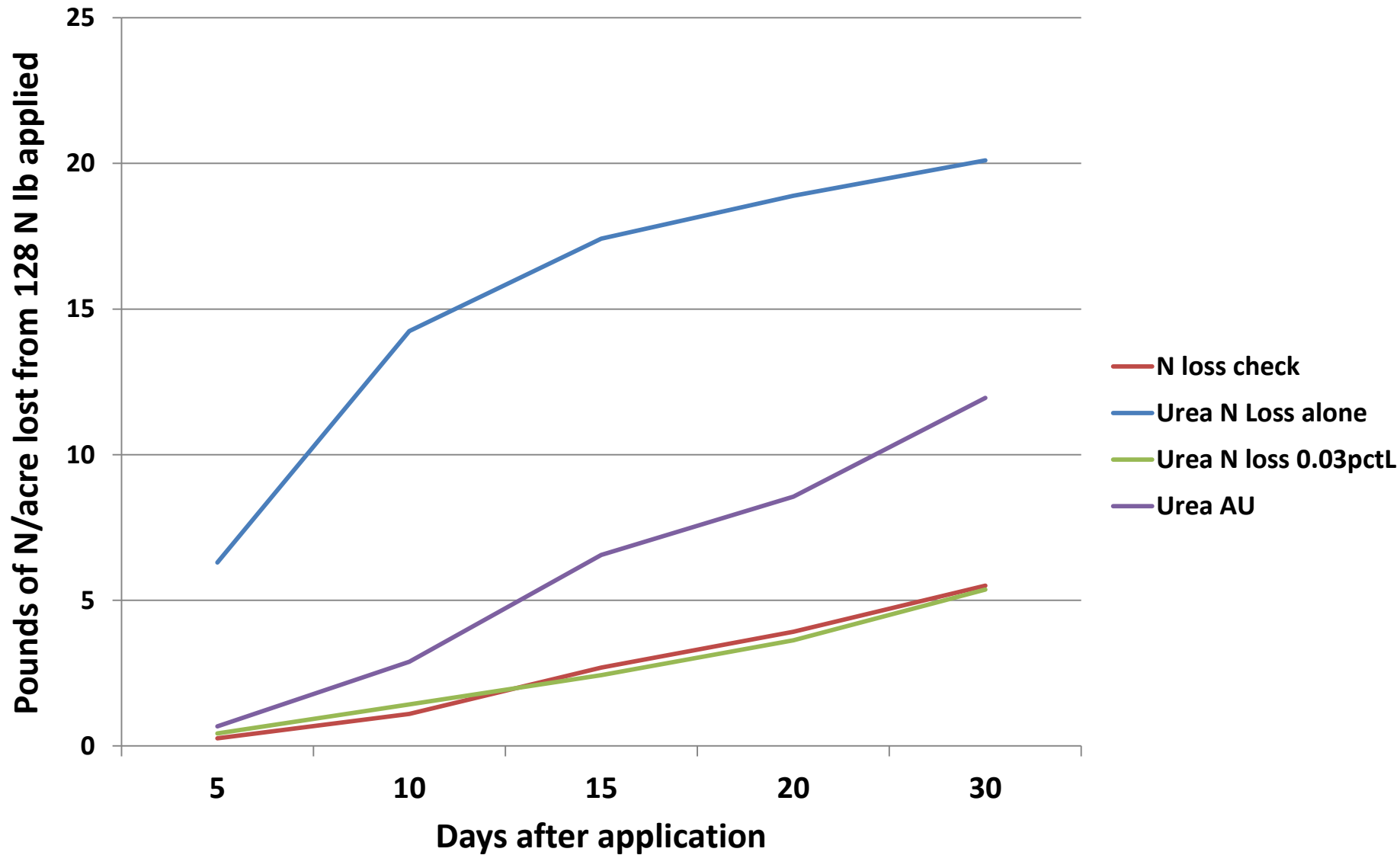
# Gardner spring wheat inhibitor study, 2013

Treatment	Yield, bushels/acre	Protein, per cent
Check	52.9 d	10.7 a
<b>50 lb N, urea</b>	<b>69.7 ab</b>	<b>11.4 ab</b>
<b>50 lb N, urea/LIMUS</b>	<b>61.5 bcd</b>	<b>11.2 ab</b>
<b>50 lb N, urea/Agrotain</b>	<b>66.0 abc</b>	<b>11.4 ab</b>
100 lb N, urea	73.8 a	12.8 b
100 lb N, urea/LIMUS	72.6 a	13.0 b
100 lb N, urea/Agrotain	70.8 a	12.6 b
<b>200 lb N, urea</b>	<b>73.2 a</b>	<b>14.4 c</b>
<b>200 lb N, urea/LIMUS</b>	<b>71.6 a</b>	<b>14.4 c</b>
<b>200 lb N, urea/Agrotain</b>	<b>72.7 a</b>	<b>14.4 c</b>
<b>200 lb N, urea/NBPT</b>	<b>73.4 a</b>	<b>14.2 c</b>
100 lb N, ESN	53.9 cd	11.6 ab
100 lb N, BASF Exp coating	58.4 cd	11.5 ab

# Valley City spring wheat inhibitor study, 2013

Treatment	Yield, bushels/acre	Protein, per cent
Check	37.9 a	13.5 ab
<b>50 lb N, urea</b>	<b>50.3 b</b>	<b>14.1 b</b>
<b>50 lb N, urea/LIMUS</b>	<b>47.4 b</b>	<b>13.9 ab</b>
<b>50 lb N, urea/Agrotain</b>	<b>38.4 a</b>	<b>14.4 b</b>
100 lb N, urea	51.7 b	15.6 c
100 lb N, urea/LIMUS	51.2 b	15.1 c
100 lb N, urea/Agrotain	58.3 c	15.4 c
<b>200 lb N, urea</b>	<b>51.7 b</b>	<b>16.3 d</b>
<b>200 lb N, urea/LIMUS</b>	<b>52.1 b</b>	<b>16.5 d</b>
<b>200 lb N, urea/Agrotain</b>	<b>56.6 bc</b>	<b>16.2 d</b>
<b>200 lb N, urea/NBPT</b>	<b>52.4 b</b>	<b>16.3 d</b>
100 lb N, ESN	50.5 c	14.3 b
100 lb N, BASF Exp coating	38.9 a	13.0 a

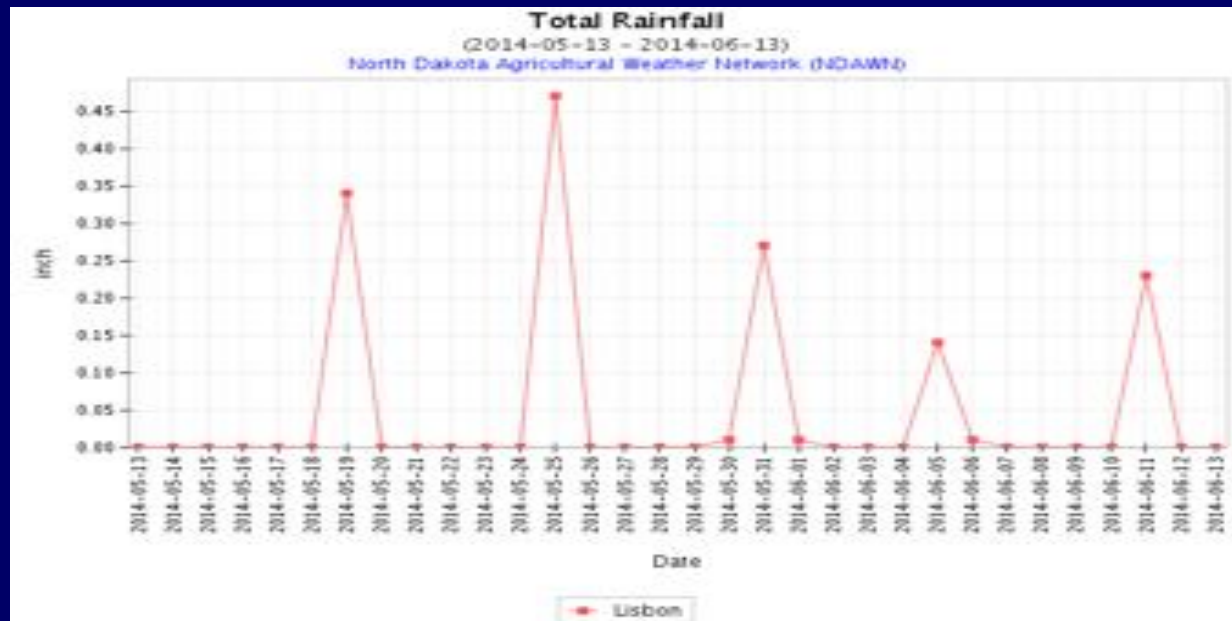
# N losses in field covered cylinder experiments with labeled Limus rate on urea compared to urea alone, no-till Winter Wheat, 2014, NDSU



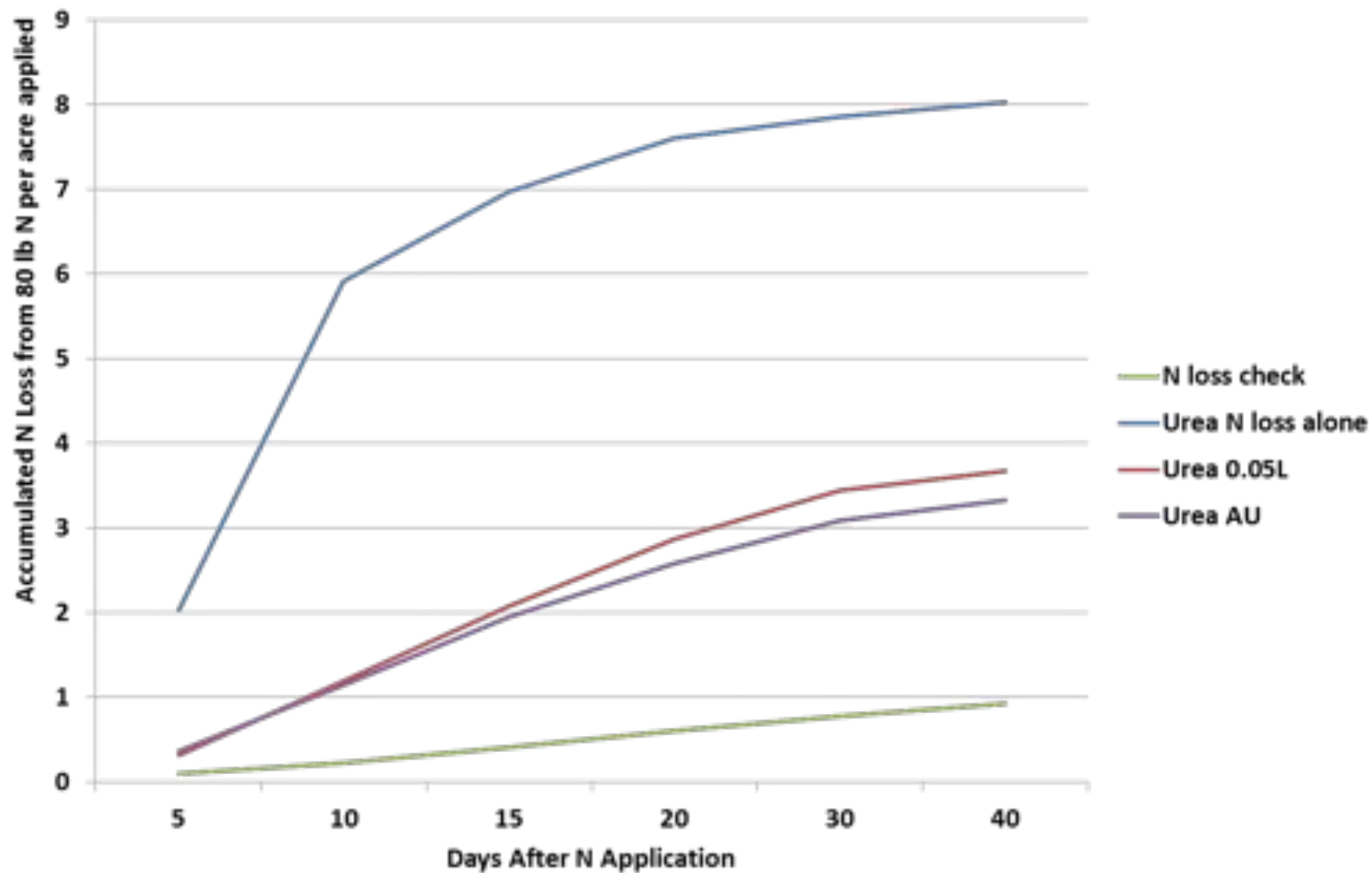


# Yield/Protein winter wheat, Lisbon, 2014

Treatment	Yield, bu/acre	Protein, percent
Check	38 a	9.9 a
128 lb N Urea	66 b	11.2 b
128 lb N 3% Limus	65 b	11.4 b
128 lb N AgtnUltra	69 b	11.9 b

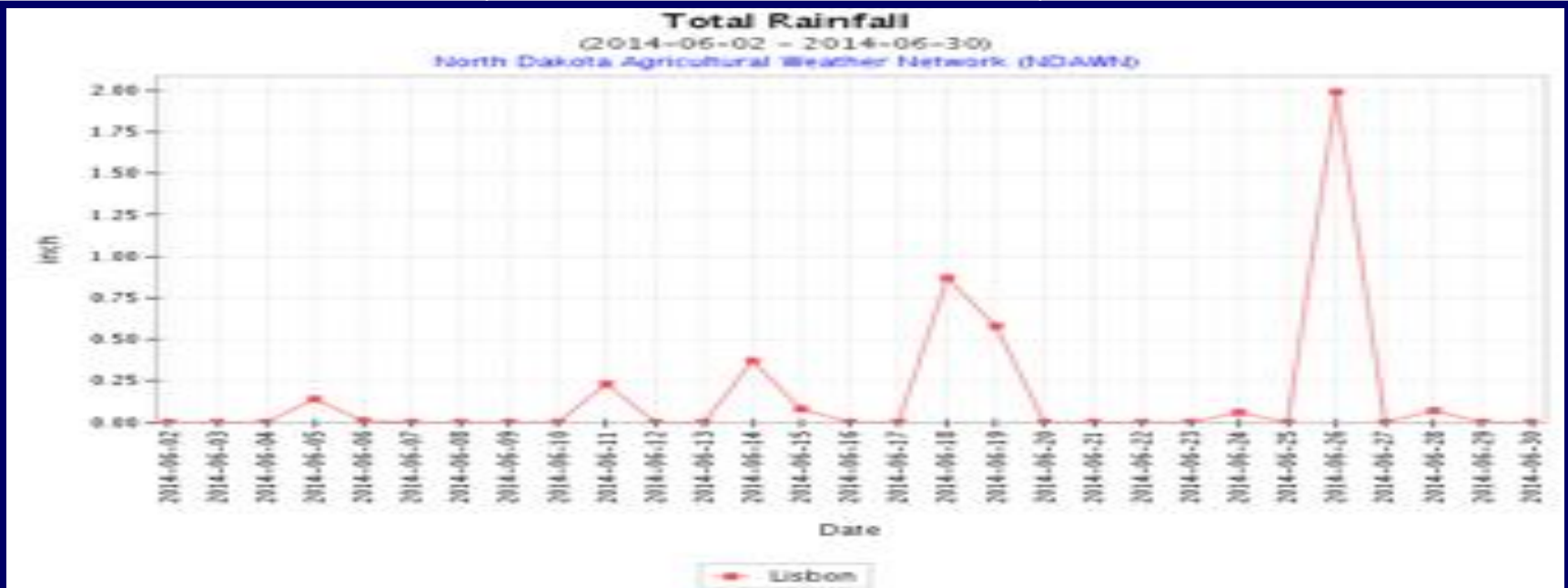


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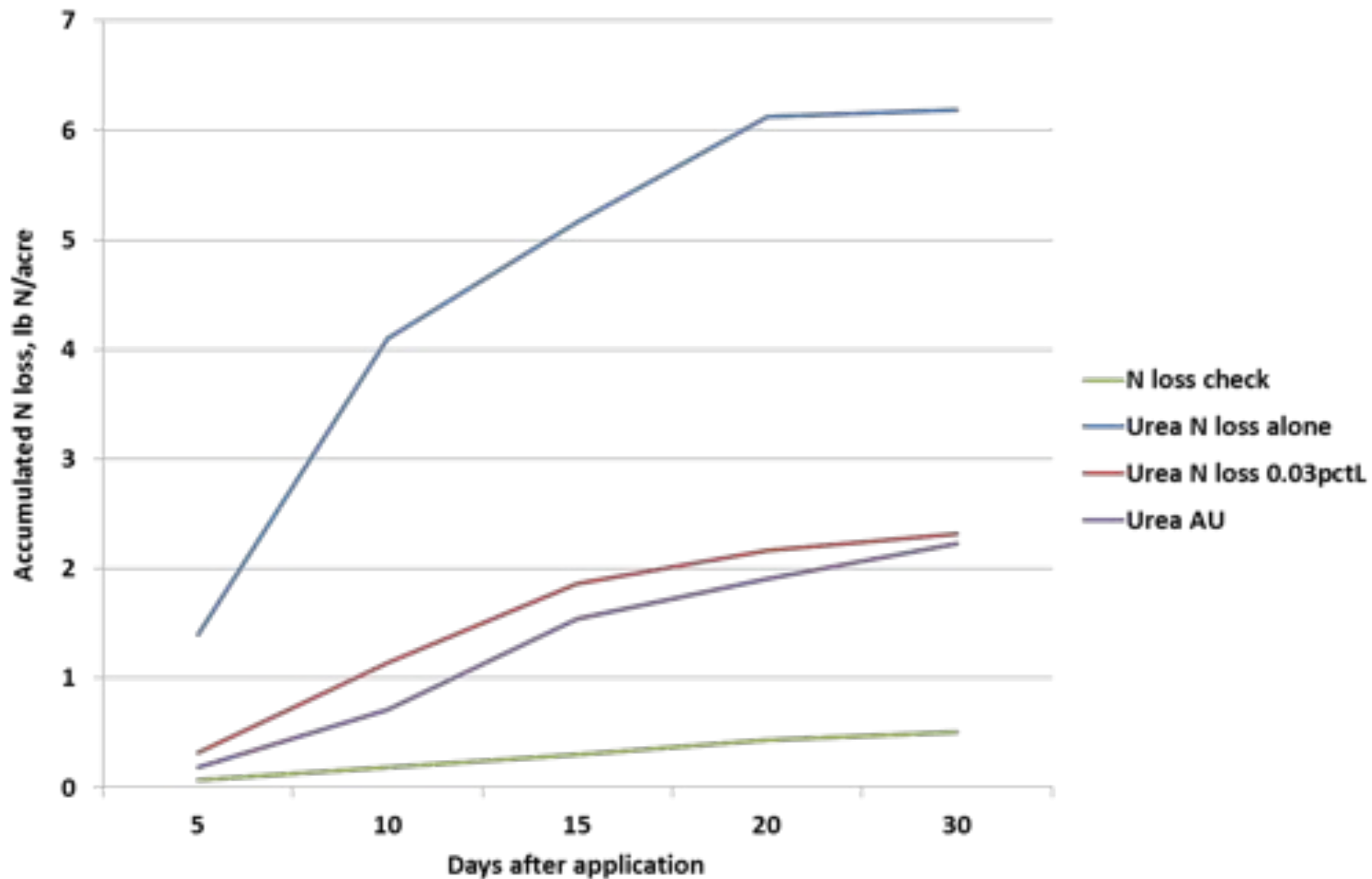


# Yield/Protein Spring Wheat, Lisbon, 2014

Treatment	Yield, bu/acre	Protein, percent
Check	52 a	10.6 a
80 N Urea	79 b	10.9 ab
80 N Urea 3% Limus	80 b	11.5 b
80 N Urea AgrtnUltra	79 b	11.5 b



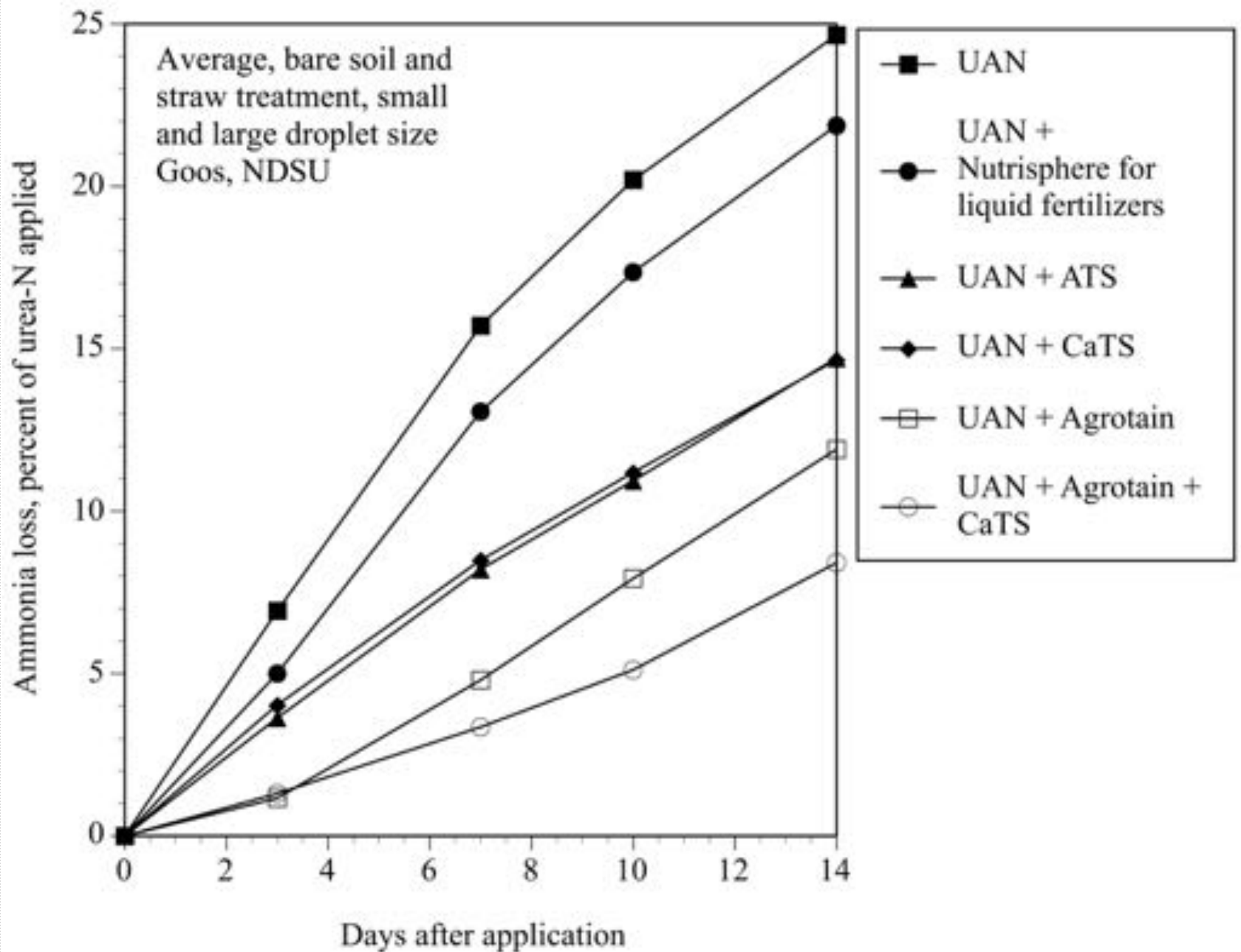
### 2014 Corn Limus work, no-till, Lisbon, ND



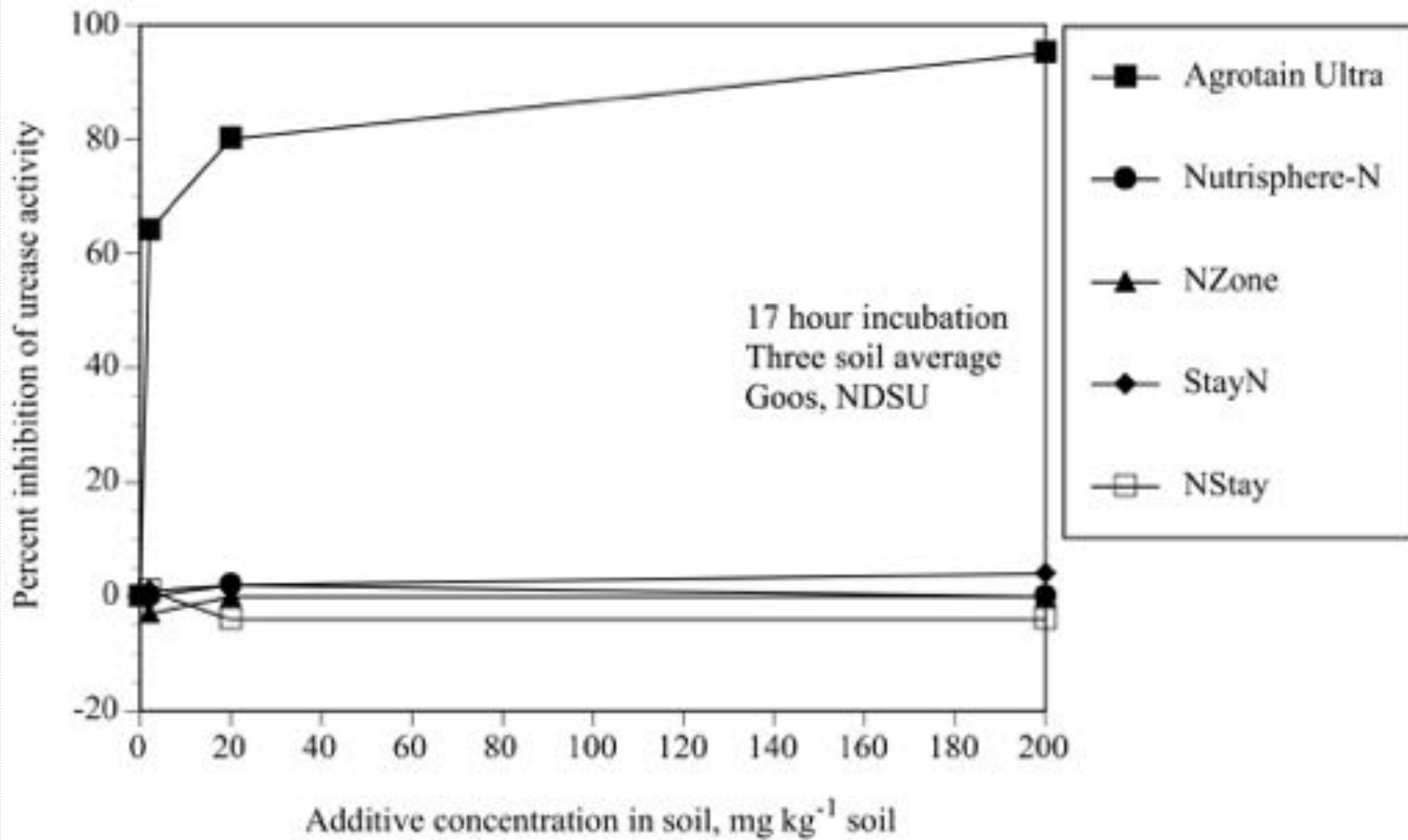
# Yield/Moisture Corn Lisbon, 2014

Treatment	Yield, bu/acre	Moisture, percent
Check	141 a	23.6 a
80 N Urea	163 b	23.6 a
80 N 3% Limus	177 b	22.8 a
80 N AgrtnUltra	175 b	22.3 a





- Goos



- Goos, unpublished

## **SUMMARY-**

**Nitrapyrin and DCD are proven nitrification inhibitors. Their use is limited due to the inability to predict when they would be economically beneficial.**

**Growers should not use these products to push their timing and spread work loads, rather use them to improve overall N use efficiency**



## **SUMMARY-**

**Agrotain is a proven urease inhibitor. Its use is becoming increasingly more common in no-till systems that still rely on surface application of urea.**

**Limus is a newly introduced, well-researched urease inhibitor that is at least as effective as NBPT.**

## **SUMMARY-**

**Ammonium thiosulfate is a limited use nitrification and urease inhibitor due to the rate of mineralization of the fertilizer.**

**It may be of some value if used at the correct rate, but other products are more consistent in their activity.**

## **SUMMARY-**

**Nutrisphere has no nitrification or urease inhibition properties and should not be used for these purposes.**

**The mode of action of maleic itoconic acid was investigated and the research found that the mode of action claimed is unjustified.**

## **SUMMARY-**

**N-Zone has no nitrification properties and is not labeled as a urease inhibitor.**

**N-Stay and Stay-N were both tested as urease inhibitors and as nitrification inhibitors.**

**The results of careful laboratory experiments did not support their use for these purposes.**

# **Phosphate additives??**

**There are no effective P fertilizer additives on the market today.**

**Product(s) that claim to be P fertilizer availability/efficiency enhancers are either ineffective or unproven.**

**See Degryse et al., 2013- Sequestration of phosphorus binding cations by complexing compounds is not a viable mechanism to increase phosphorus efficiency.  
Soil Science Society of America Journal**