

Overview of the Principles of Nitrogen Management and Sources on Crop Production

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**More Nitrogen is used in regional crops
than any other nutrient**

**Microbial transformations of ammonia
fertilizers set us up for loss**

Ammonia volatility through urease

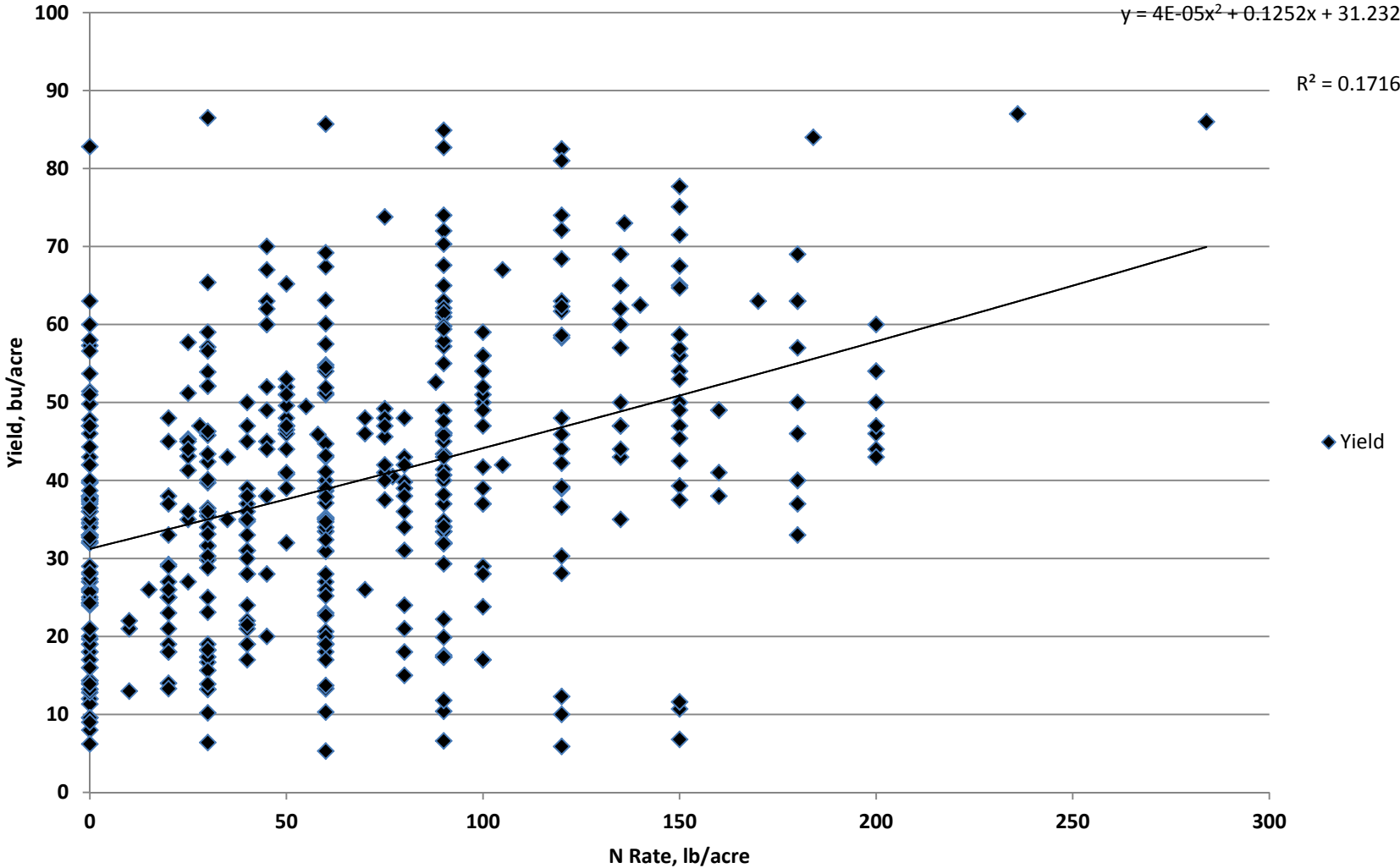
Nitrate loss after nitrification through leaching

**Nitrous oxide loss after nitrification and
denitrification**

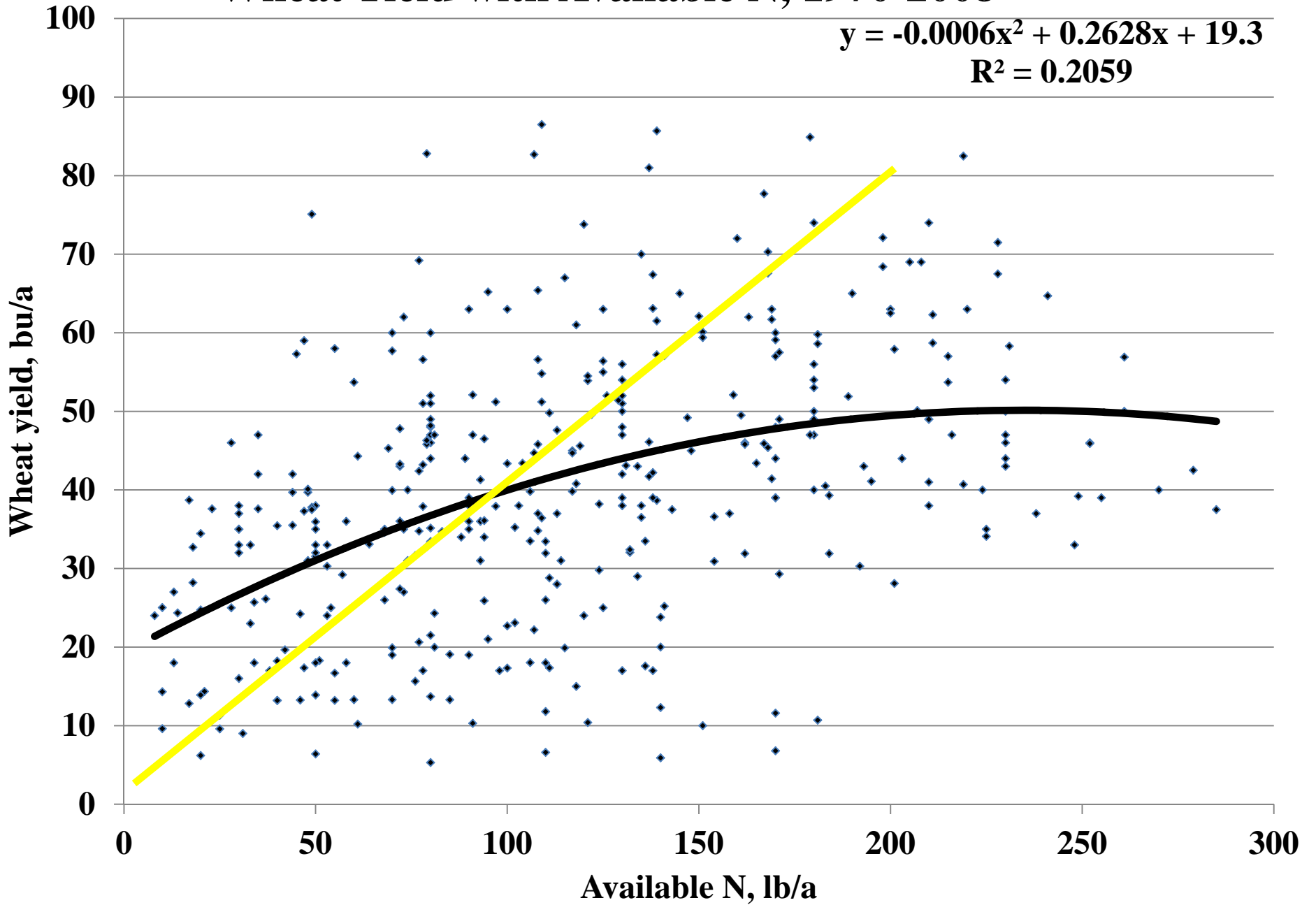
Nitrogen use efficiency-

**Worldwide about 33% NUE
(Raun and Johnson, 1999)**

Yield with N Rate Only- Soil Test N and Previous Crop Not Considered



Wheat Yield with Available N, 1970-2008

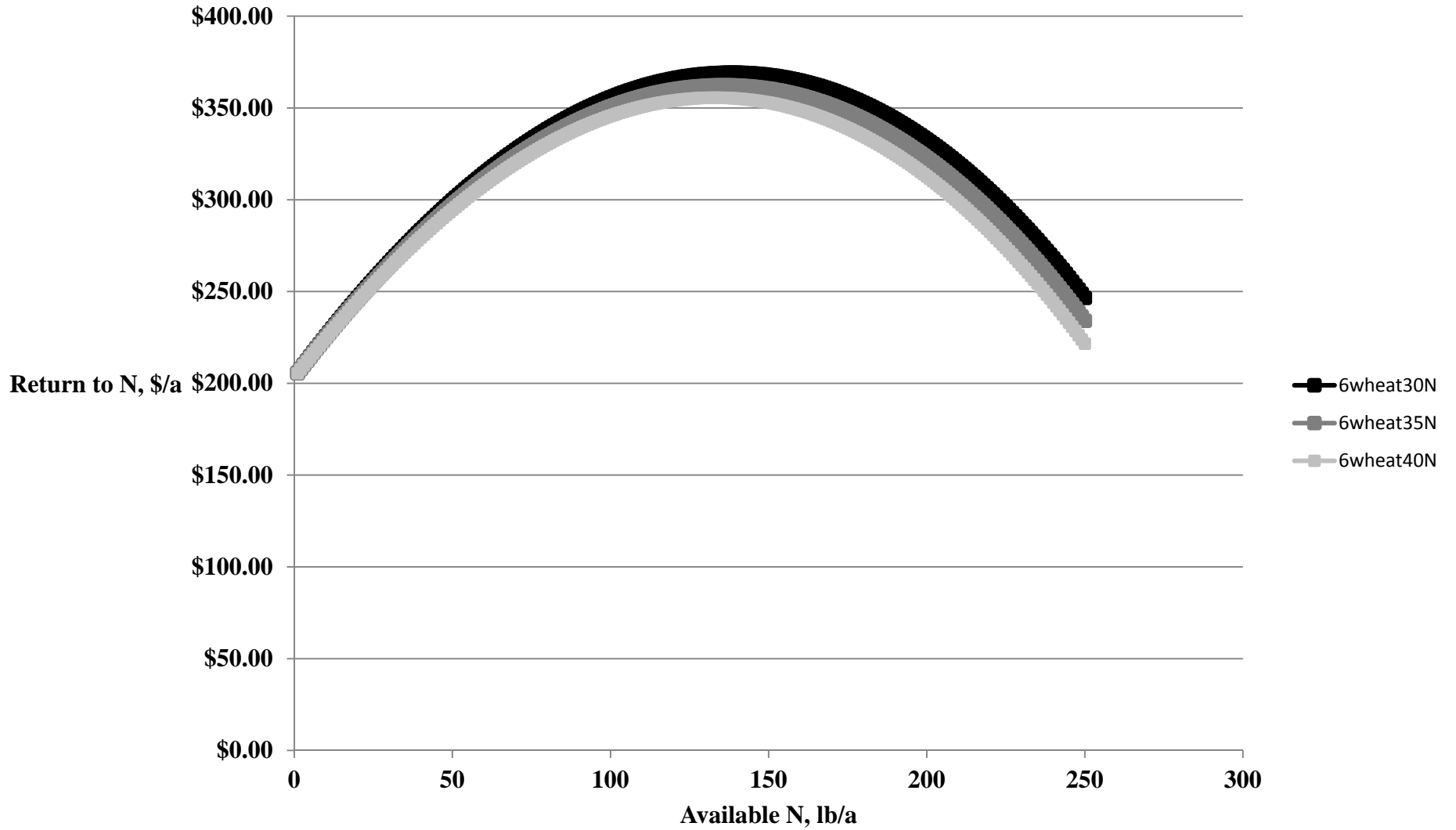


The “Return to N” model-

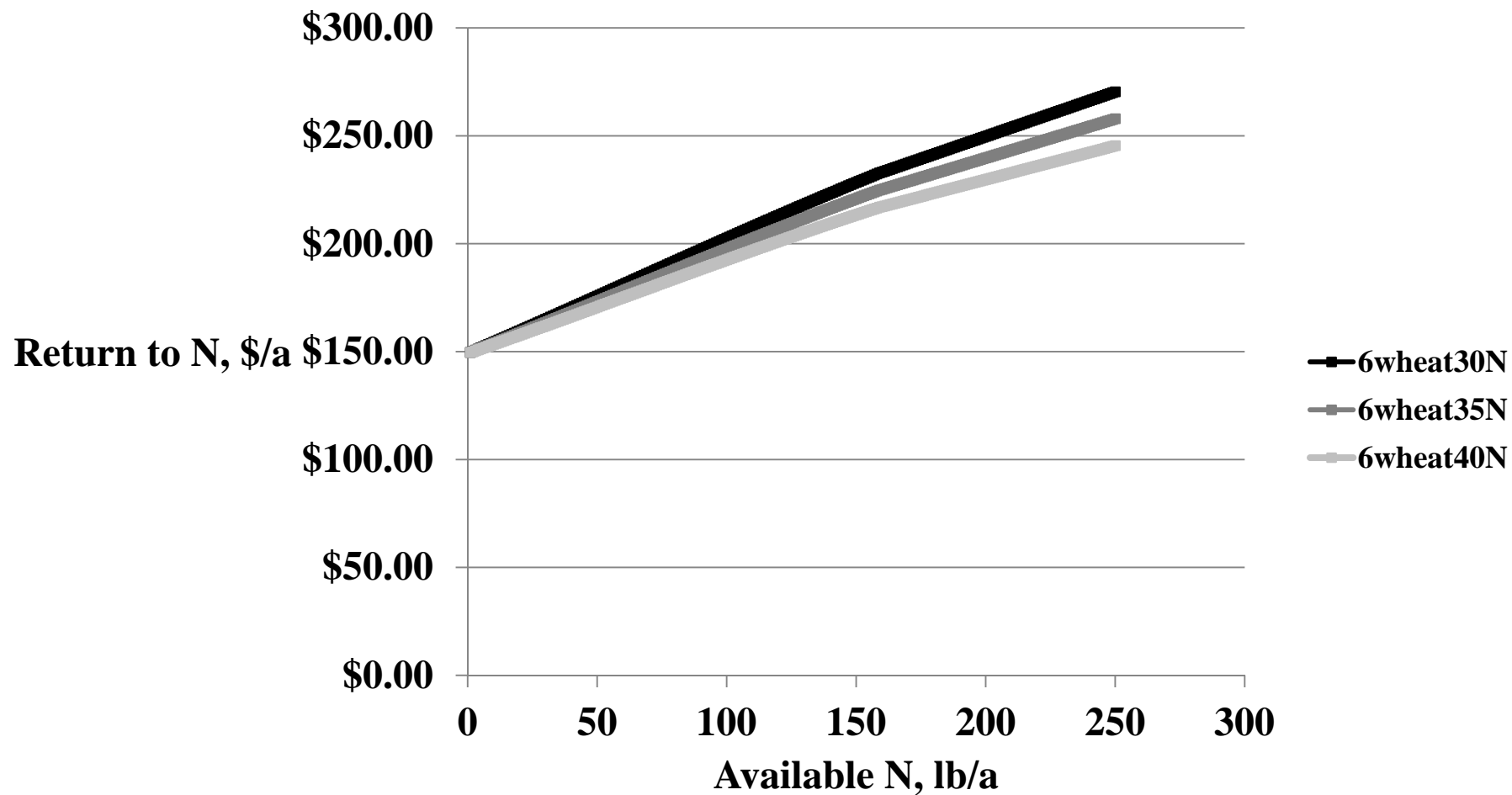
**Developed by John Sawyer, Iowa State
and Emerson Nafziger, Illinois
(2005, Proc. Ext-Ind Soil Fert. Conf.)**

**This model is used in several corn-belt
states, including
Iowa, Illinois, Wisconsin, Minnesota,
Ohio, and Michigan**

Langdon Wheat Response to N, \$6 Wheat, 30-40 cent N



Eastern ND Wheat Response to N, \$6 wheat, 30-40 cent N



Langdon Region-

Low = less than 40 bu/acre

Medium = 41-60 bu/acre

High = greater than 60 bu/acre

Eastern Region-

Low= less than 40 bu/acre

Medium=41-60 bu/acre

High= greater than 60 bu/acre

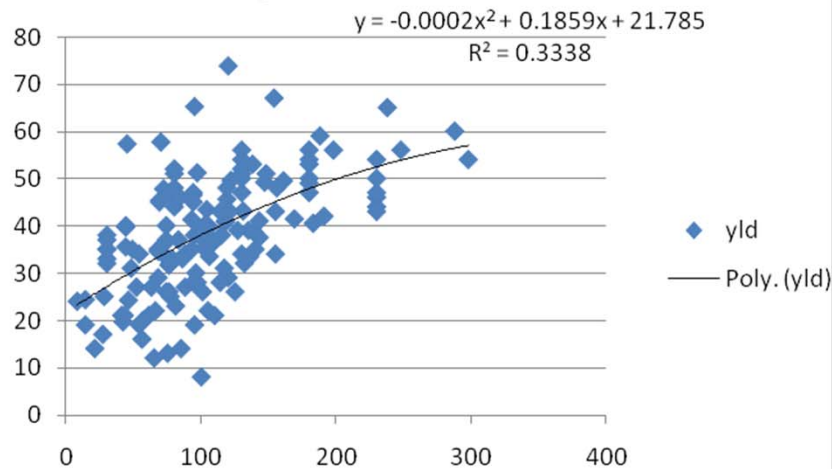
Western Region-

Low= less than 30 bu/acre

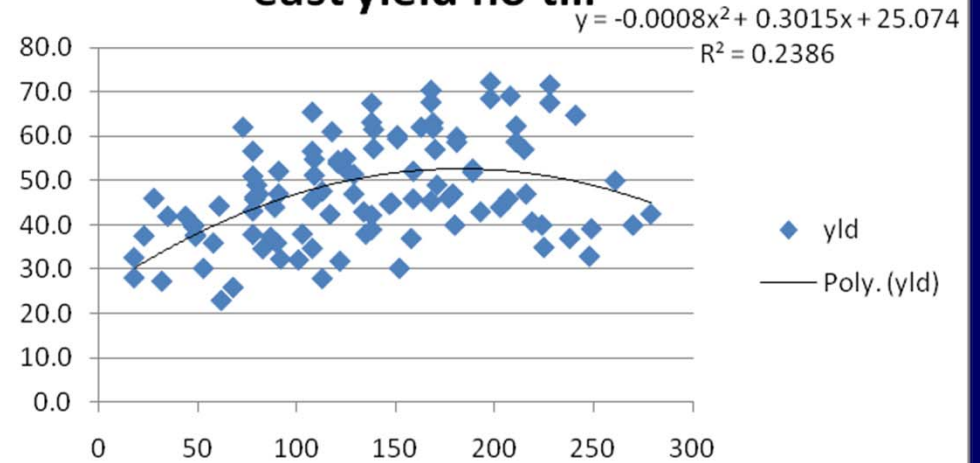
Medium=31-50 bu/acre

High=greater than 50 bu/acre

east yield conventional till



east yield no till



In both eastern and western spring wheat/durum N rate trials, 50 lb/acre less N was required for long-term no-till sites to attain similar yield/protein compared to conventional till plots.

Welcome to the North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. Click on the map for a detailed view.



- Eastern North Dakota
- Western North Dakota
- Langdon Region

1

Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre

Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre

High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please select the historical productivity of the farm from the options below.

- Low Productivity
- Medium Productivity
- High Productivity

2

Select Nearest Wheat Price (\$/bushel)

\$5.00

Please indicate the crop previously planted in the field.

- No Nitrogen-supplying crop
- Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- Sugarbeet with yellow-green leaves
- Sugarbeet with green leaves
- Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

Nitrogen provided by previous crops: 0

Please indicate the previous tilling method used in the field.

Low Productivity
 Medium Productivity
 High Productivity

Select Nearest Wheat Price (\$/bushel)

3

Select Nearest N Cost (cents/lb)

4

Nitrogen Recommendation Before Credits:

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.)

Soil test for Nitrogen analysis (lbs/acre 2-ft. depth) Input OK

5

Sugarbeet with green leaves
 Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

6

Nitrogen provided by previous crops:

Please indicate the previous tilling method used in the field.

Is the field/area conventionally tilled (chisel and/or disc, and/or field cultivator or plow)?
 Has the field/area been in No-till for 1 to 5 years?
 Has the field/area been in No-till for more than 5 years?

7

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.) (If soil organic matter exceeds 5.9%, please type in the soil organic matter value. If 5.9% or less, please leave blank.)

Organic matter % Input OK

8

Input OK

Nitrogen recommendation: plus/minus 30 lbs. N

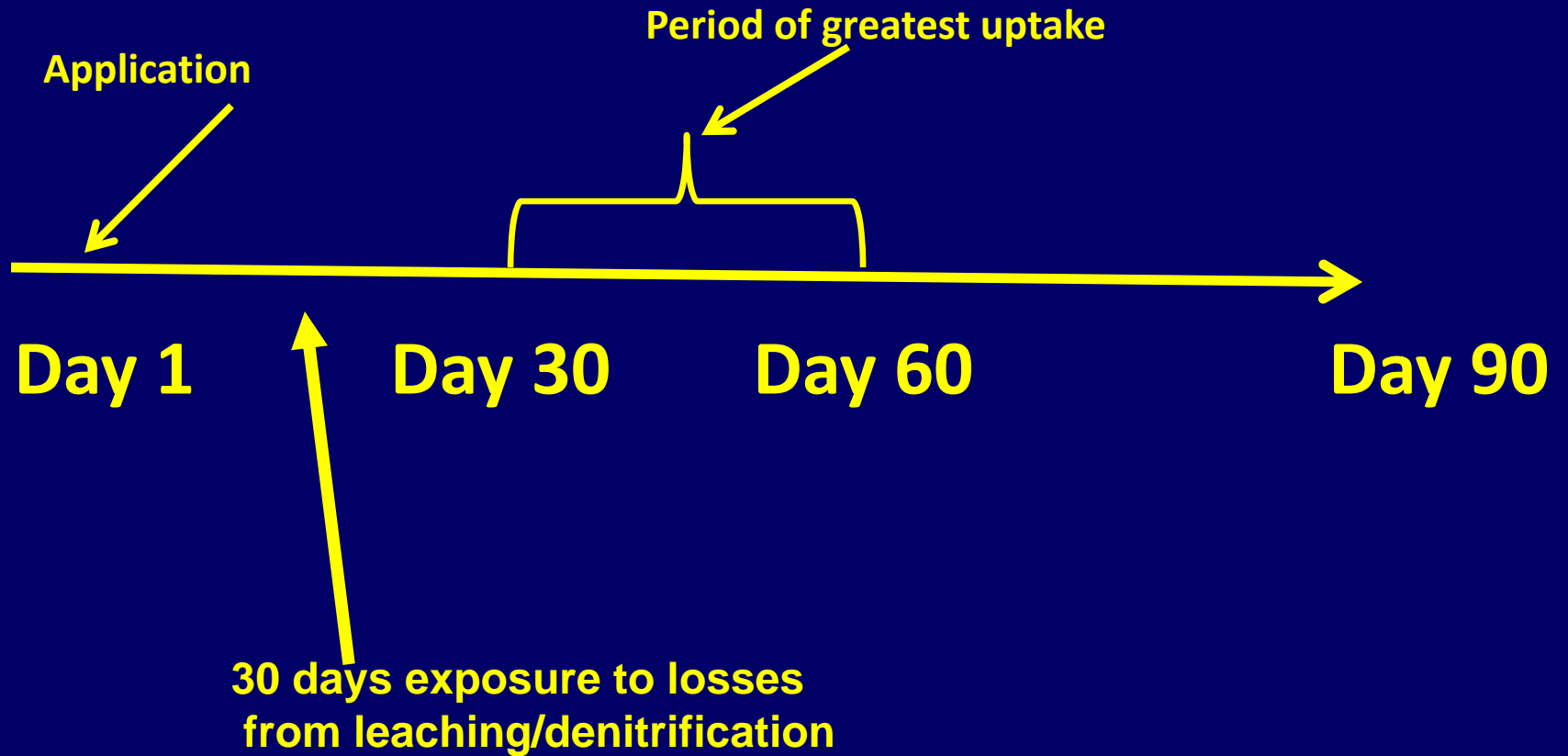
The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

The final number is not the final number

The recommendations state that growers might consider adjustments up to 30 lb N/acre up or down due to-

- Varietal protein characteristics**
- Less than optimal N application methods**
- Soils with denitrification tendencies**
- Excessive straw the previous year**
- Other grower experiences**

Spring Wheat N timeline



-Nitrification inhibitors

-Urease inhibitor additives

-Nitrification and urease inhibitor

**-Urease inhibition through chemical binding
with urea as applied with slow-release properties**

**-Urease inhibition through physical separation
of urea from soil**

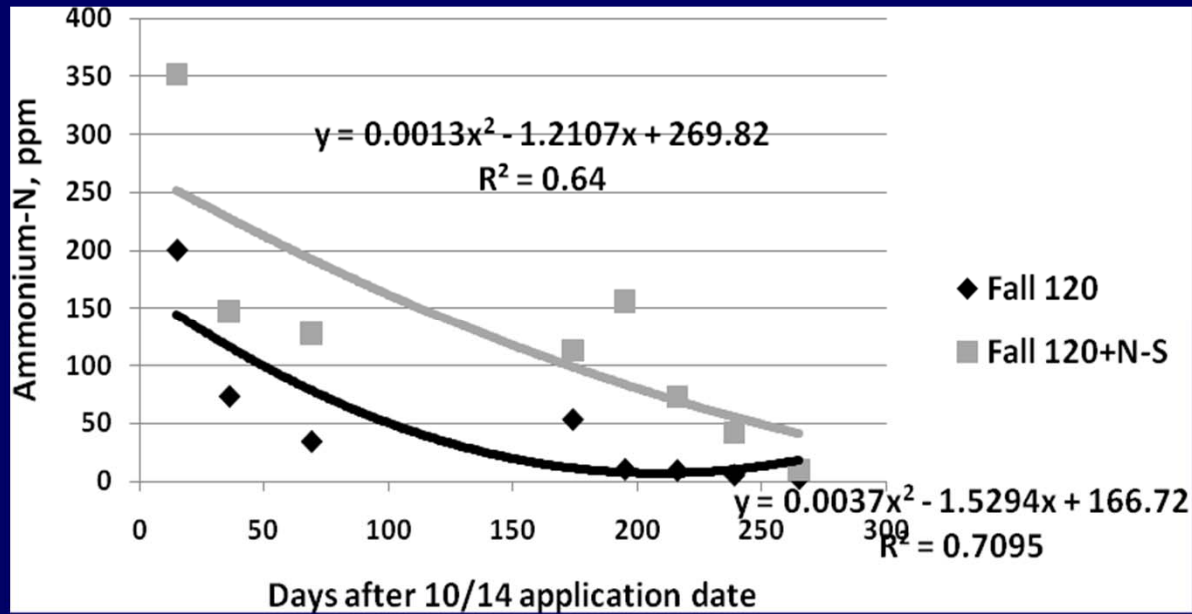
Nitrification inhibitors-

N-Serve[®] /Instinct[®]

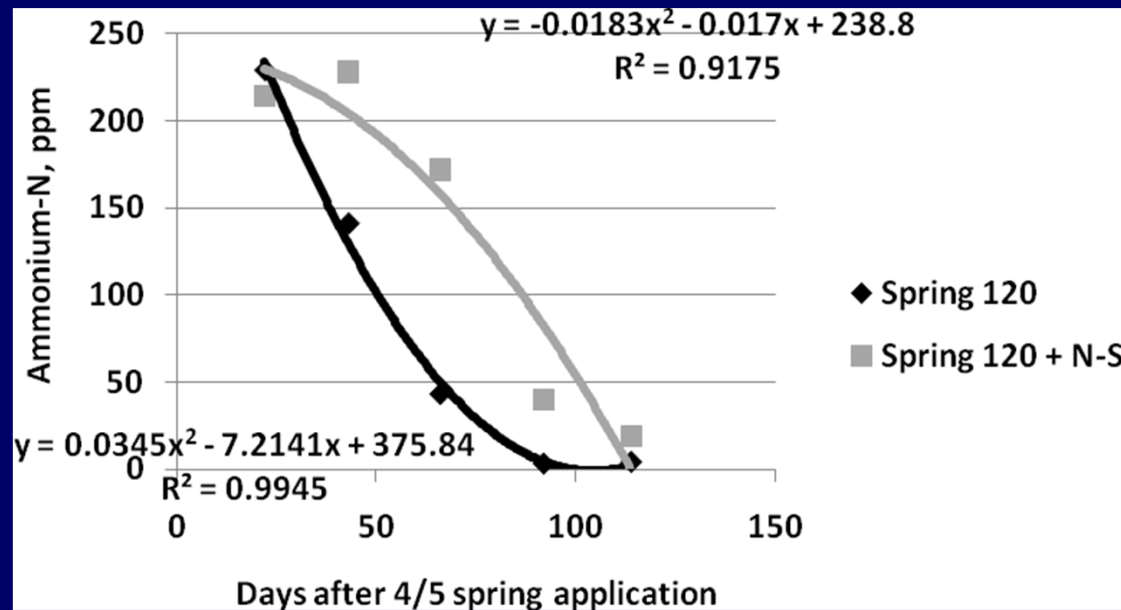
nitrapyrin (2-chloro-6-[trichloromethyl] pyridine)

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[®] is a new formulation of Nitrpyrin that can be mixed with ammonium fertilizers and can stay on the soil surface without incorporation.

Research so far at Minnesota, Illinois, Iowa and Nebraska have shown no yield benefit to the use of Instinct over N fertilizer alone, although the product inhibits nitrification

(Kentucky, Schwab, unpublished data)

Wisconsin-

**Corn yield increase with Instinct in
2008, but not 2009.**

DCD- a nitrification inhibitor

Found in

AgrotainPlus (Agrotain, Int.)

SuperU (Agrotain, Int.)

Guardian DF (Conklin)

Guardian DL (Conklin)

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

Agrotain

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

**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

Nitrification and urease inhibitors

Ammonium thiosulfate

Nutrisphere[®]

ATS has nitrification and urease inhibiting properties.

It is not as effective generally as nitrapyrin, DCD, or NBPT.

ATS is most effective as a nitrification inhibitor at concentrations of 25 ppm S. (0.1% ATS)

Under warm conditions (>60° F), mineralization is complete in a week.

Under cooler temperatures, mineralization is slower; about 3 weeks.

Nutrisphere,

SFP Specialty Products, LLC, Leawood, KS

Formulation for dry fertilizer-

30-60% maleic-itoconic copolymer,

pH 2.5-5

Formulation for liquid fertilizer-

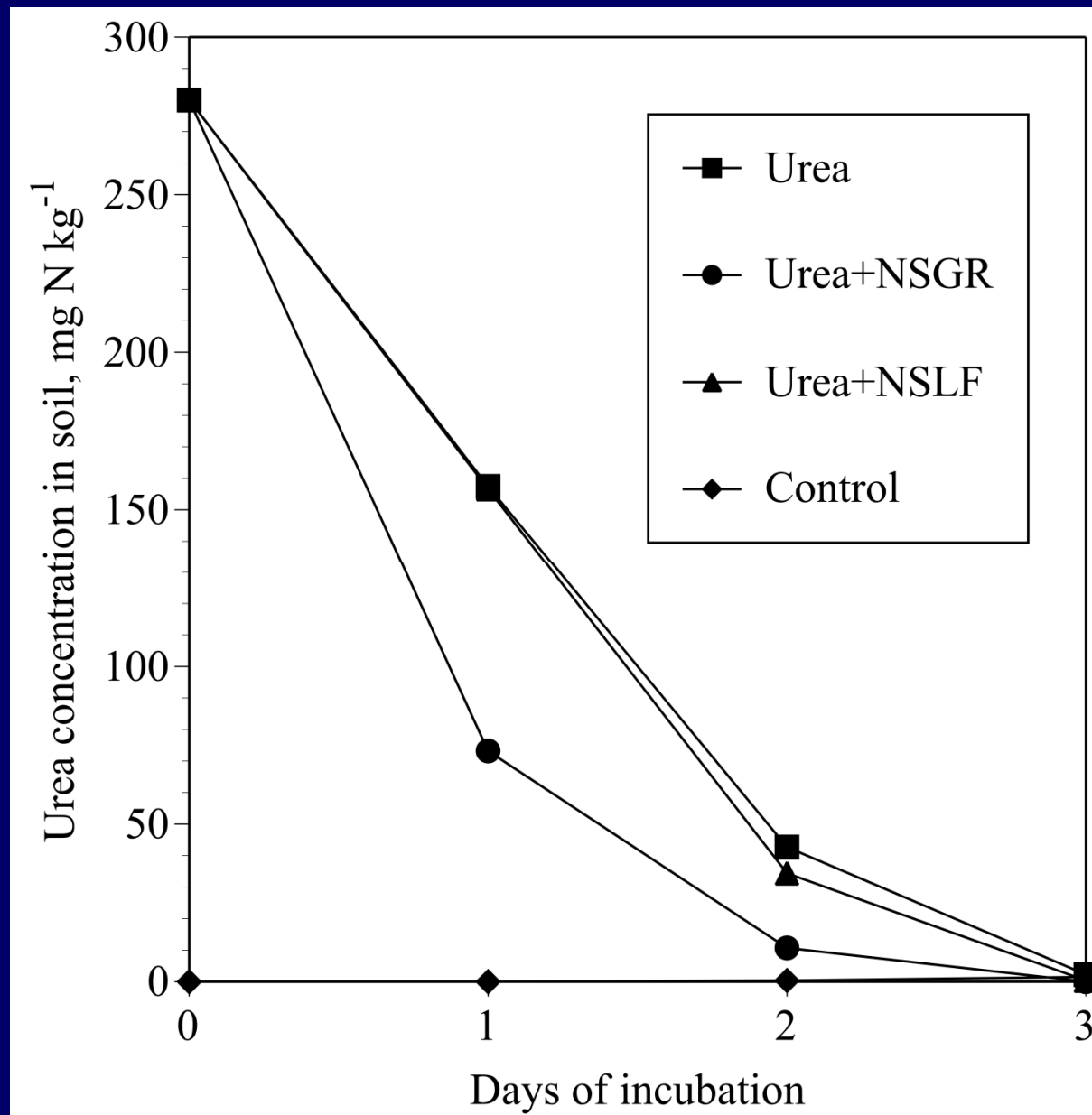
40% maleic-itoconic copolymer, pH 1-2

Product literature states that nitrification inhibition is based on product ability to tie-up copper- a critical metal used by nitrification bacteria.

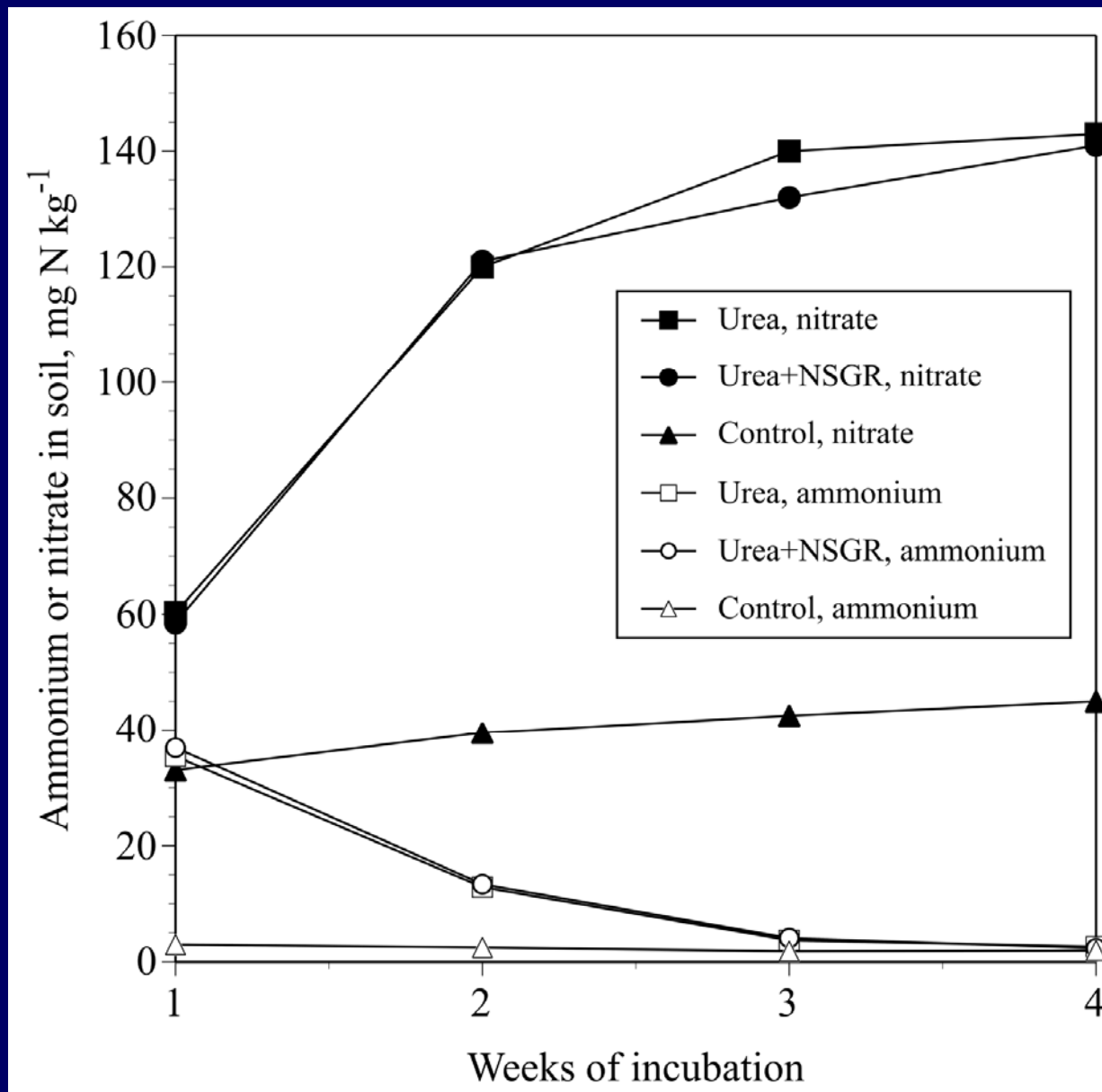
Inhibition of urease activity is due theoretically to a tie-up of soil nickel- a critical metal constituent of urease enzyme.

Effects of N additive, averaged over source (UAN and urea) and N rate on corn grain yield, earleaf-N and grain-N, Scandia, KS (2-year average). From Gordon, 2008.

Treatment	Yield, bu/acre	Earleaf N, %	Grain N, %
Check	152	1.72	1.13
Urea/UAN	168	2.57	1.26
ESN	185	2.96	1.33
Nutrisphere-N	183	2.96	1.35
Agrotain	183	2.98	1.36
LSD 5%	6	0.09	0.04



(Research by R.J. Goos, in Franzen et al., J. Plant Nut 2011)



(Research by R.J. Goos, in Franzen et al., J. Plant Nut 2011)

Cumulative ammonia volatilization losses for urea, ammonium sulfate, urea + NBPT, and urea + 0.25% Nutrisphere (NSN) from a Dewitt silt loam soil during a 15-day laboratory incubation at 25°C. (Norman data, University Arkansas, Fayetteville, from Franzen et al., 2010?)

N sources	Days after N source application			
	3	7	11	15
	Cumulative NH₃ loss, % of N applied			
Urea	14.5	35.9	51.8	56.9
Ammonium sulfate	0.1	0.2	0.5	0.6
Urea + NBPT[†]	0.006	2.7	12.9	18.3
Urea + 0.25% NSN	17.6	42.2	57.8	62.7
LSD(0.05)[‡]	12.2			
LSD(0.05)[§]	9.6			

One possible reason for the yield increase is the pH of the product, particularly with the liquid formulation. Acid pH lowers the rate of nitrification. Perhaps it is not the Nutrisphere that is active. Perhaps it is its acidity?

Maybe it acts as a chelating agent for micronutrient metals like Zn?

No one really knows.

N Zone- (AgXplore International, Inc., Parma, MO)

**Proprietary blend of Ca-Aminoethylpiperazine
and Ca-Heteropolysaccharides**

**Use rate, varies by product and length of
“benefit” required. Generally 1-2 qts/ton.**

Arkansas has shown no benefit.

**Initial lab work by Dr. Goos on one ND soil
shows it has no nitrification inhibiting ability.**

Urease inhibitors through chemical binding with urea and slow-release properties

Nitramin- (Georgia-Pacific/N-Demand- Wilbur-Ellis)

30L = 12% N urea, 18% from Triazone, methylene urea

CoRon (Helena)28-0-0

(19.6% methyl-urea, methyl-diurea, urea (8.6%))

(There are 20 different CoRon formulations)

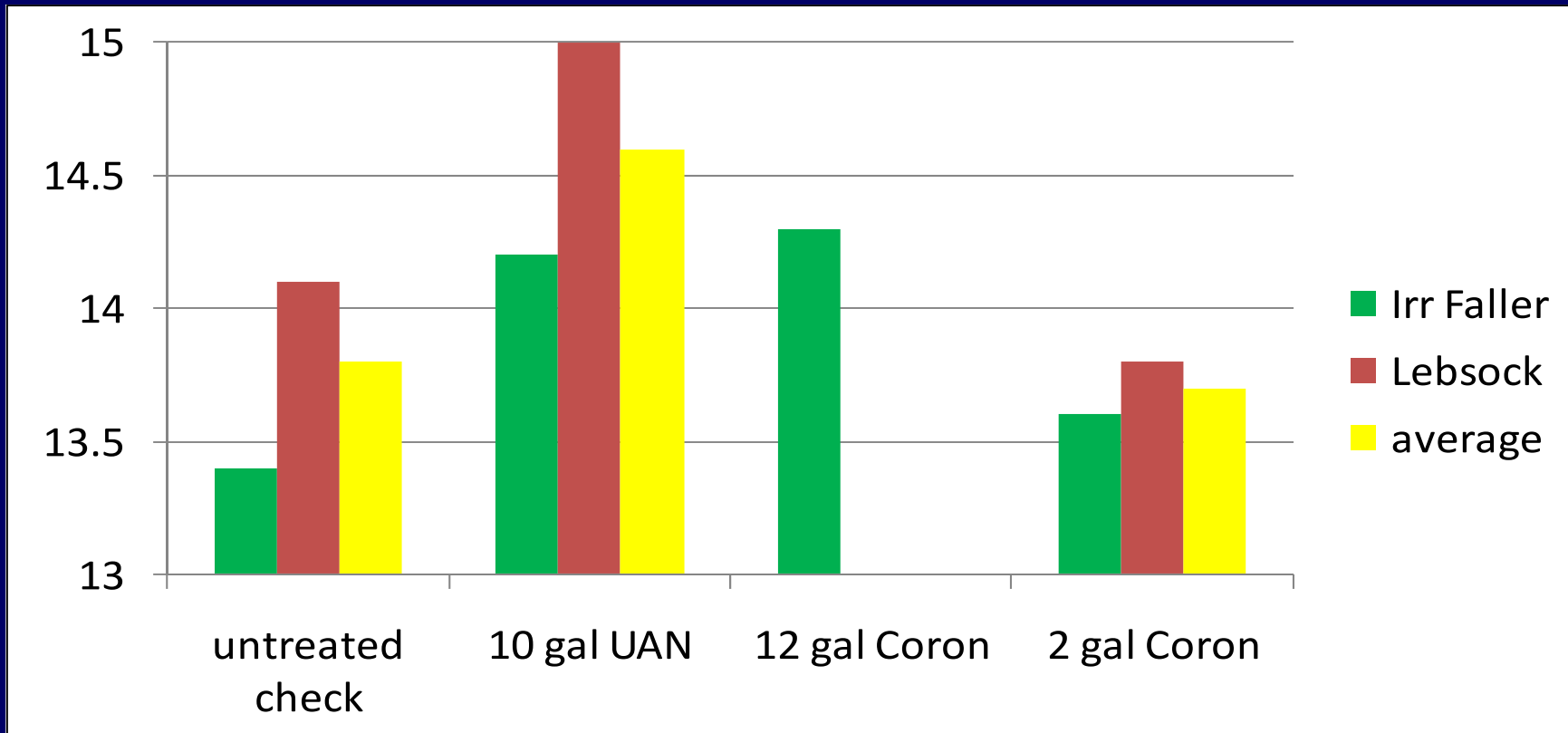
N-Pact (UAP) 9.6% Methyl-triazole, urea 17.4%

Nutralene (Agrium) 40-0-0SGN 225

6% urea N, 20 % methylenediurea and dimethyleneurea, 14% from water insoluble N.

Nitroform (38-0-0) (Agrium) 5% urea N, 8% from urea Formaldehyde, 25% water insoluble

2009 Carrington, ave. 2 sites, post-anthesis application for protein enhancement. Schatz



Faller yields over 100 bu/acre

Slide courtesy of Greg Endres, NDSU, Carrington REC

Urease inhibition through physical separation of urea from soil

These are fertilizers with physical coatings. The most common fertilizer of this type being marketed across the region is ESN by Agrium

Illinois-

4 locations over 12 years, ESN was similar in corn yield to urea + Agrotain, and 3 bu/a higher in yield than urea alone.

In 4 years of no-till, ESN was 21 bu/a better than urea surface-applied.

(Ebelhar et al., 2010)

Kansas-

**At drier locations, ESN not beneficial
to corn or grain sorghum.**

**At wetter locations, some studies showed
a benefit to its use.**

(Weber et al., 2009a and 2009b)

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.

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 appear to be more consistent in their activity.

SUMMARY-

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

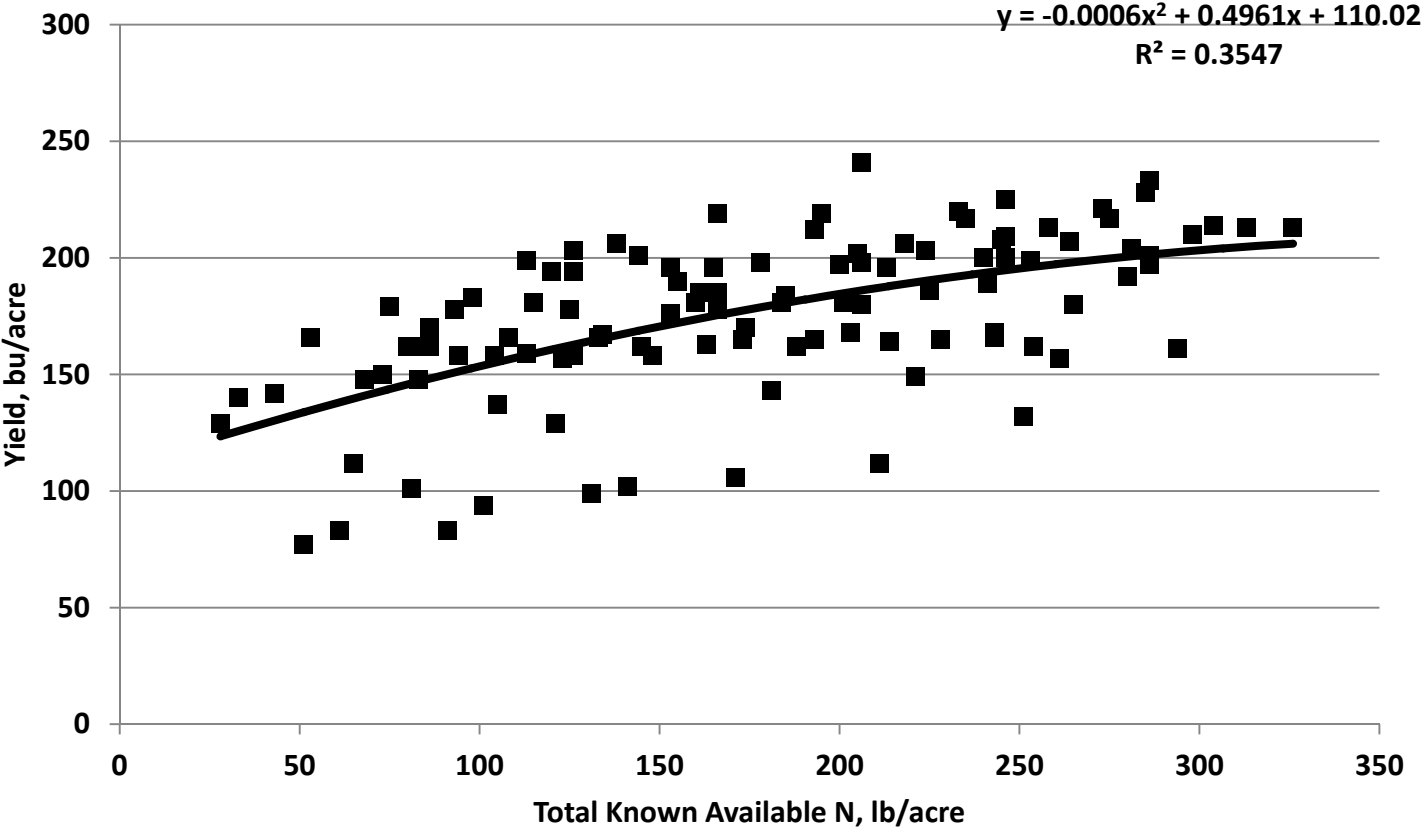
Within the small number of yield increases, most are not related to N uptake by the crop.

These yield increases are curious and should be investigated by the company to determine the reason for yield increases.

SUMMARY-

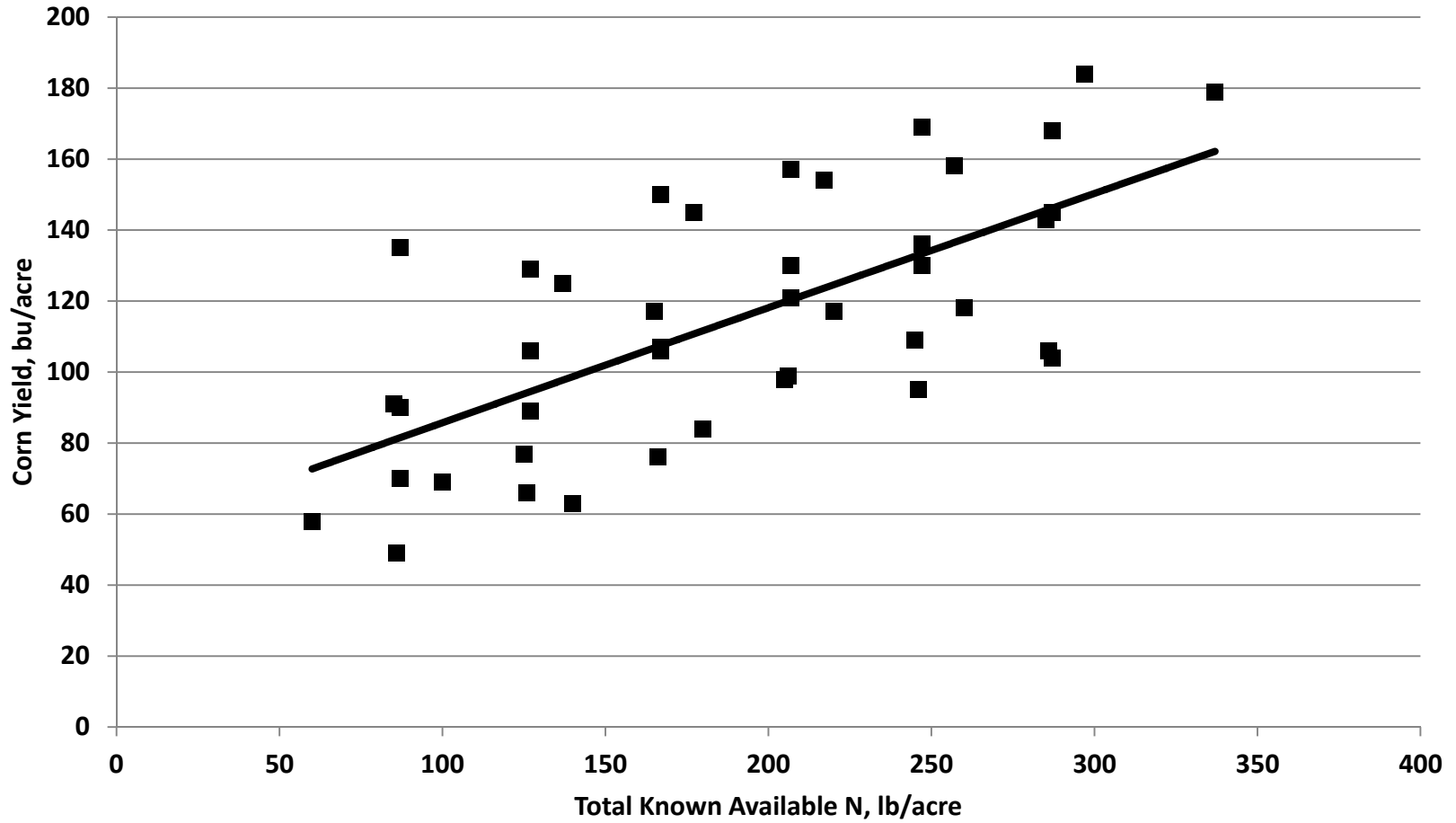
Positive results have been shown with ESN in several states when weather conditions might result in loss of conventional urea products. Its cost makes it much more competitive as a slow-release product compared to the triazole-, methyl-urea based products.

Yield vs Total Known Available N
Eastern Conventional Medium Texture Sites Not S
Affected



Yield vs Total Known Available N 2011-12, clay sites only

$$y = -1E-05x^2 + 0.3272x + 53.126$$
$$R^2 = 0.4561$$



Denitrification is a HUGE issue in high-clay soils. Leaching is a significant issue, but denitrification over-shadows it.

Nitrification inhibitors can be very useful in wet springs.

Use the ones that work- avoid the ones that don't.

Enhance protein using the 'recipe', not low rates of slow-release products.