Basics of Nitrogen

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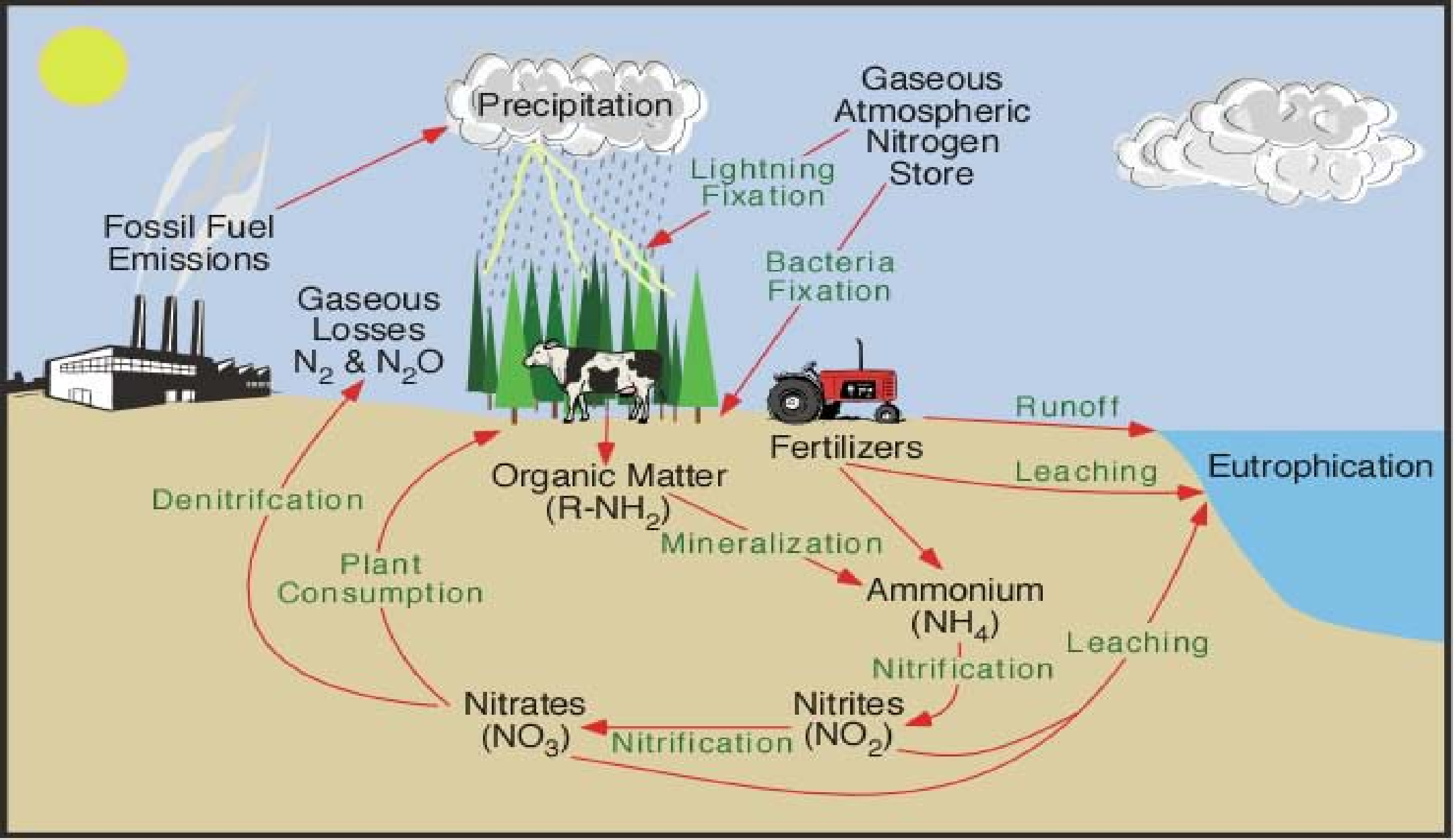


http://www.physicalgeography.net/fundamentals/9s.html

Forms of N Present in Soils

THREE major forms of N?

1) Organic N (e.g., plant residues, manures)
2) Ammonium (NH_4^+)
3) Nitrate (NO_3^-)

Organic Nitrogen

1) Plant residues, manures, soil OM

2) Plants CANNOT use until mineralizes

3) **Mineralization:** Biological Process

Organic N => Ammonium (NH_4^+)

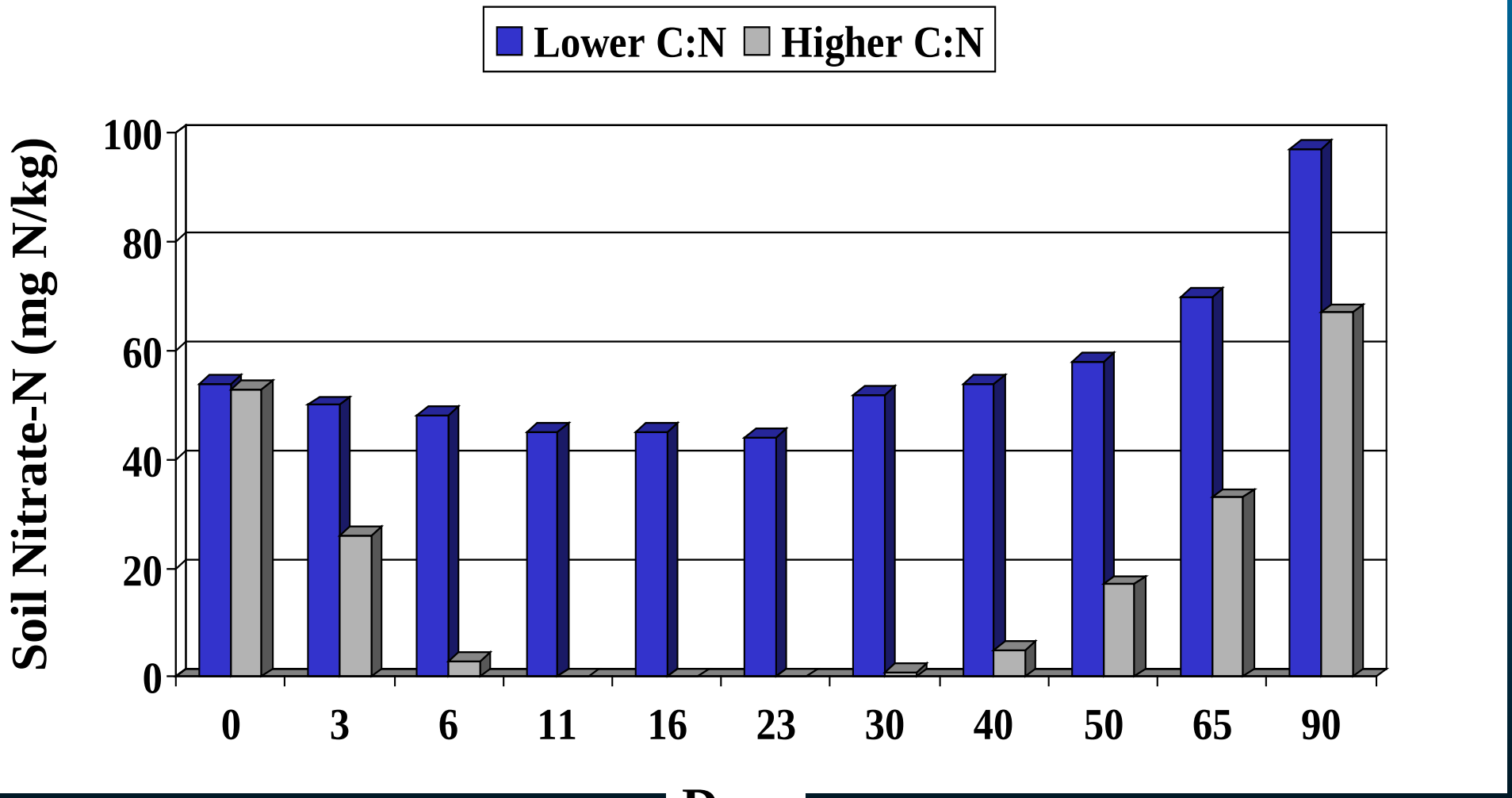
4) Soil Organic Matter: 5% = 3,000 lb N/ac

5) SOM can supply 50 to 150 lb N/ac per year

IMMOBILIZATION

1) This is NOT a net loss of N?
2) This is a TEMPORARY "tie-up" of N
3) Influenced by the C:N ratio of residue
4) Microorganisms break down residue
5) >30:1 = immobilization (N is unavailable)
6) <20:1 = mineralization (N is released)
7) Important when broadcasting N onto residue with high C:N ratio

Effect of C:N Ratio on Immobilization



Blackmer and Green, 1995 (SSSAJ)

Ammonium N (NH_4^+)

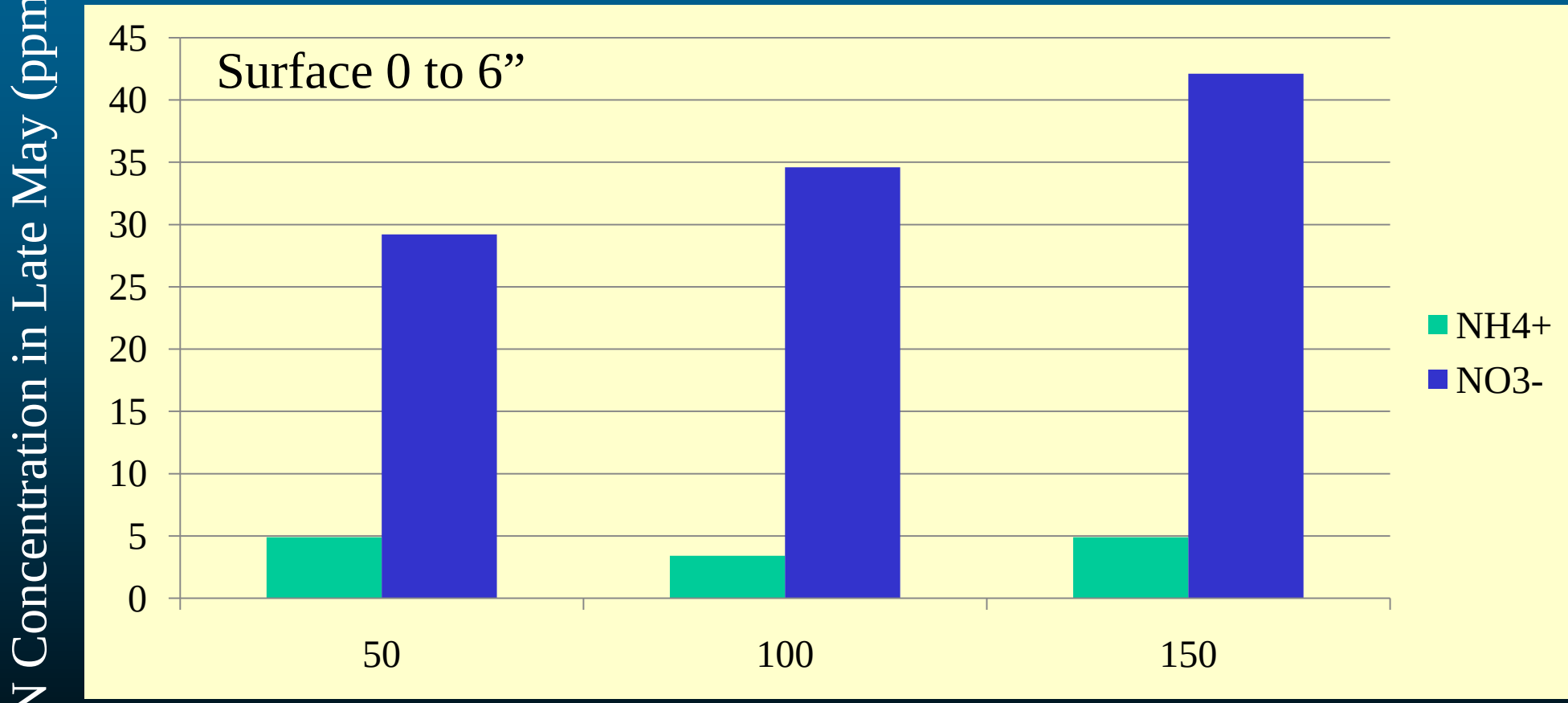
1) Plant available form of N
2) Held in soils on CEC
3) What happens to Ammonium in a soil?
   - Taken up an utilized by the plant
   - MAIN thing is…

NH_4^+

NITRIFICATION

1) Conversion of Ammonium to Nitrate
2) $NH_4^+ + 2O_2 \Rightarrow NO_3^- + H_2O + 2H^+$
3) Biological Process
4) Nitrification is temperature dependent
5) Nitrification insignificant below 50 ºF
6) How fast does the conversion occur?

Nitrification of Ammonium Sulfate



Nitrate N (NO_3^-)

1) Plant available form of N
2) NOT held in soils on CEC
3) Due to nitrification, NO_3^- most common
   Nitrification: $NH_4^+ \Rightarrow NO_3^-$
4) Nitrate is lost relatively easily from soils

NO_3^-

How is Nitrogen Lost?

THREE ways N is lost from soils:

1) LEACHING
2) DENITRIFICATION
3) VOLATILIZATION

LEACHING

1) Primary form of N lost this way? NO_3^-

2) Nitrate with Excess Water = Leaching

3) Soil Type is a major influence

Greater Sand content = Greater leaching

4) Leaching can occur in most soils

5) How can this be MINIMIZED?

6) Minimize amount of time that N is present in soil without plants growing

DENITRIFICATION

1) Form of N lost this way? NO_3^-

2) Nitrate with no oxygen = denitrification

3) Soil Type is a major influence

Poor drainage = Greater denitrification

4) Fine-textured soils = greater potential

5) How can this be MINIMIZED?

6) Minimize amount of time that N is present in soil without plants growing

Time of N Application

At-Plant = 118 bu/A **Sidedress = 127 bu/A**

Fox and Beegle, Penn State

VOLATILIZATION

1) Form of N lost this way? NH_4^+

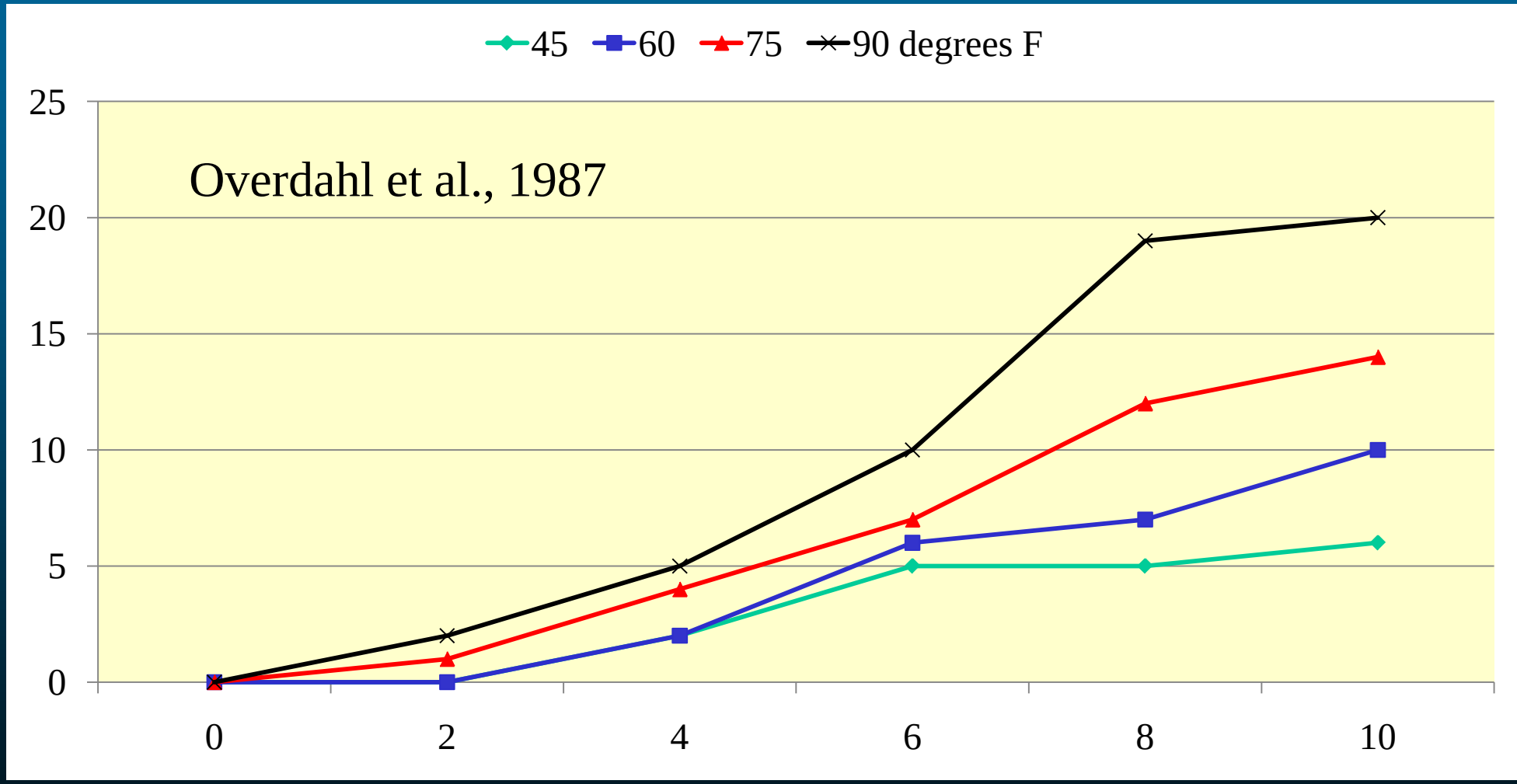
2) Ammonium in high pH environment

3) Soil pH is THE major influence

4) $NH_4^+ <=> NH_3(g) + H^+$

5) Other important factors: CEC, wind, and TEMPERATURE

Ammonia Volatilization



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4) $NH_4^+ <=> NH_3(g) + H^+$

5) Other important factors: CEC, wind, and TEMPERATURE

6) Prevent by incorporation of ammonium

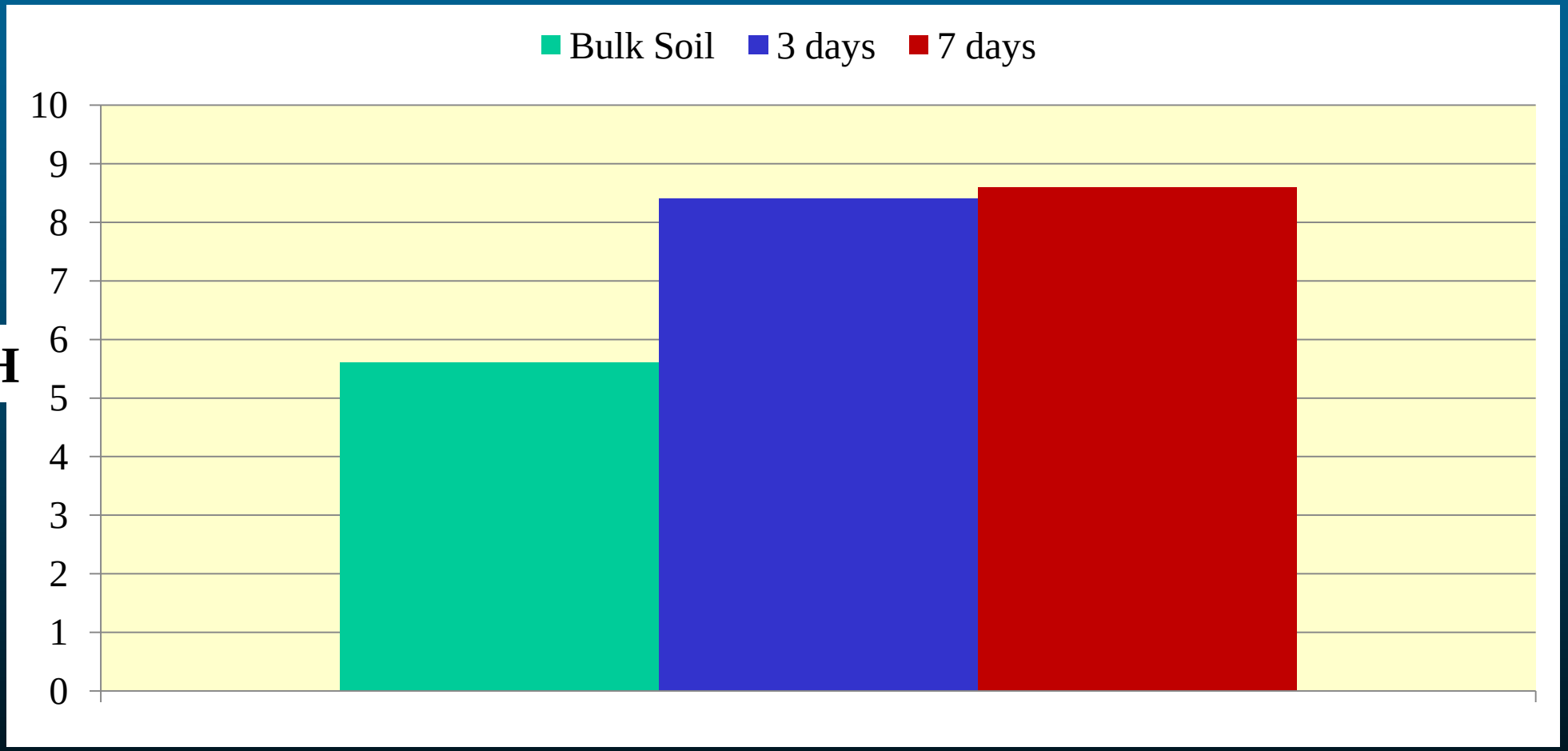
7) Two big concerns: Surface applications of Manures and UREA containing fertilizers

Urea Fertilizer in Soils

1) Urease is the enzyme that breaks down urea

2) Urea ($NH_2 – CO – NH_2$) => NH_4 Carbonate

Urea Prill Microsite pH



Hauck, 1984

Urea Fertilizer in Soils

1) Urease is the enzyme that breaks down urea

2) Urea ($NH_2 – CO – NH_2$) => NH_4 Carbonate

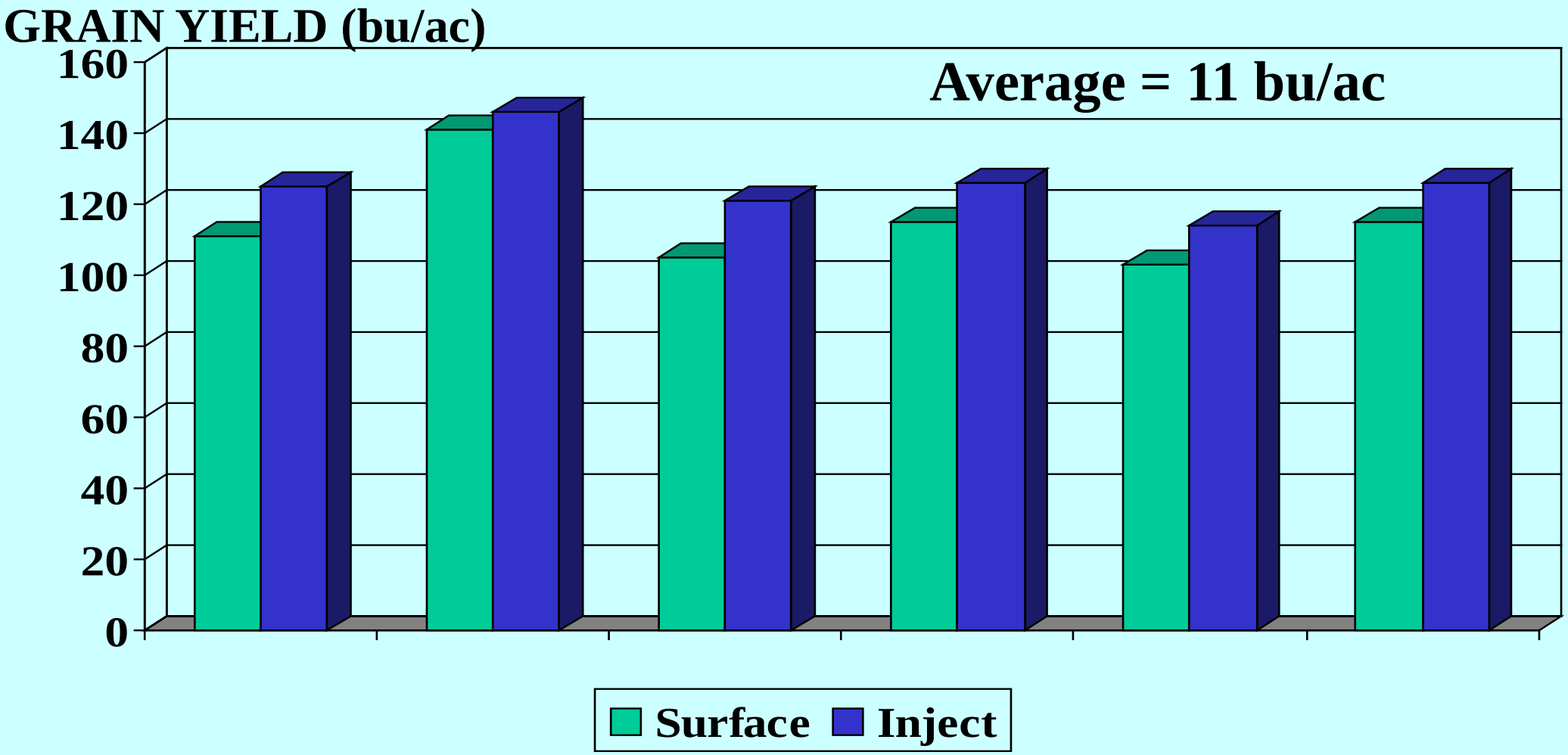
3) NH_4^+ in a high pH environment goes to $NH_3(g)$

4) $NH_4^+ <=> NH_3(g) + H^+$

5) Urease inhibitors keep N as urea until in soil

6) If urea gets into the soil (rain or tillage), then there is no need for a urease inhibitor

Volatilization of Urea



Source: Fox and Beegle, Penn State

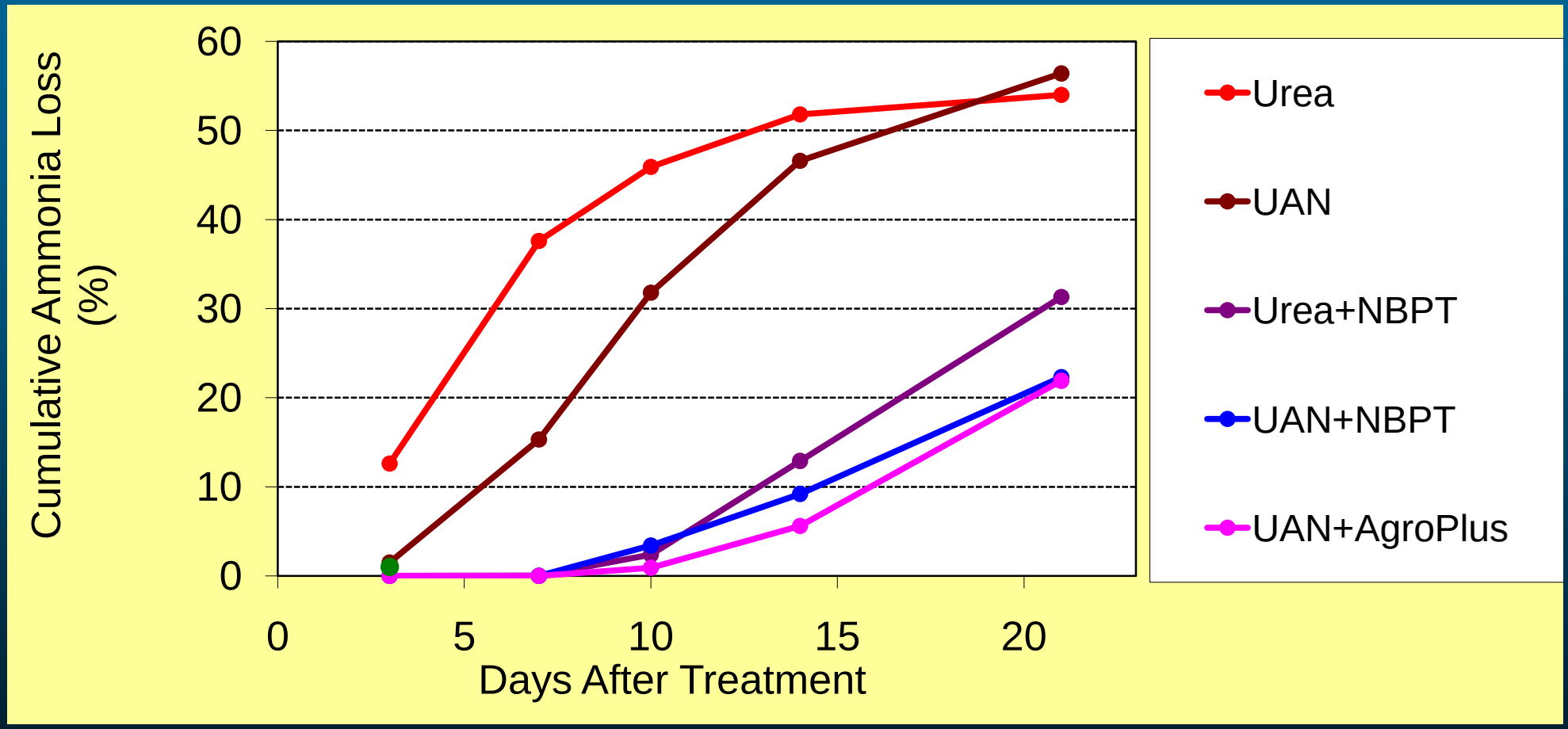
NITROGEN TECHNOLOGY

1) Products designed to improve NUE
2) Nitrification Inhibitors
3) Urease Inhibitors
4) Slow Release Products

NITROGEN TECHNOLOGIES

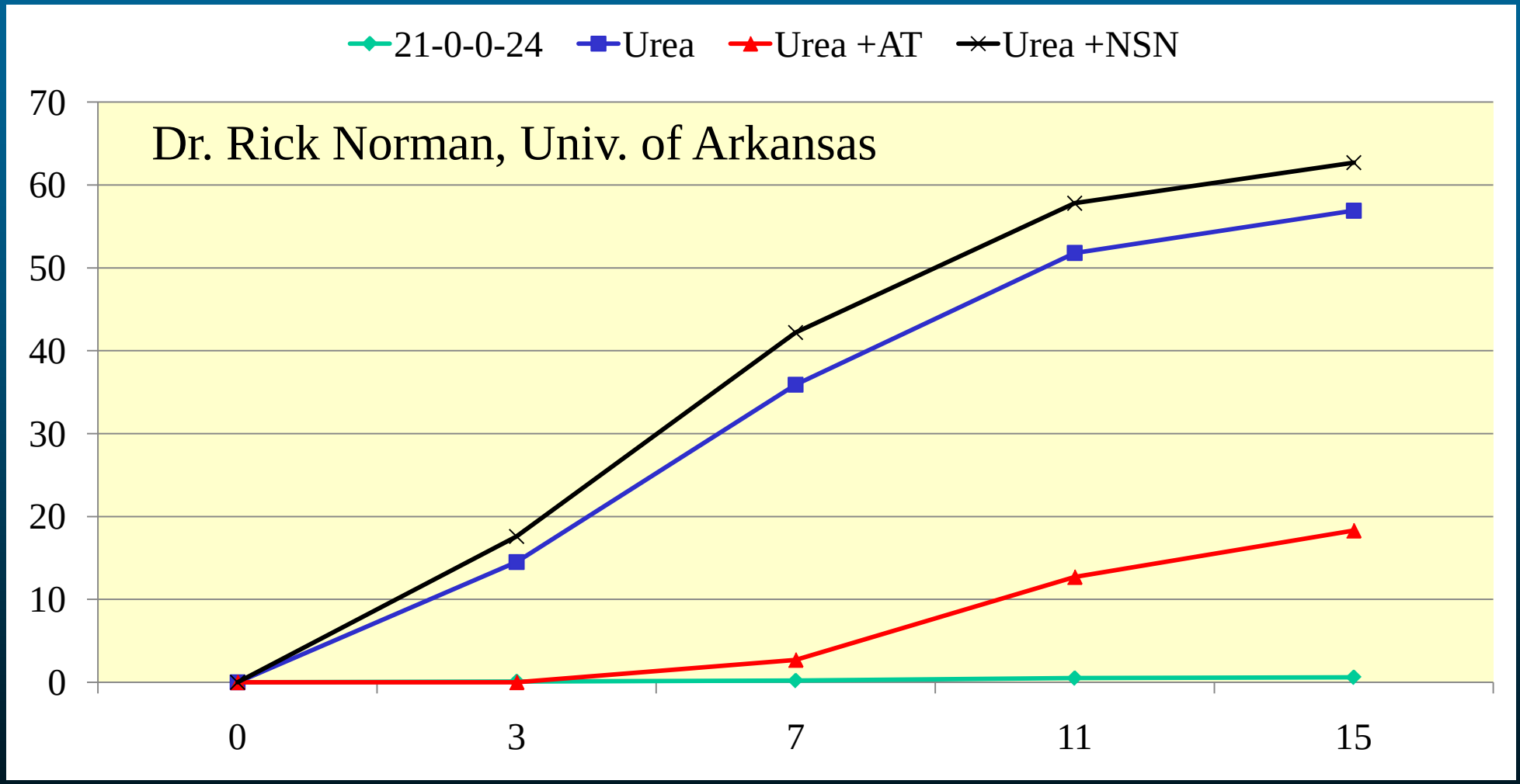
1) Agrotain: urease inhibitor
2) Agrotain Plus: urease + nitrification inhibitor
3) Super U = urease + nitrification inhibitor
4) Nutrisphere-N = urease + nitrification inhibitor?
5) ESN = polymer-coated urea fertilizer
6) N Serve = nitrification inhibitor
7) Instinct = nitrification inhibitor

Ammonia Losses: AGROTAIN

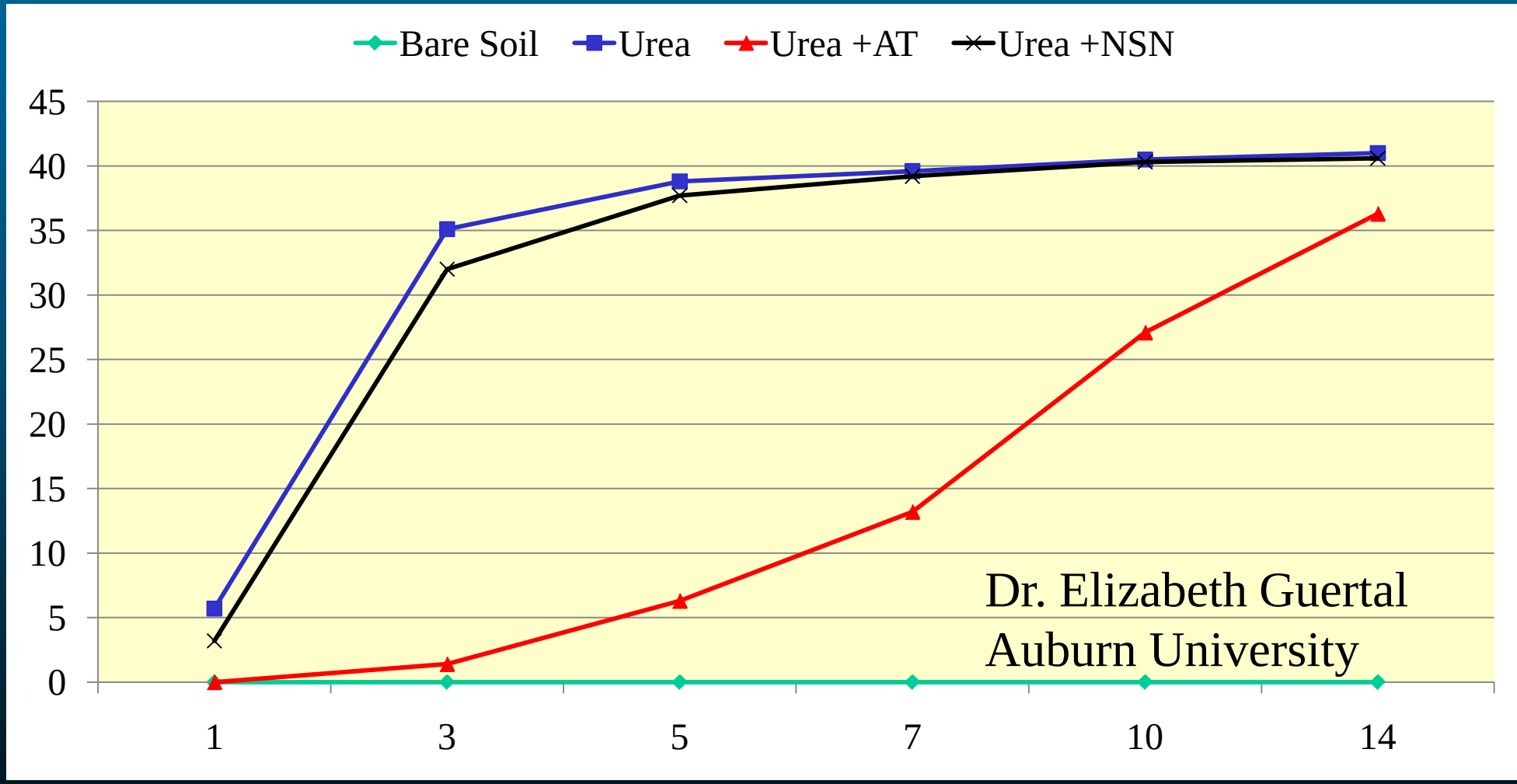


Source: Dr. W. Thornberry, Sturgis, KY; Dr. S. Ebelhar, Univ of Illinois
Laboratory incubation

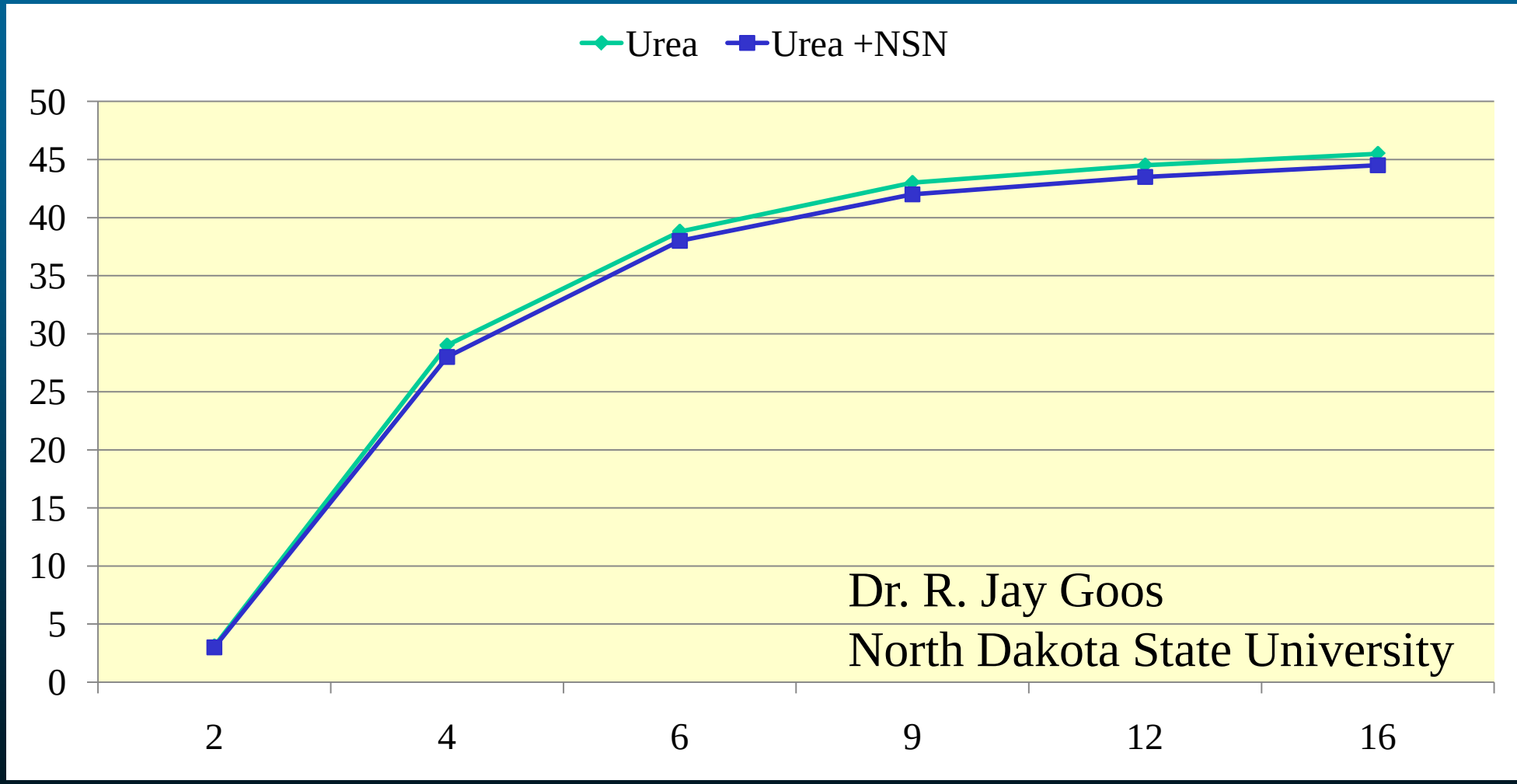
Ammonia Volatilization: AT/NSN



Ammonia Volatilization: AT/NSN



Ammonia Volatilization: NSN



Nitrification Inhibitor Technology

1) Slows conversion of ammonium to nitrate

2) $NH_4^+ + 2O_2 \Rightarrow NO_3^- + H_2O + 2H^+$

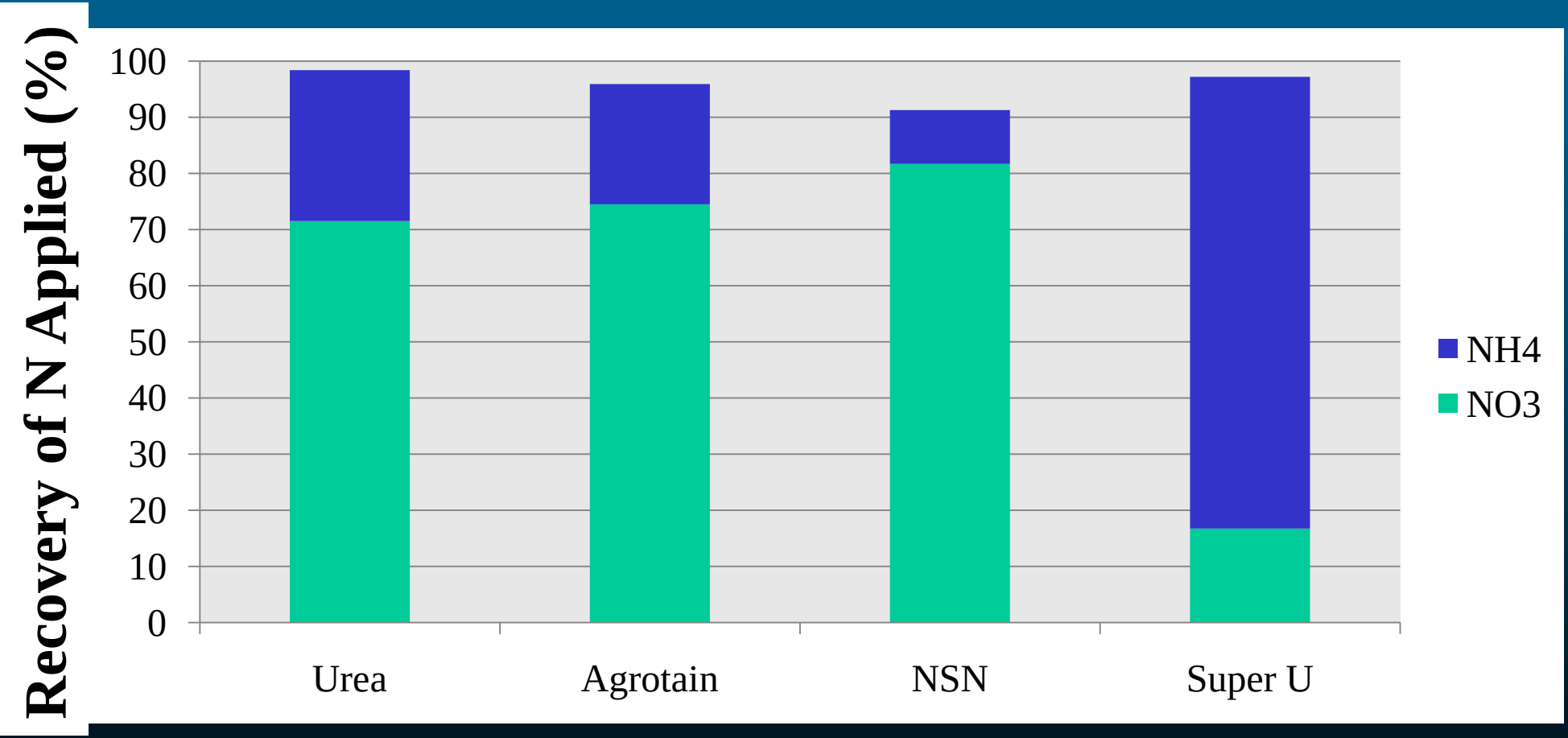
3) Reduces N loss potential

4) Some studies have shown a benefit

5) Potential benefit greater in today's fertilizer market

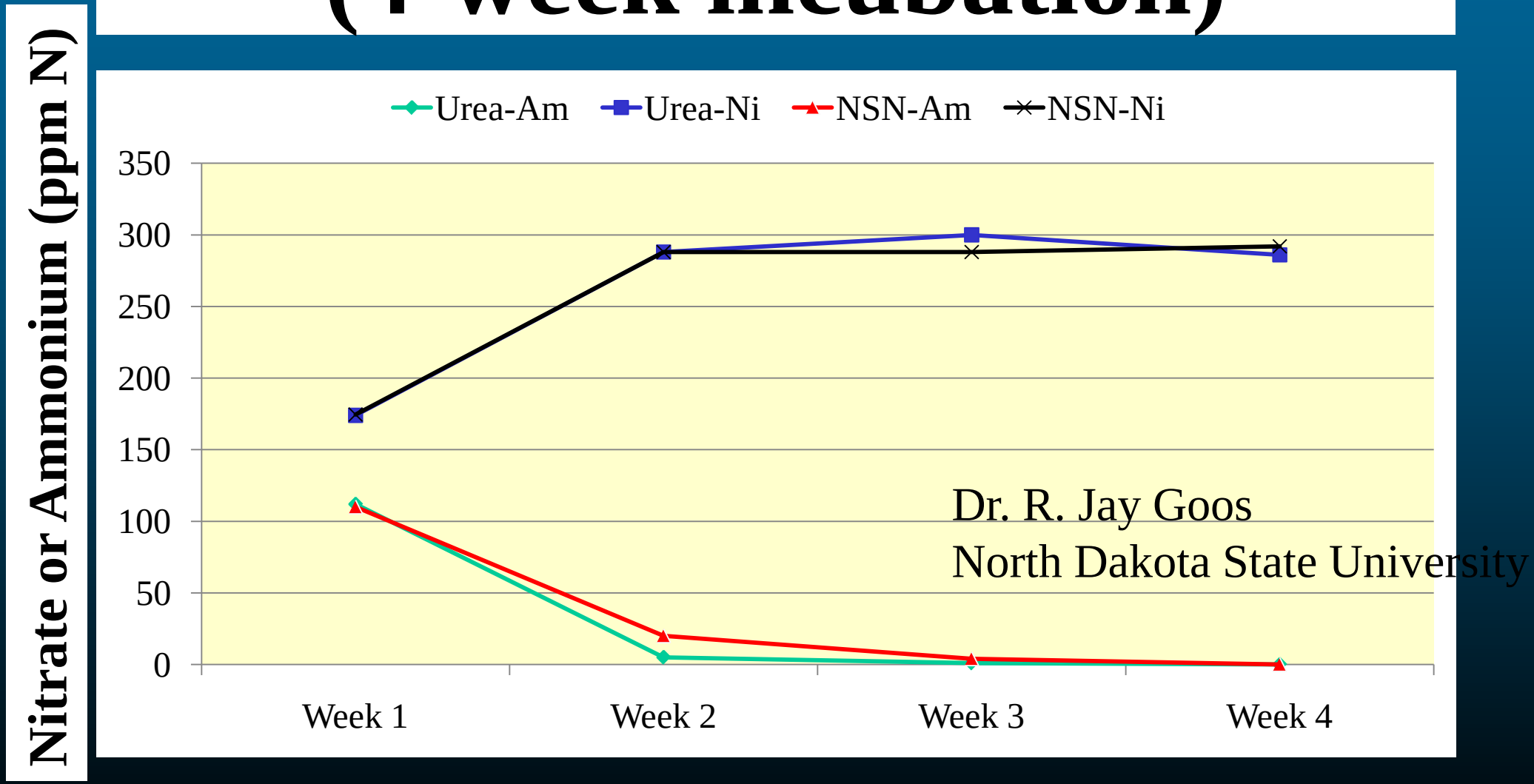
6) Potential value increases with length of time between application and plant demand

Effect on Nitrification (14-day incubation)

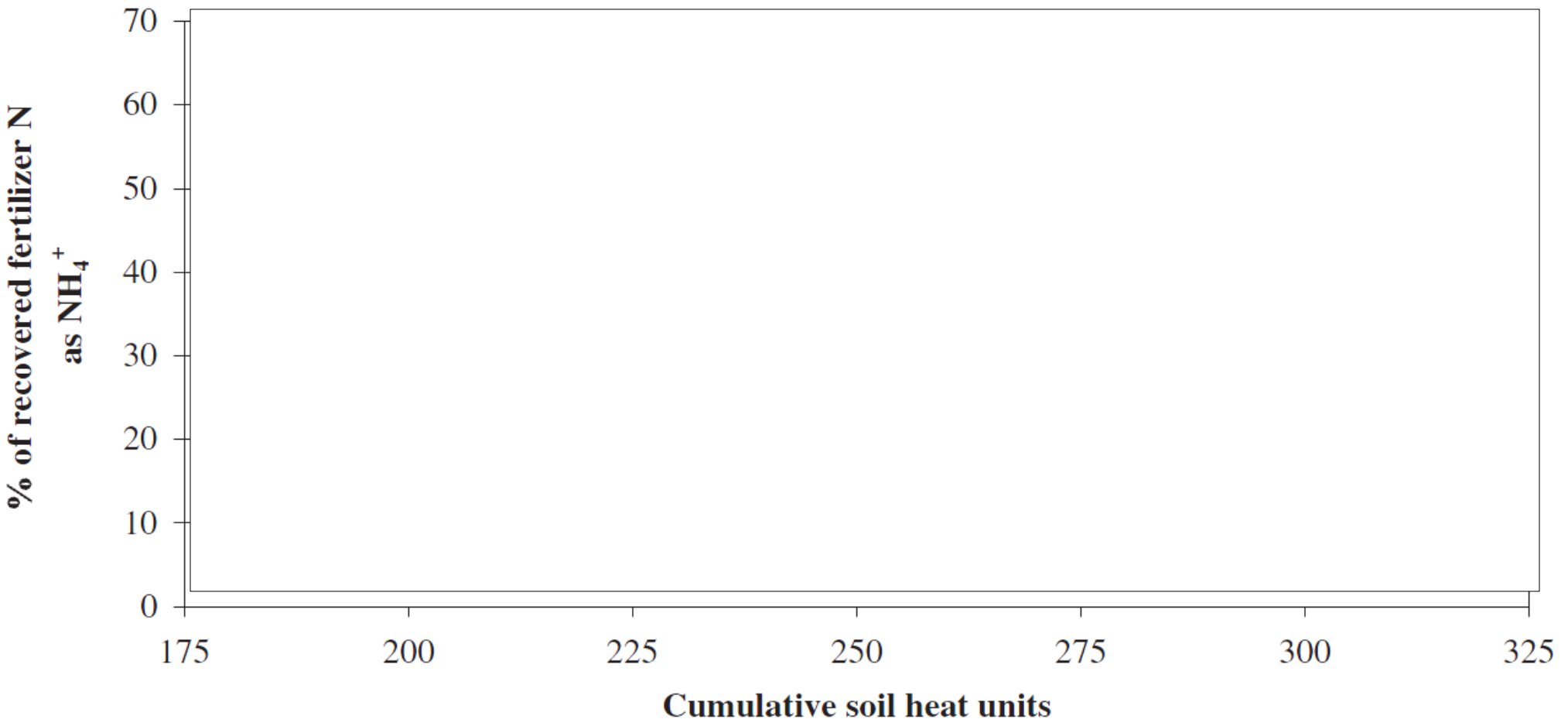


Rick Norman, Univ. of Arkansa

Effect on Nitrification (4-week incubation)

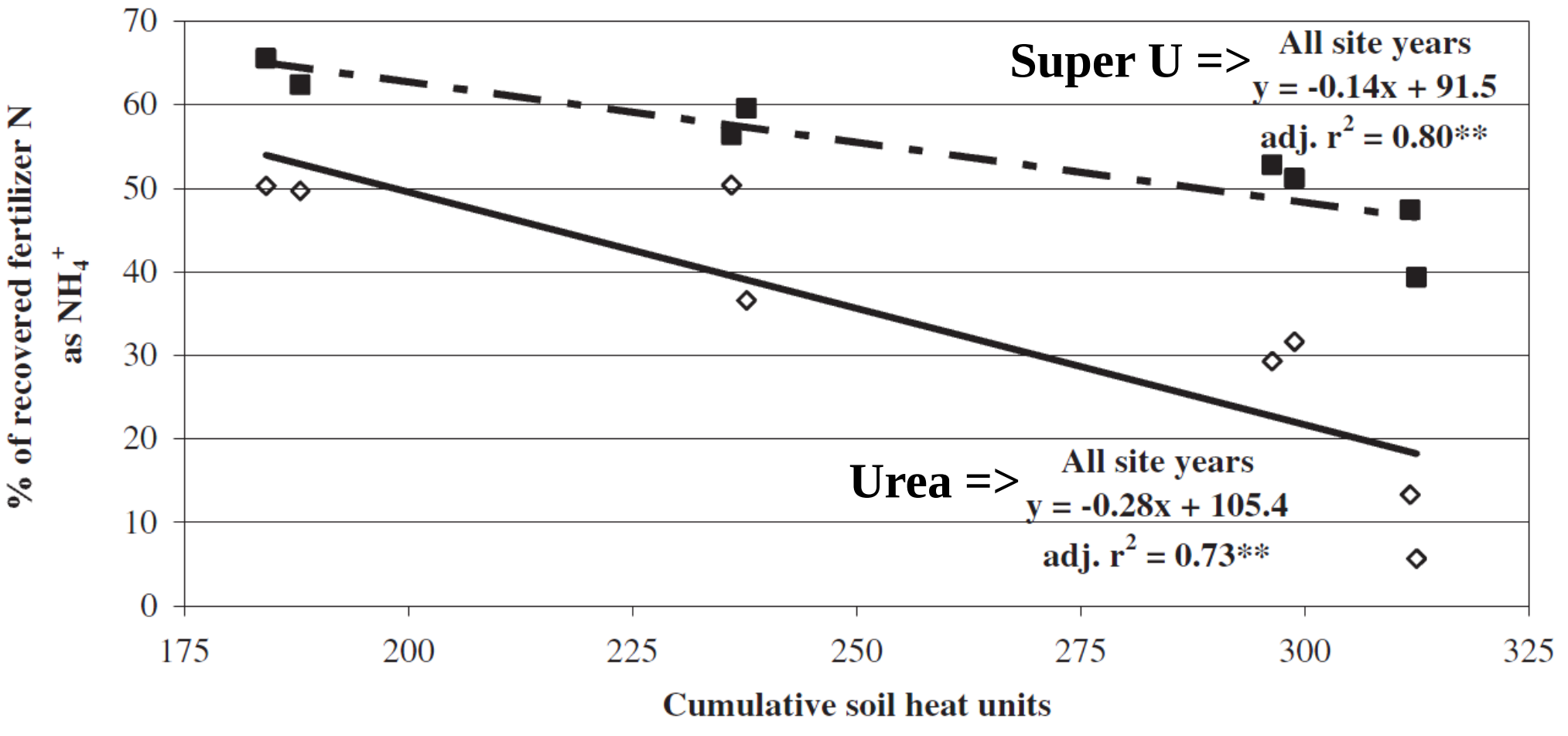


Nitrification with Super U



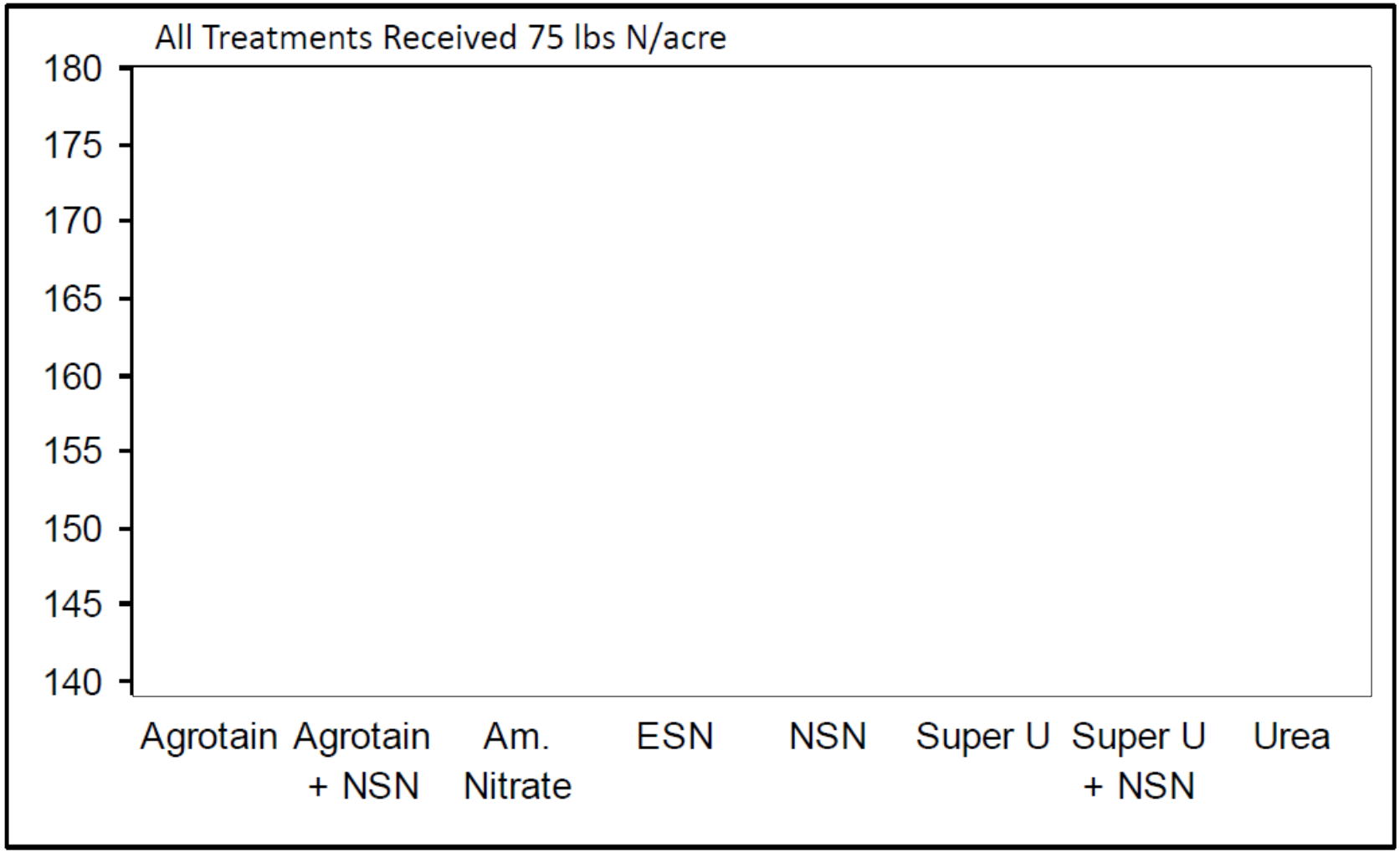
Tiessen et al., 2006 (AJ)

Nitrification with Super U



Tiessen et al., 2006 (AJ)

2007 N volatilization Study (Princeton, KY)



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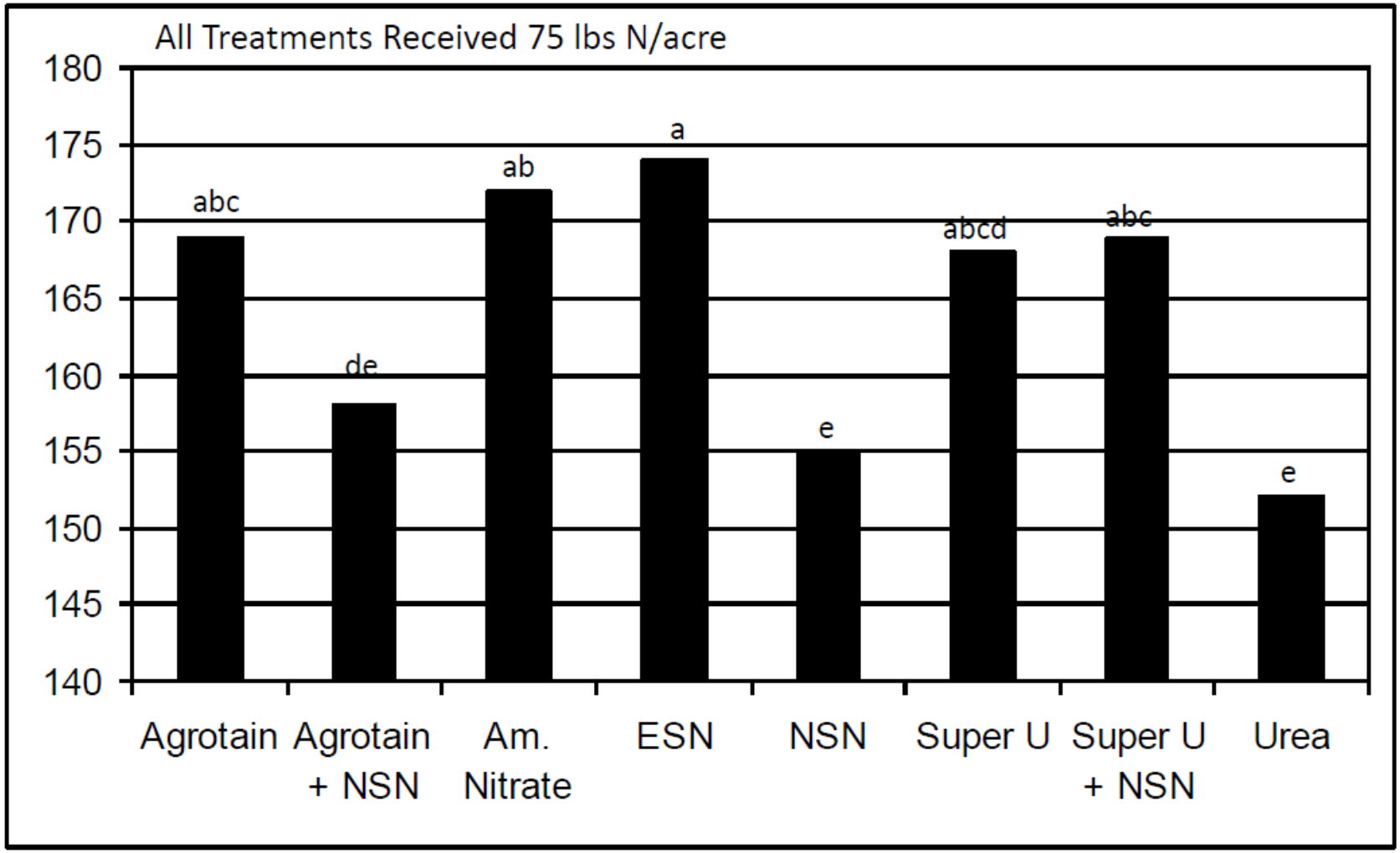
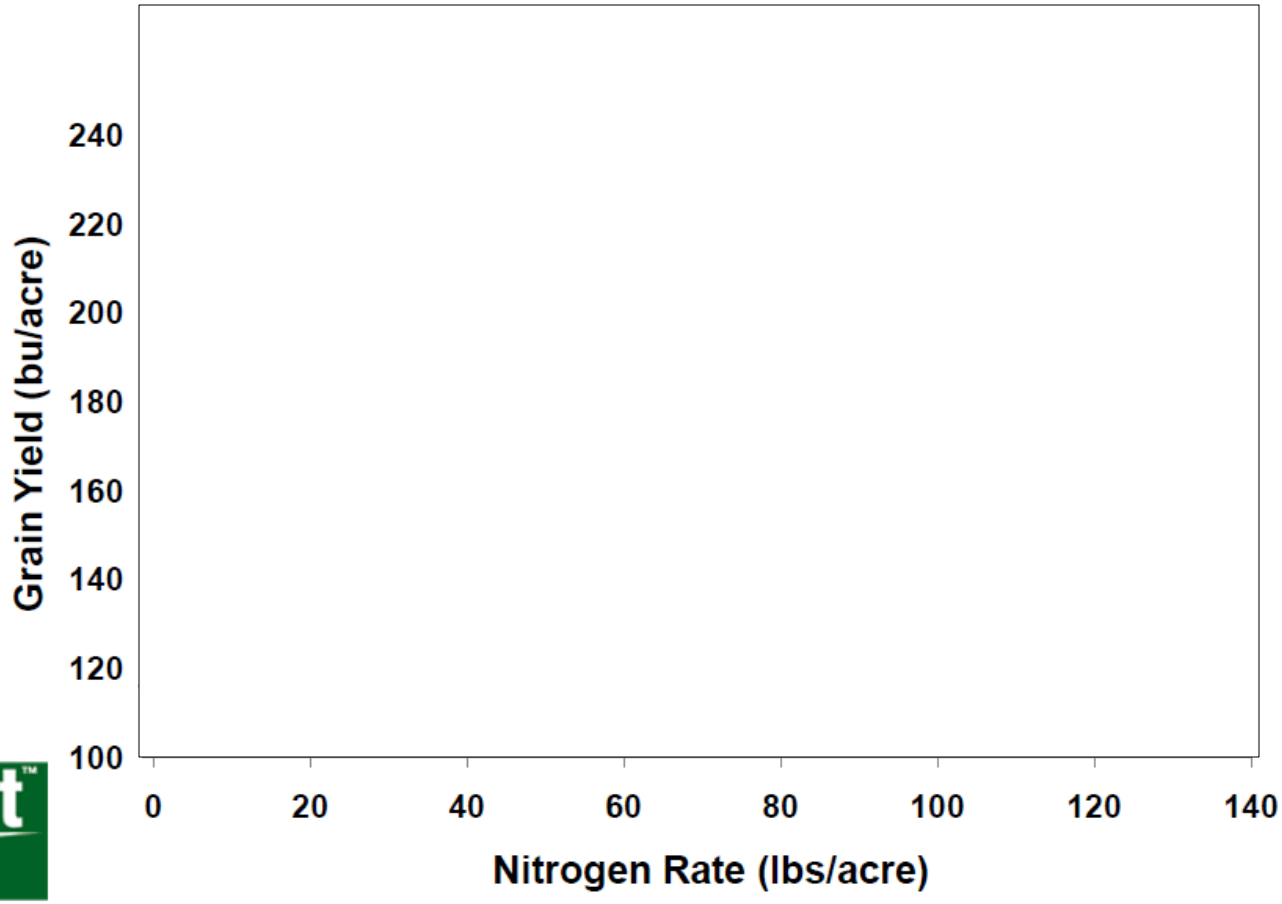


2009 Lexington Nitrification Study



Dow AgroSciences Instinct™ Nitrogen Stabilizer
™Trademark of Dow AgroSciences LLC

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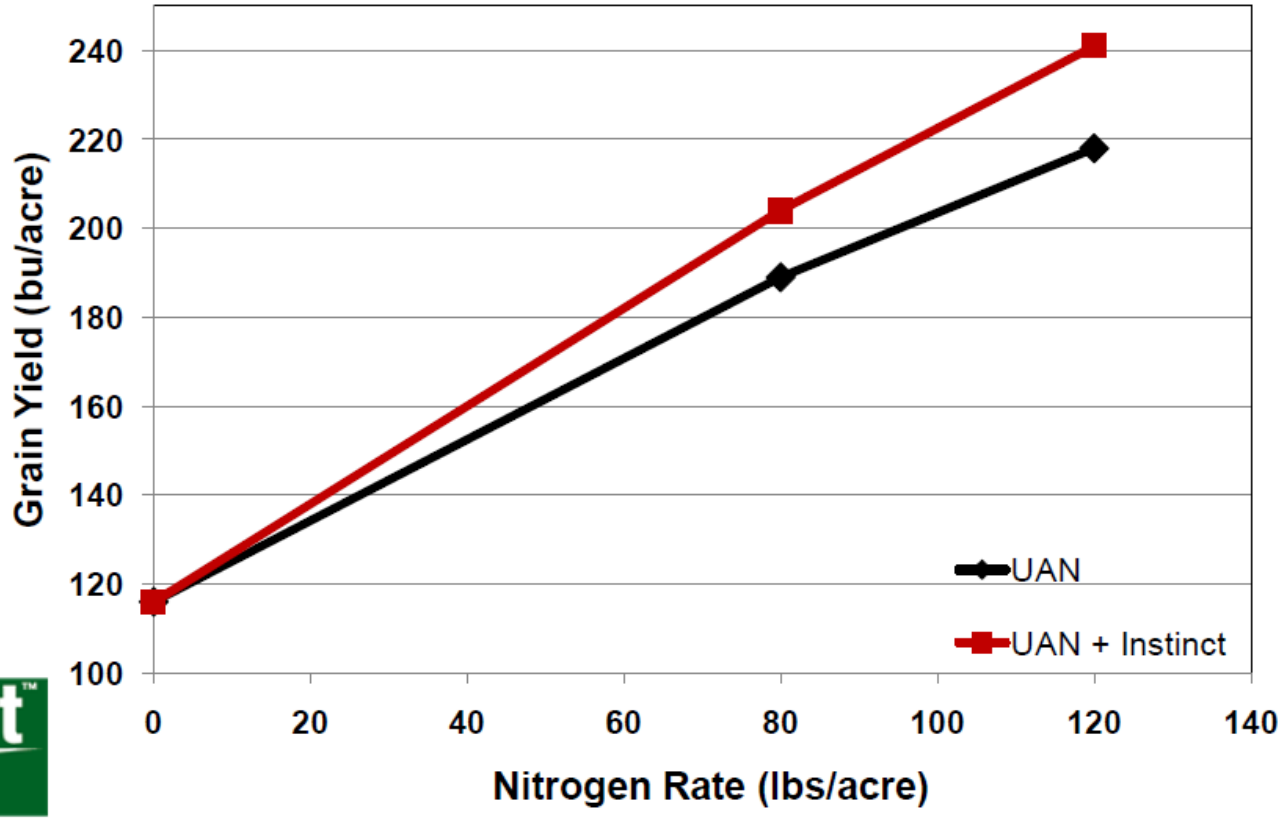

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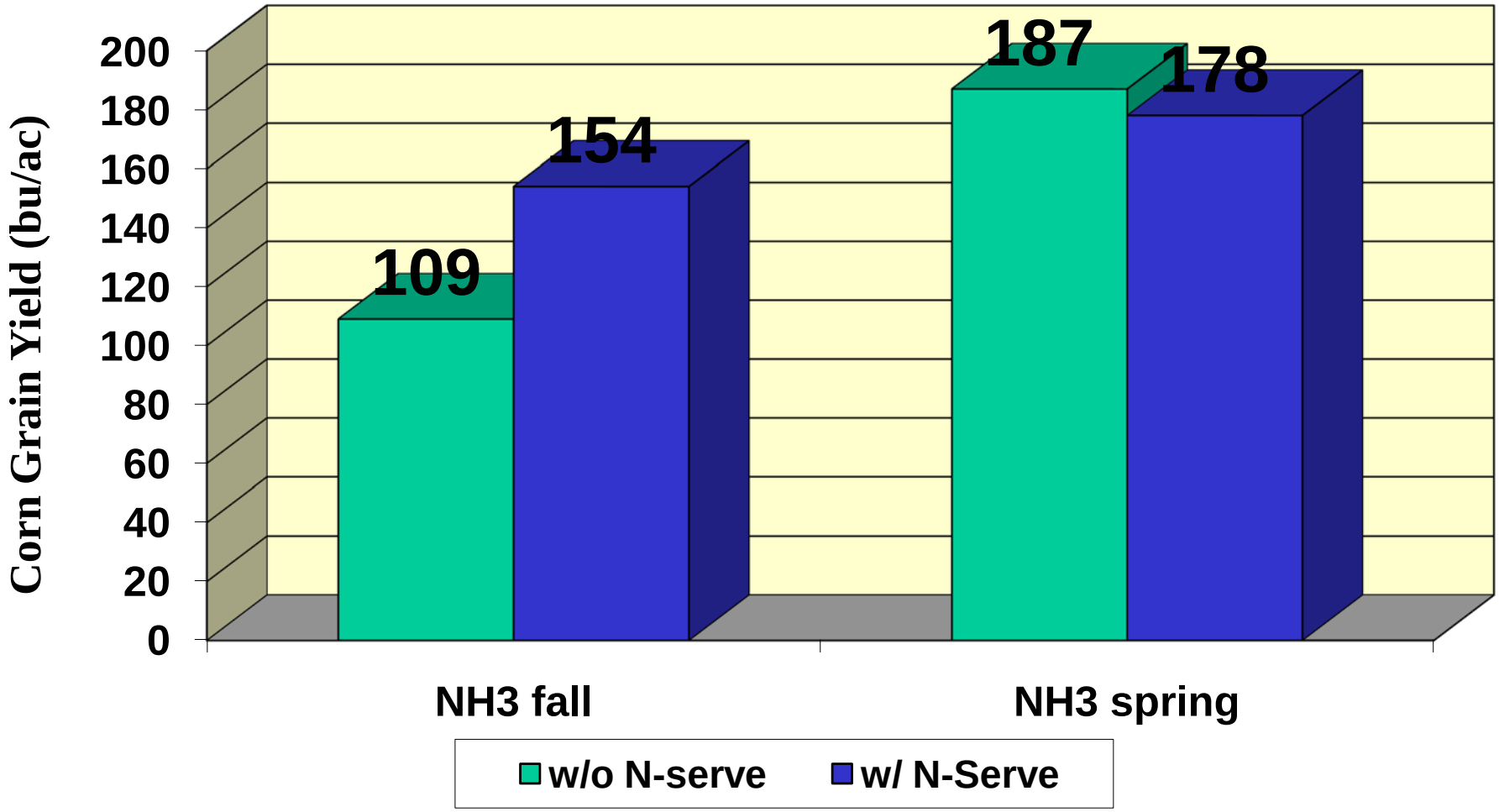
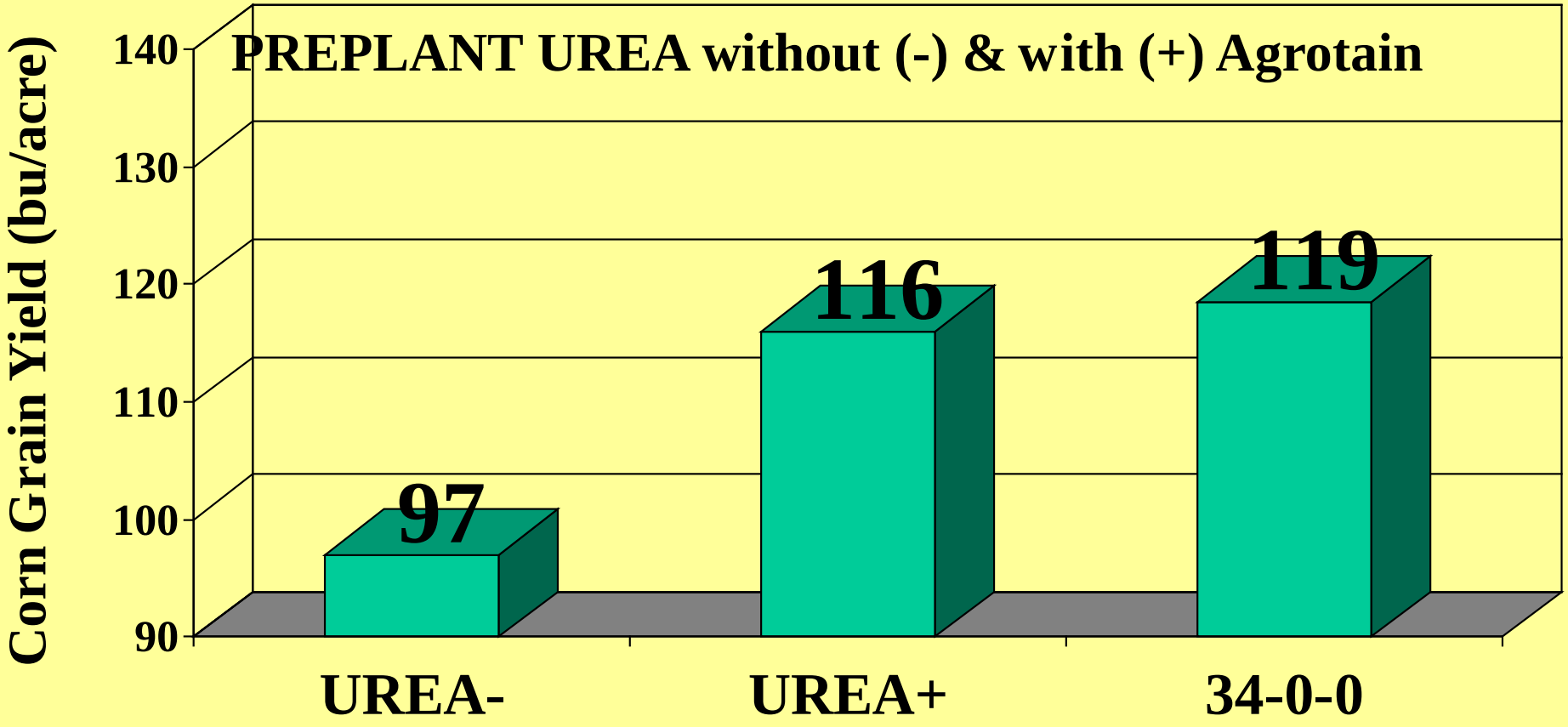
Minnesota: N-Serve 1999



Randall and Vetsch

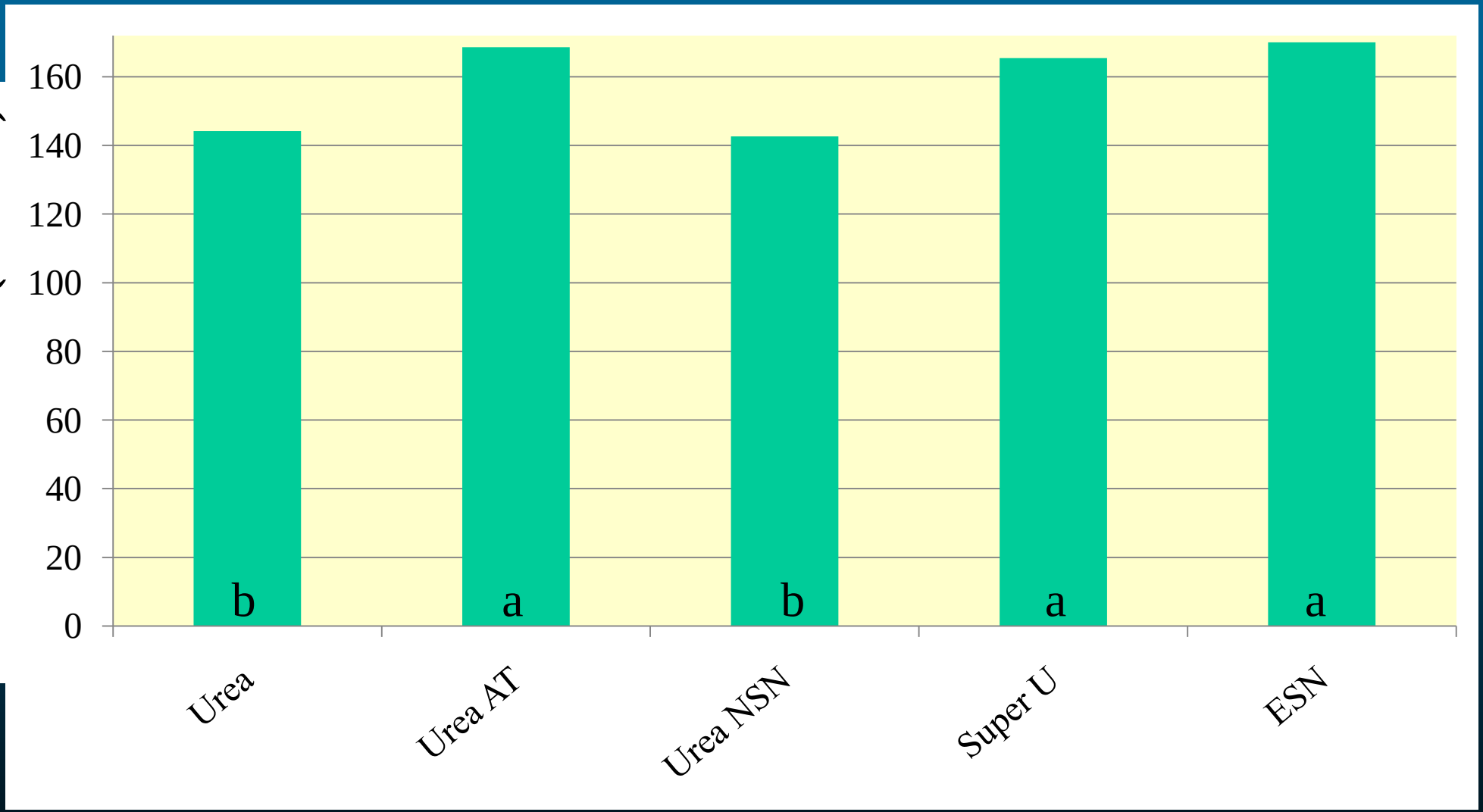
PA Study (Fox & Piekielek, 1993)



3-year study

Avg. 100 + 150

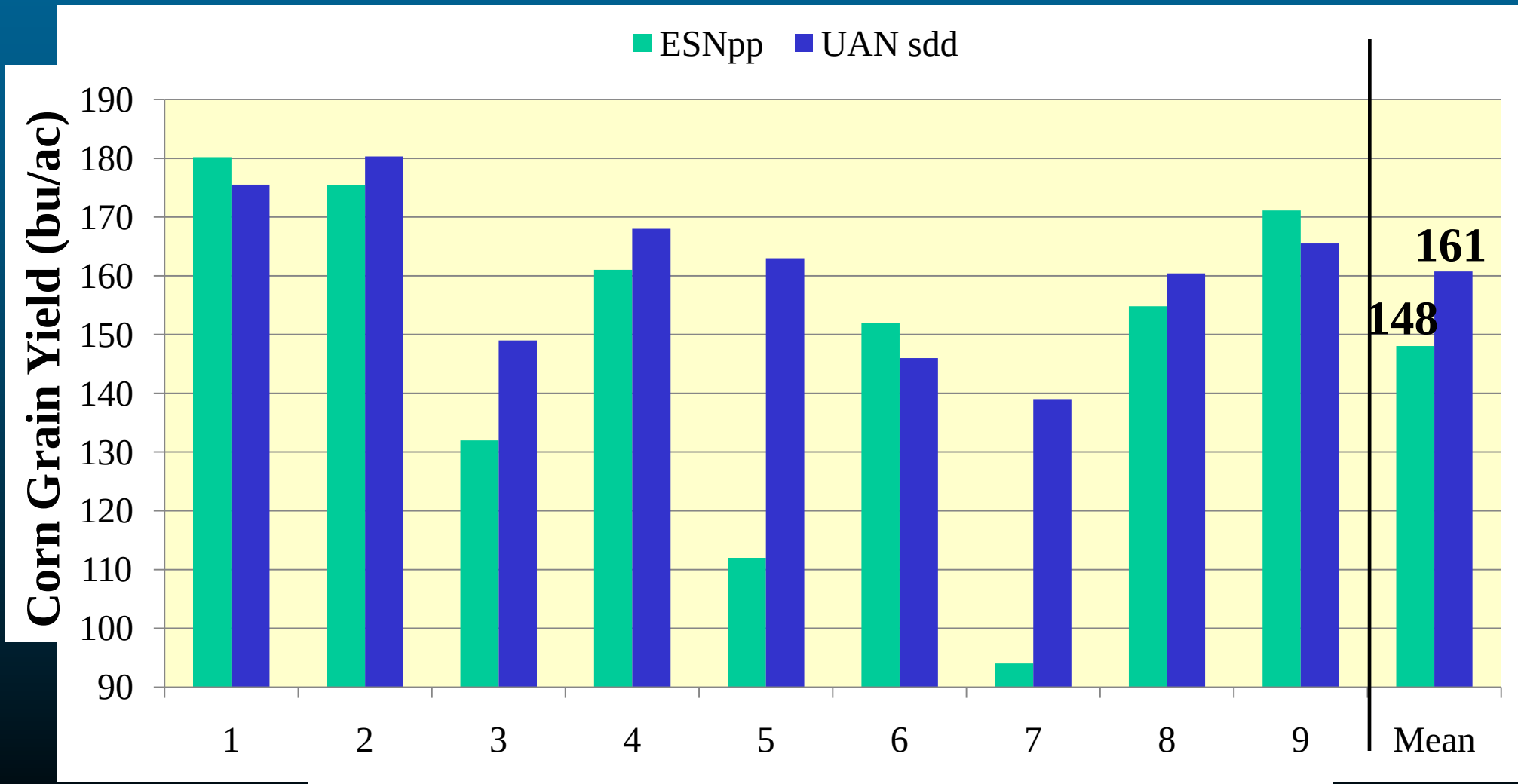
No-Till Corn in 2007: Illinois



Silt Loam Soil

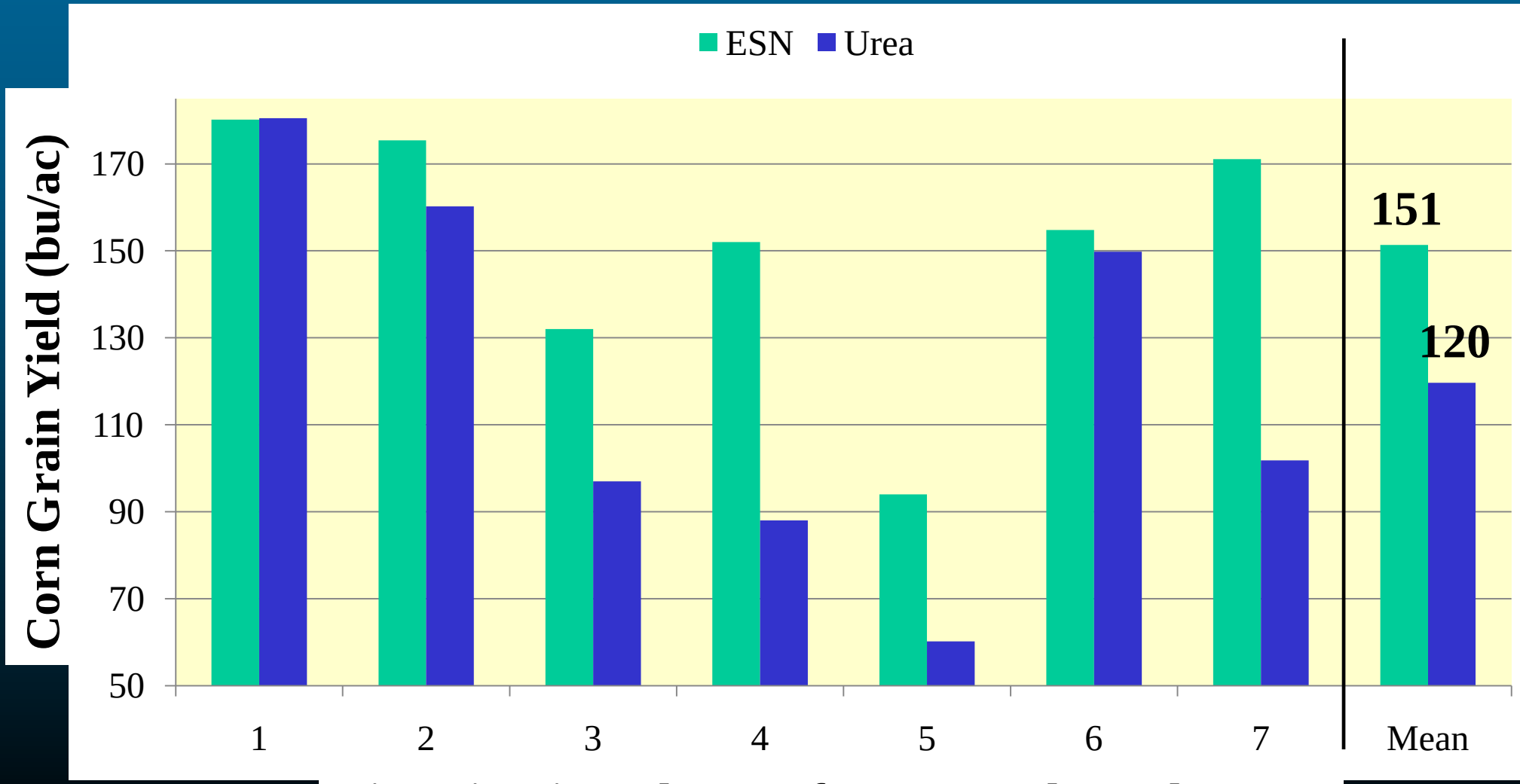
Steve Ebelhar: University of Illinois

ESN preplant vs UAN sidedress



Nine Sites in Delaware from 2004 through 2008

ESN vs Urea BOTH preplant



Nine Sites in Delaware from 2004 through 2008

SUMMARY

1) The N cycle is a dynamic system
2) Understanding = improved management
3) Improved management = ↓ loss potential
4) Improved management = ↑ profitability
5) Products for improving N efficiency
   - Know mechanism (urease/nitrification/slow)
   - Do you need that?
   - Does it really do what's claimed?

QUESTIONS???

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