

# Optimizing Fertilizer Applications on Sugar Beet

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# Objectives

- Discuss sugar beet nutrient use;
- Describe fertilizer recommendations and how each component of can be optimized to stretch fertilizer dollars;
- Discuss results of N fertilizer trials.

# Introduction

- Sugar beet is highest value crop grown in Wyoming and is regionally economically important;
- Also the most resource-intensive crop, requiring large amounts of water, fertilizers, and pesticides;
- Until recently high value dwarfed input costs and producers had little incentive to conserve, but high fertilizer prices have changed that;
- There is evidence that fertilizer rates can be reduced without sacrificing profits;
- Requires careful nutrient management, which starts with understanding crop nutrient use and the factors that impact it;
- Begins with annual soil testing.

# Fertilizer requirements

- Wyoming soil tests usually indicate needs for supplemental nitrogen, phosphorus, and often sulfur;
- N is most limiting to growth and yield:
  - Most common, plant available form is nitrate ( $\text{NO}_3^-$ ), which is very soluble and volatile;
- P as phosphate ( $\text{P}_2\text{O}_5$ ) is less soluble but is rapidly tied up in soil minerals;
- S is often applied as ammonium sulfate;
- Placement near the seed is important for rapid uptake and minimal loss.

# Sugar beet nutrition

- Sugar beets convert energy from the sun into sugar so need to close their canopy rapidly to intercept maximum sunlight;
- This requires abundant fertility, especially nitrogen, early in the season;
- But N uptake later in the season forms impurities and promotes vegetative growth at the expense of root growth.

# Sugar beet nutrition

- Challenge is to provide abundant nutrition early but limit access later;
  - Beets have limited lateral root development;
  - Growth starts slow in cool spring temperatures;
- Irrigation can provide excellent control for nutrient management because  $\text{NO}_3$  is soluble and moves with water;
- But over irrigation with over fertilization carries excess N below the early season roots, possibly making it available as roots extend downward later in the season.

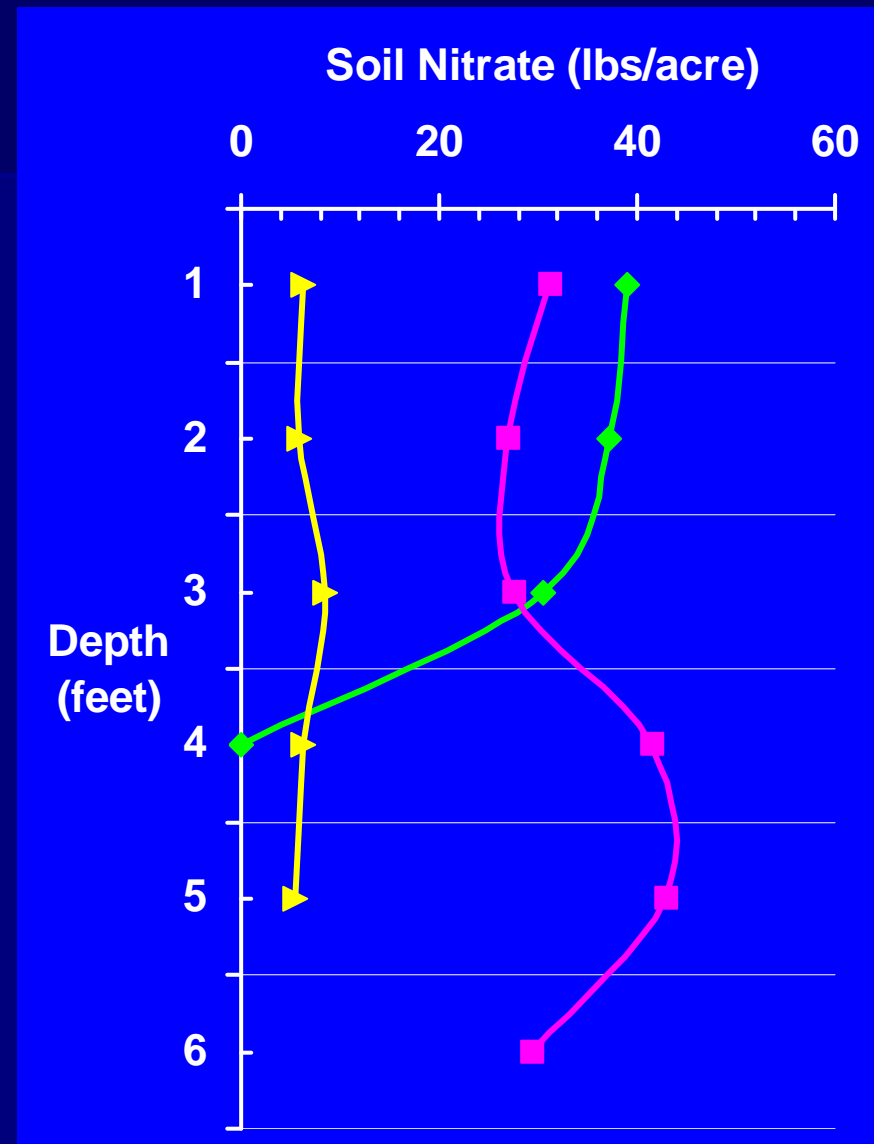
# Sugar beet nutrition

- Application at soil-test-based rates combined with careful water management would limit access to deep, late season N;
  - Sprinkler or surge irrigation improves control
- This may reduce early season growth somewhat but should increase quality and reduce fertilizer costs.

# Nitrate movement

2007 PREC "all  
preplant" plot:

- Late June
- Mid August
- October 2  
(harvest)



# Basis for sugar beet recommendations

Required for growth:

- Nitrogen: 9 lbs per ton;
- Phosphorus: 3 lbs per ton;
- Potassium: 9 lbs per ton;
- So 20 tons per acre requires:
  - 180 tons of N per acre
  - 60 tons of P per acre
  - 180 tons of K per acre
- Recommendations use total required minus RSN, nutrients from decomposing organic matter, and other credits from legumes, manure applications, etc.

# Components of reliable fertilizer recommendations

1. Analysis of representative soil samples at a reliable lab;
2. Realistic yield goals;
3. Residual soil nutrients;
4. Soil organic matter;
5. Irrigation water management;
6. Cropping history;
7. Nutrient balance.

# Representative soil sample

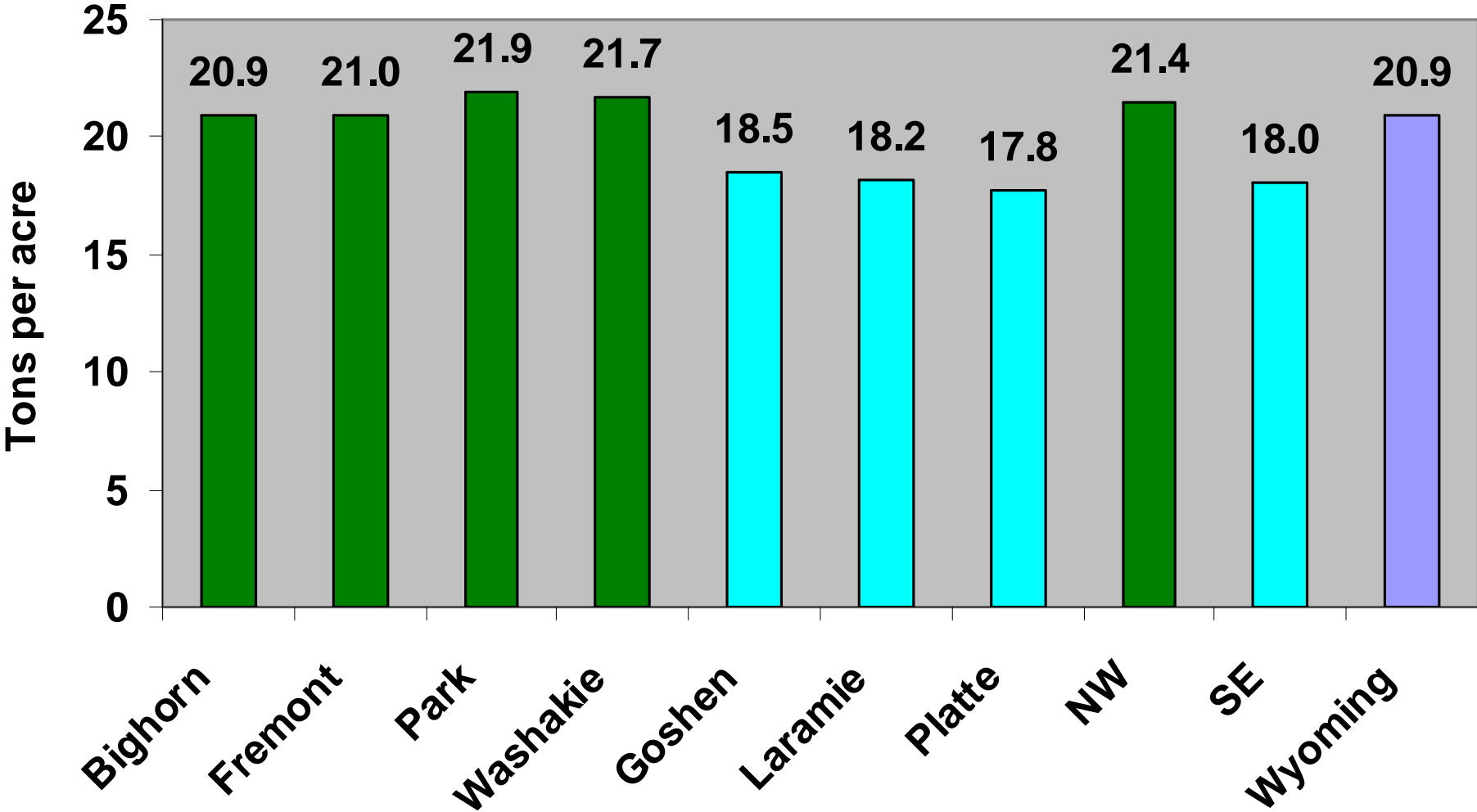
- Bulk by one-foot depth increments down to three feet or deeper:
  - Mix samples from 15-20 points with like soils and management and subsample;
  - More is better, especially where fertilizers have been banded.
  - Dry samples thoroughly ASAP, but don't oven dry.
  - Each year for N and P, every 3-4 years for other nutrients, pH, and organic matter.
- <http://ces.uwyo.edu/PUBS/MP6.3.pdf>



# Realistic yield goals

- Use average yields for particular fields, not maximum or record yield:
  - Long-term average in Wyoming = 21 T/ac
- Yield goals set too high result in excess fertilizer that wastes money and can degrade quality.

# Average Sugarbeet Yield, 1998-2006



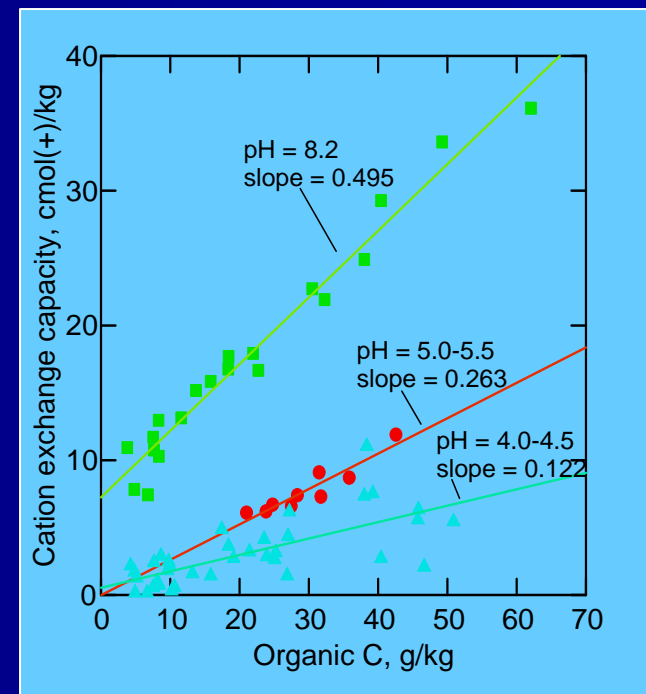
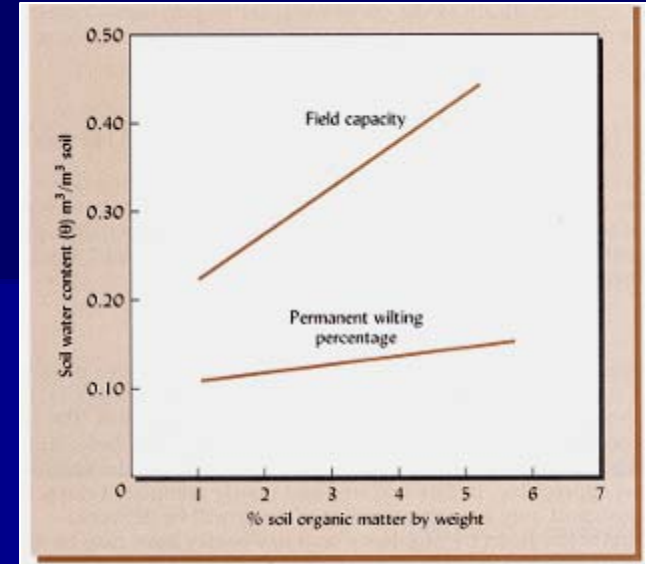
# Residual soil nutrients

- Available nutrients left in the soil after the previous crop;
- Impacted by:
  - Yield & management of previous crop;
  - Weather: SOM mineralization, leaching;
- N and P can be lost:
  - Measure as close to planting as possible;
  - Don't apply excess;
- Should be measured by a lab for best recommendations.



# Organic matter

- Crop residues & humus;
- Store of time-release nutrients;
- UWyo soil lab assumes 20 lbs of N per year for each 1 % SOM;
- Many other attributes:
  - Increases water- and nutrient-holding capacity;
  - Improves tilth;
  - Dark color;
- Can be increased or decreased by management.



# Increasing SOM

- Whole cropping system soil management:
- Manure applications to other crops in rotation: much N becomes available late in the season so not good on sugar beets but good on crops where high protein is desired;
- Green manure crops: Planted after barley, for instance, and then plowed down in fall;
- Legumes in rotation increase beet yields;
- Reduced tillage.



# Tillage

- Tillage speeds loss of SOM;
- Renewed interest in strip till with high fuel costs and RR beet varieties;
- Long-term study in Montana shows reduced fuel and labor costs;
- Beets grow faster early on then slower, turn yellow sooner, and have higher sucrose content with similar yields;
  - Banded N separate from residue is more available to growing plants, which use it up;
  - Later immobilization may limit access to N;
  - Conserves SOM: will eventually reduce fertilizer needs.



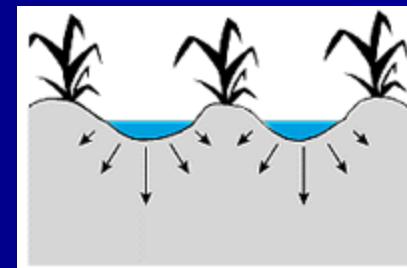
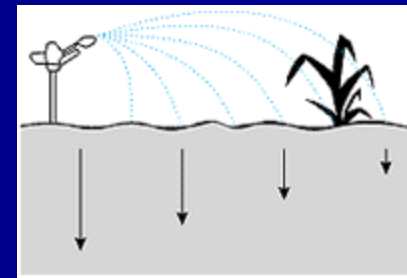
# Fertilizer placement

- Important for early access with limited lateral root development;
- Options include broadcast, knife banded, and point injected;
- Broadcast & incorporation of urea is common, but losses can be large because of poor early season access;
- banding liquid provides better placement and can save an operation;
- Knife banding liquid UAN known to reduce losses and increase availability, but takes more horsepower;
- In research at PREC point injection performed better than knife banding with less disturbance and fuel.



# Irrigation water management

- Irrigation enables precise nutrient management because dissolved fertilizers move where the water moves;
- Early on, shallow irrigation prevents losses through leaching: Most fertilizer used up before roots, and irrigation, extend deeper into soil
- Recommend irrigation water management plan based on soil intake and water holding capacity:
  - Sprinklers provide most control over nutrient movement;
  - Surge irrigation, at least in early-season applications, much better than standard furrow.



# Nitrogen from legumes and manure

		Lbs N / ac credit		
		Year 1	Year 2	Year 3
Alfalfa	>80% stand	100-140	50-70	0
	60-80% stand	60-100	30-50	0
	0-60% stand	0-60	0-30	0
Dry beans		30	15	0

		Lbs N / ton (dry wght)		
Manure	Typical Dry Matter	Year 1	Year 2	Year 3
Beef	50%	10	2	2.5
Dairy	20%	15	7.5	3.75
Poultry litter	75%	25	12.5	6.25

The N and moisture content of manure is variable: have it tested in a lab for accurate credit.

# N credit from irrigation water

- Have NO<sub>3</sub> content of irrigation water tested at lab;
- Each ppm NO<sub>3</sub> = 2.7 lbs N per acft of water;
- Sugar beets can use about 22 inches, or 1.1 acft of water per season;
- ppm NO<sub>3</sub> in water x acft of water use = Lbs N / acre;
- This can change through the season, so having several samples tested can support better estimates.

# N source, rate, and placement study

## ■ Products:

- **Urea**: standard dry N form (46 % N);
- **UAN**: standard liquid N form (32 % N);
- **Agrium ESN**: coated, slow release urea;
- **Simplot NSN**: coated, slow release urea;
- **Agro-Culture NRG**: liquid slow release;
- **Georgia Pacific Nfusion**: slow release, mix 80/20 with UAN.

# Treatments

- RATES:

- UW N recommendation: 150 lb/ac;
- Standard application at PREC: 220 lb/ac;

- TIMING:

- All preplant;
- Split: half preplant/half with UAN sidedress;

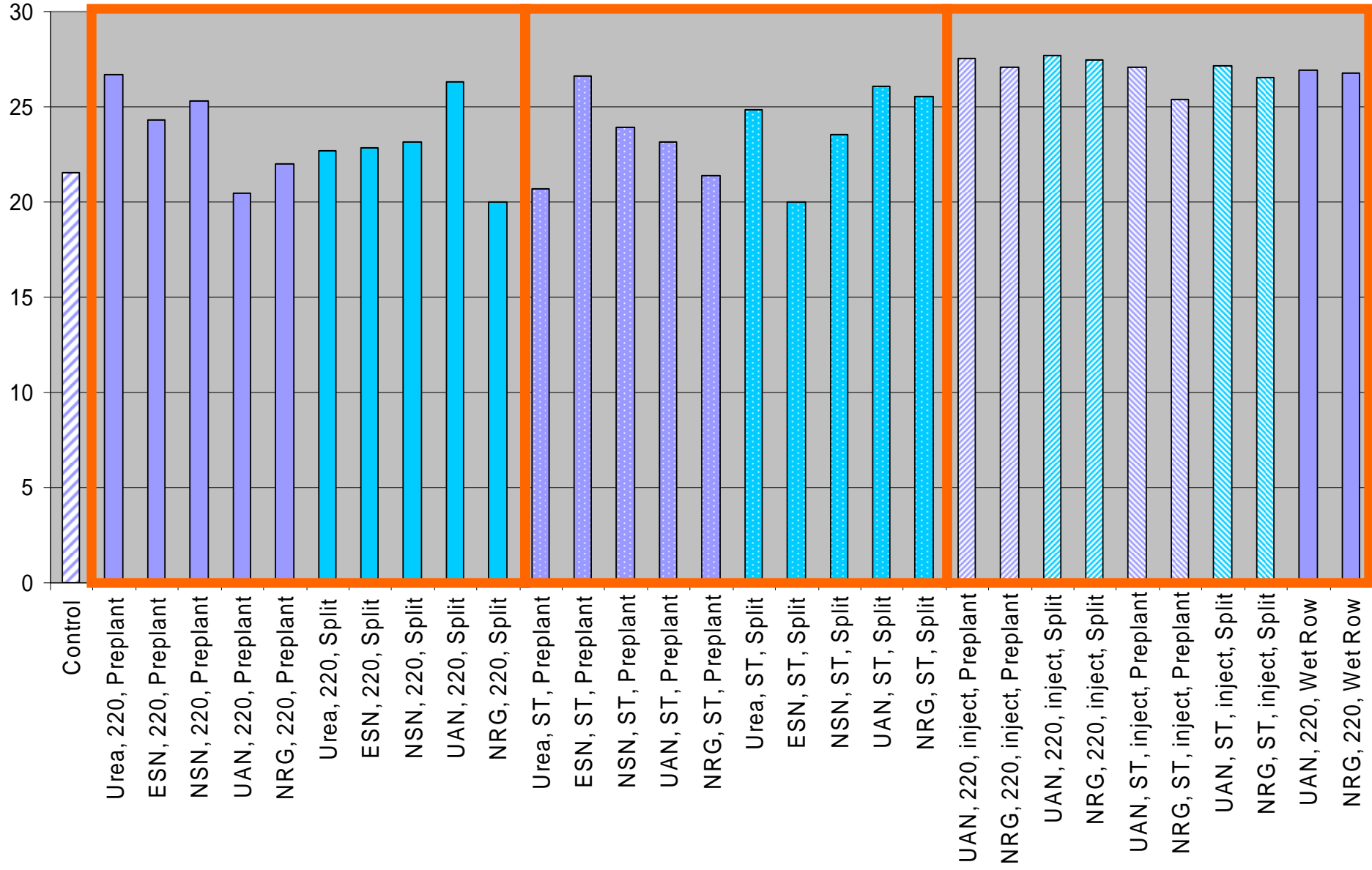
- PLACEMENT:

- Broadcast vs injection of liquid products;
- Wet row vs dry row injection.

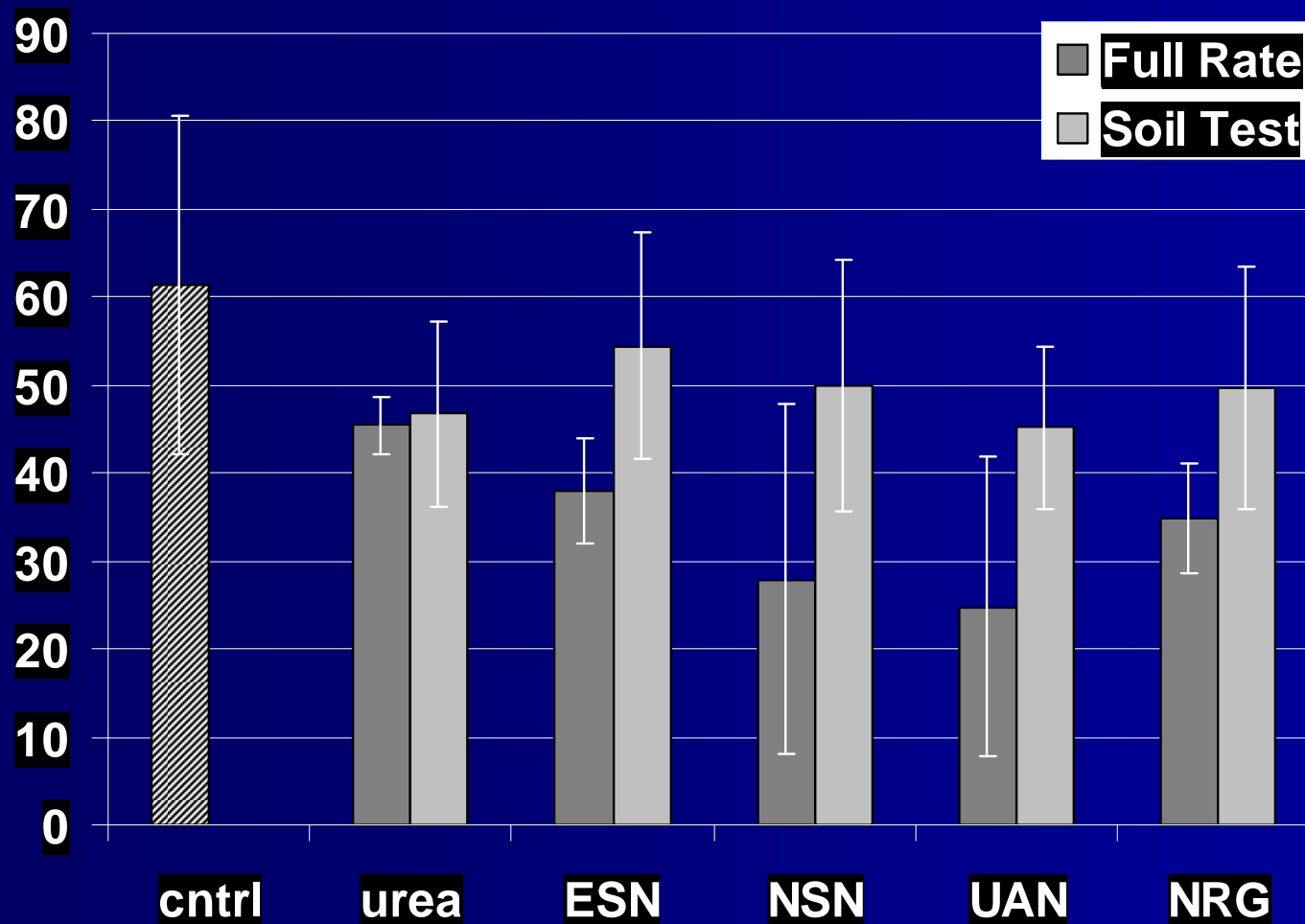
# Results

- Currently in second year of study comparing five N products, two rates, and injection vs broadcast;
- First-year results: variability larger than treatments differences
- Yields from injected liquids higher than broadcast;
- And lower, "soil test" rates more economical.





# Pounds sugar per N dollar



# Summary

- Optimizing returns from fertilizer requires
  - Knowledge from soil testing;
  - Realistic yield goals;
  - Building soil organic matter;
  - Tillage and fertilizer placement advances;
  - Careful water management;
  - Remembering what happened last year.
- Preliminary data suggest placement is important and soil test rates are more profitable than traditional higher rates.