What did we find from nitrogen fertilization trials in 2016

Joel Ransom

NDSU Extension Agronomist

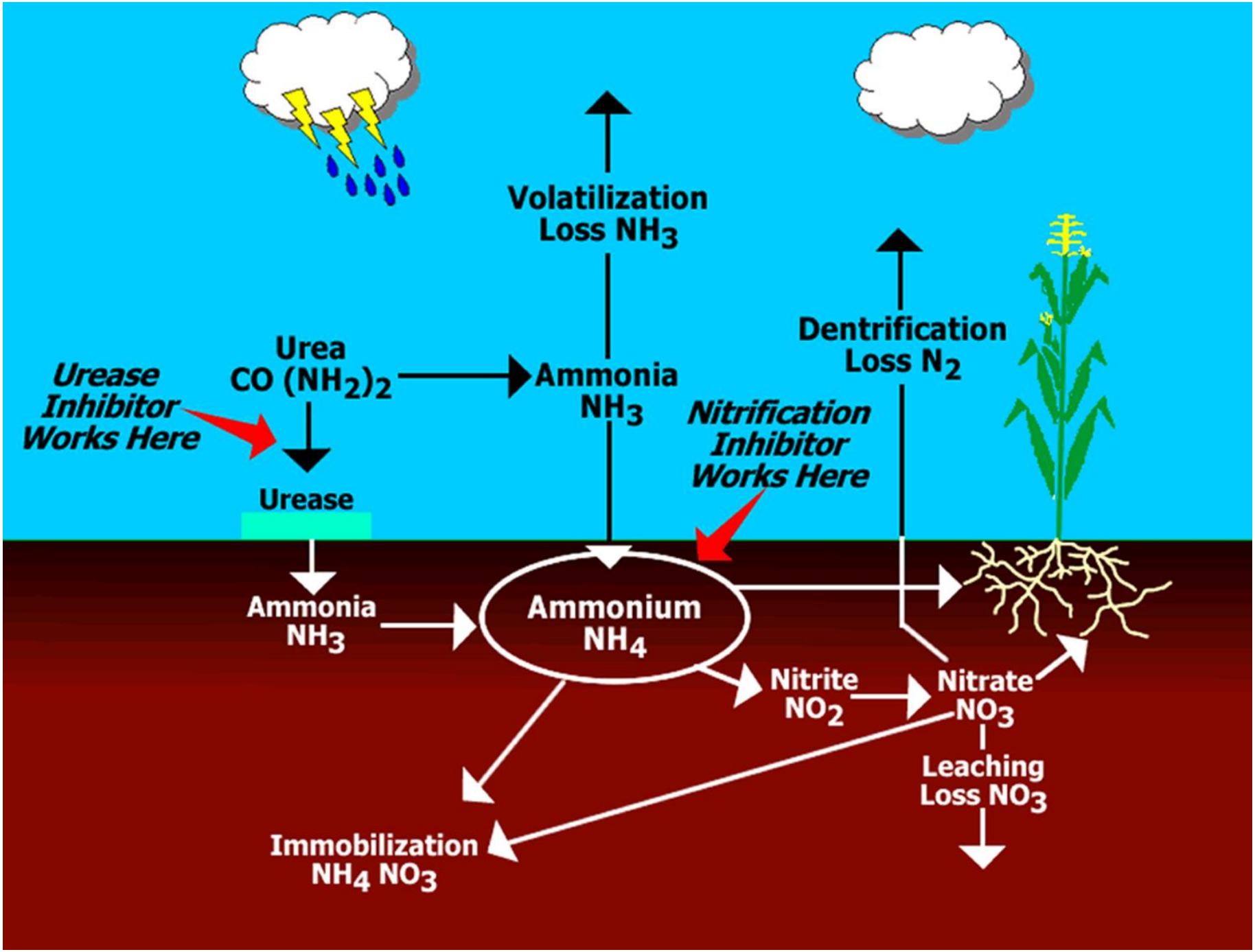
NDSU EXTENSION SERVICE

Projected crop budget for HRS wheat, NC ND, 2017

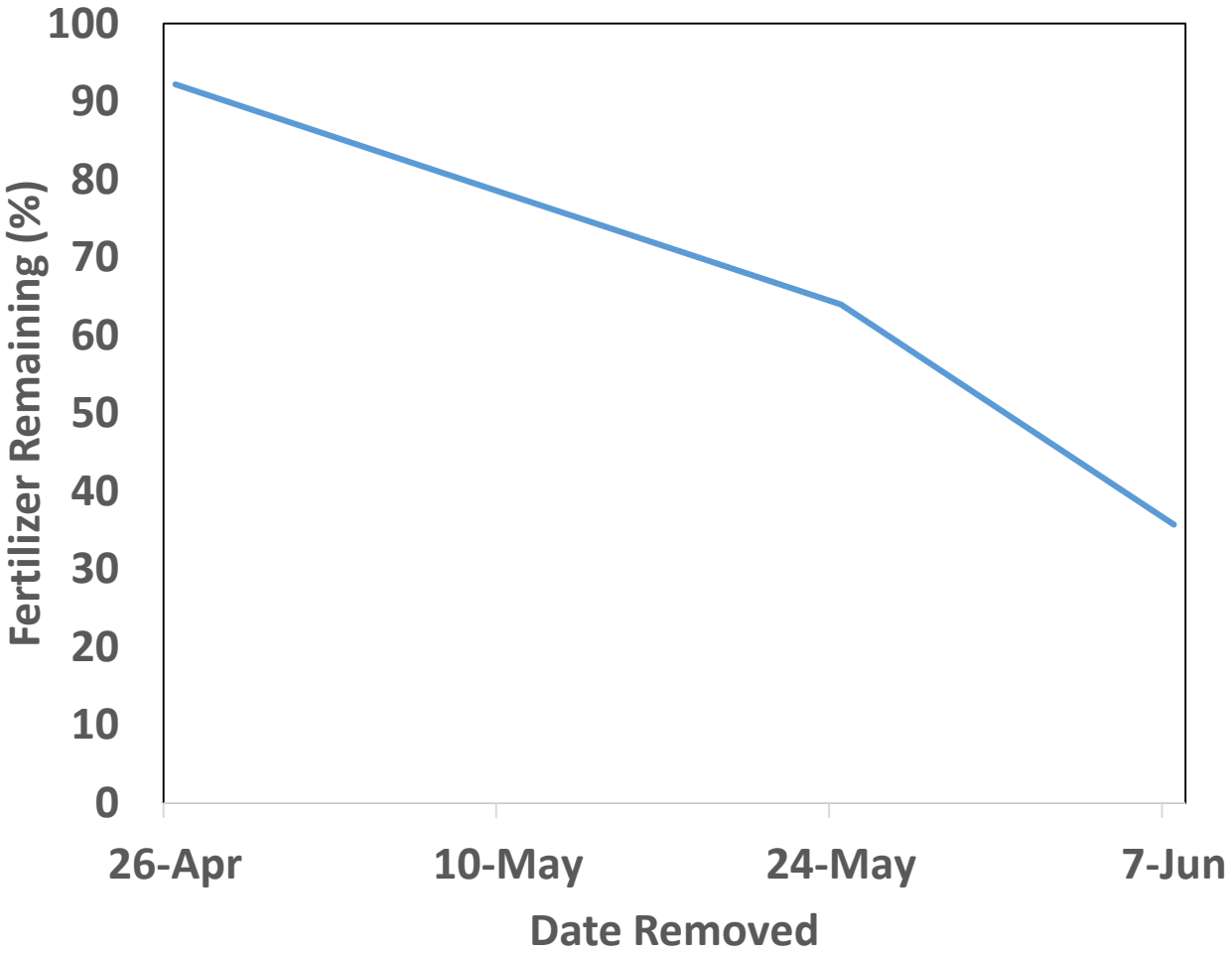
Spring Wheat	**North Central**			
Market Yield	40		**Fixed costs**	
Market Price	4.94		Misc. Overhead	6.90
Market Revenue	197.60		Machinery depreciation	18.37
			Machinery investment	10.00
Direct Costs			Land Charge	38.00
Seed	13.13		***Sum of listed fixed costs***	***73.27***
Herbicides	25.20			
Fungicides	5.00		***Sum of all listed costs***	*201.70*
Insecticides	0.00			
Fertilizer	39.92		**Return to labor**	-4.10
Crop Insurance	11.10			
Fuel	7.86		**Cost per bushel**	5.04
Repairs	15.74			
Drying	0.00			
Misc	7.50			
Operating Interest	2.98			
Sum of listed direct costs	***128.43***			

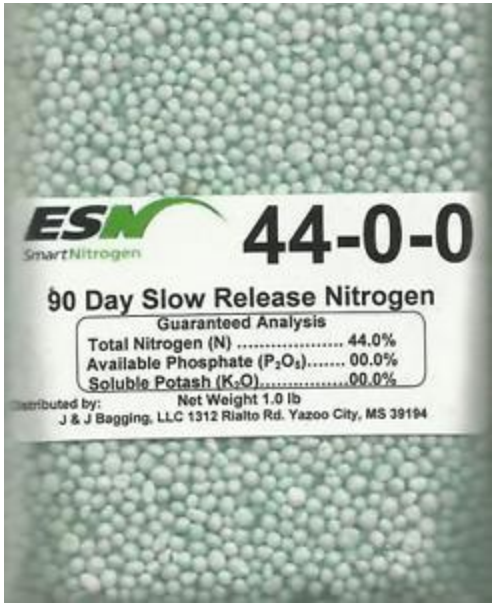
Fertilizer is the largest budget item

- Nitrogen fertilization impacts
  - Yield (improving yield improves returns)
  - Market value (protein premium/discount)
- Nitrogen is the most costly fertilizer and the most likely to be lost
- Our research looked at reducing losses and managing N for protein
  - The right rate, right type, right place, right time


Volatilization
Loss NH_3
Dentrification
Loss N_2
Urease
Inhibitor
Works Here
Urea
$CO(NH_2)_2$
Ammonia
NH_3
Nitrification
Inhibitor
Works Here
Urease
Ammonia
NH_3
Ammonium
NH_4
Nitrite
NO_2
Nitrate
NO_3
Leaching
Loss NO_3
Immobilization
$NH_4\ NO_3$

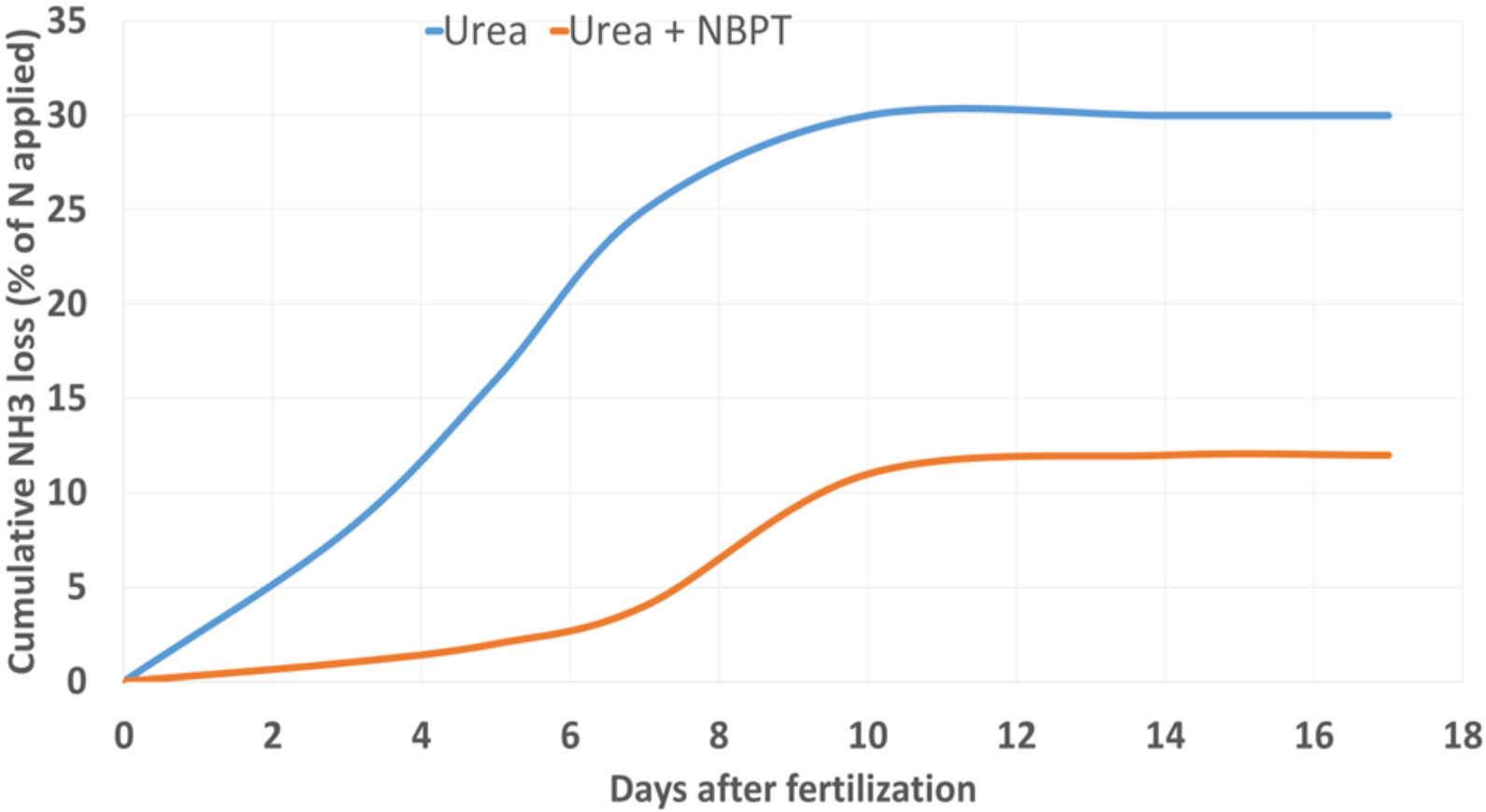
Dissolution of ESN over time, Casselton, 2016





Tracy Hillenbrand
and Calli Feland

Cumulative NH3 loss over time after application of urea and urea + NBPT.



Adapted from Silva et al., 2017 Agron. J.

Cumulative emissions of nitrous oxide over 126 days from various fertilizers amended on two contrasting soils (lab based data).
Adapted from Awale and Chatterjee, 2017)

Treatment	Cumulative N_2O-N emissions (% of applied N)	Difference from urea (%)
Sandy Loam Soil		
Urea	7.4	
Urea + NBPT	6.5	-12.1
Urea + NP (Instinct)	5.7	-23.5
SuperU	4.2	-43.8
PCU (ESN)	3.7	-51.1
Silty Clay Soil		
Urea	6.8	
Urea + NBPT	5.2	-22.4
Urea + NP (Instinct)	4.5	-34.1
SuperU	4.5	-32.9
PCU (ESN)	4.5	-33.3

Topic #1. Impact of Nitrogen Type, Timing, and Additives on Grain Yield and Protein in Hard Red Spring Wheat

2016 Season Data

Student researcher: Calli Feland

NDSU NORTH DAKOTA STATE UNIVERSITY

NDSU PLANT SCIENCES

N Products and Additives

- Instinct® II (Nitrapyrin)
  - nitrification inhibito
  - newer formulation of N-Serve
- Agrotain® Plus
  - urease enzyme inhibitor (NBPT)
  - nitrification inhibitor
- Controlled-Release (urea) Fertilizer
  - Polymer-coated urea (PCU)
  - “Environmentally Smart Nitrogen” (ESN)

Treatments

N Type

- ESN
- Urea

Rate (% Optimum N)

- 50%
- 75%
- 100%
- untreated check
- 200 lb N-rich strip

Application Timing

- Fall
- Spring

ESN+ Urea Blends

- 50% ESN + 50% urea
- 75% ESN + 25% urea

Application Timing (Granular)

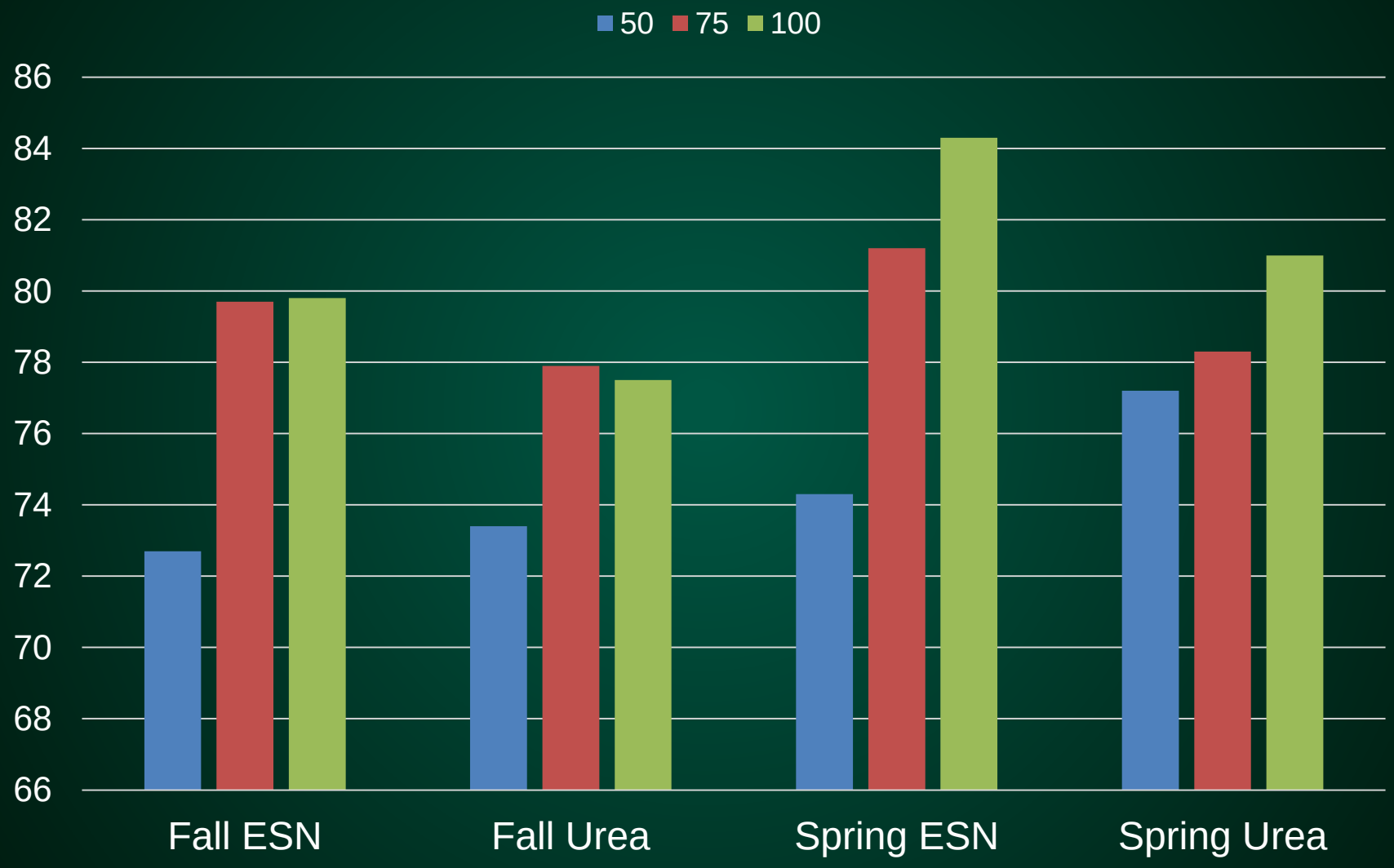
- Fall
  - Applied and incorporated after temperatures drop below 10 degrees C
- Spring
  - Applied and incorporated before planting

NDSU NORTH DAKOTA STATE UNIVERSITY

Application of Additives

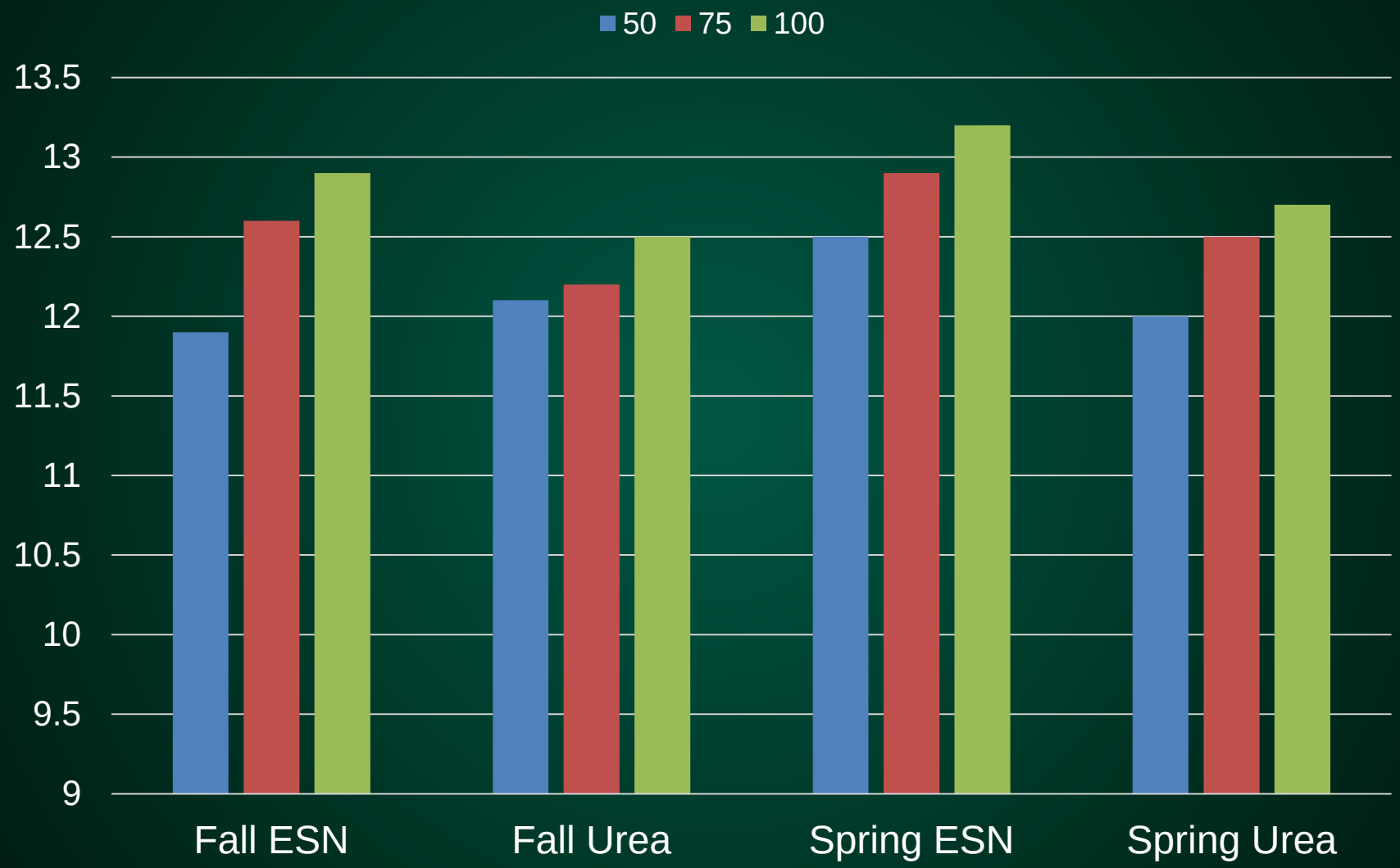
- Instinct II (Nitrapyrin)
  - applied with urea
  - fall and spring
- Agrotain Plus w/ UAN
  - streamed on at 4-leaf stage using a backpack sprayer and streamer bars
  - spring

Effect of fertilizer type and time of application on yield of spring wheat, average of five locations, 2015-16.



NDSU NORTH DAKOTA STATE UNIVERSITY

Effect of fertilizer type and time of application on protein of spring wheat, average of five locations, 2015-16.



NDSU NORTH DAKOTA STATE UNIVERSITY

Effect of N source and timing of application on yield and protein, 100% rate, 5 locs, 2015-2016.

N source	Timing	Yield	Protein
None		61	11.6
PCU	Fall	80	**12.9**
Urea	Fall	**78**	**12.5**
PCU:urea 50:50	Fall	81	12.8
Urea + Instinct	Fall	81	12.6
PCU	Spring	**84**	**13.2**
Urea	Spring	81	**12.7**
PCU:urea 50:50	Spring	81	**13.2**
Urea + Instinct	Spring	**84**	13.0
Urea + UAN	Spring	81	**12.7**
Urea + UAN +	Spring	83	13.0
N rich plot	*Spring*	*86*	*13.8*
LSD 0.05		4.2	0.4

Conclusion

- Spring applications tended to be more efficient than fall for yield and protein
- ESN improved protein over urea
- Differences between products were minor and profitability doubtful at current prices with losses we observed

Topic 2: Timing of N fertilizer

- Determine the effect of timing of N application on yield and protein
  - 4 leaf, boot and post flowering
- Comparison of UAN and urea

- Student researcher: Matthew Rellaford

Effect of nitrogen timing and amount on yield and protein, average of two locations, 2016.

Treatment	Protein	Yield
Check	11.2	55
70% rate urea at planting (77 lbs/acre)	12.3	65
100% rate urea at planting (110 lbs/acre)	12.9	72
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea 4 to 5 leaf stage	13.2	73
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN 4 to 5 leaf stage	12.7	73
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea at the boot stage	13.4	71
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN at the boot stage	12.8	73
70% rate urea at planting (77 lbs/acre) + 30 lbs N of UAN at flowering	13.3	72
200 lbs. urea at planting	13.3	71
LSD	0.2	7

Topic #3. Improving the efficacy of a late season foliar N application

- Experiment 1: Can UAN or urea solution be applied with a fungicide used for scab control?
- Experiment 2: Does droplet size and or surfactant type impact protein enhancement?

Table 1. Experiment one individual treatment and N timing. Nitrogen rate of 33 kg ha^{-1} and volume applied 187 L ha^{-1}.

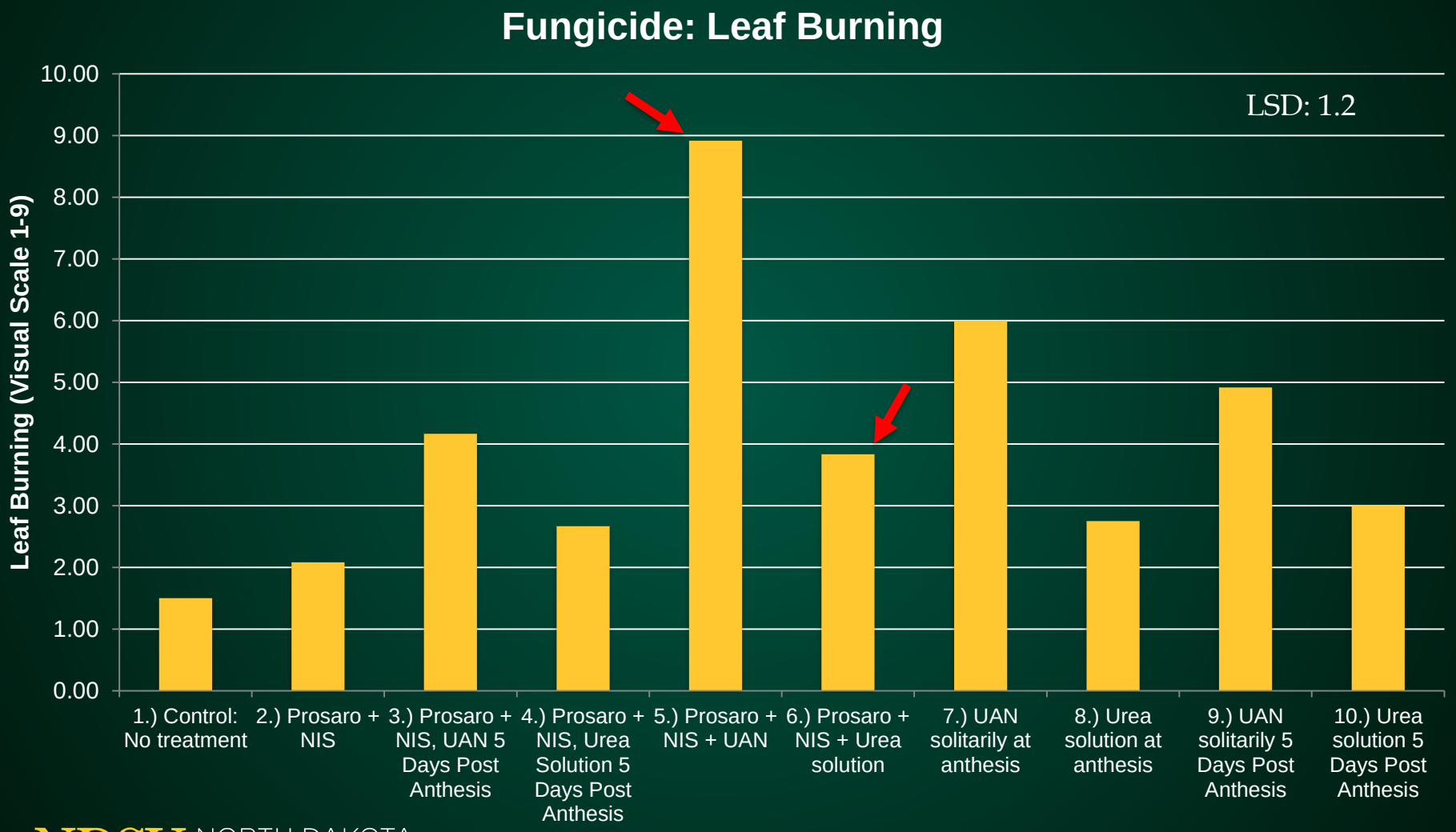
Treatment	Timing
1.) No treatment	
2.) Fungicide + NIS†	Flowering
3.) Fungicide + NIS UAN application‡	Flowering 5 days PA
4.) Fungicide + NIS Urea Solution application	Flowering 5 days PA
5.) Fungicide + NIS + UAN	Flowering
6.) Fungicide + NIS + Urea solution	Flowering
7.) UAN	Flowering
8.) Urea solution	Flowering
9.) UAN	5 days PA
10.) Urea solution	5 days PA
11.) UAN + Urease inhibitor	Flowering
12.) Urea solution + Urease inhibitor	Flowering

†NIS = Non-Ionic Surfactant
‡UAN= Urea Ammonium Nitrate (28-0-0)

NDSU NORTH DAKOTA STATE UNIVERSITY

Student researcher: Nicholas Schimek

Preliminary Results: Exp. One



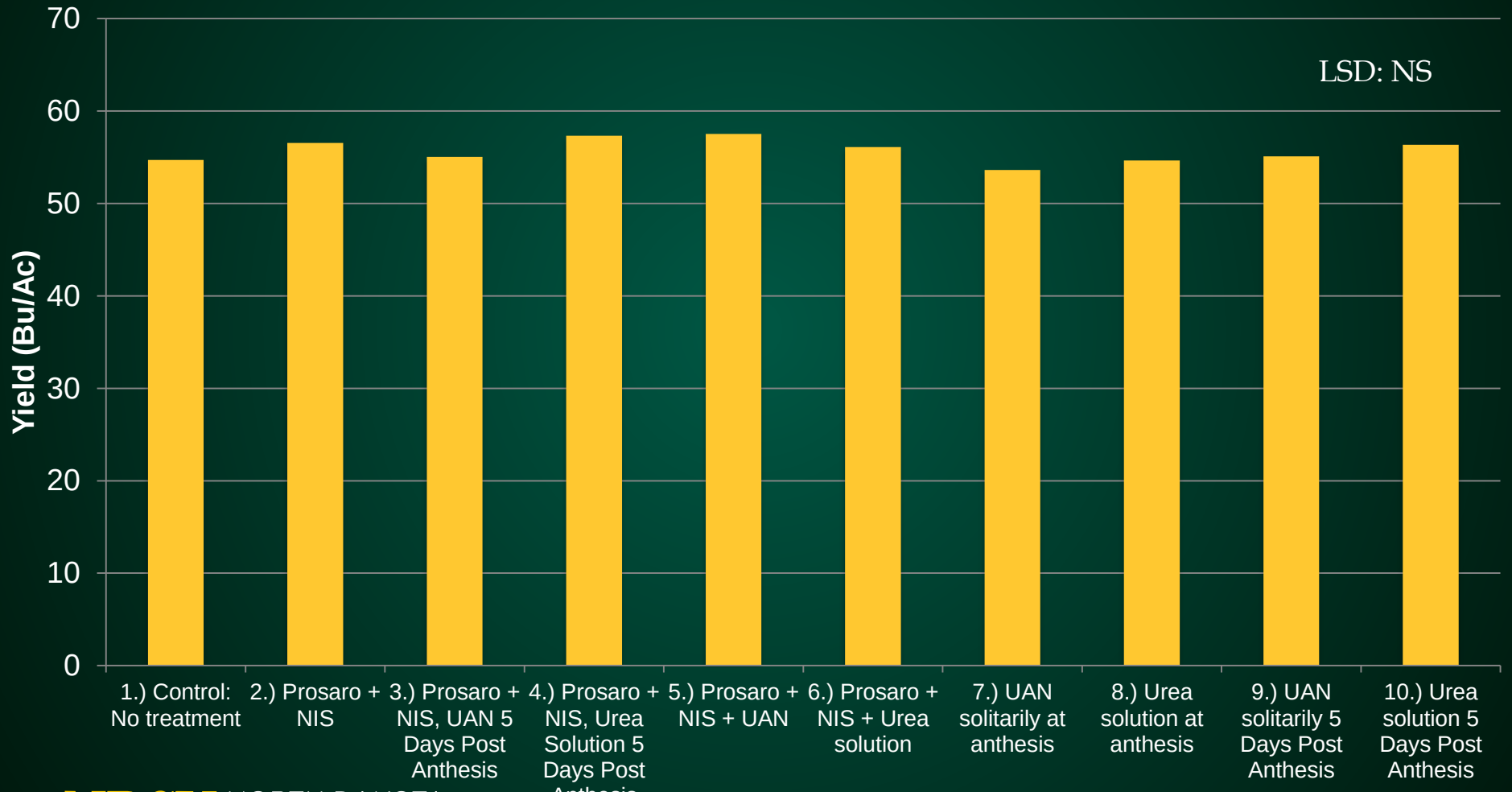
NDSU NORTH DAKOTA STATE UNIVERSITY

Treatment 1: Check

Treatment 5: Prosaro + NIS + UAN

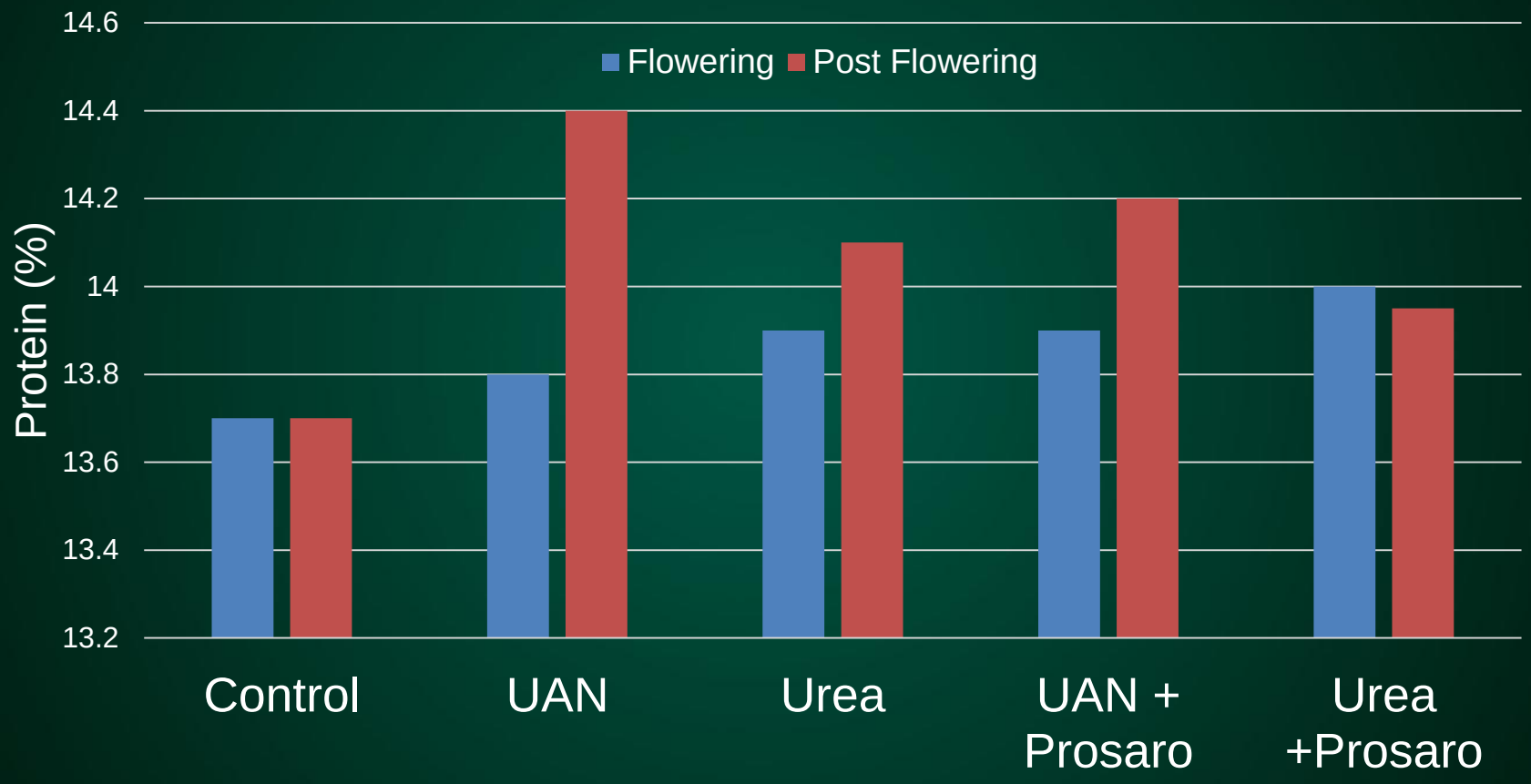
Preliminary Results: Exp. One

Fungicide: Yield



NDSU NORTH DAKOTA STATE UNIVERSITY

Preliminary Results: Exp. One



NDSU NORTH DAKOTA STATE UNIVERSITY

Experiment two individual treatment components.

Nitrogen solution treatment	Adjuvant	Nozzle	Spray volume ratio†	Rate
1.) No treatment				
2.) UAN		1††	1:1	
3.) UAN		2‡‡	1:1	
4.) UAN	MSO‡	1	1:1	1.75 l ha^{-1}
5.) UAN	MSO	2	1:1	1.75 l ha^{-1}
6.) UAN	POC§	1	1:1	2.34 l ha^{-1}
7.) UAN	POC	2	1:1	2.34 l ha^{-1}
8.) UAN	NIS¶	1	1:1	0.5% v/v
9.) UAN	NIS	2	1:1	0.5% v/v
10.) UAN	MSO & OS#	1	1:1	438 ml ha^{-1}
11.) UAN	MSO & OS	2	1:1	438 ml ha^{-1}
12.) UAN	Urease Inhibitor	1	1:1	2.34 l ha^{-1}
13.) Urea solution	Urease Inhibitor	1	1:1	4.68 l ha^{-1}
14.) UAN		1		
15.) UAN		1		

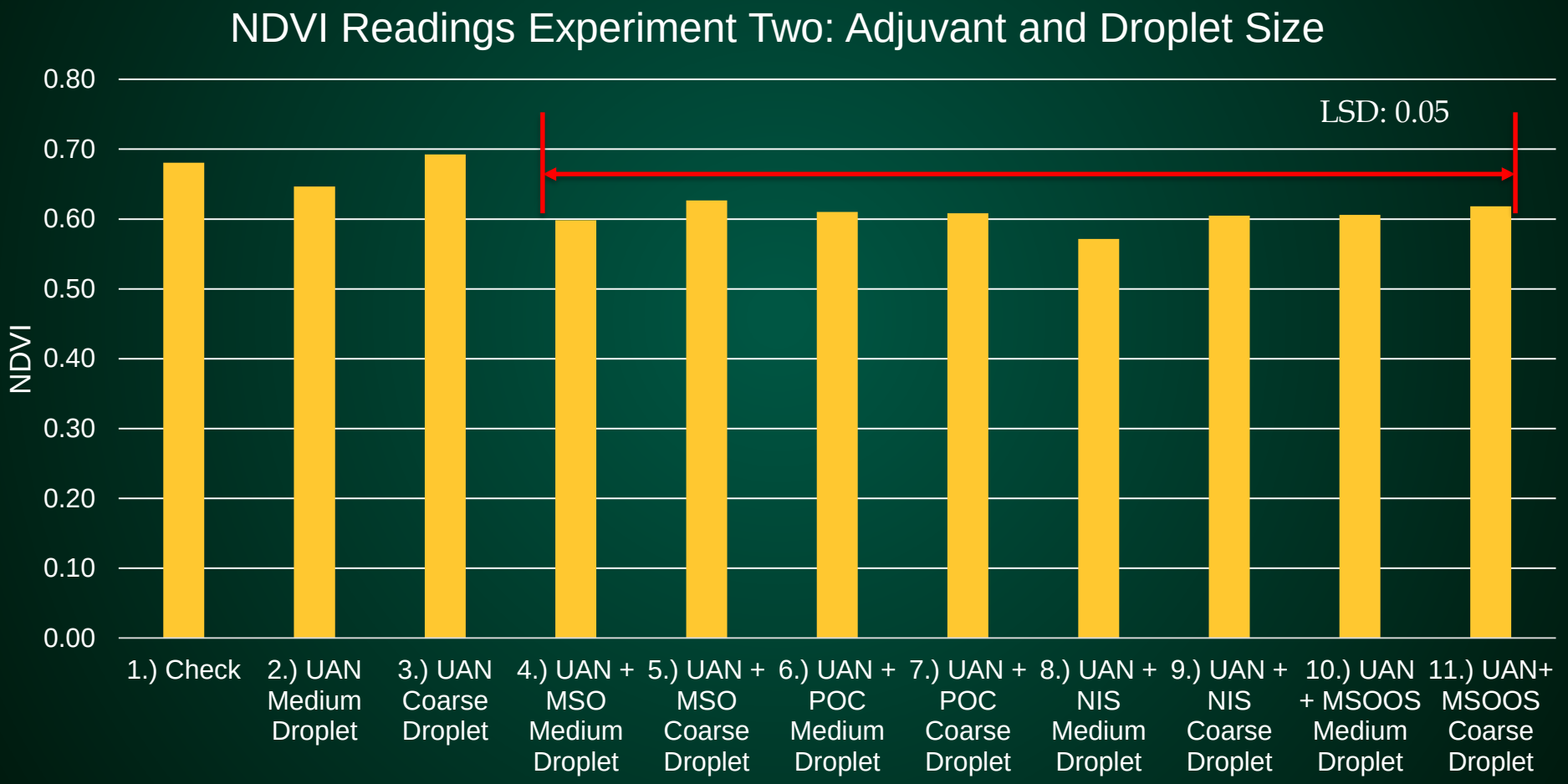
† Ratio of nitrogen solution to water volume
‡ MSO = Methylated Seed Oil
§ POC = Petroleum Oil Concentrate
¶ NIS = Non-Ionic Surfactant
# MSO & OS = Methylated Seed Oil & Organosilicone Surfactant
†† XR11002- Medium Droplet
‡‡ TT1102- Coarse Droplet

†† XR11002- Medium Droplet

‡‡ TT1102- Coarse Droplet

NDSU NORTH DAKOTA STATE UNIVERSITY

Preliminary Results: Exp.Two



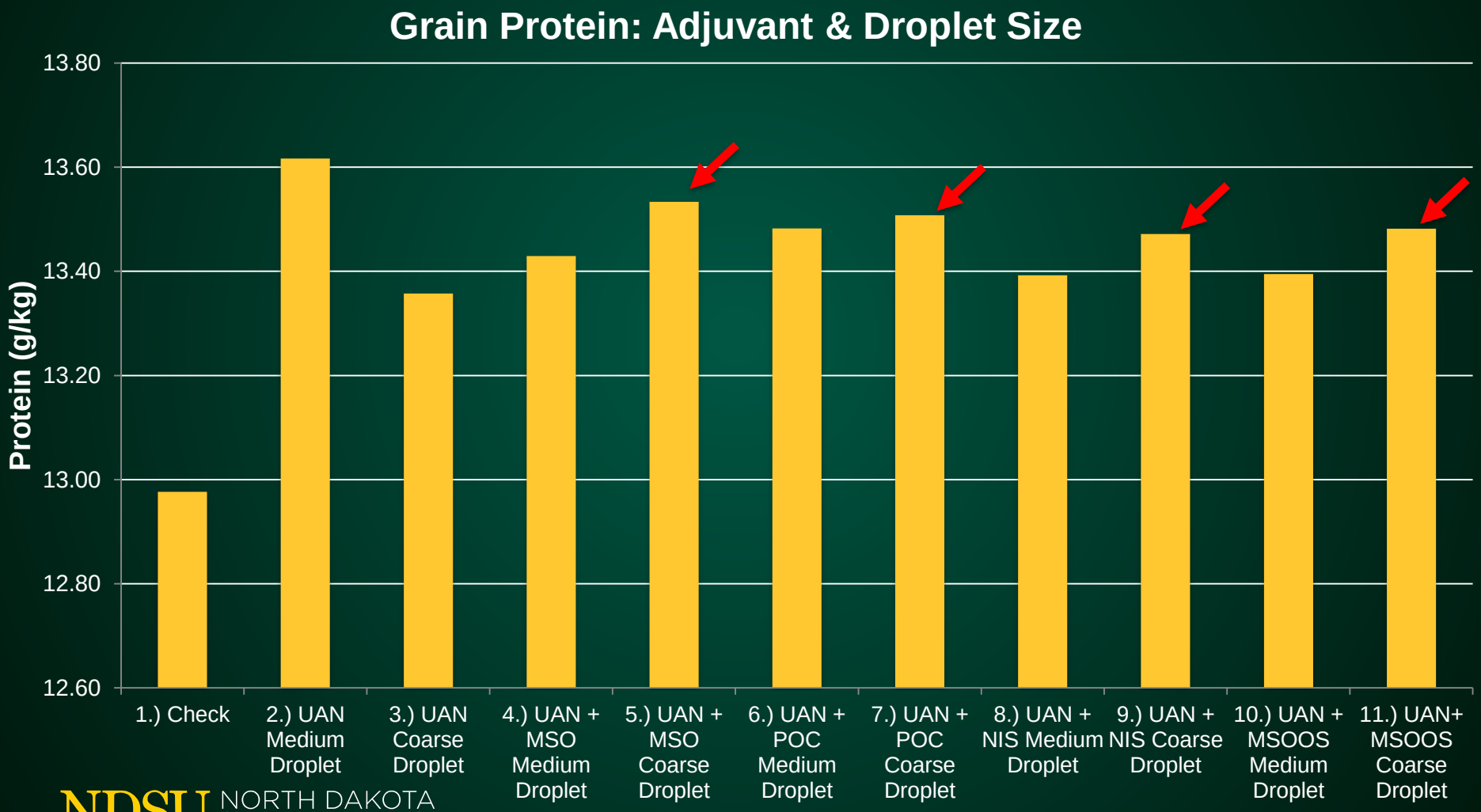
NDSU NORTH DAKOTA STATE UNIVERSITY

Treatment 1: Check

Treatment 10: UAN + MSOOS Coarse Droplet

NDSU NORTH DAKOTA STATE UNIVERSITY

Preliminary Results: Exp. Two



NDSU NORTH DAKOTA STATE UNIVERSITY

Conclusions

- For protein concentration UAN > urea solution
- Applying UAN at flowering did not appreciably increase injury, but protein content was lower than when applied five days post anthesis
- Adding surfactants increased leaf burn, but did not increase protein.
- Medium droplet size best without surfactant, large best with surfactant.