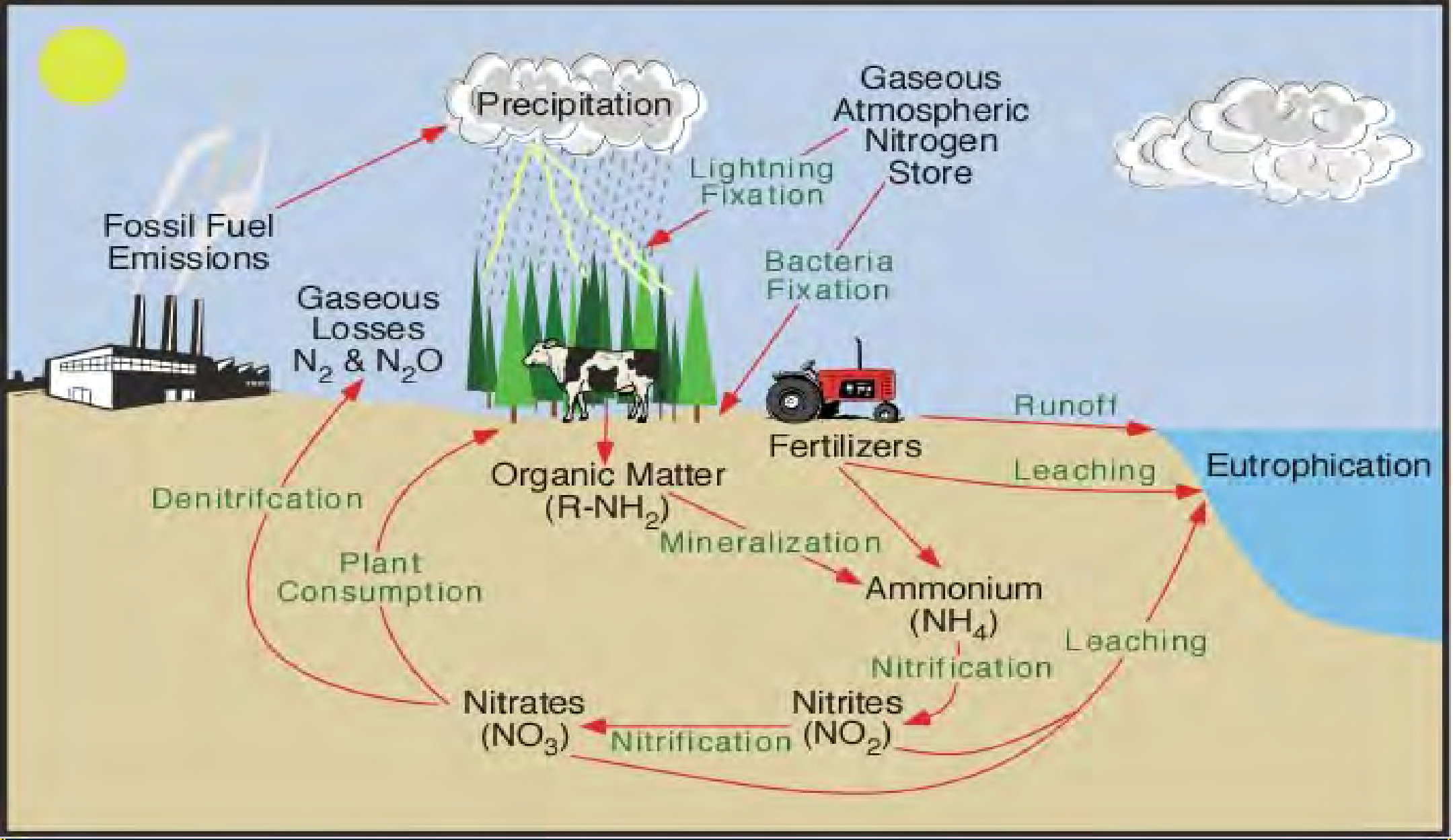
Products for Improving the Efficiency of N Fertilizers

Greg Binford
University of Delaware
302-831-2146
binfordg@udel.edu



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

Forms of N Present in Soils

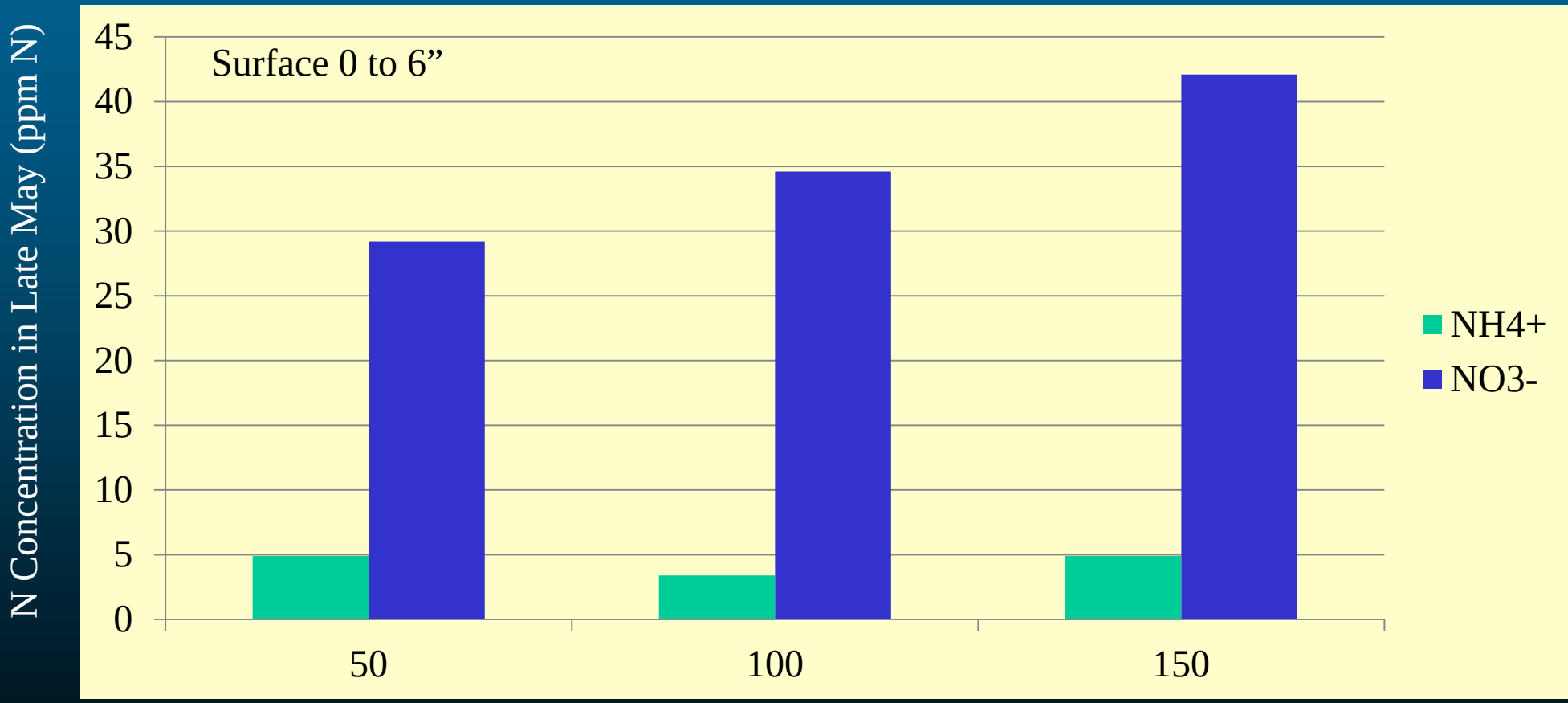
THREE major forms of N?

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

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



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

How is Nitrogen Lost?

THREE ways N is lost from soils:

1) LEACHING
2) DENITRIFICATION
3) VOLATILIZATION

VOLATILIZATION

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

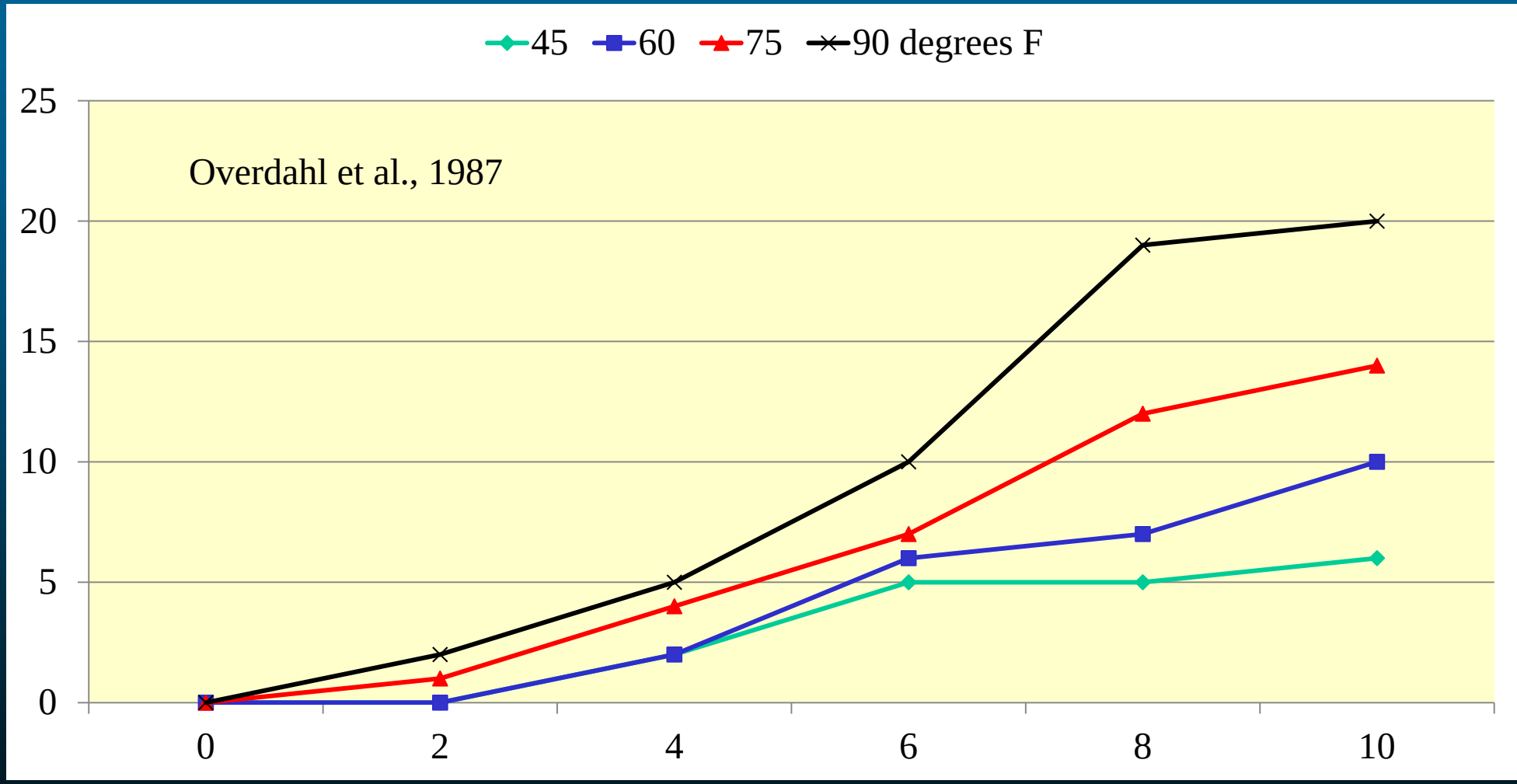
2) Ammonium in high pH environment

3) Soil pH is THE major influence

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

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

Ammonia Volatilization



VOLATILIZATION

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

2) Ammonium in high pH environment

3) Soil pH is THE major influence

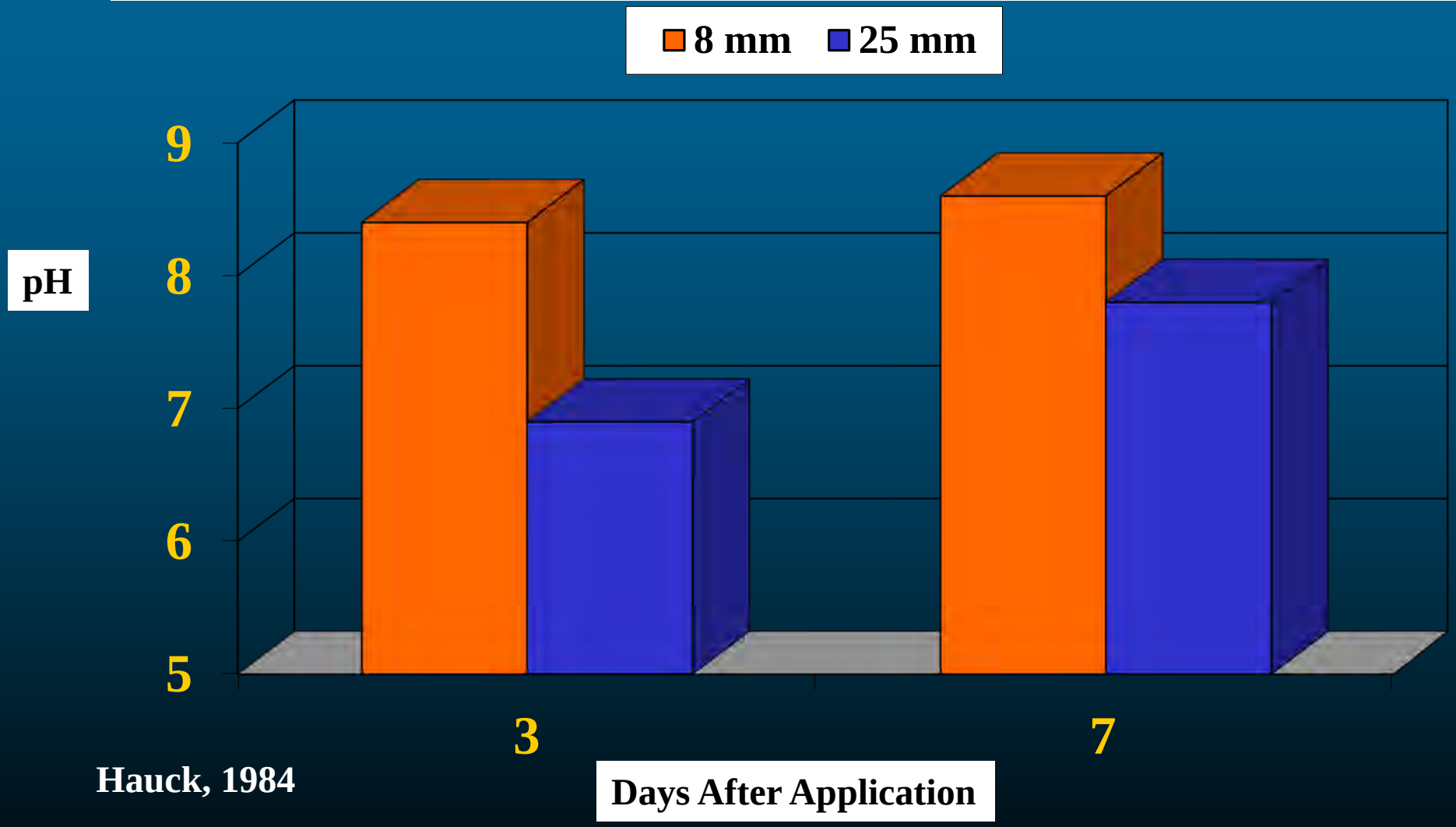
4) $NH_4^+ <=> NH_3(g) + H^+$

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

6) Prevent by incorporation of ammonium

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

Urea Prill Microsite pH



Hauck, 1984

Soil pH effects on percentages of N present as ammonia and ammonium

	Ammoniacal N	
Soil pH	Ammonia	Ammonium
	----------% ----------	
6	0.058	99.94
7	0.57	99.43
8	5.4	94.6
9	36.5	63.5

Urease Inhibitors

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) Urease inhibitors keeps N as urea until in soil

5) Rating the potential for response:

    1) UREA broadcast on soil surface

    2) UAN broadcast on soil surface

    3) UAN in a dribble band ??

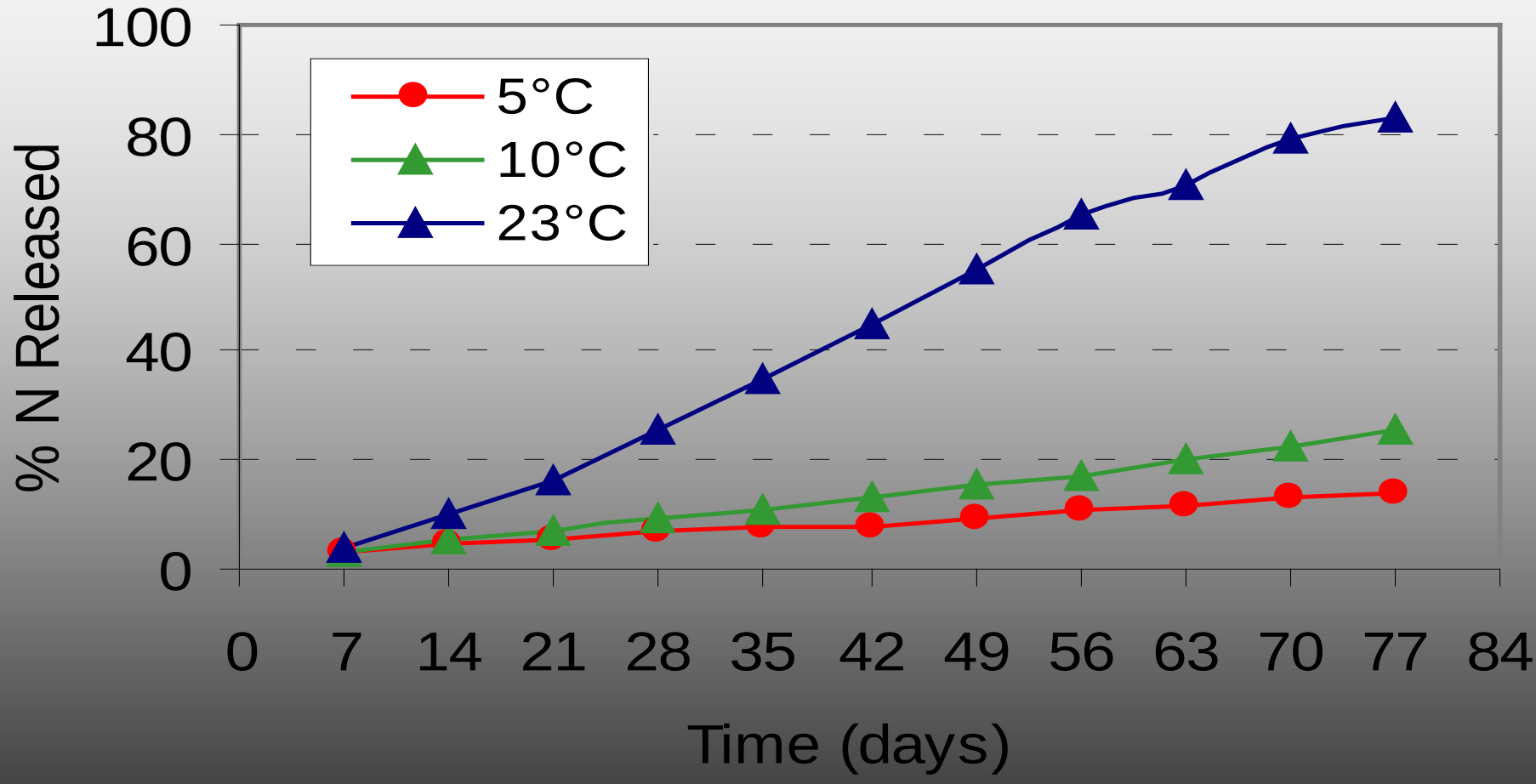
6) If urea gets into the soil (rain or tillage), then there is no need for a urease inhibitor

New Products: Nitrogen

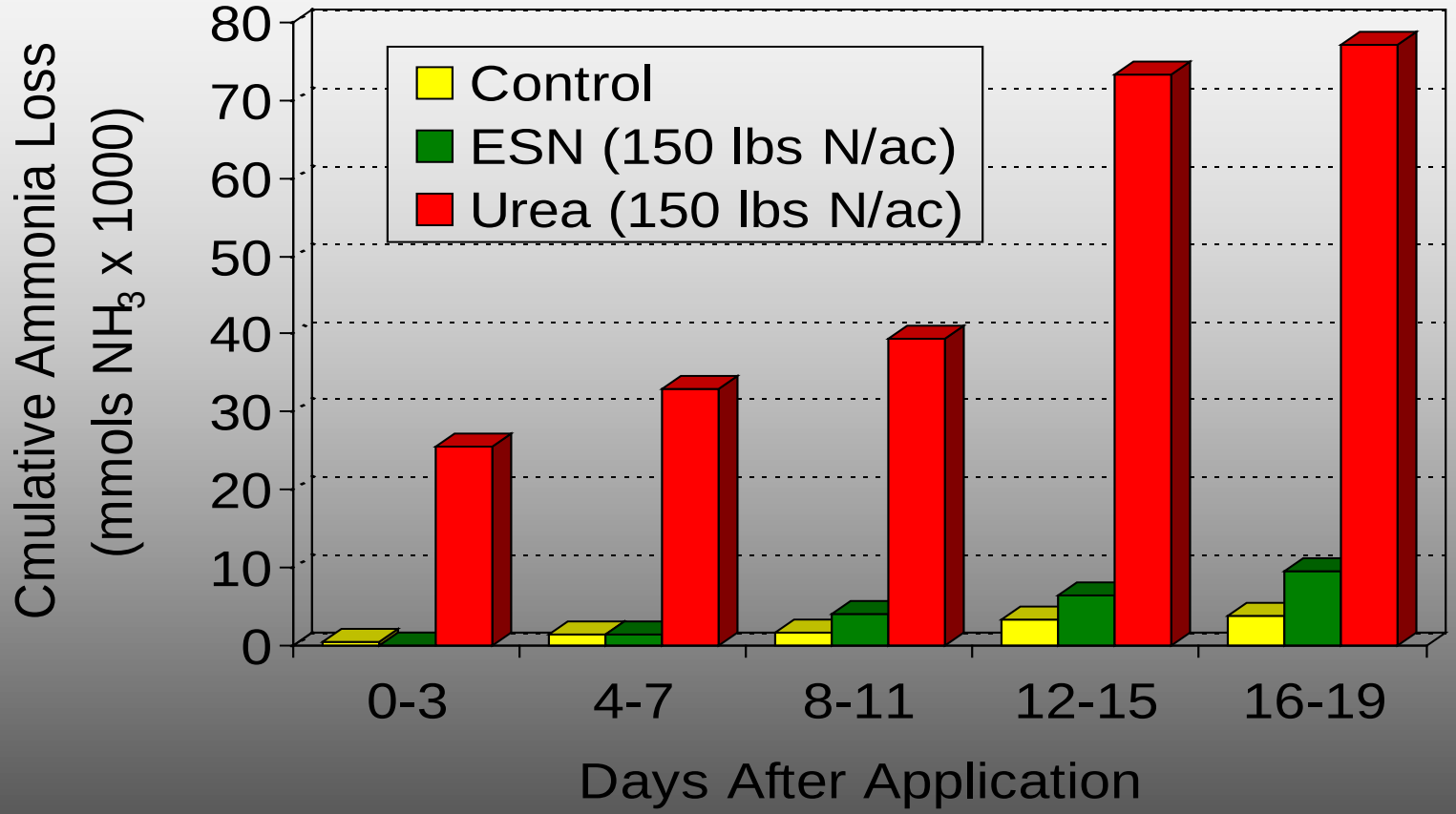
1) ESN = Polymer-Coated UREA fertilizer
2) Agrotain = Urease Inhibitor (urea/UAN)
3) Agrotain + = urease & nitrification inhibitor
4) Super U = urease & nitrification inhibitor
5) Nutrisphere-N (NSN) = urease & nitrification inhibitor

ESN STUDIES

ESN Release in Water

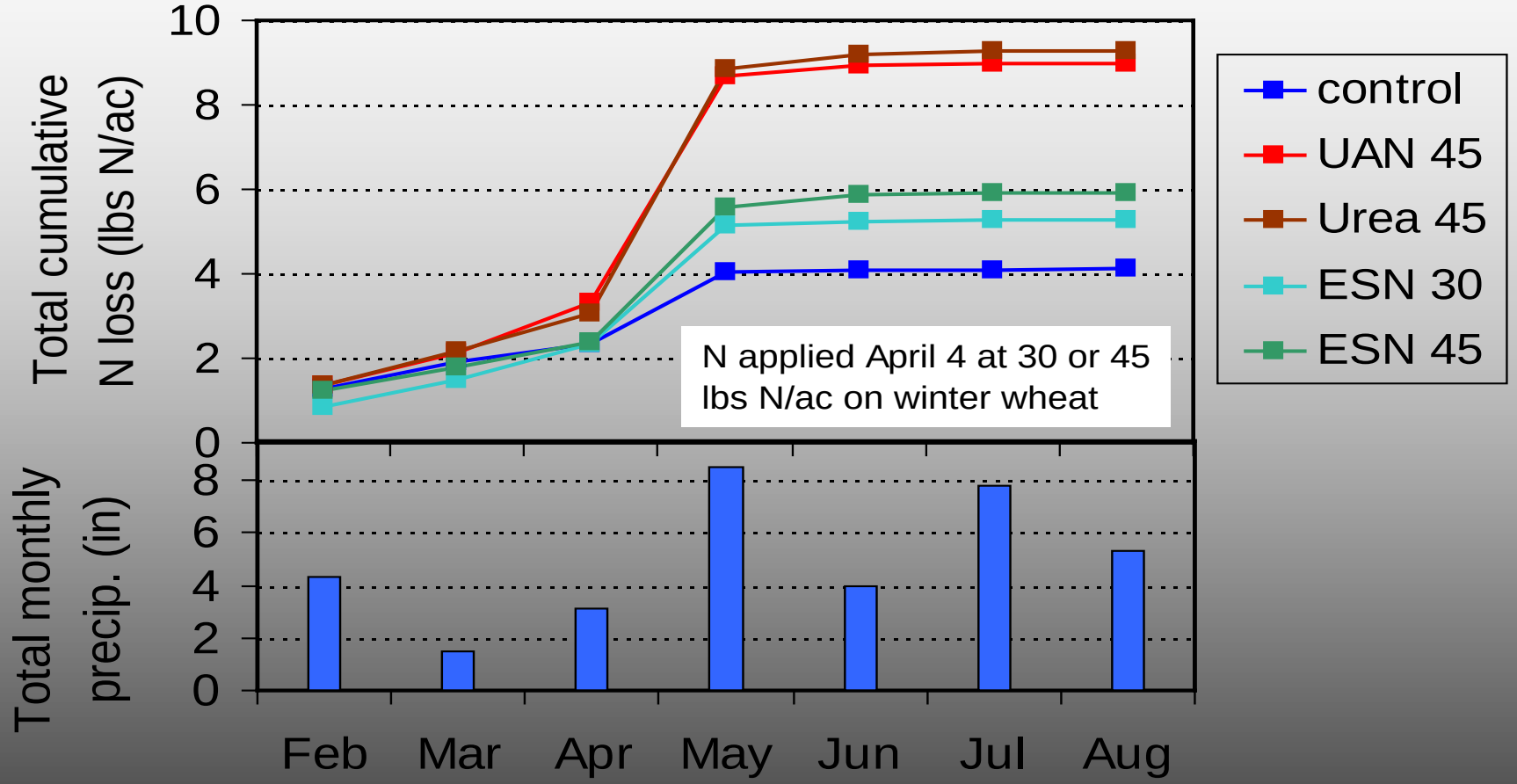


N Source and Ammonia Volatilization Washington, 2007



Field study; spring top-dress application on winter wheat
Source: R Koenig, Washington State Univ

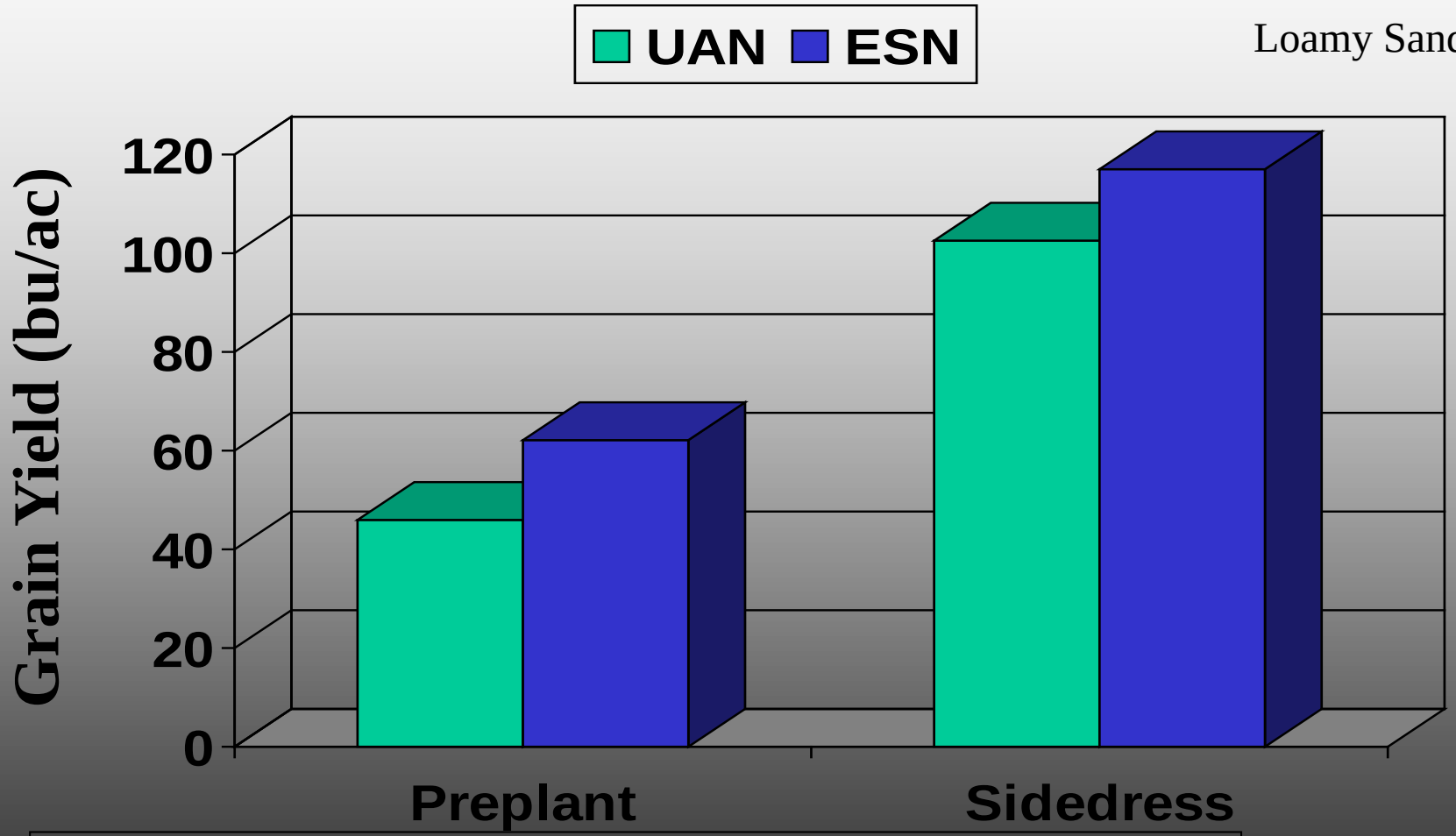
N Source and N Leaching Losses Winter Wheat, Ohio, 2003



Source: Dr. R. Islam, The Ohio State Univ, 2003.
Inorganic N in leachate from 100- x 30-foot lysimeters.
Calculated from total water volume and N concentration.

Delaware: Irrigated Corn in 2003

Statistically significant differences among all yields



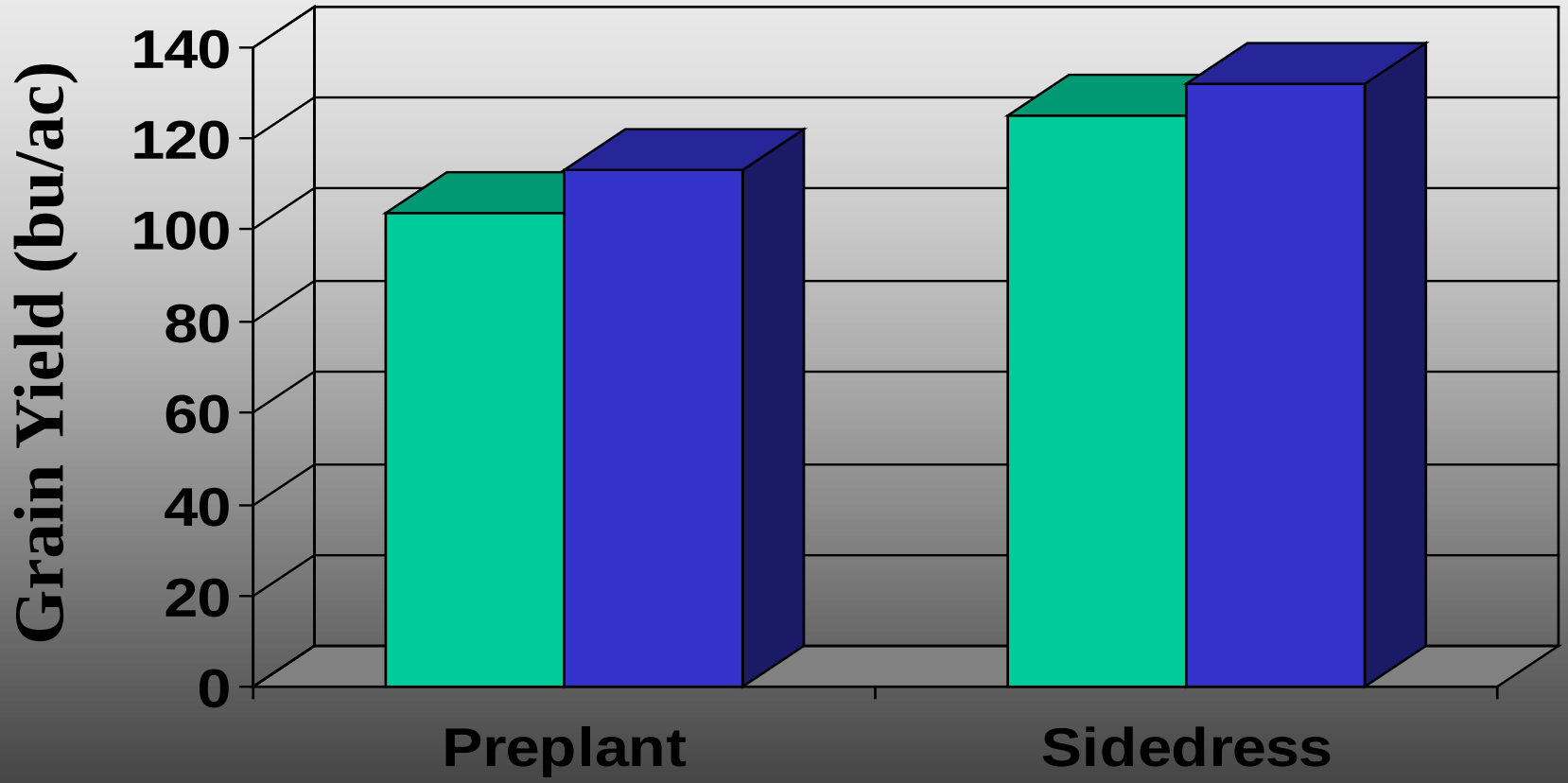
150 lb N/ac applied total; sidedress = 40 preplant & 110 sidedress

All treatments incorporated; weather was wettest year in more than 100 yrs

Delaware: Dryland Corn in 2003

Statistically significant differences b/w PP & SD

Silt Loam Soil

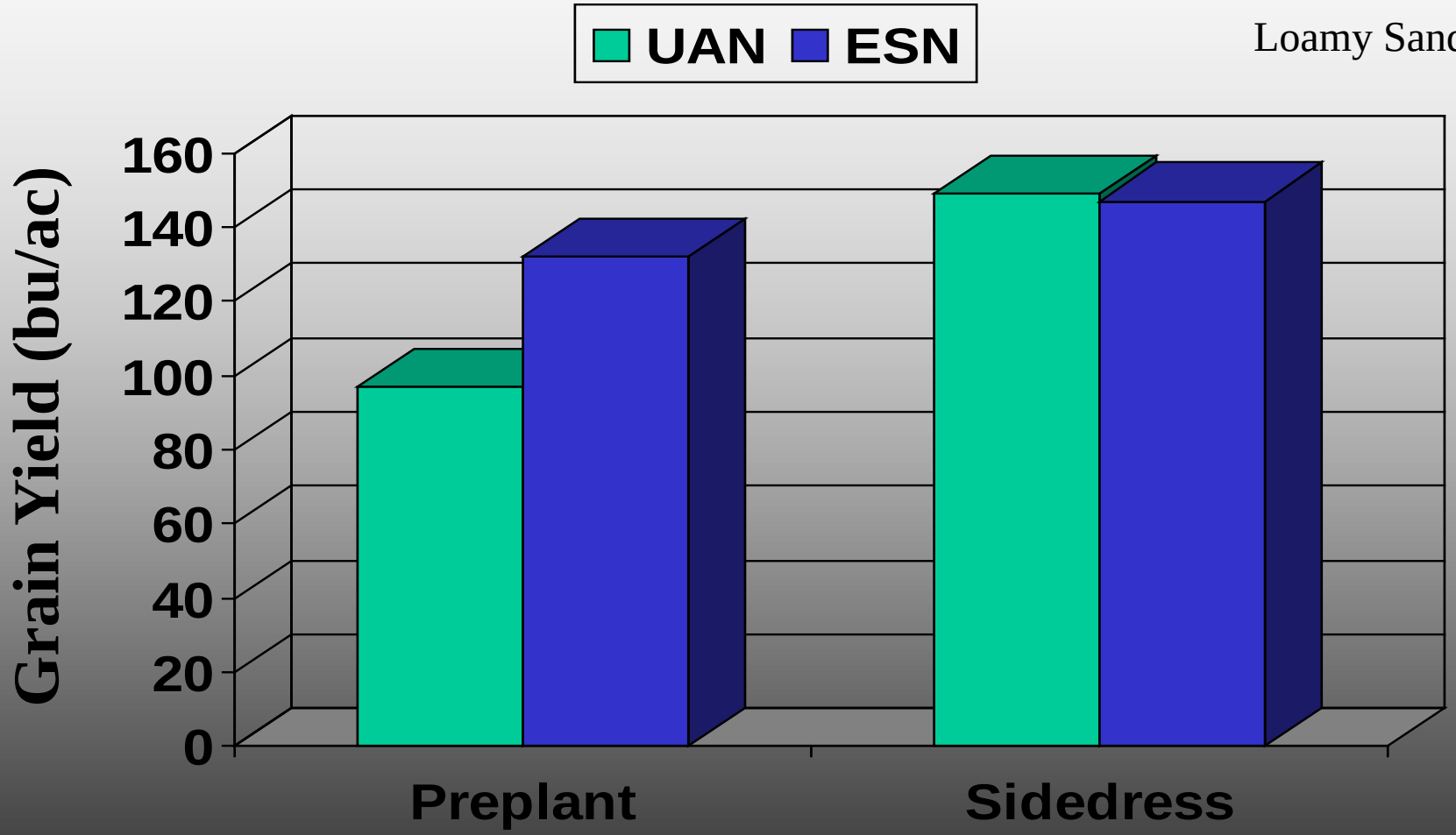


150 lb N/ac applied total; sidedress = 40 preplant & 110 sidedress

No-tilled into wheat stubble; weather was wettest year in more than 100 yrs

Delaware: Irrigated Corn in 2005

Statistically significant yield differences except for SD treatments

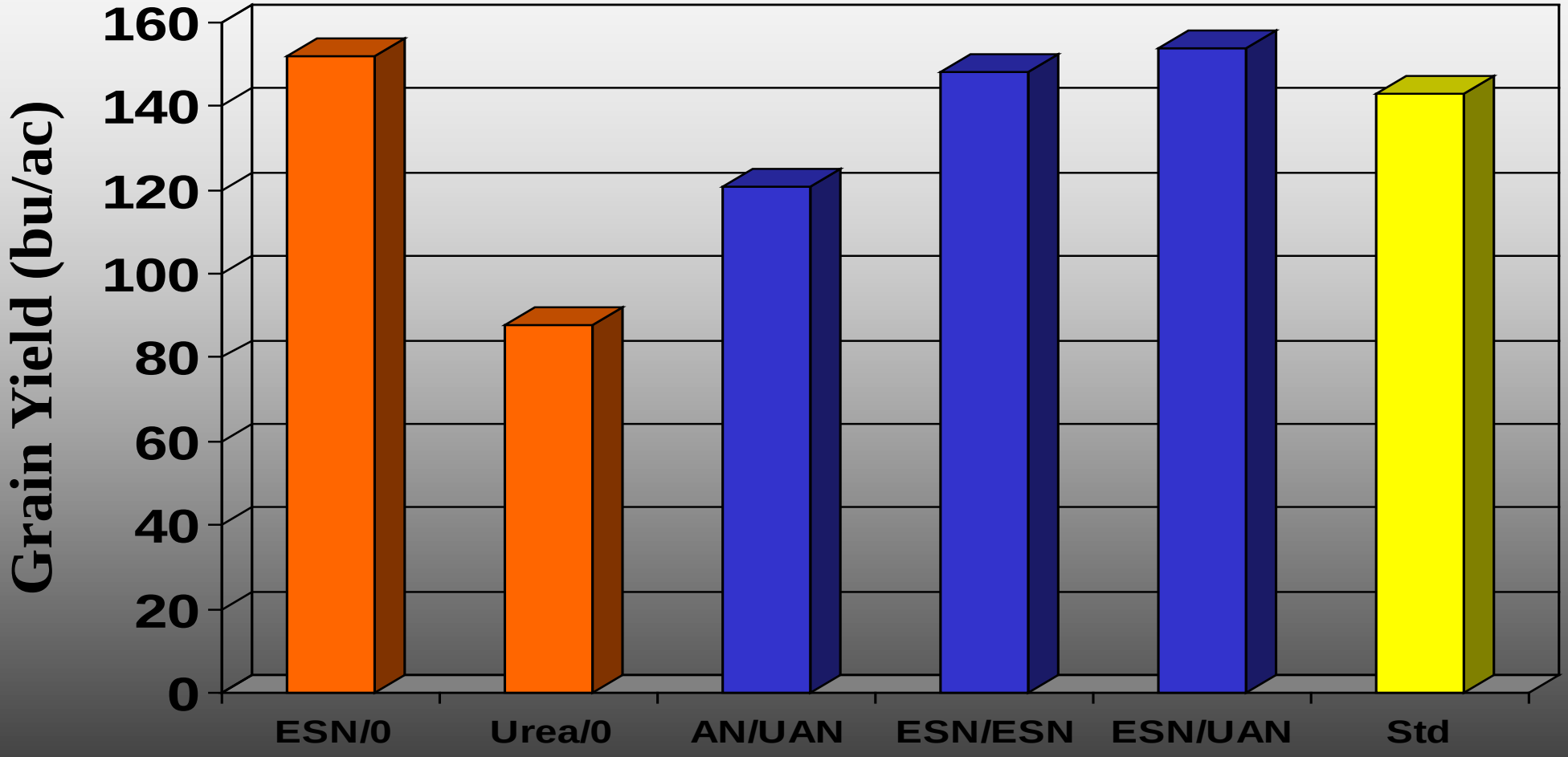


150 lb N/ac applied total; sidedress = 30 preplant & 120 sidedress

All treatments incorporated; rainfall was near-normal

Delaware: Irrigated Corn 2005

LSD = 18 bu/ac Loamy Sand Soil



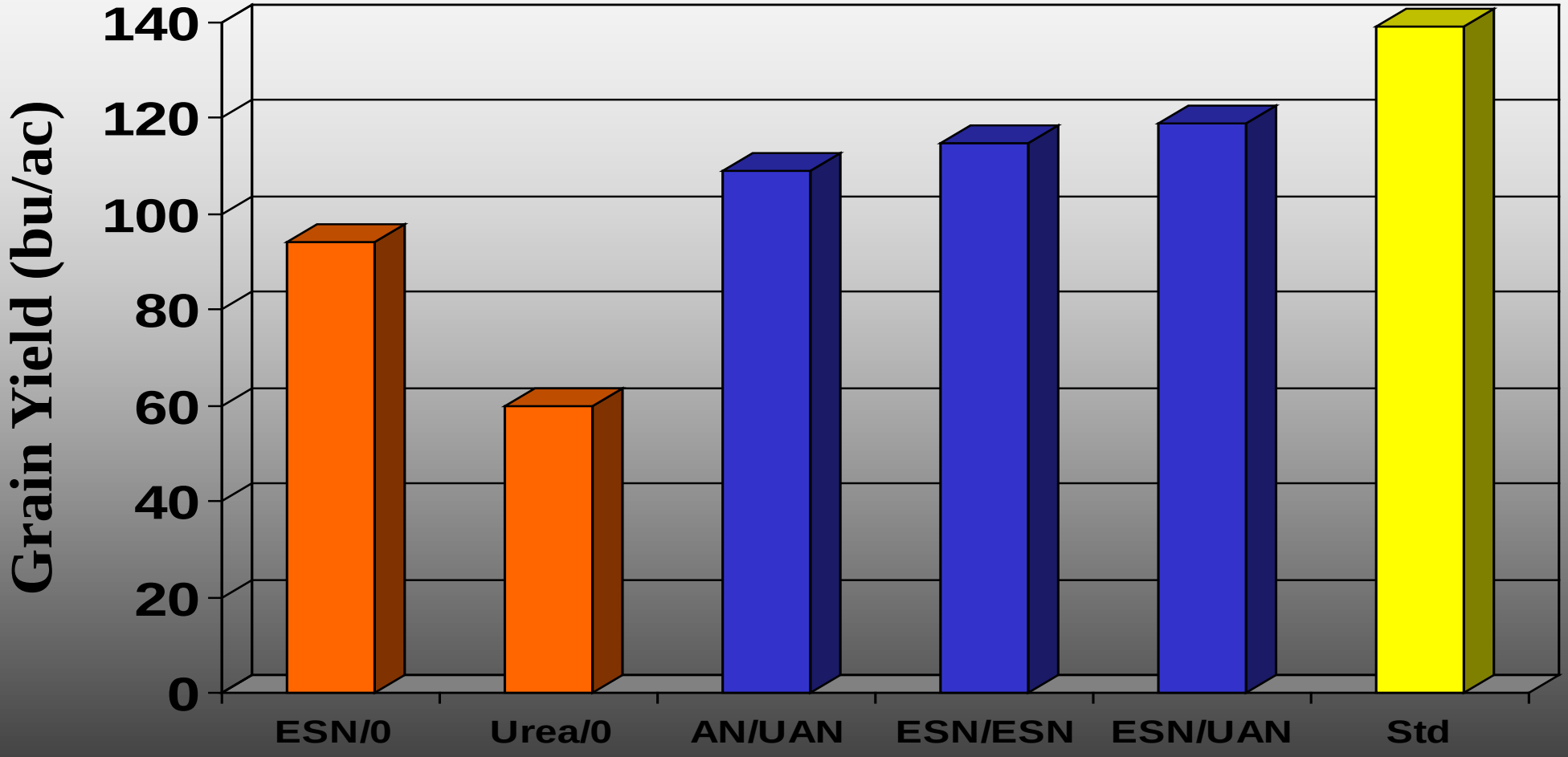
170 lb N/ac applied total; Split = 85 PP & 85 SD; Std =30 PP/140 SD

ONLY preplant treatments incorporated

ESN Application on Bare Soil

Delaware: Irrigated Corn 2006

LSD = 18 bu/ac Loamy Sand Soil

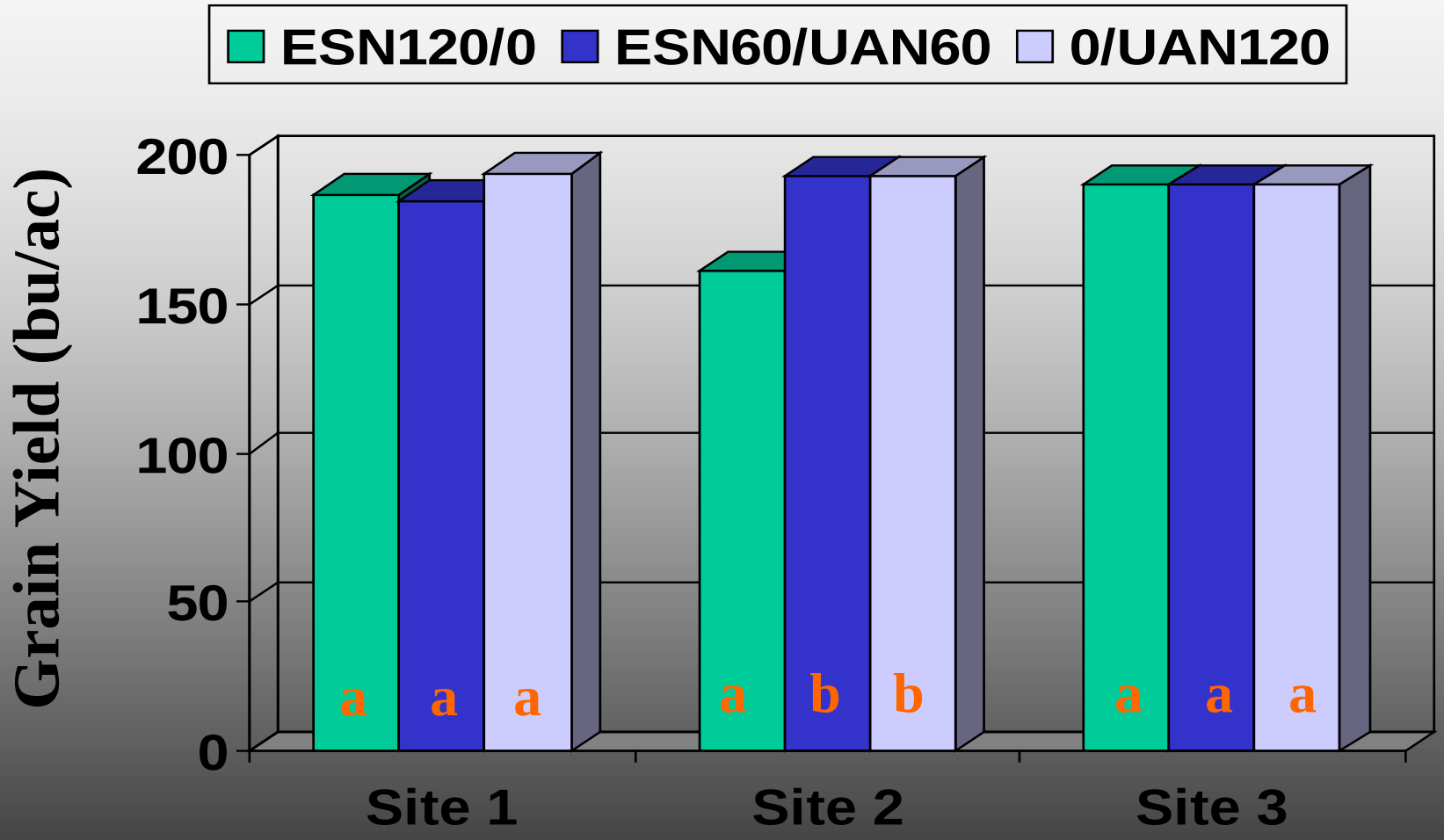


170 lb N/ac applied total; Split = 85 PP & 85 SD; Std =30 PP/140 SD

ONLY preplant treatments incorporated

Delaware: Corn in 2006

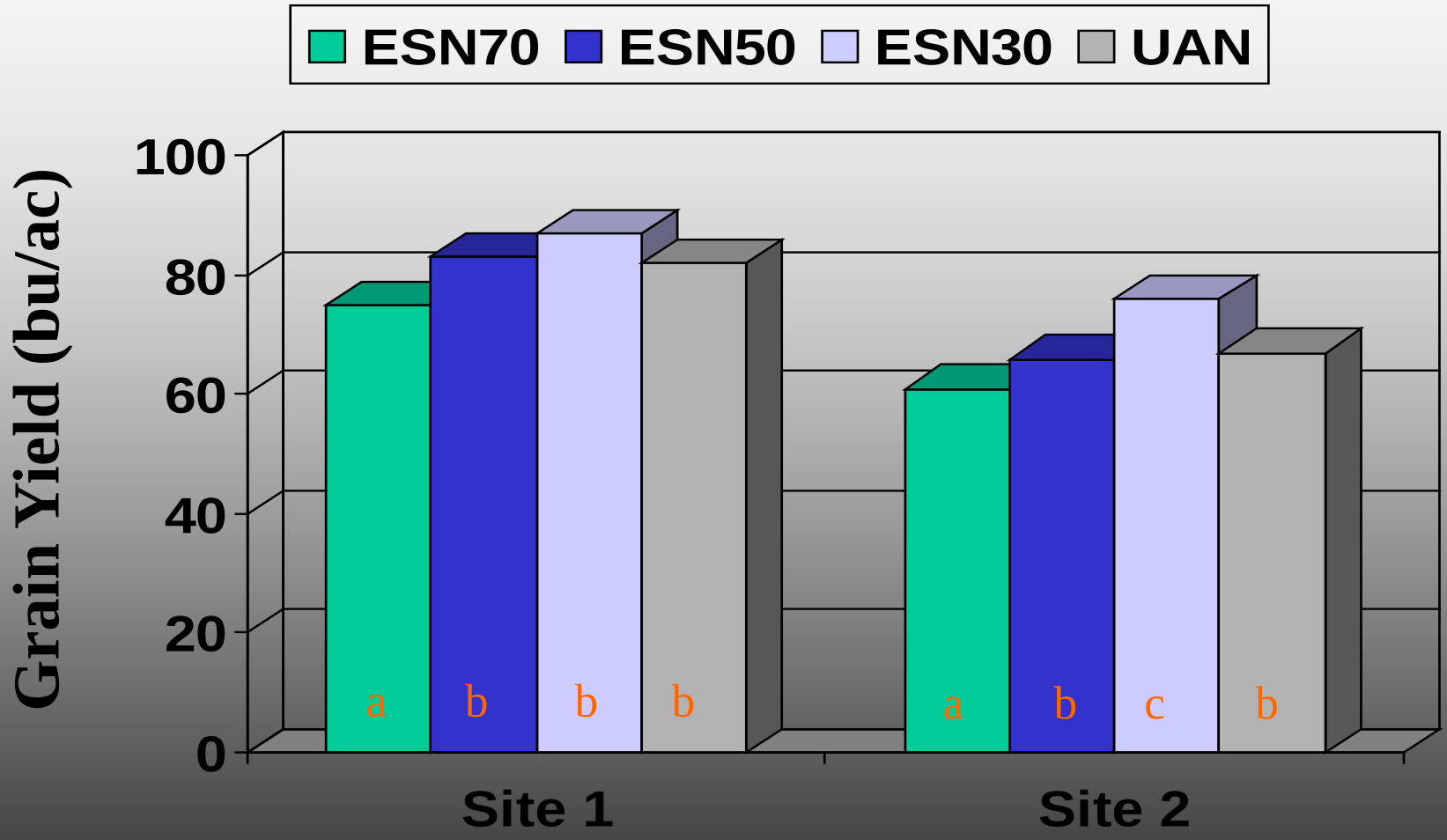
Yields with same letter within a site are not statistically different



120 lb N/ac Applied either Preplant, Sidedress, or as Even Split

Delaware: Winter Wheat in 2005

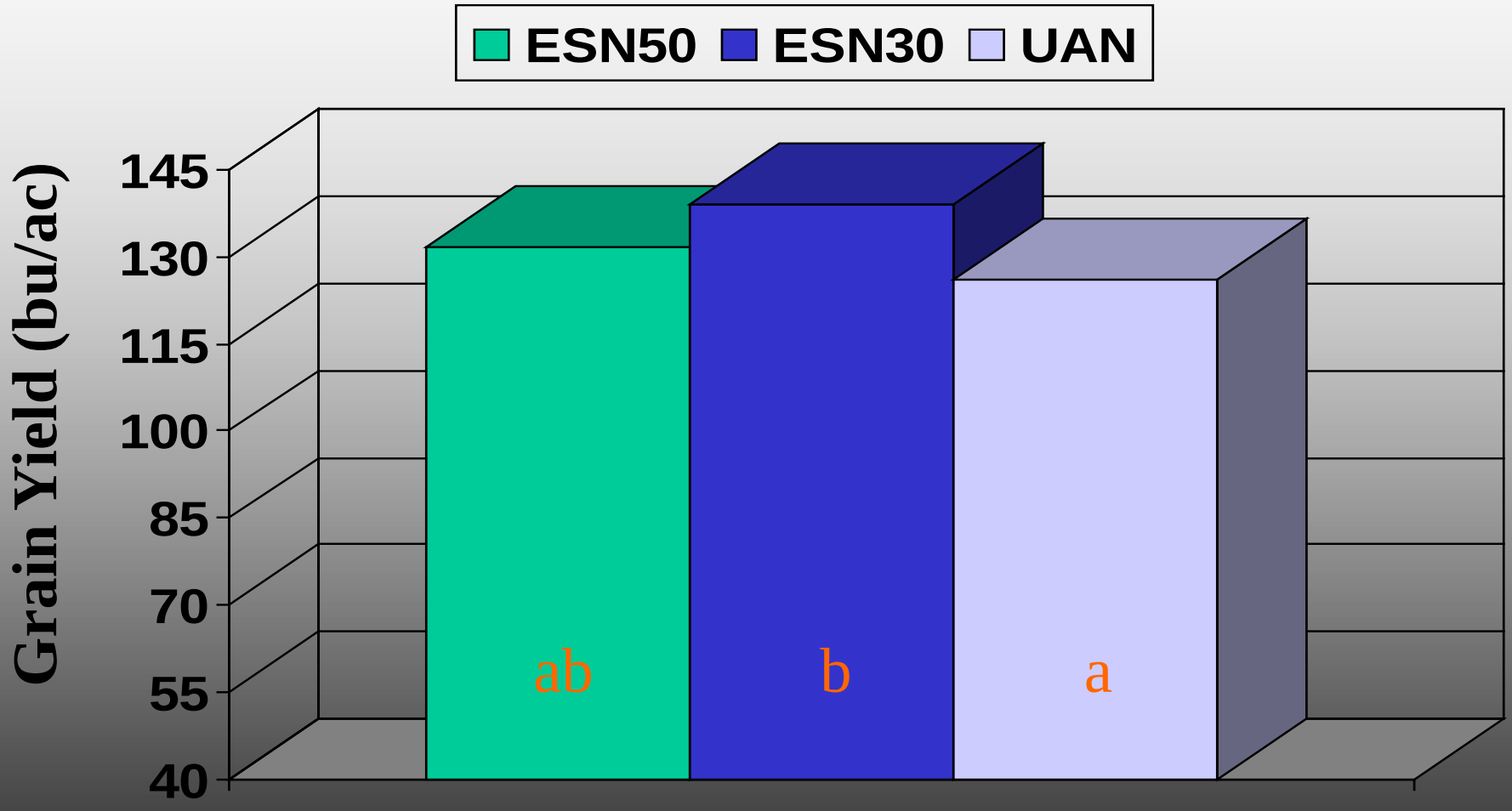
Yields with same letter within a site are not statistically different



75 lb N/ac applied at green-up as spring topdress

Delaware: Winter Wheat in 2006

Yields with same letter are not statistically different



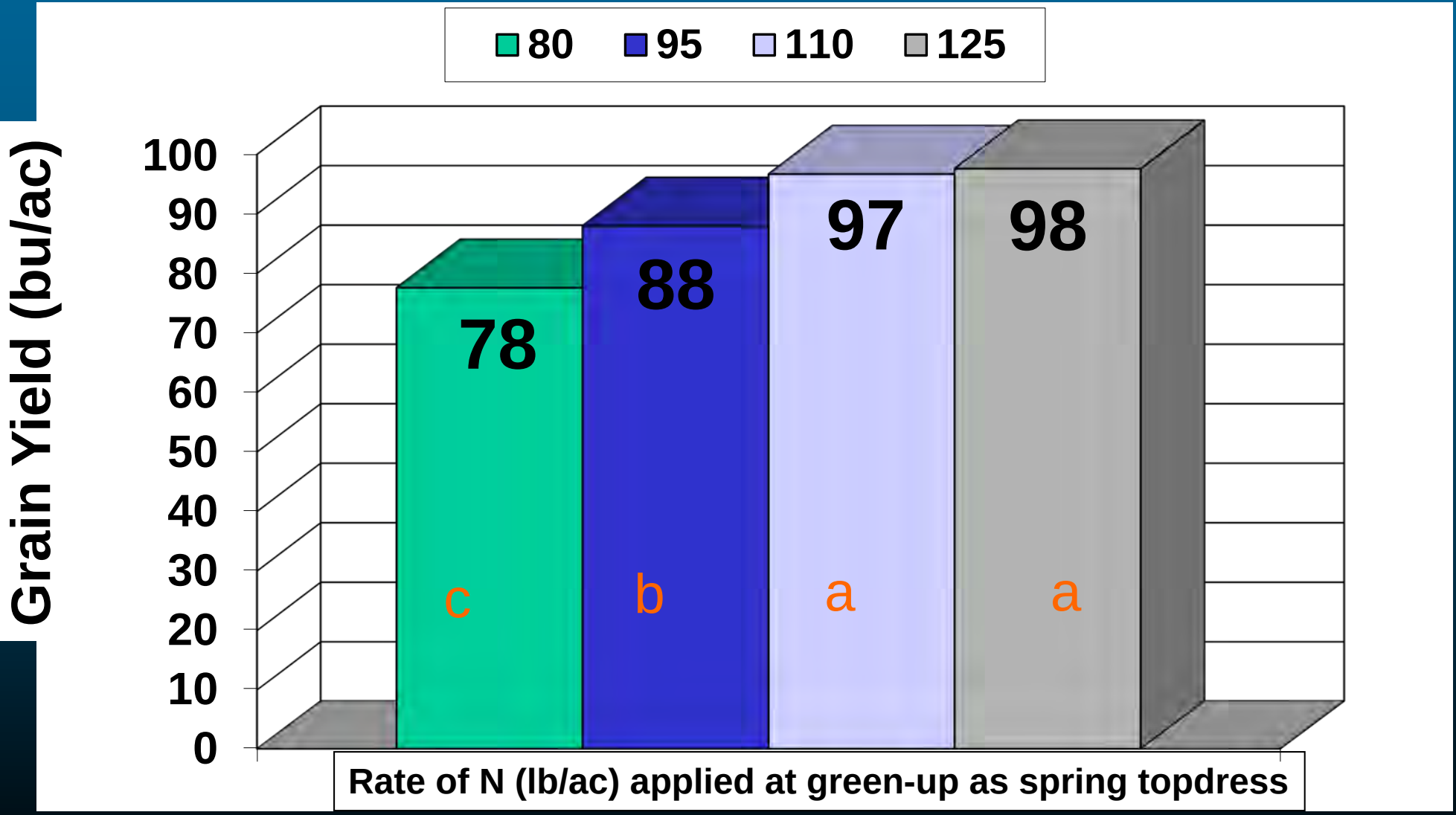
90 lb N/ac applied at green-up as spring topdress

Winter Wheat Treatments in ‘07 & ‘08

1) FOUR N Rates as UAN
2) Agrotain
3) Agrotain Plus
4) Nutrisphere N
5) Polymer Coated Urea
6) Ammonium Nitrate and/or Urea

Winter Wheat in 2007: Sussex (Irrigated)

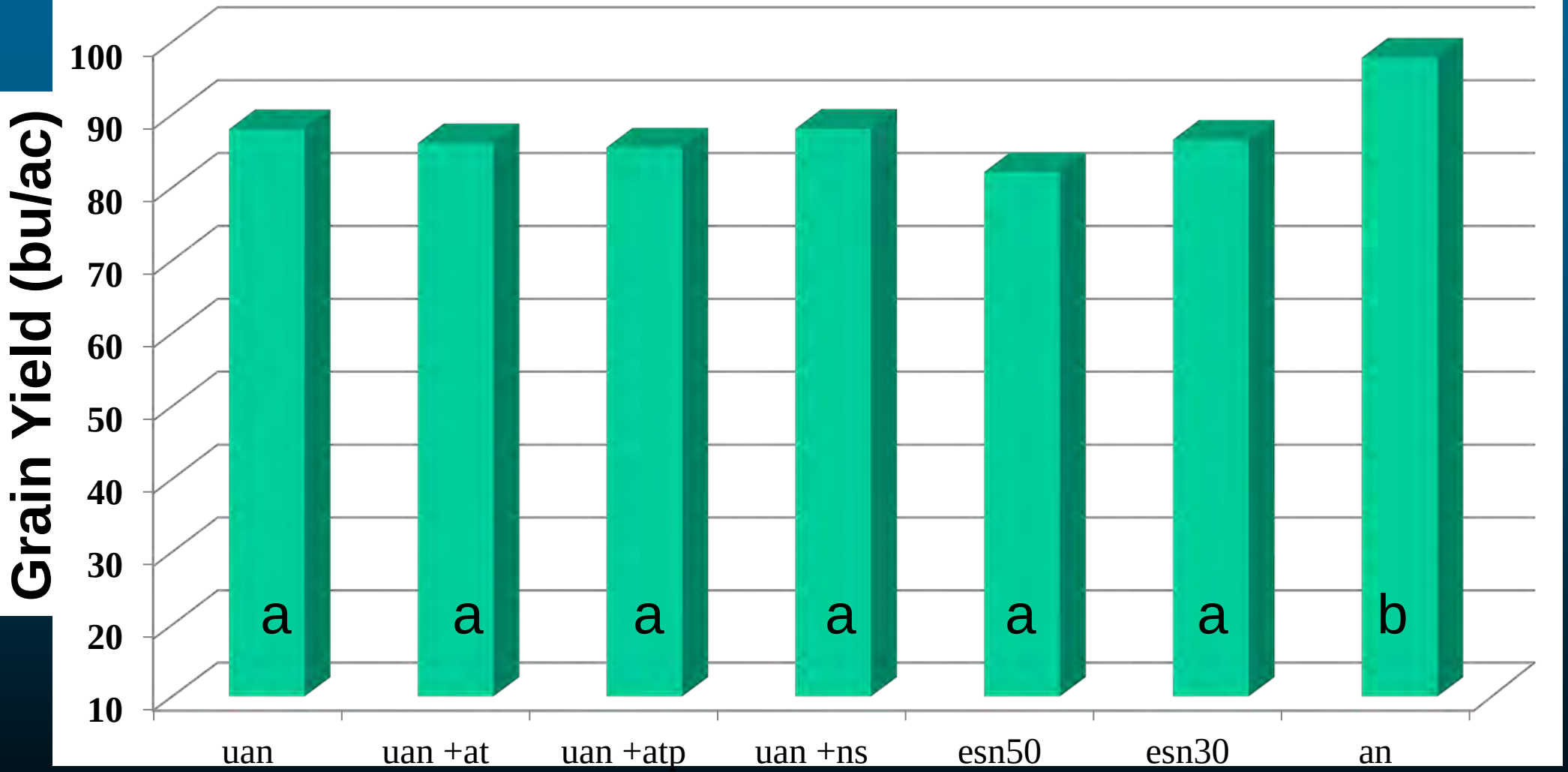
Yields with same letter are not statistically different



Winter Wheat in 2007: Sussex (Irrigated)

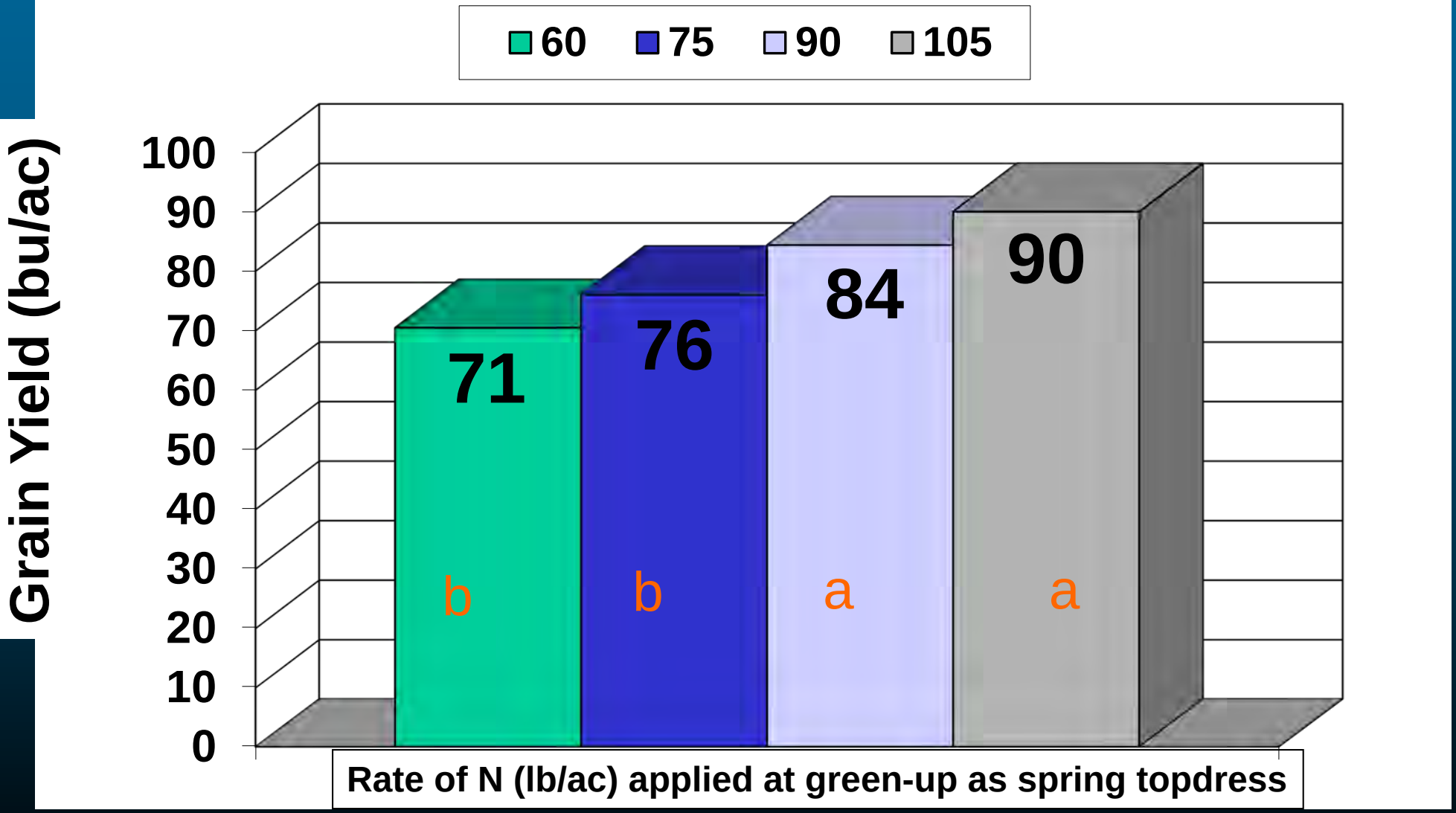
Yields with same letter are not statistically different

LSD = 5.3



Winter Wheat in 2007: New Castle

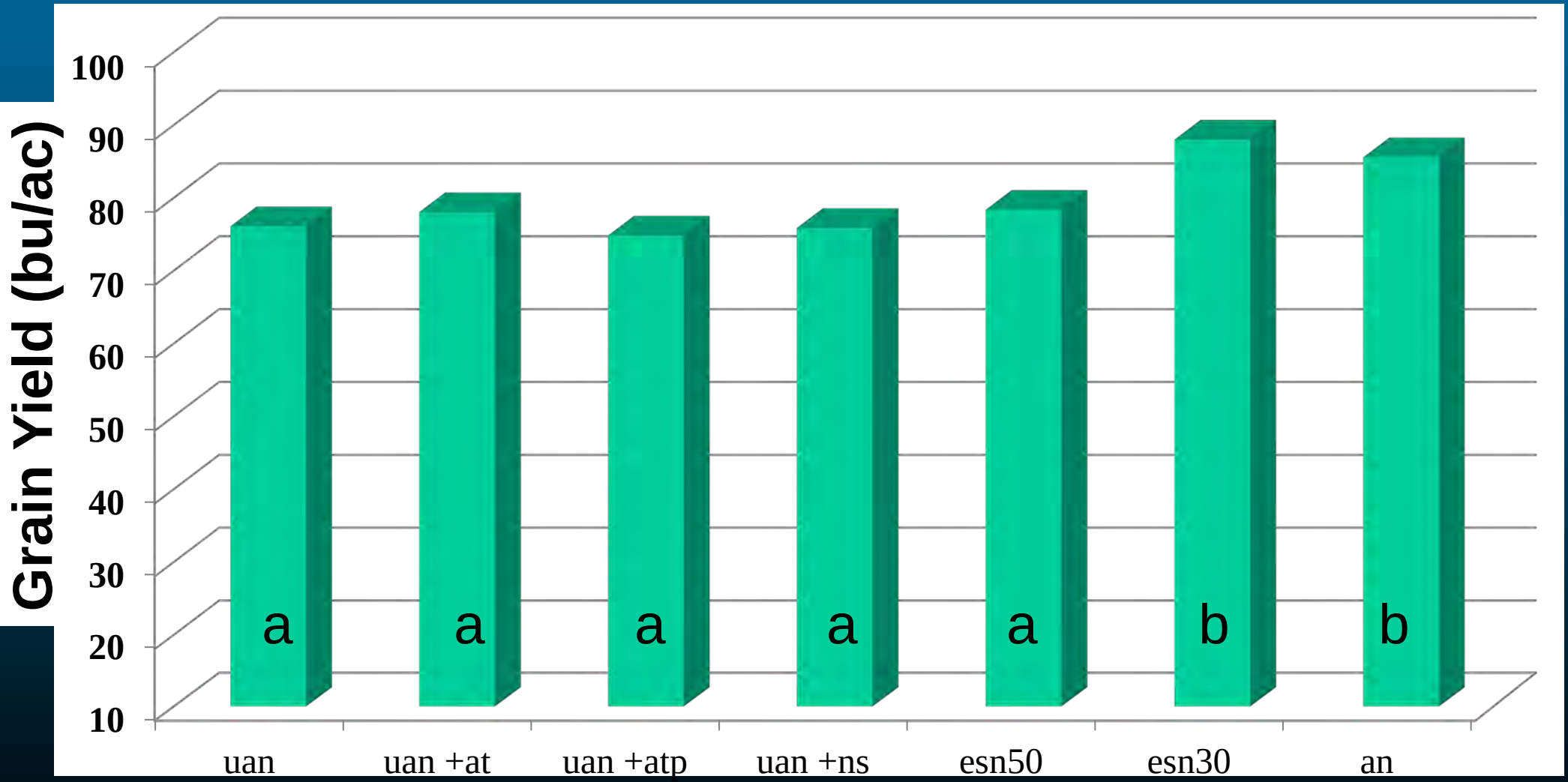
Yields with same letter are not statistically different



Winter Wheat in 2007: New Castle

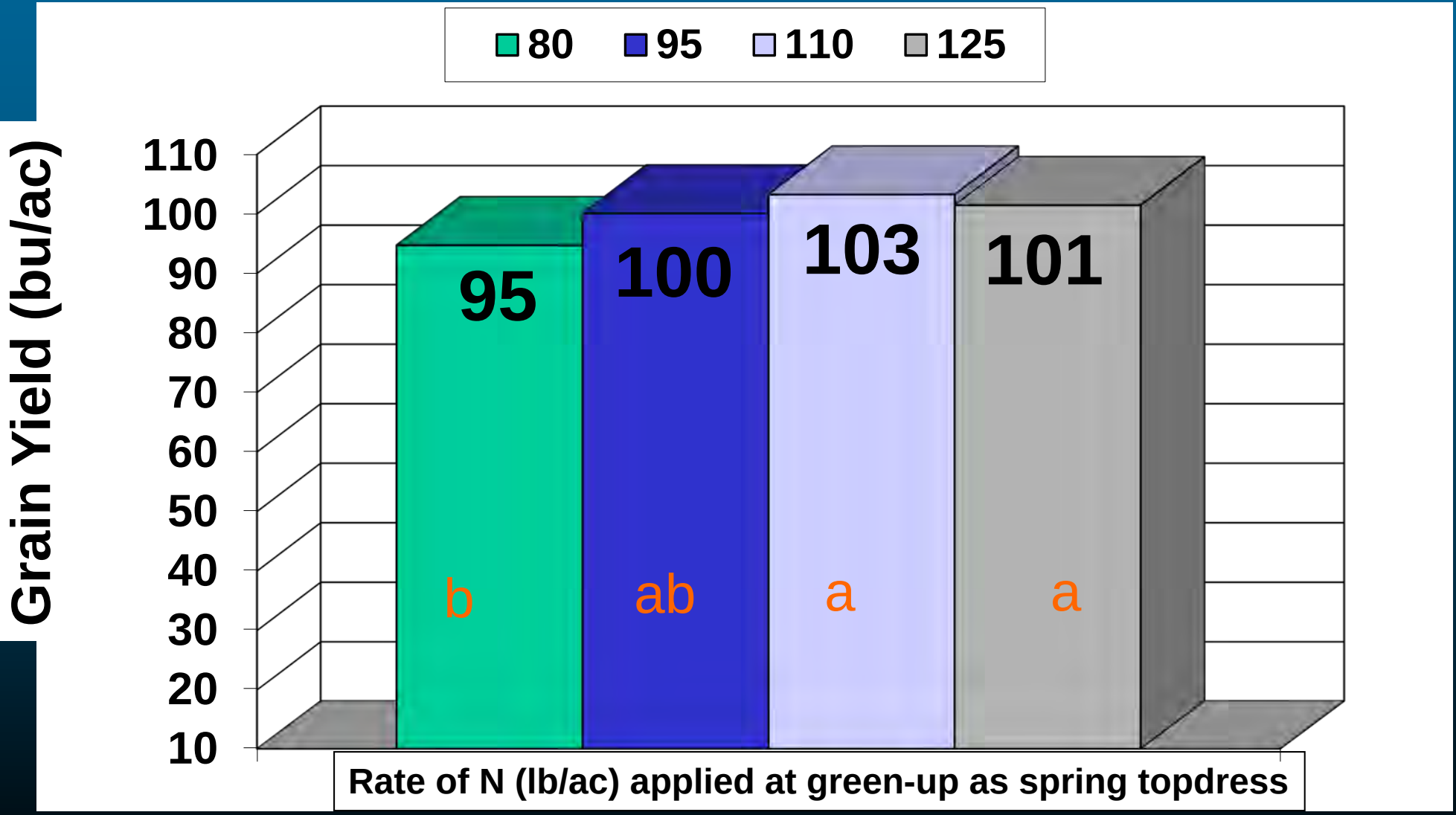
Yields with same letter are not statistically different

LSD = 6.6



Winter Wheat in 2008: Sussex (Irrigated)

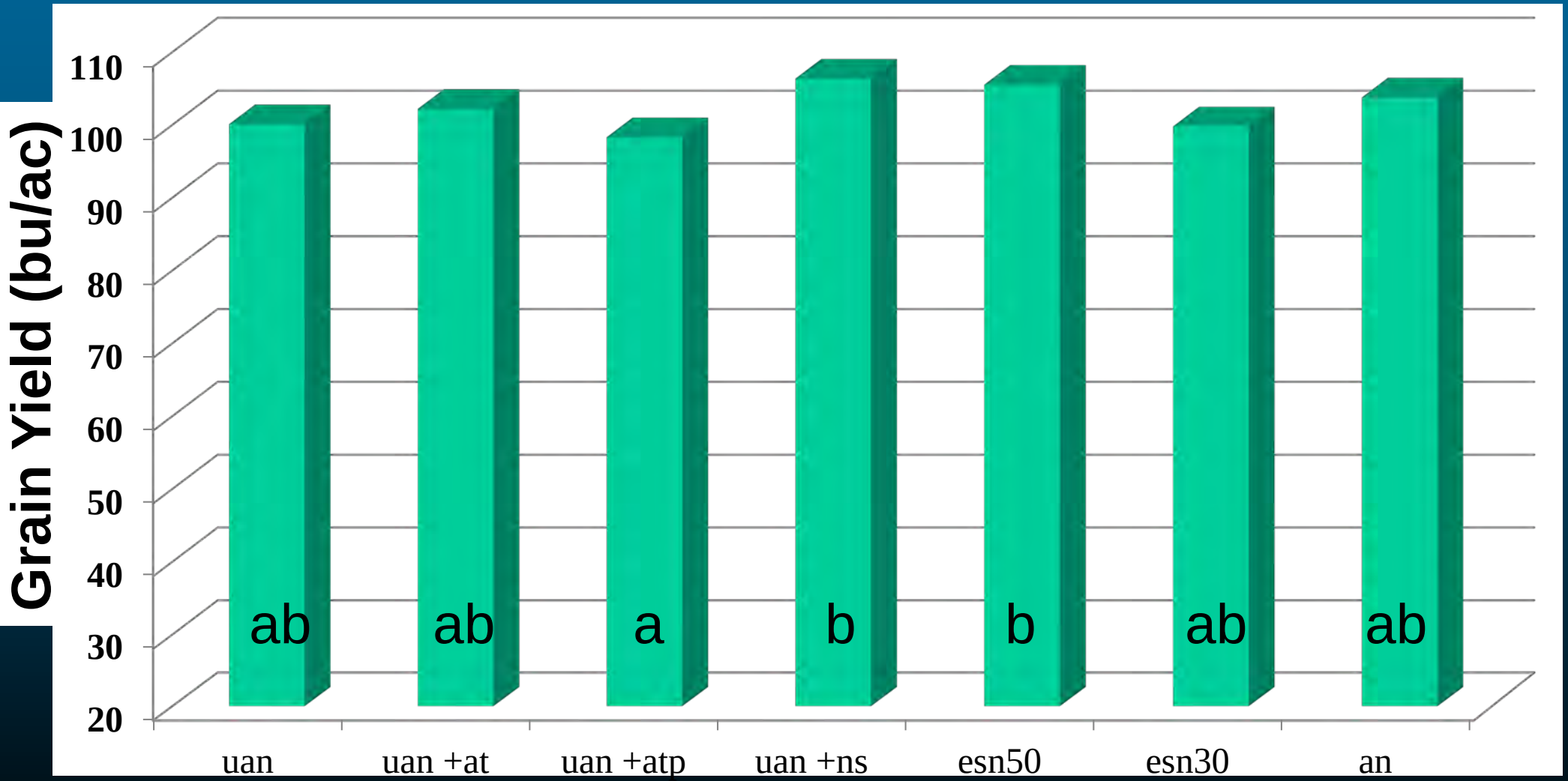
Yields with same letter are not statistically different



Winter Wheat in 2008: Sussex (Irrigated)

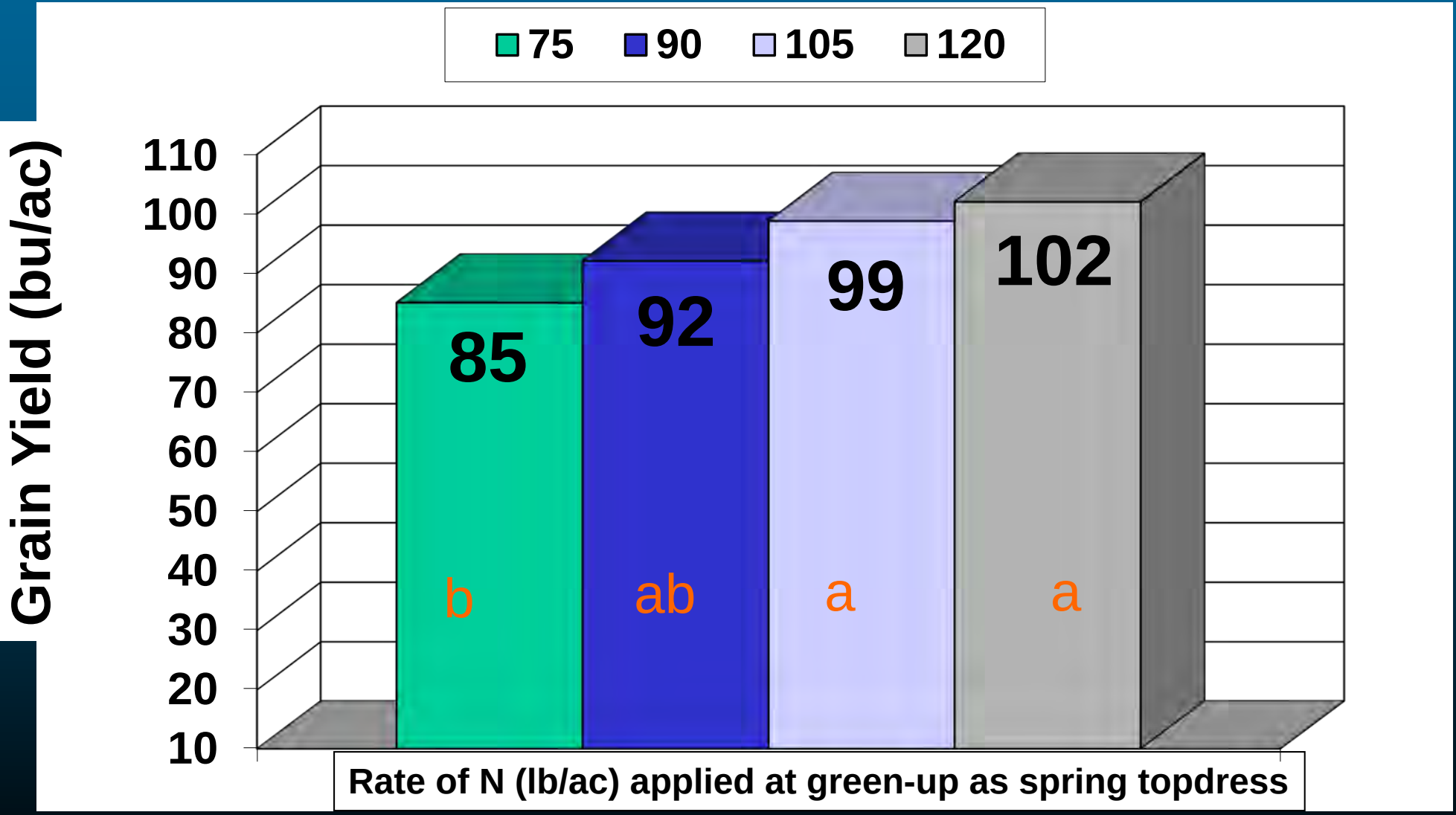
Yields with same letter are not statistically different

LSD = 7



Winter Wheat in 2008: Sussex (Dryland)

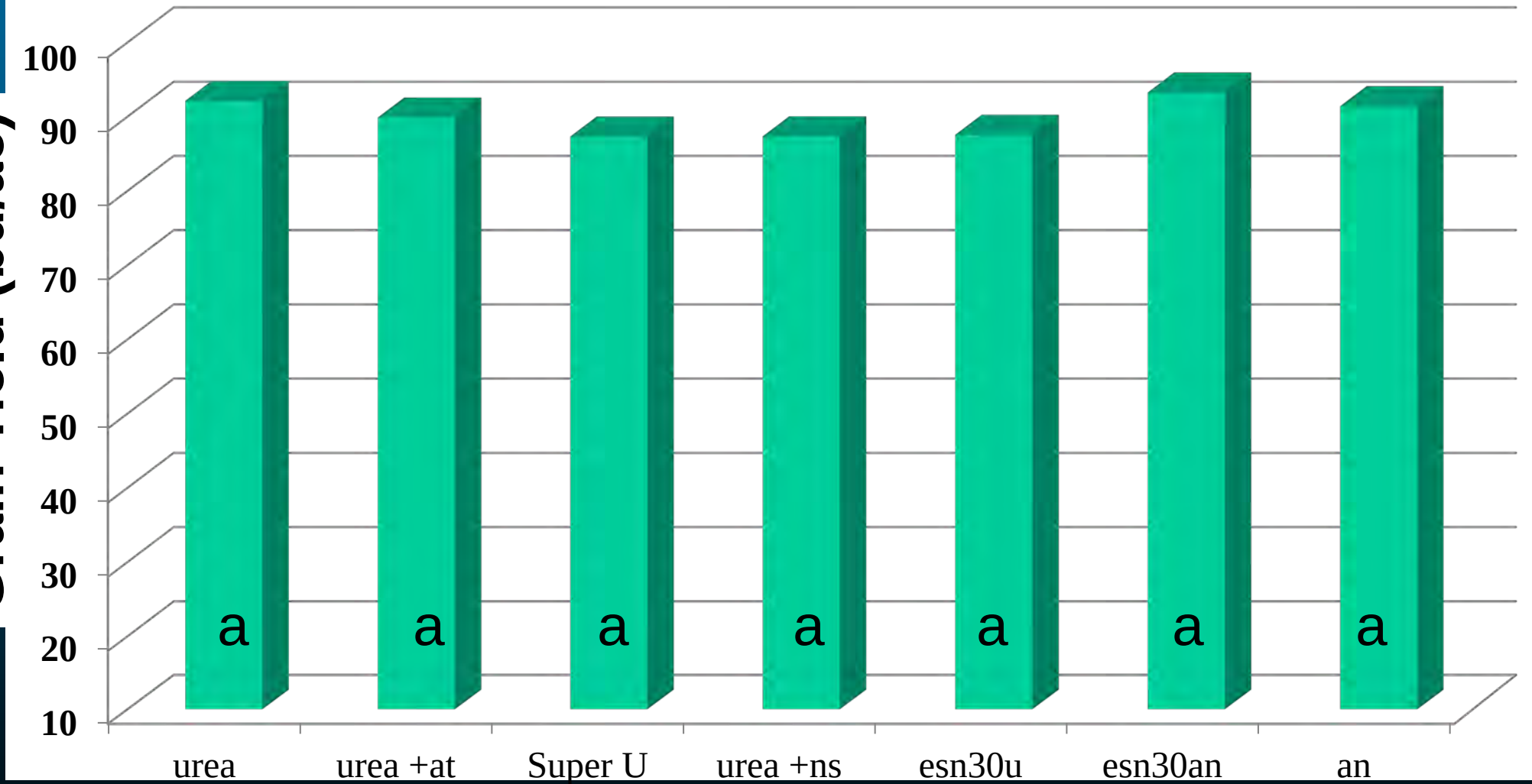
Yields with same letter are not statistically different



Winter Wheat in 2008: Sussex (Dryland)

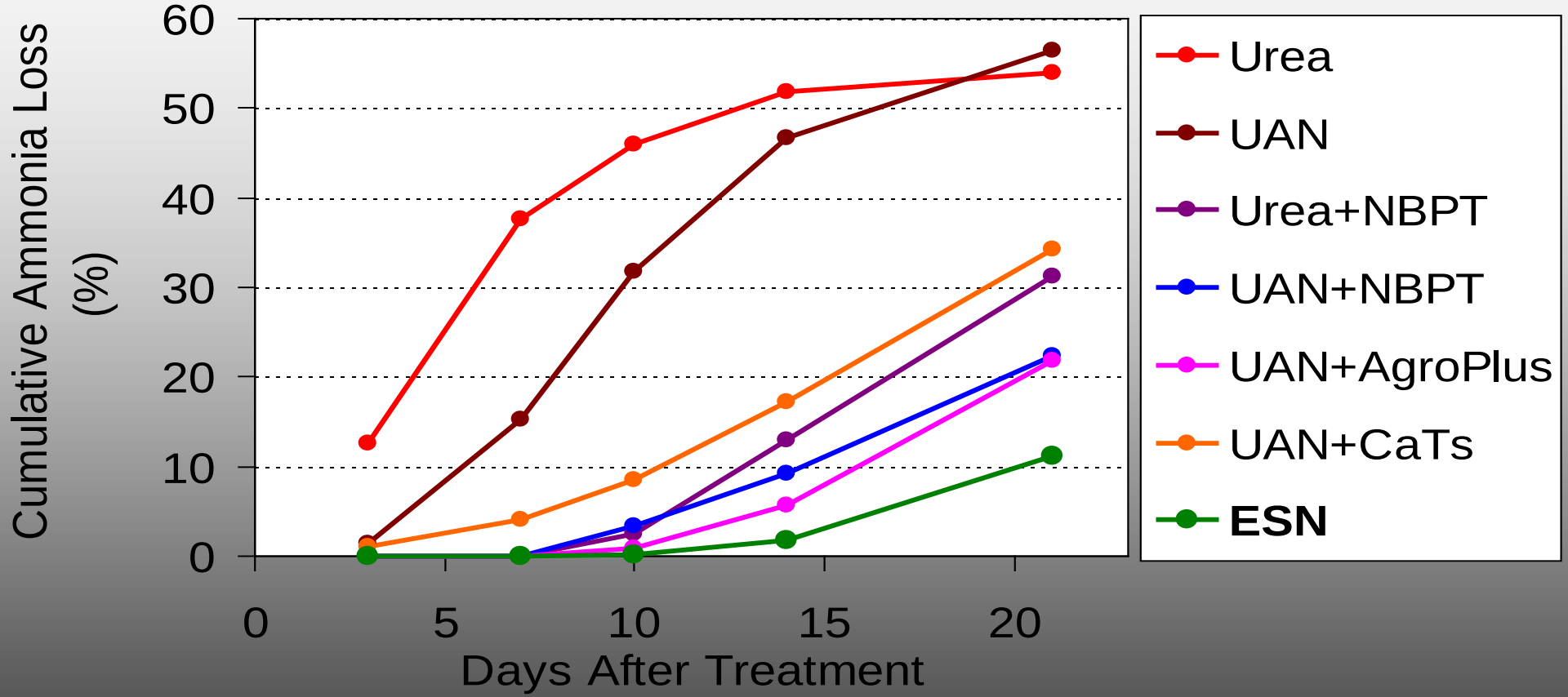
Yields with same letter are not statistically different

LSD = 9.9



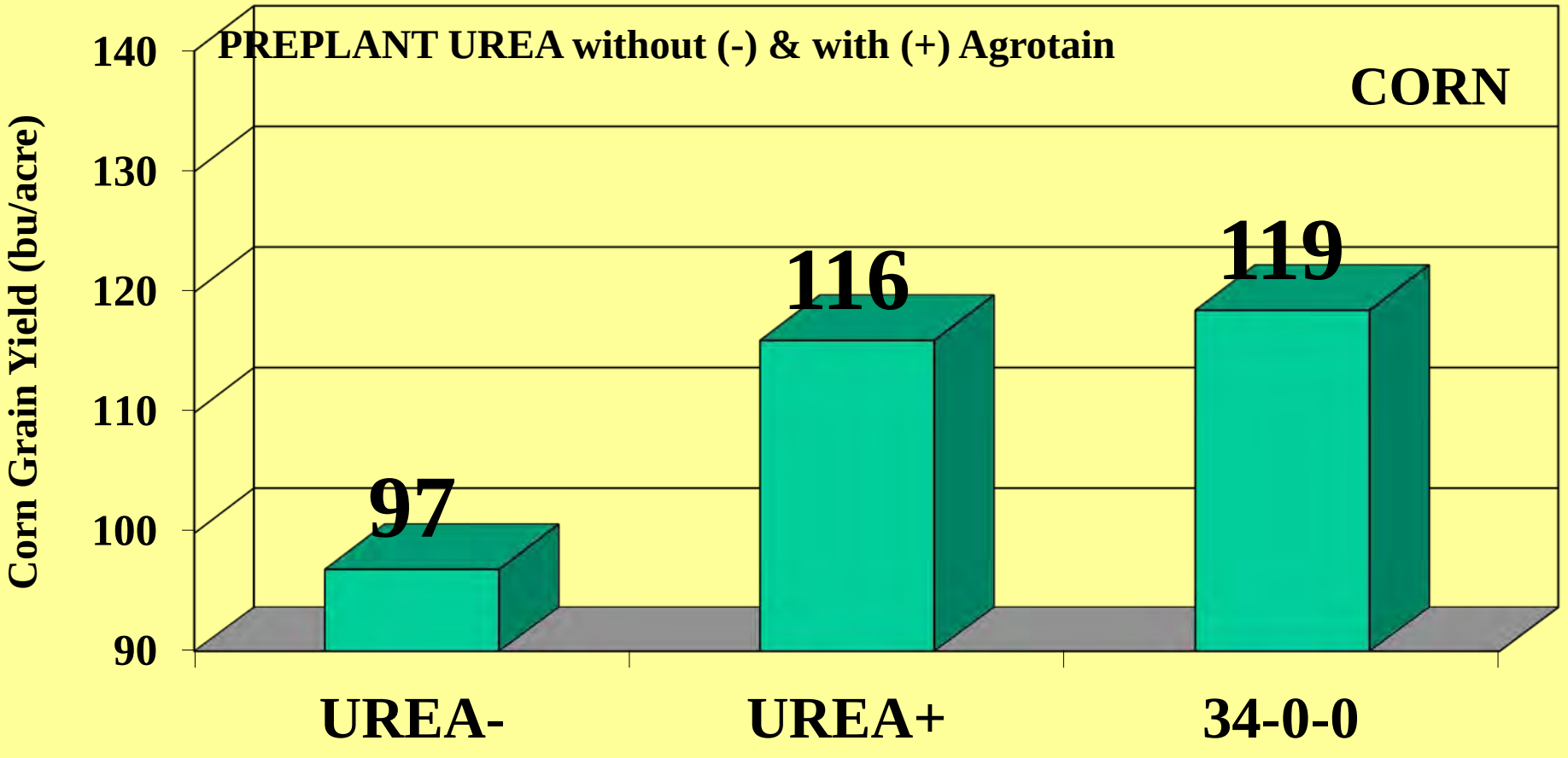
AGROTAIN STUDIES

ESN/Agrotain Ammonia Losses



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

PA Study (Fox & Piekielek, 1993)

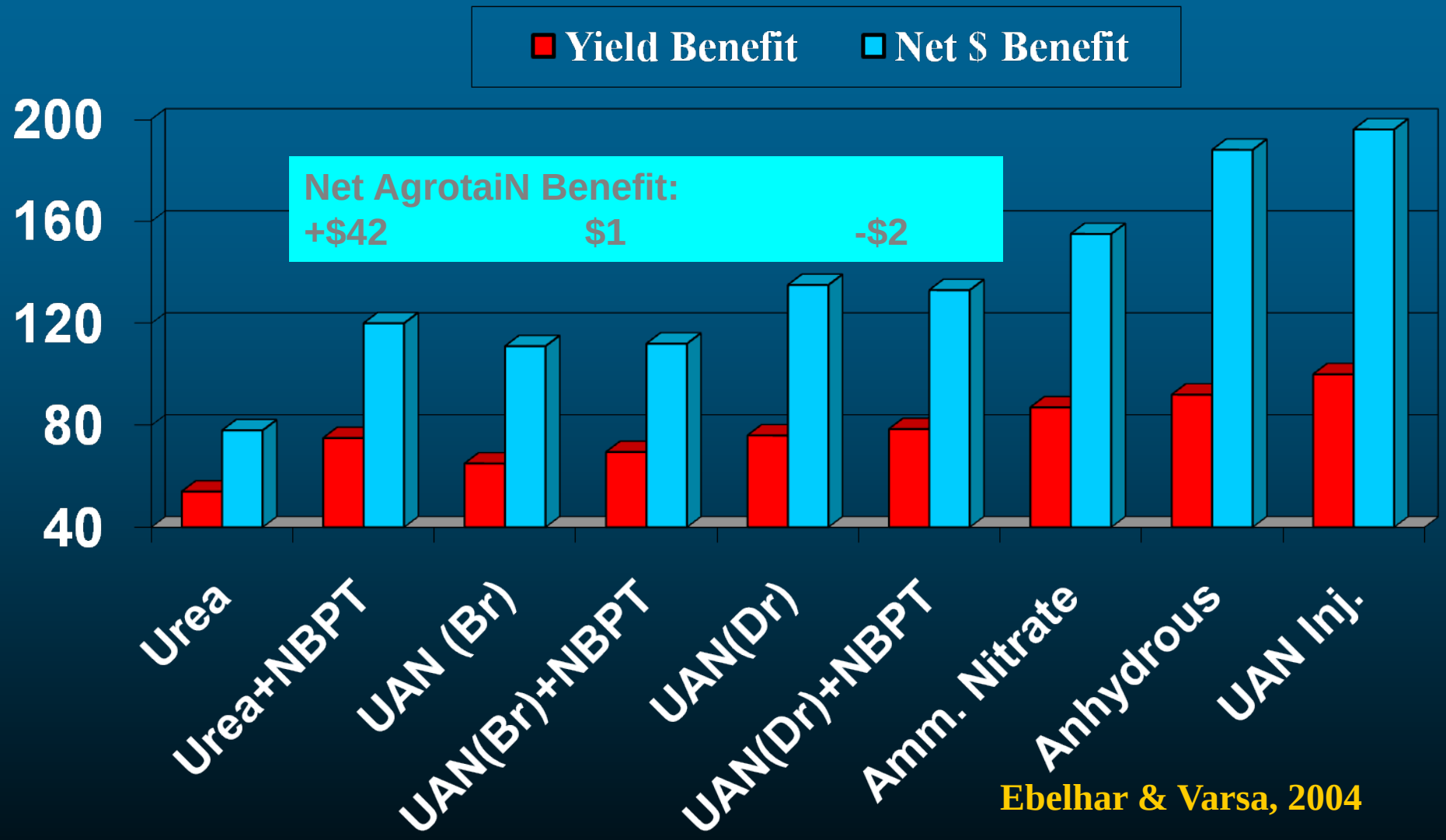


3-year study

Avg. 100 + 150

N Sources for No-till Corn

Summary: Eight Site-years

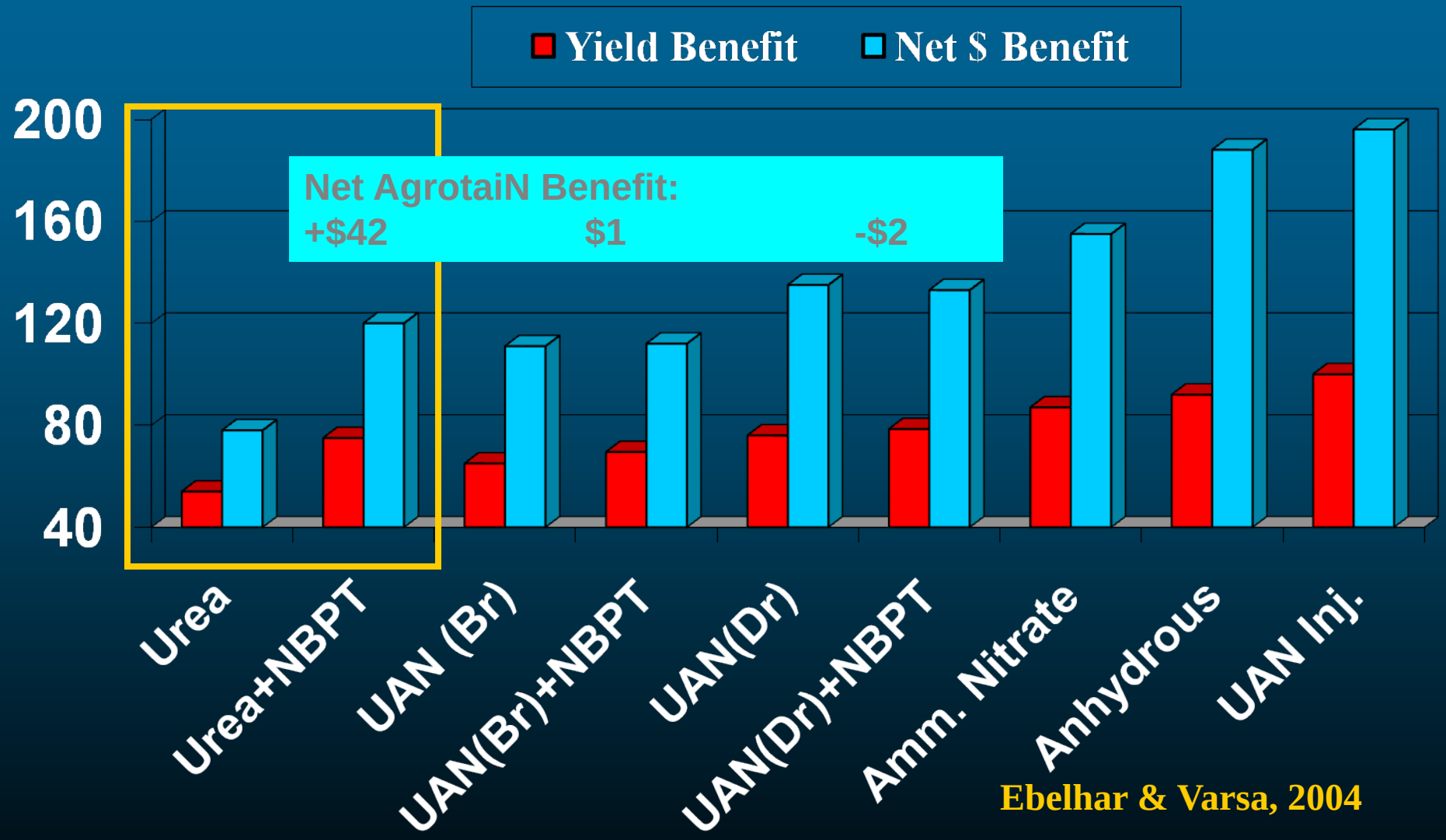


Ebelhar & Varsa, 2004

Yield and Net $ Benefit compared to check treatment.

N Sources for No-till Corn

Summary: Eight Site-years



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N Sources for No-till Corn

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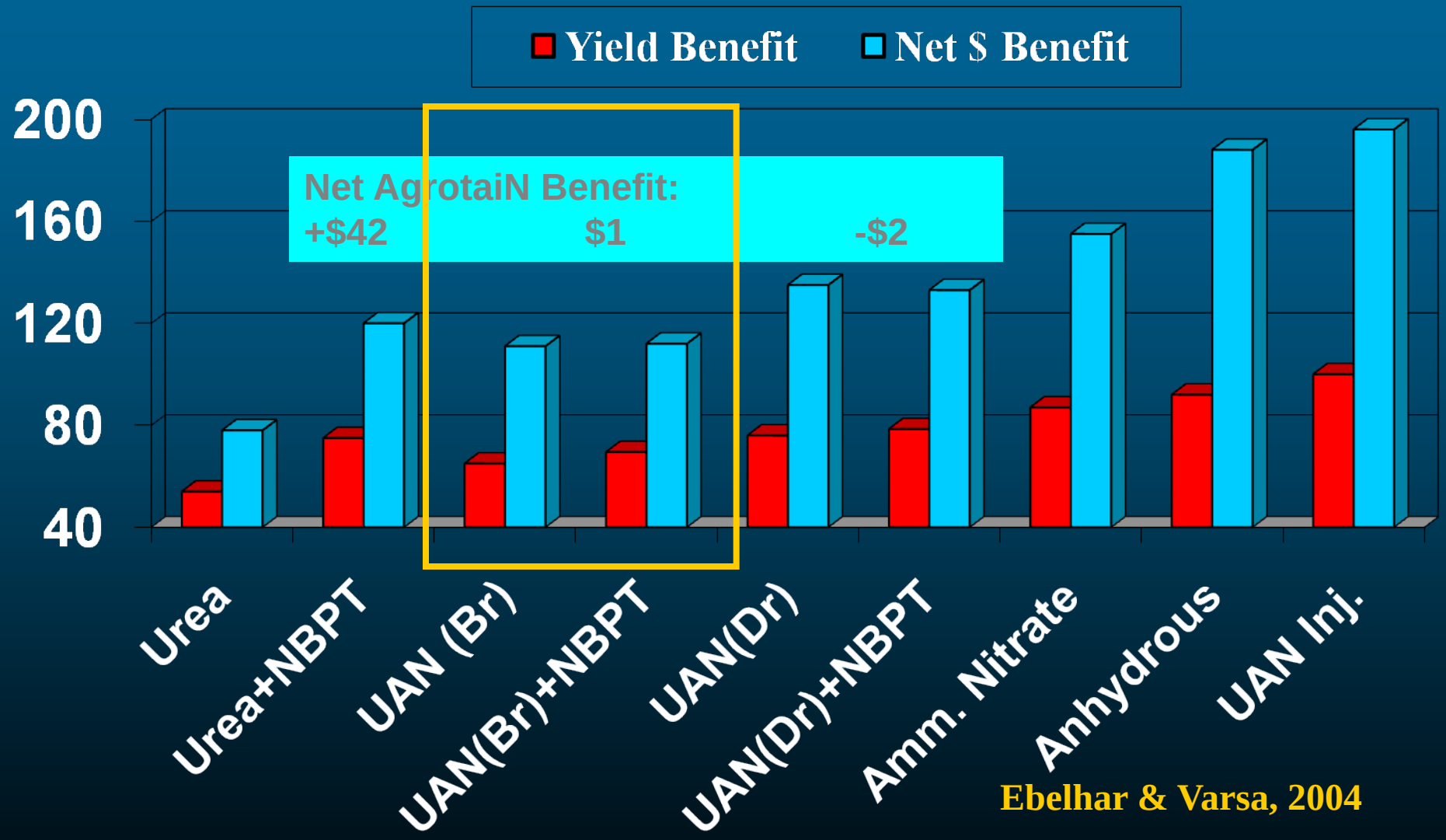
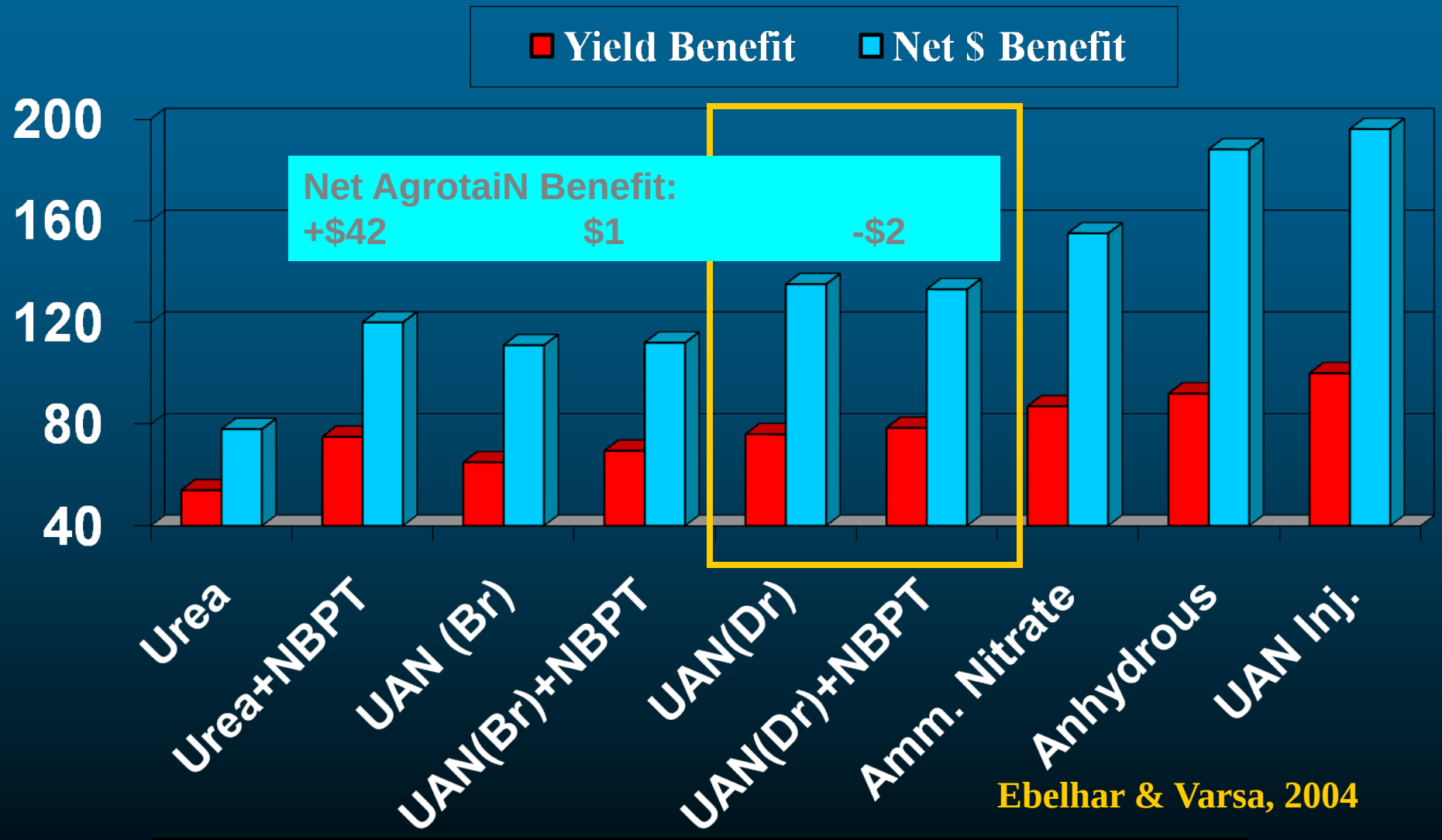


Ebelhar & Varsa, 2004

Yield and Net $ Benefit compared to check treatment.

N Sources for No-till Corn

Summary: Eight Site-years in Illinois



Ebelhar & Varsa, 2004

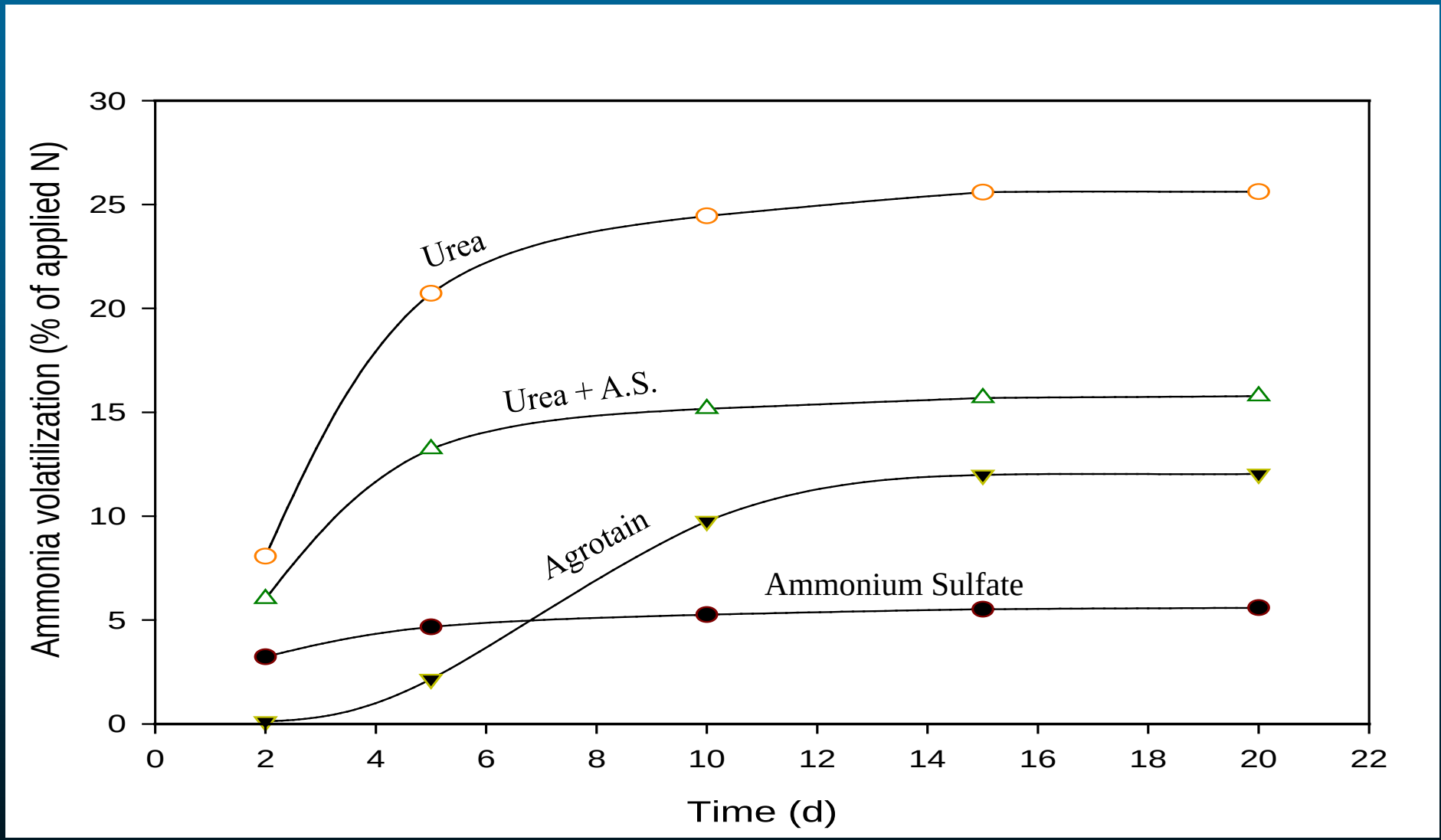
Yield and Net $ Benefit compared to check treatment.

N Fertilizer Source and Rate Studies on Rice Yield and N Uptake

-Calloway silt loam, pH ~ 7.6-

- **N Sources**
  - Urea
  - Agrotain
  - Ammonium Sulfate
  - Urea/Ammonium Sulfate Blend
- **N Rates**
  - 0, 67, and 134 kg N/ha
- **Timing**
  - 1, 5, and 10 days prior to flooding
- **Experiment Design**
  - Factorial with 4 replications
- **Measurements**
  - Ammonia volatilization, grain yield and N uptake

Ammonia Volatilization Losses



LSD (0.05) between times = 1.66%; LSD (0.05) between N sources = 4.08%

Preflood N Source X Time Prior to Flooding Effects on Total N Uptake

N Fert Sources	N Rate (kg N/ha)	Application time Prior to Flooding (days)		
		1	5	10
		N Uptake (kg N/ha)†		
UTC	0	----------105----------		
Urea	134	194	158	145
Agrotain		193	185	173
AS		187	189	177
Urea + AS		185	170	161
LSD (0.05)			14	

† Beginning Heading

Source: Rick Norman, University of Arkansas

Preflood N Source X Time Prior to Flooding Effects on Rice Grain Yield

N Fert Sources	N Rate (kg N/ha)	Application time Prior to Flooding (days)		
		1	5	10
		Grain Yield (kg/ha)		
UTC	0	----------4,838----------		
Urea	134	9,424	8,061	7,562
Agrotain		9,482	9,173	8,820
AS		9,125	8,974	8,618
Urea + AS		9,226	8,473	8,014
LSD (0.05)			433	

Source: Rick Norman, University of Arkansas

Urea Compared To Nutrisphere Applied At Different Times Prior To Flooding

Mississippi-2006

- **Locations**
  - DREC: Sharkey clay, pH=8.0
- **N Sources**
  - Urea
  - Nutrisphere (0.5%)
  - Nutrisphere (1.0%)
- **N Rates**
  - 101 and 168 kg N/ha
- **Timing**
  - 1 and 10 days prior to flooding
- **Experiment Design**
  - Factorial with 4 replications
- **Measurements**
  - Grain yield

Nutrisphere Study
Mississippi

N Rate kg N/ha	DREC
	----------Grain yield, kg/ha----------
101	7913
168	9173
LSD 0.05	353

Source: Rick Norman, University of Arkansas

Nutrisphere Study
Mississippi

N Applied Time†	DREC
	----------Grain yield, kg/ha----------
1 dbf	8,770
10 dbf	8,316
LSD 0.05	353

Source: Rick Norman, University of Arkansas

† dbf = days before flooding.

Nutrisphere Study
Mississippi

N Source	DREC
	----------Grain yield, kg/ha----------
Urea	8,518
Nutrisphere (0.5%)	8,417
Nutrisphere (1.0%)	8,669
LSD 0.05	NS

Source: Rick Norman, University of Arkansas

Urea Compared To Nutrisphere Applied At Different Times Prior To Flooding

Arkansas-2007

- **Locations**
  - LHRF: Hilleman silt loam, pH=6.1
  - RREC: Dewitt silt loam, pH=6.3
- **N Sources**
  - Urea
  - Nutrisphere
- **N Rates**
  - 0, 67, and 134 kg N/ha
- **Timing**
  - 1, 5, and 10 days prior to flooding
- **Experiment Design**
  - Factorial with 4 replications
- **Measurements**
  - Grain yield

Nutrisphere Study
Arkansas

N Rate kg N/ha	LHRF	RREC
	----------Grain yield, kg/ha----------	
0	7,006	2,822
67	8,114	6,149
134	8,468	8,014
LSD 0.05	403	504

Source: Rick Norman, University of Arkansas

Nutrisphere Study

Arkansas

N Applied Time†	LHRF	RREC
	----------Grain yield, kg/ha----------	
1 dbf	8,921	8,266
5 dbf	8,215	7,258
10 dbf	7,862	5,746
LSD 0.05	403	504

Source: Rick Norman, University of Arkansas

† dbf = days before flooding.

Nutrisphere Study

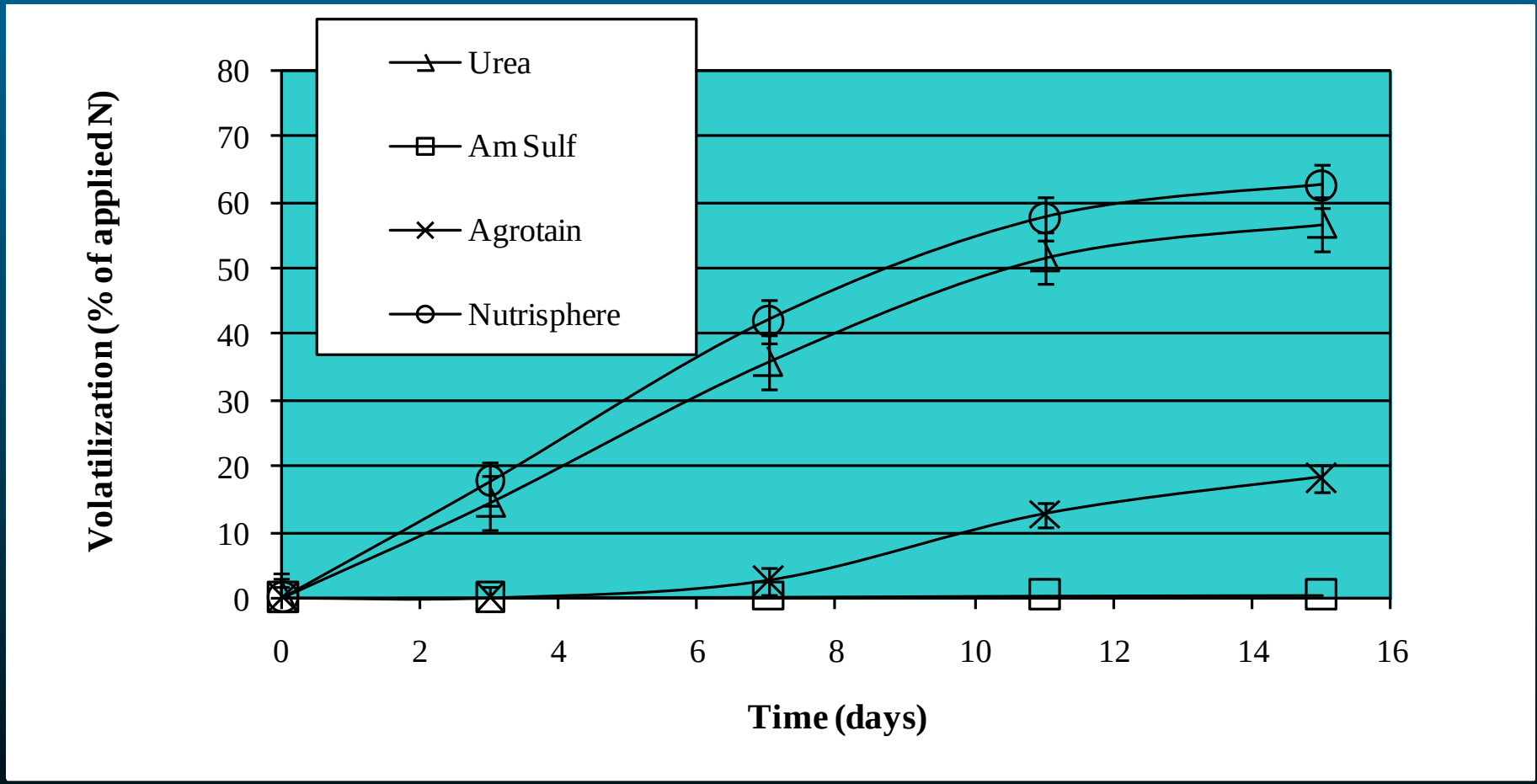
Arkansas

N Source	LHRF	RREC
	----------Grain yield, kg/ha----------	
Urea	8,417	7,157
Nutrisphere	8,266	7,006
LSD 0.05	NS	NS

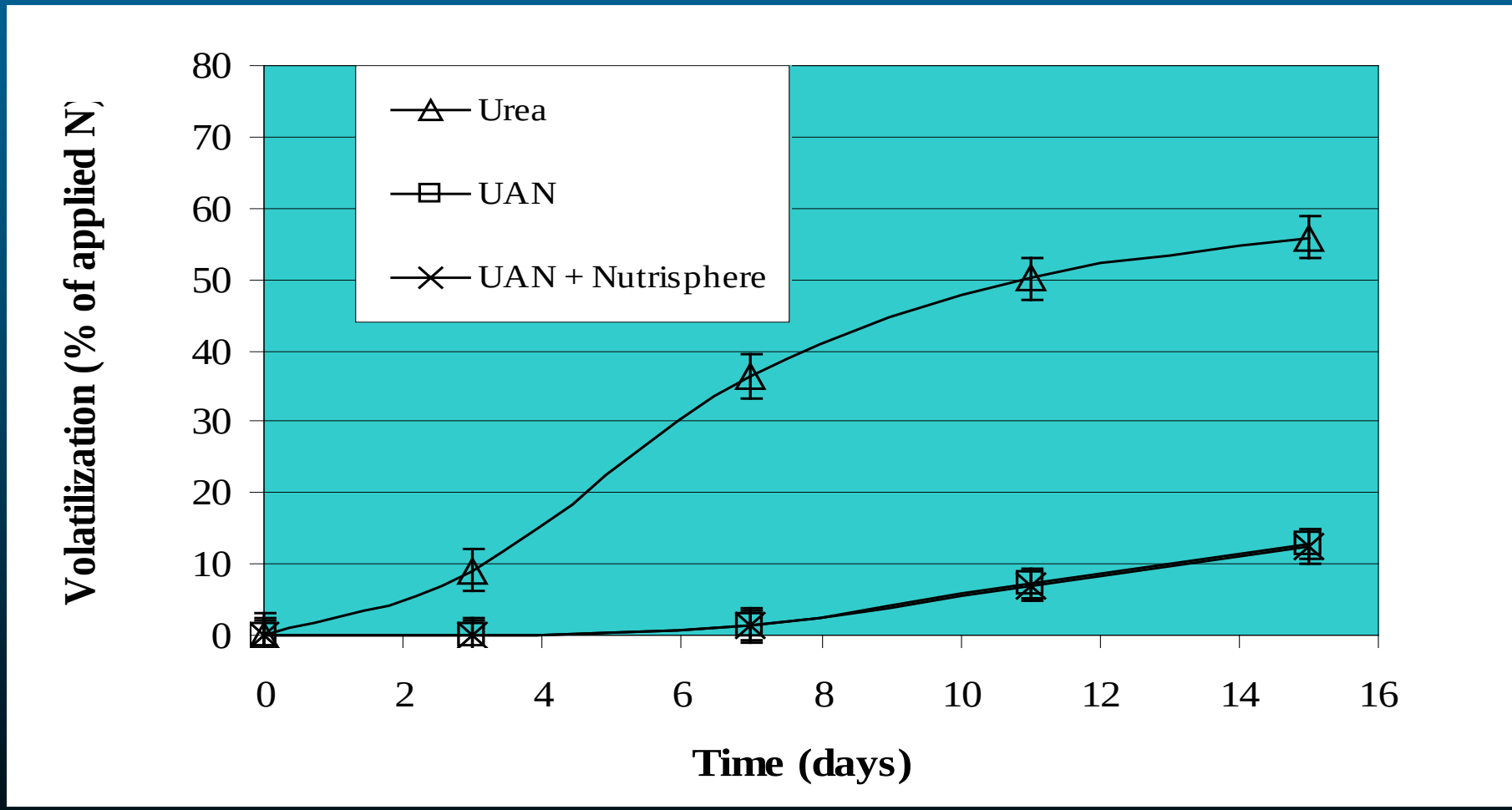
Source: Rick Norman, University of Arkansas

Laboratory-Incubation Study

Ammonia volatilization of urea, ammonium sulfate, Agrotain, and Nutrisphere applied to a Dewitt silt loam soil in an lab-incubation study at 25°C



Ammonia volatilization of urea, UAN and UAN + Nutrisphere applied to a Dewitt silt loam soil in an lab-incubation study at 25°C



SUMMARY: ESN

1) ESN does provide a slow release of N

2) Volatilization is of little concern

3) For preplant N in corn, ESN appears to have value compared to UAN or Urea applied preplant

4) Applying ESN preplant should NOT replace the standard practice of applying sidedress N

5) ESN should NOT be applied to bare soils and left on the soil surface without incorporation

6) Spring topdressings on wheat should contain no more than 30 to 50% ESN (@ green-up)

SUMMARY: Agrotain

1) Agrotain does reduce urea volatilization

2) Broadcasting urea on warm soils would provide the greatest potential value from Agrotain

3) Rainfall or irrigation (0.5”) eliminates the need for using urease inhibitors

4) Broadcasting UAN on warm soils would provide the second greatest potential value from Agrotain

5) Dribbling UAN on warm soils appears of questionable value…most data suggests little value

6) PLUS in Agrotain still not proven benefit

SUMMARY: Nutrisphere-N

1) NSN appears to have little effect on volatilization
2) Several studies with positive results are reported on Specialty Fertilizer's web site
3) Research database is limited in this region
4) DE work has shown no benefit (started in 2006)
5) Effect on Nitrification has not been proven

QUESTIONS???

Greg Binford @302-831-2146 or binfordg@udel.edu

Winter Wheat in 2008; Fall N Rate Study

Yields with same letter are not statistically different