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Predicting the Likelihood of Response of Spring Wheat to In-Crop Applications of UAN and Use of Enhanced Efficiency Fertilizers

Cynthia Grant and Alan Moulin AAFC - Brandon Research Centre
Nicolas Tremblay AAFC - St. Jean

Canada

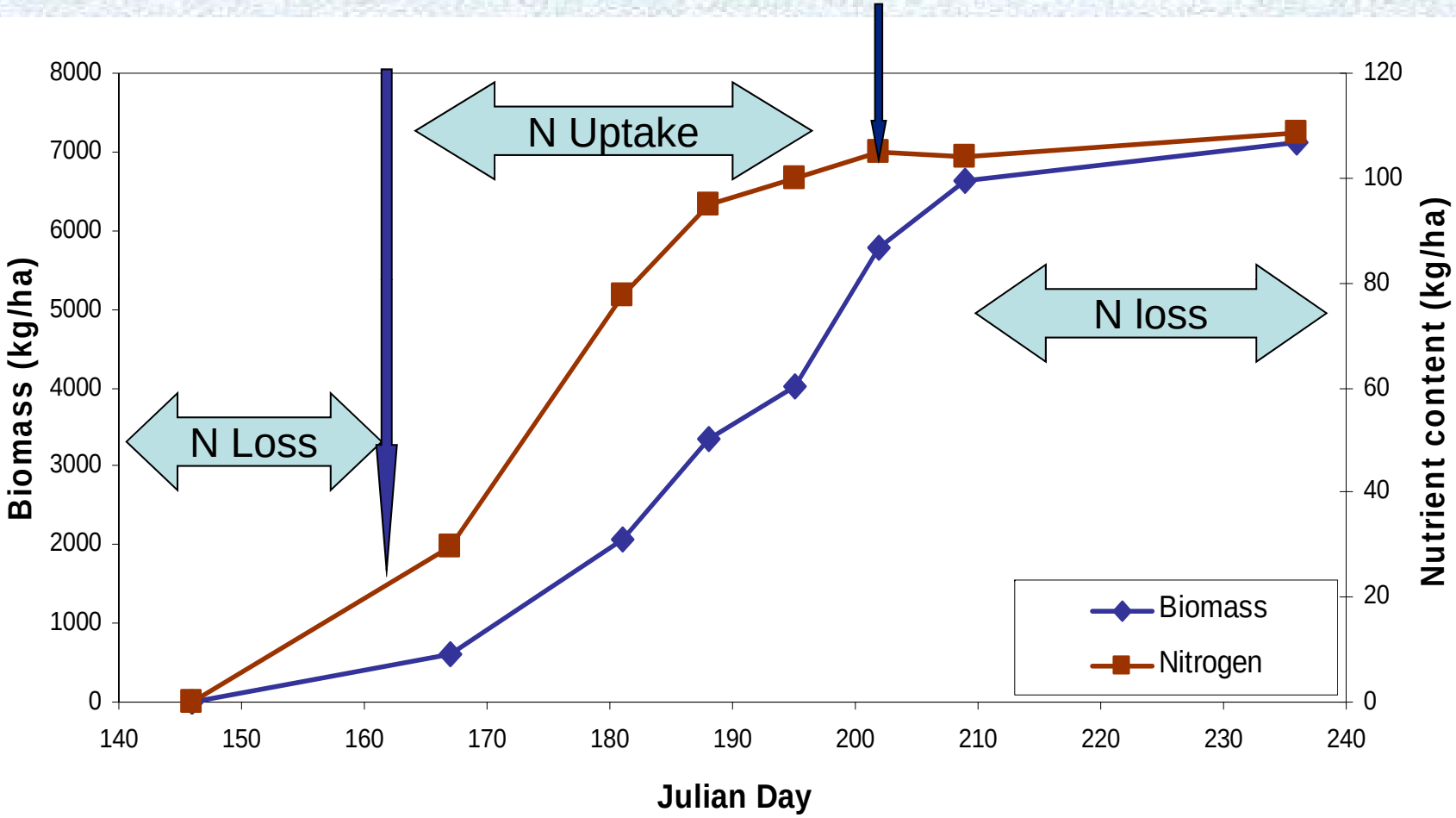
Producers have Adopted Many Fertilizer BMPs

- Rate
- Source
- Timing
- Placement
  - More than 75% of fertilizer in Canada is banded – even higher proportion in the prairies

But:

Fertilizer N use efficiency is generally less than 50%

Synchrony of N Supply and Uptake Can Improve NUE



Adrian Johnston

Split applications used to match supply to uptake

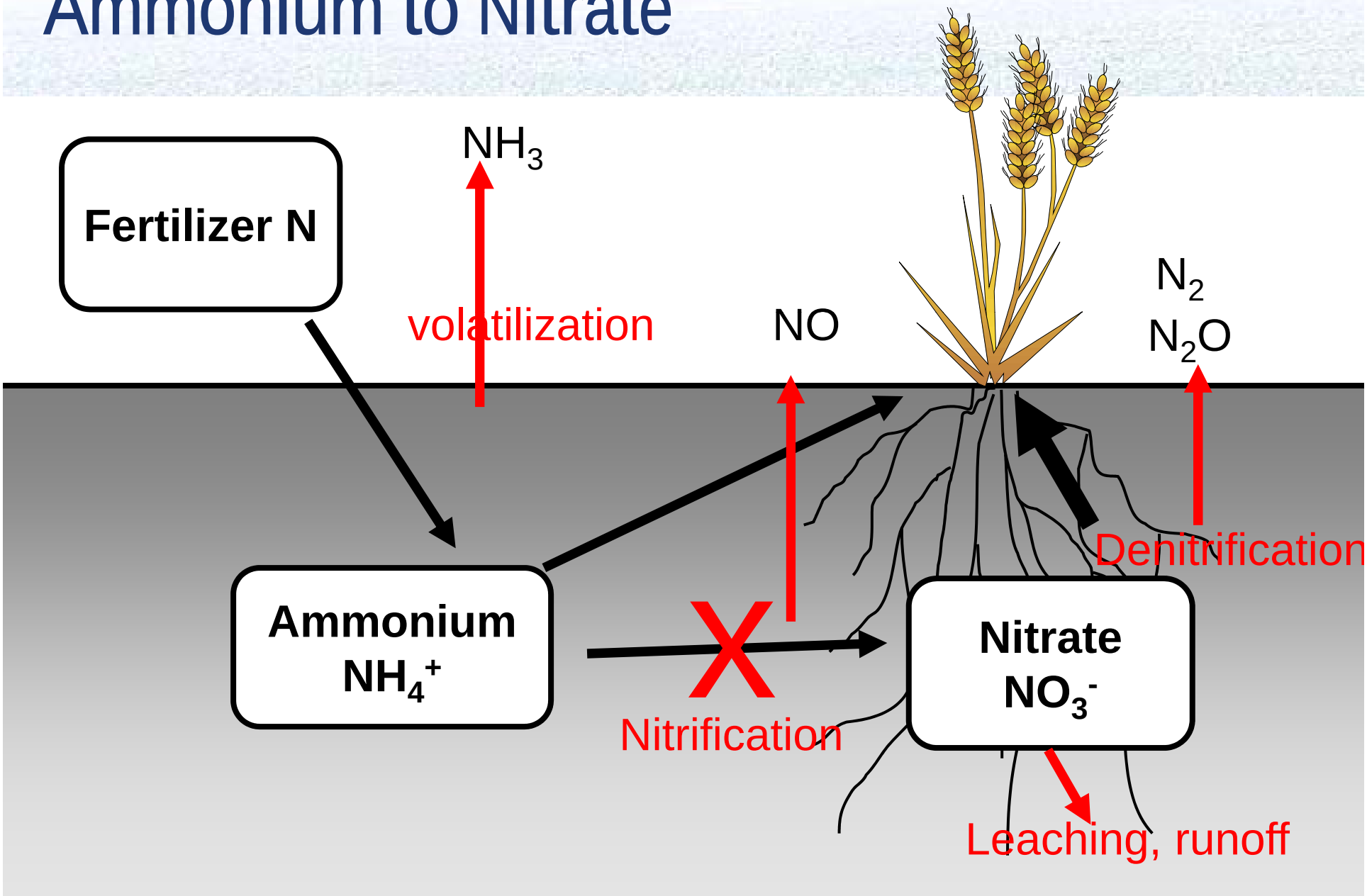
Critical risk periods for N loss

- Where environmental conditions and excess nitrate in the soil solution combine to increase risk of N loss.
- Nitrate present in soil without active plant growth

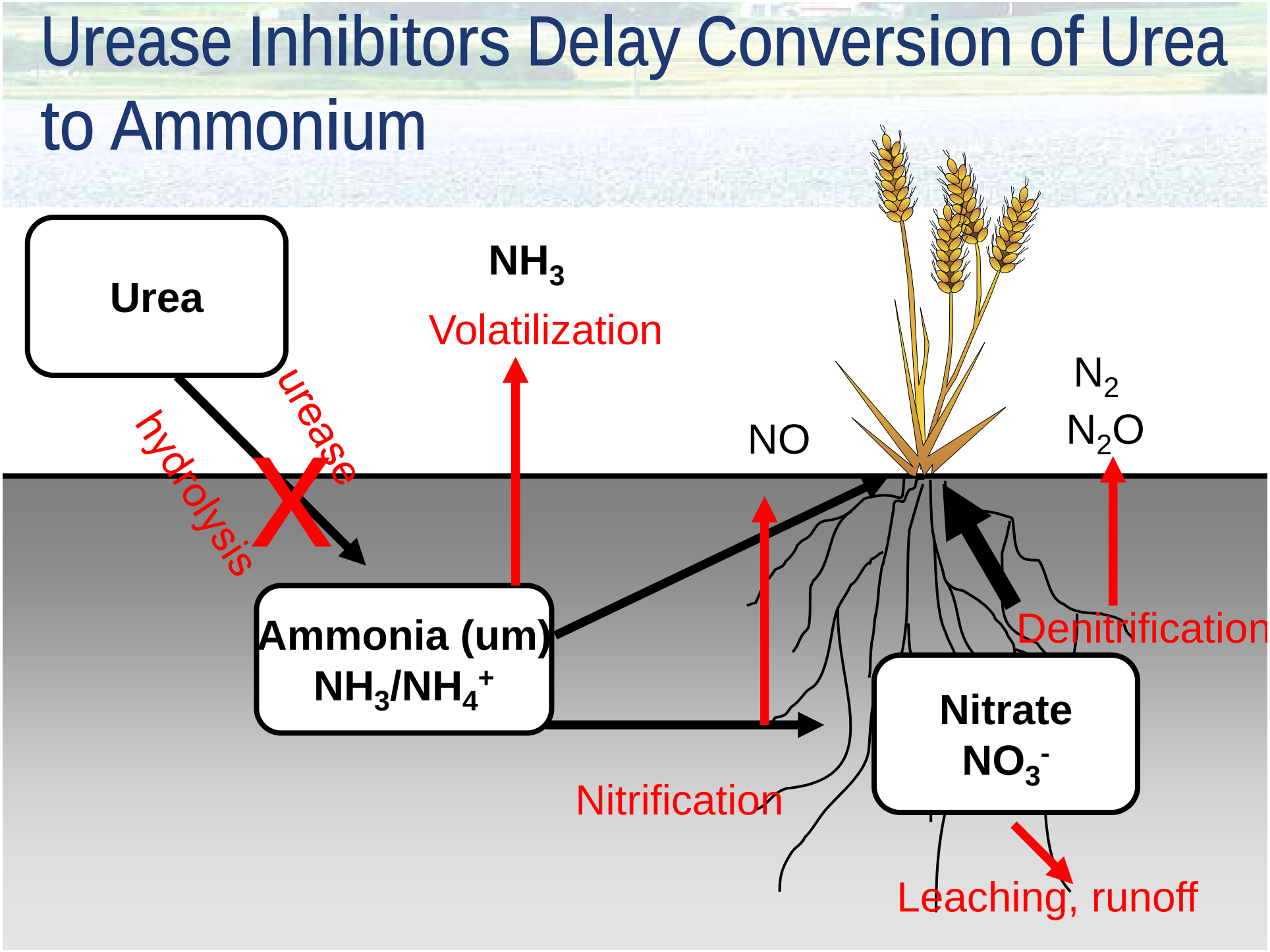
Enhanced Efficiency Fertilizers

- Fertilizers formulated to reduce losses and improve the plant uptake as compared to the “unenhanced” formulation
- Chemical action
  - Inhibitors and stabilizers
- Physical action
  - Uncoated, slowly available forms
  - Coated soluble products
    - Slowly soluble coating
    - Polymer coating

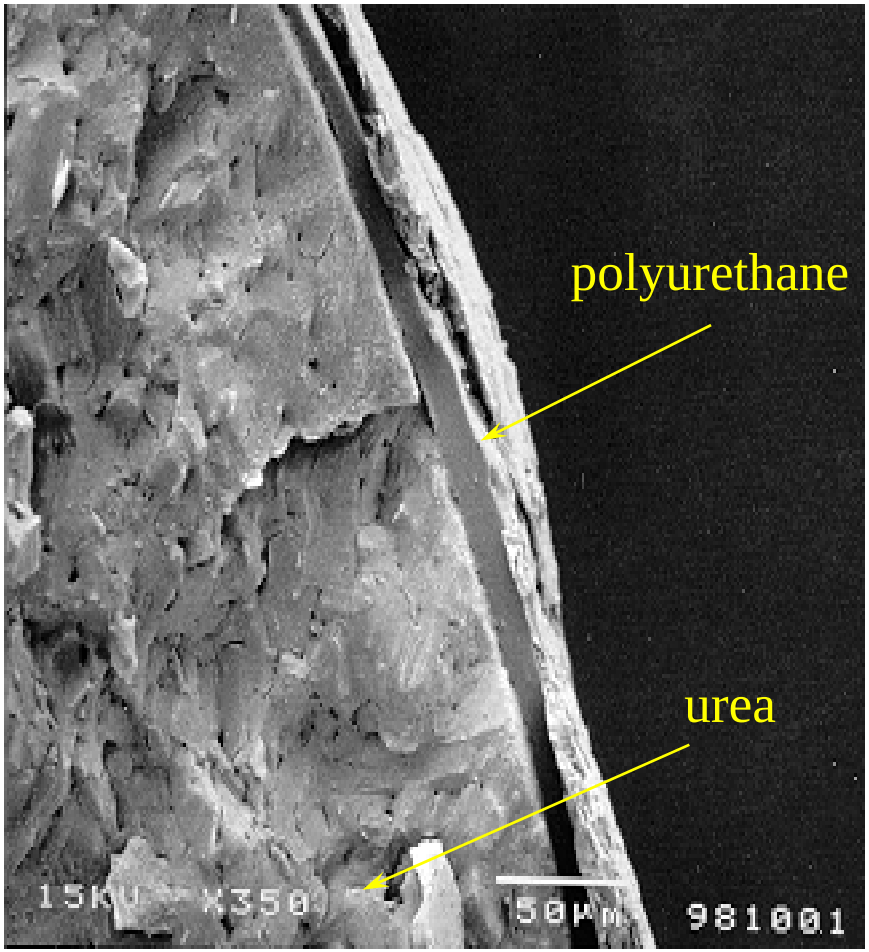
Nitrification Inhibitors Delay Conversion of Ammonium to Nitrate



Urease Inhibitors Delay Conversion of Urea to Ammonium



Controlled Release Urea May Match N supply with Crop Demand



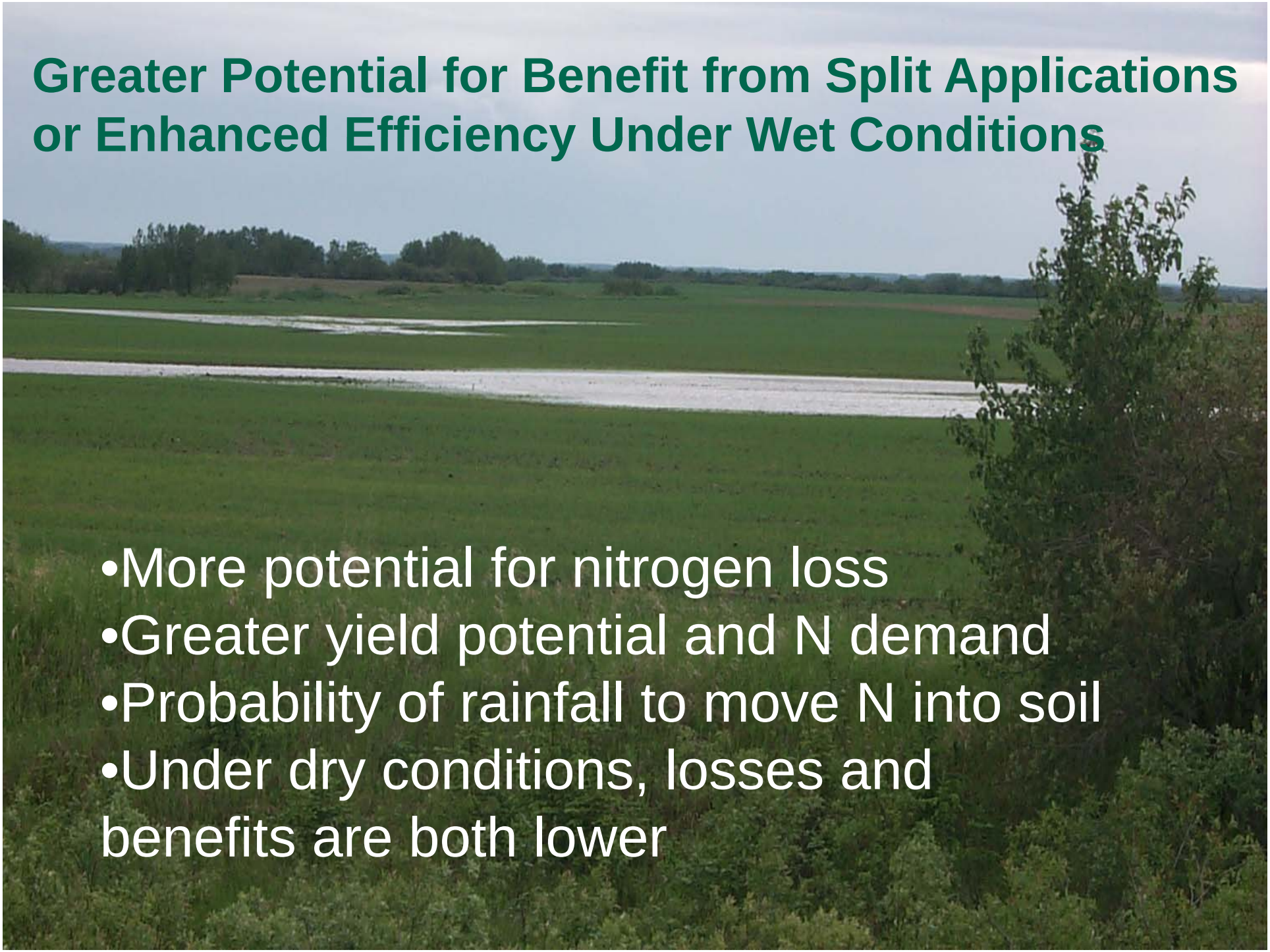
- A polyurethane membrane is applied to urea
- This membrane allows for diffusion of urea solution at a controlled rate
- The diffusion rate of urea from the granule is limited by moisture, and controlled by temperature

Not registered in Canada Yet

Enhanced Efficiency Fertilizers

- Reduce volatilization and immobilization from surface-applied fertilizers
- Reduce losses from in-soil banded applications
  - Urease inhibitors, nitrification inhibitors, Nutrisphere, coated products
- Reduce risk of seedling damage
- Slow release products can help match uptake with demand

Greater Potential for Benefit from Split Applications or Enhanced Efficiency Under Wet Conditions



- More potential for nitrogen loss
- Greater yield potential and N demand
- Probability of rainfall to move N into soil
- Under dry conditions, losses and benefits are both lower

Research Questions

- Is there an economic benefit to use of split applications or enhanced efficiency fertilizers under prairie conditions?
  - split N applications,
  - control release urea (CRU)
  - urease and nitrification inhibitors
- How does microclimate influence optimum N management?
- Should N management strategies should be altered with seeding date
- Can we predict the need for in-crop applications with sensor technology or microclimate assessment?

Treatments were applied at upper and lower slope positions at two sites

This gave us four different slope by site combinations

At each site-slope combination, two seeding dates were used

This let us test the fertilizer treatments at 8 different environments

Weather stations were located at each site-slope position to monitor soil moisture, temperature and rainfall

Treatments

- Control – no N
- Fall banded urea N at 1.0 x recommended rate
- Fall banded CRU at 1.0 x recommended rate
- Spring side-banded urea N at 0.5, 1.0 and 1.5 x recommended rate
- Spring side-banded CRU at 0.5, 1.0 and 1.5 x recommended rate
- Super U at recommended rate (broadcast before seeding)
- Agrotain Plus at 1.0 x recommended rate (dribble on seed row)
- Split N application 1
  - 0.5 side-banded at seeding and 0.5 dribble-banded as UAN at early tillering (Feekes stage 2-3) 2” off seed row
- Split N application 2
  - 0.5 side-banded at seeding and 0.5 dribble-banded as UAN at late tillering to early stem extension (Feekes stage 5-6) 2” off seed row

Measurements

1. Soil characterization
2. Soil moisture and temperature at 7.5 cm depth, air temperature and rainfall
3. Date of emergence and plant stand density.
4. Plant stand, plant biomass and tissue N at heading
5. Grain yield, straw yield, N concentration, harvest index and N harvest index
6. Tissue N, and crop assessment with SPAD and GreenSeeker meters immediately prior to fertilization at Feekes 2-3 and 4-6

The Spad meter and Green Seeker were used to assess N sufficiency

Values were compared to tissue N analysis

Data not analyzed yet

Statistics

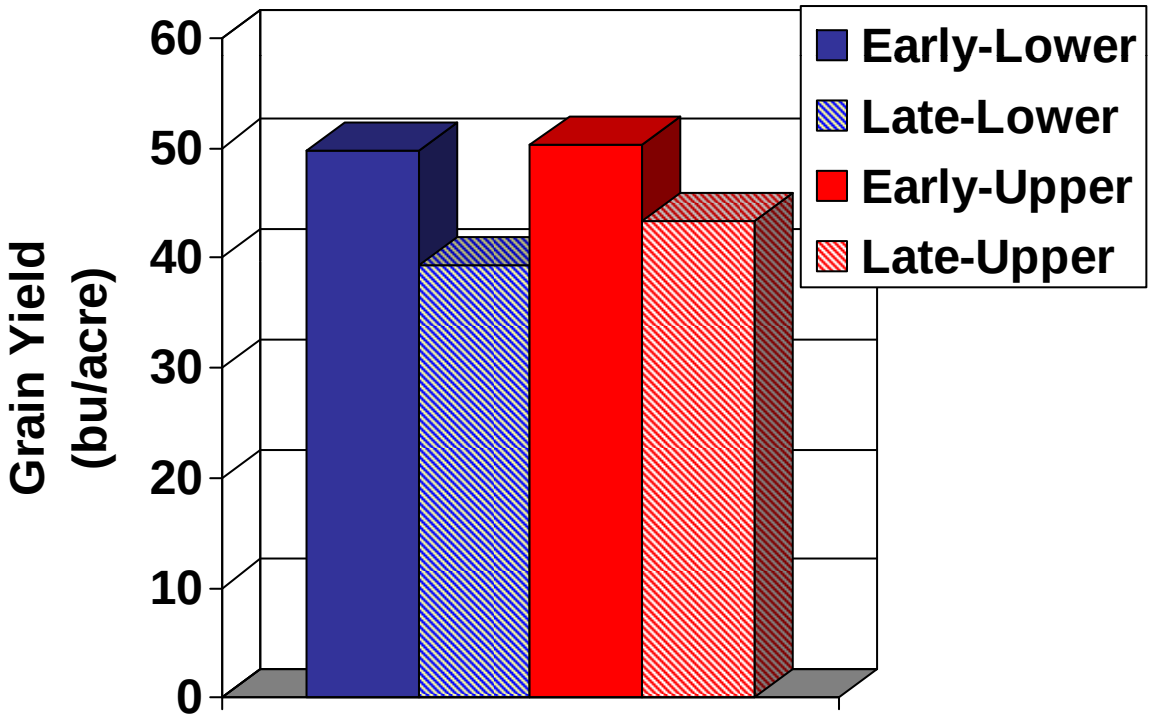
- Split plot factorial experiment with four replicates
  - seeding dates as the main plots
  - fertilizer treatments as the sub-plots,
  - 2 locations x 2 slope positions x 2 seeding dates x 13 treatments x 4 replications
  - 416 plots per year.
- Statistical analysis used contrast analysis under Proc Mixed of SAS

What was the Season Like?

- Spring had relatively wet conditions and moderate temperatures
- In July, the weather became very hot and dry
  - little to no rainfall through July and August.
  - Record high Humadex ratings for several weeks
- Yields were restricted by drought and excess heat

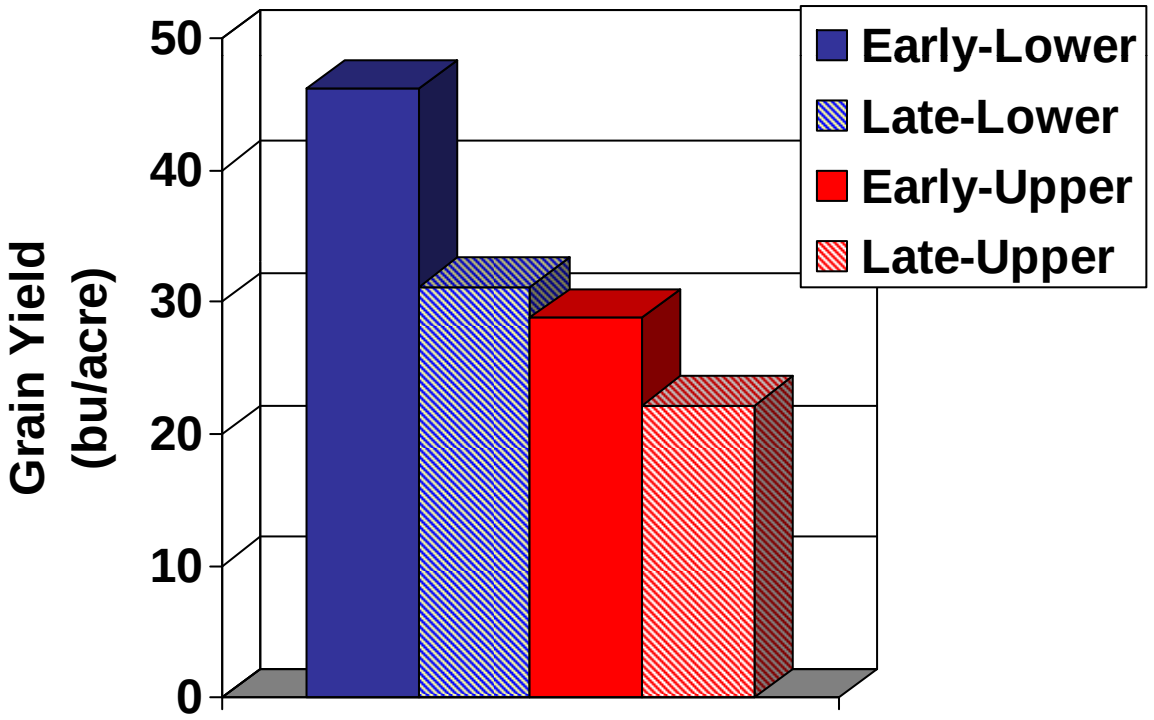
At the Silty Clay site, grain yield was affected by seeding date and slope position

- Higher yield with early seeding date
  - 7-10 bu/acre benefit
- Higher yield on upper slope than lower when crop seeded late
  - Problems with wet conditions after seeding at lower slope

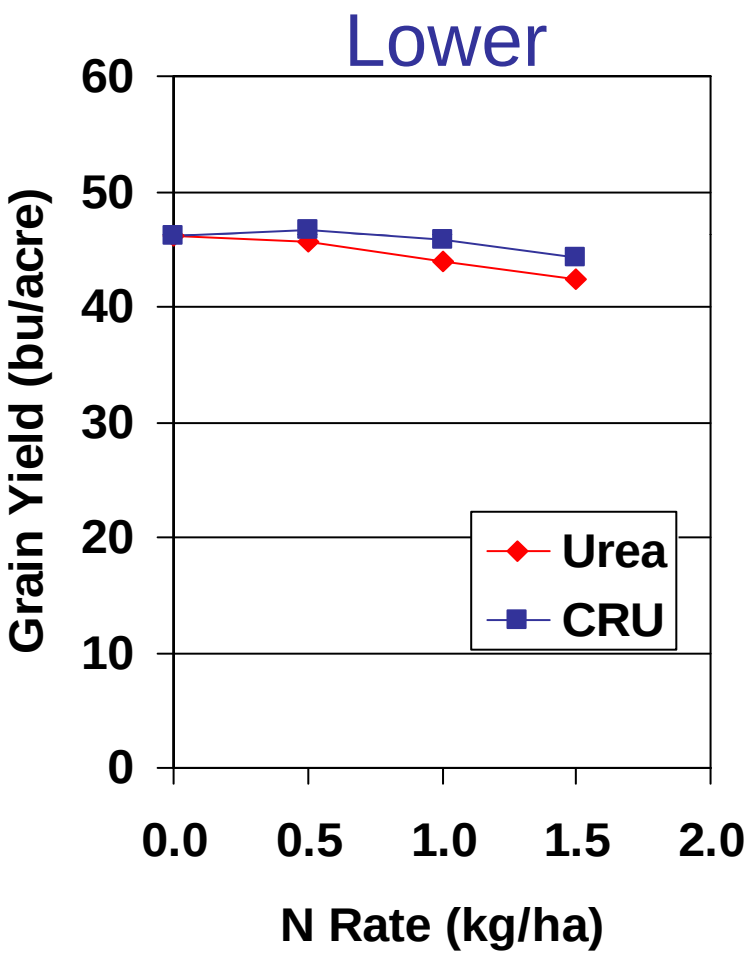


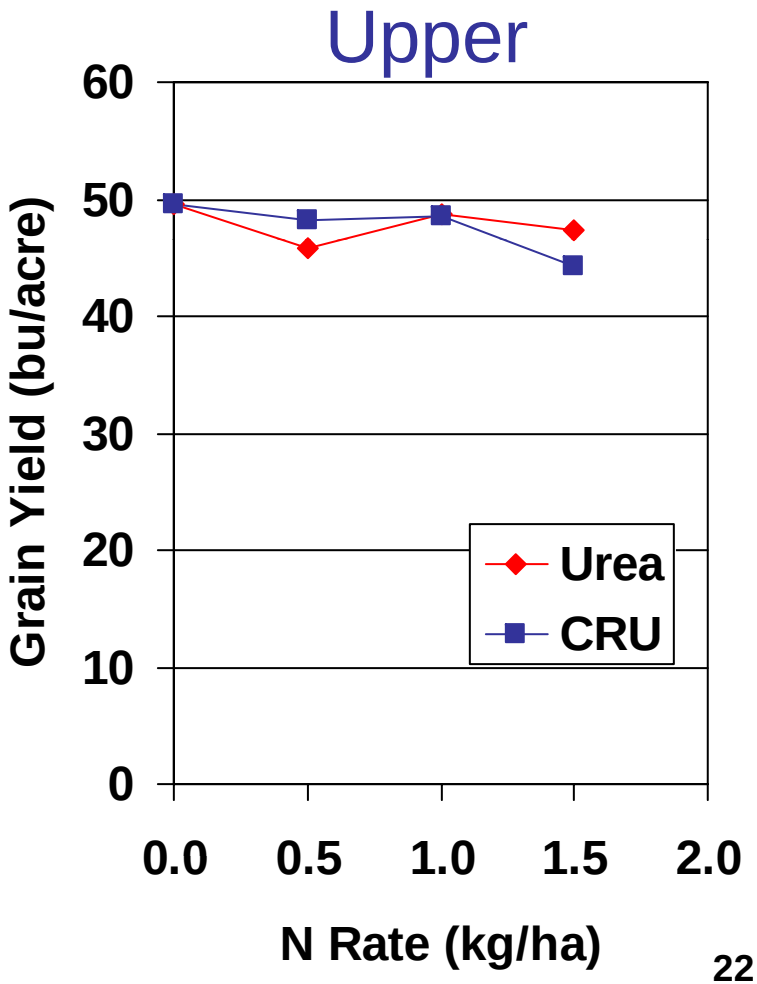
Slope position and seeding date had an even greater effect at the clay loam site.

- Higher yield with early seeding date
  - Averaged 13 bu/acre more
- Higher yield on lower than upper slope positions
  - Extra moisture on lower slope helped when conditions tuned dry
- Yield was doubled with combination of early seeding and lower slope position



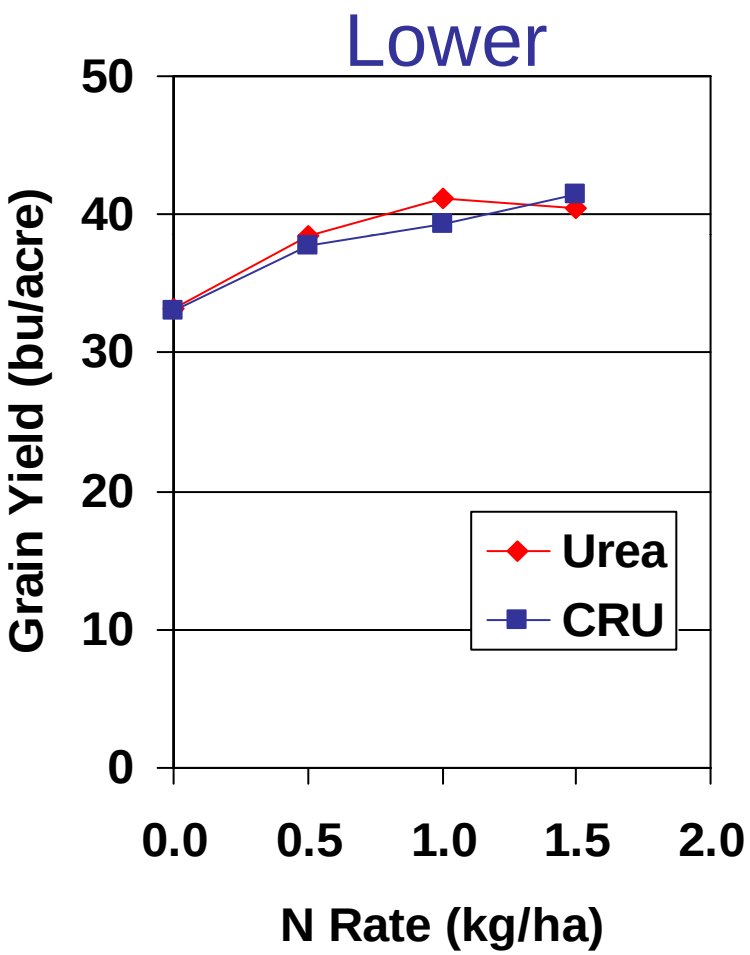
There was no effect of N application on grain yield at the Silty Clay site

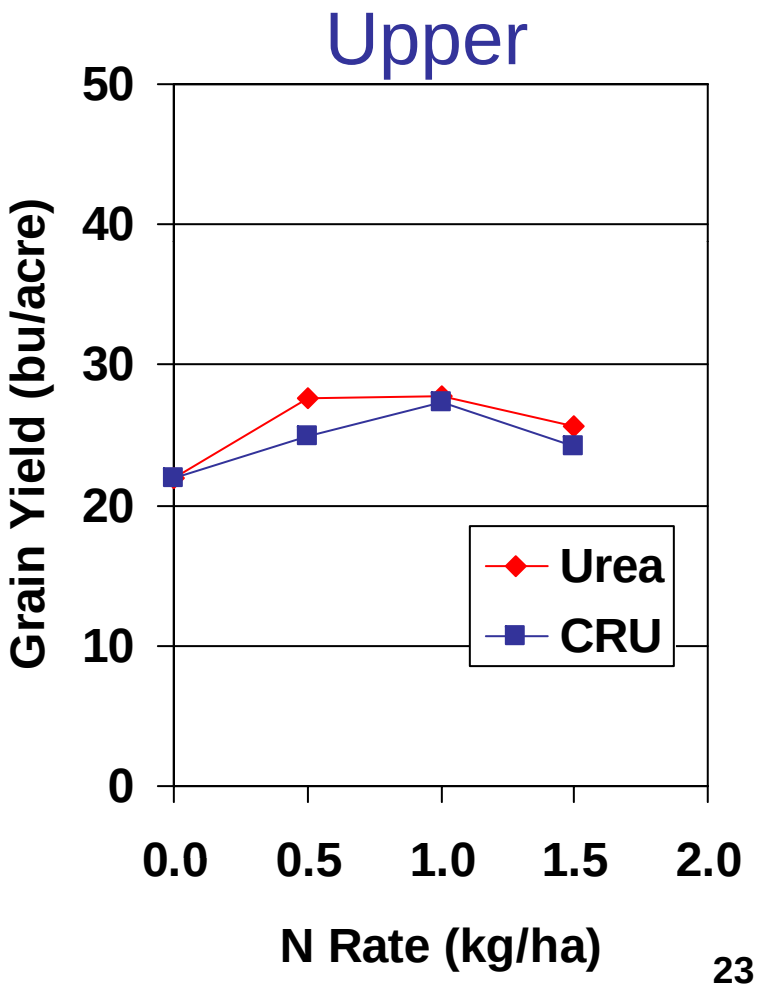




Nitrogen increased grain yield at the Clay Loam site

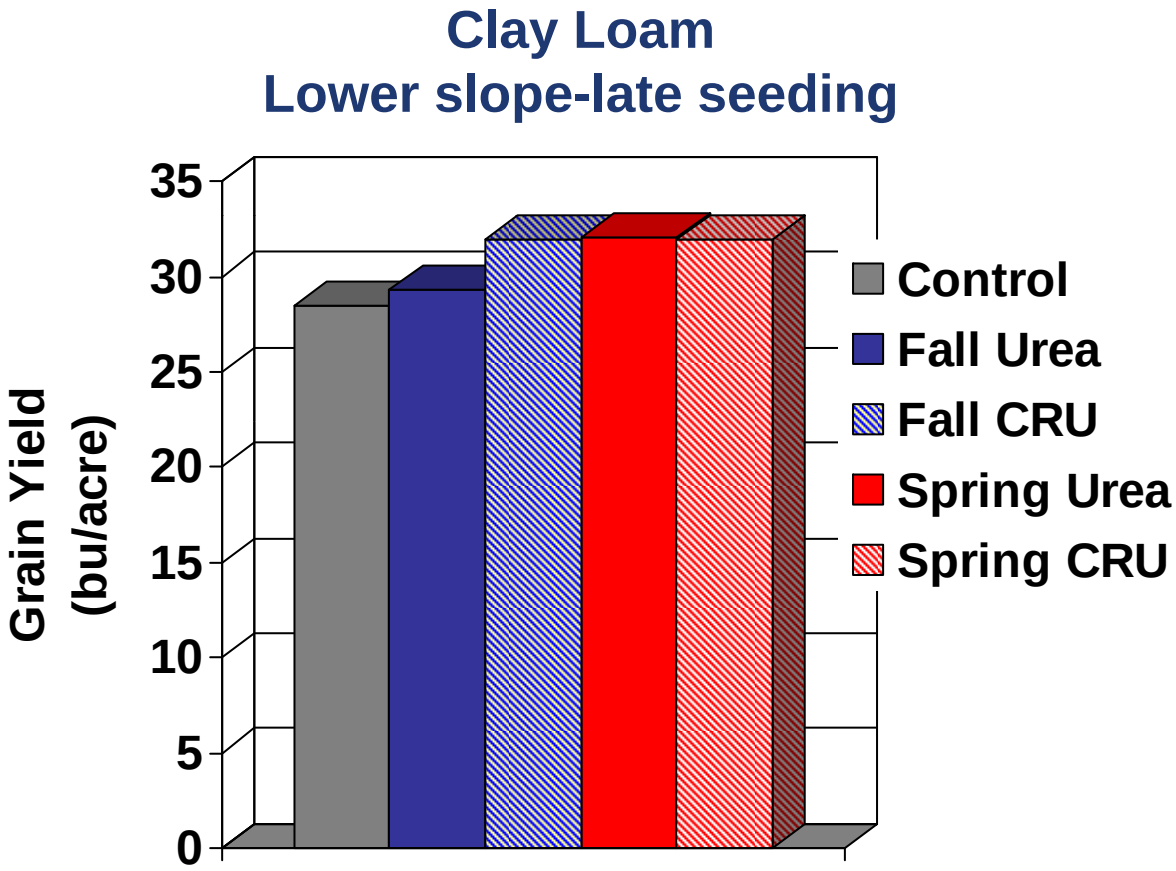
-Yield similar with CRU and urea if spring-banded





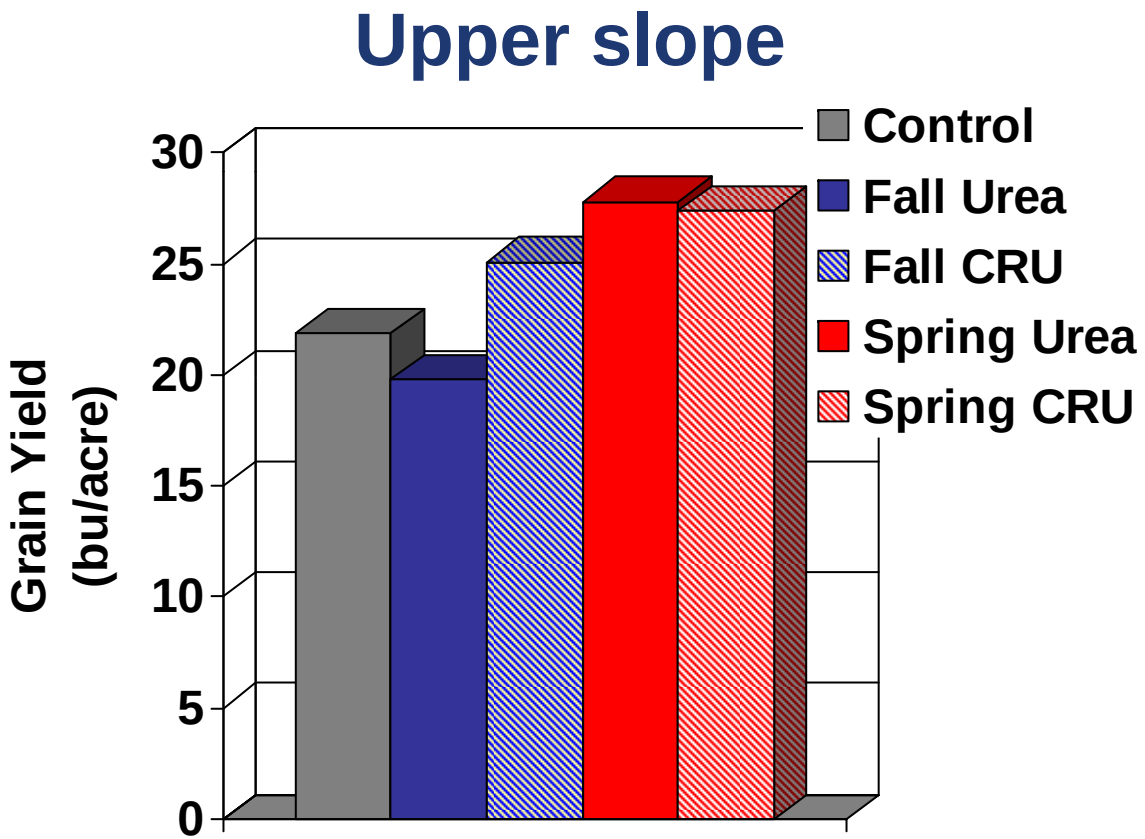
Use of CRU reduced losses from fall-banded fertilizer

- Higher yield with spring than fall-banded urea
  - Some loss of urea from fall to crop uptake
  - Bigger effect with late seeding
- Fall-banded CRU and spring-banded urea or CRU did not differ



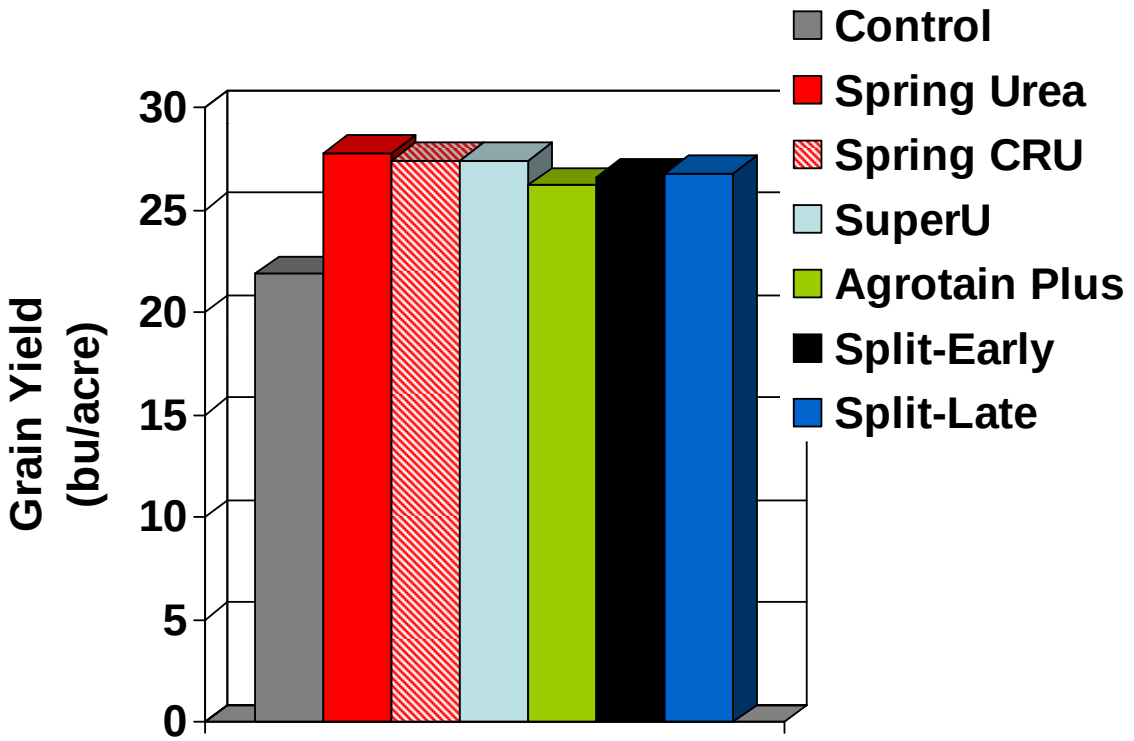
Effects of fall-banding were greater on the upper slope position

- High losses from fall-banded urea
  - Leaching losses?
  - Differs from our normal results that have greater losses on lower slope
- Fall CRU yielded more than fall urea
- Fall-banded CRU and spring-banded urea or CRU did not differ



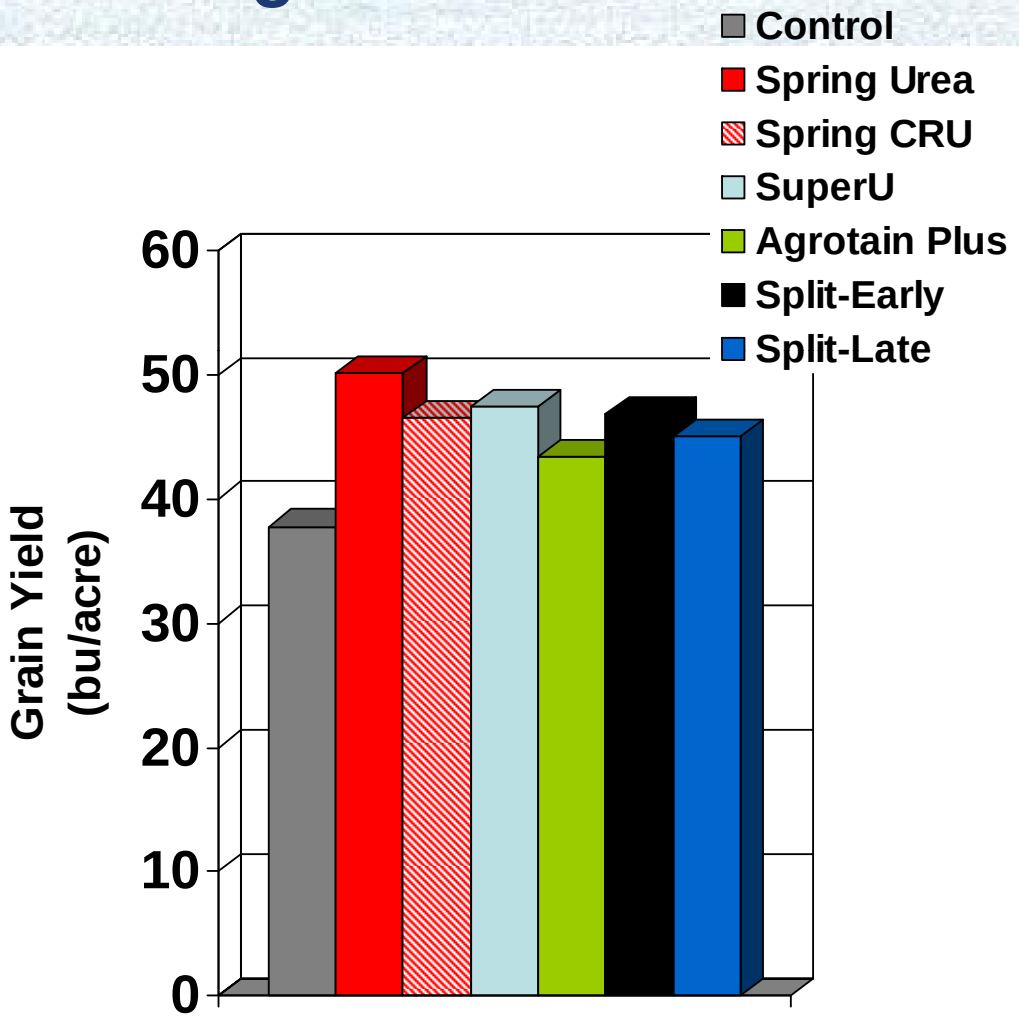
At the Clay Loam site, at the upper slope position

- Yields were low due to drought and heat stress
- N fertilizer increased yield by about 5 bu/acre
  - ½ recommended rate produced highest yield
- No significant differences among spring-applied fertilizers at either seeding date

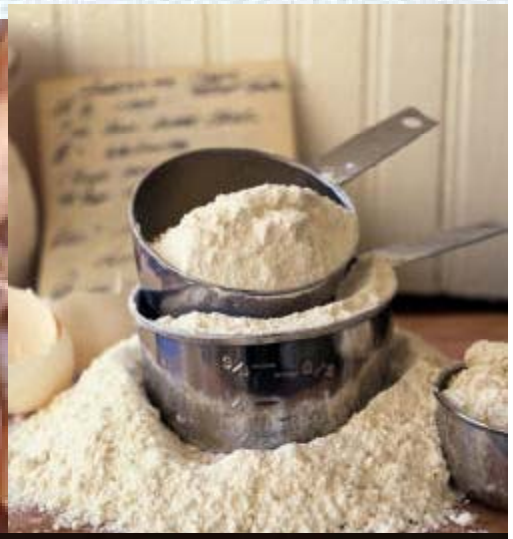


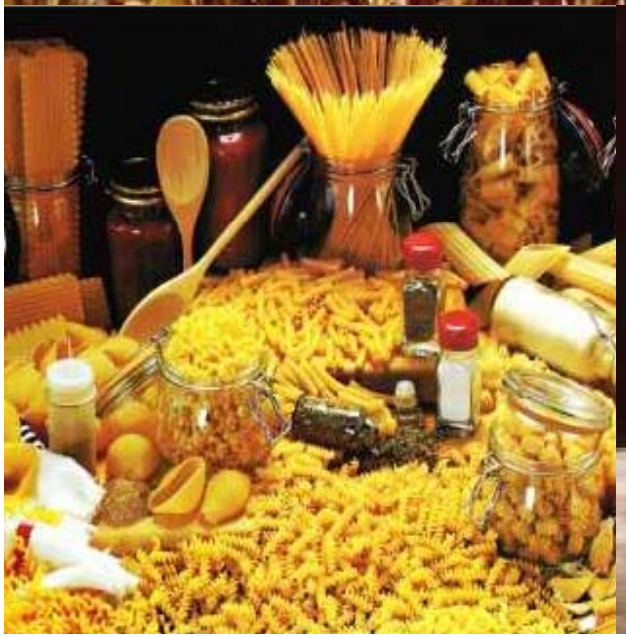
At the Clay Loam site, at the lower slope position with early seeding

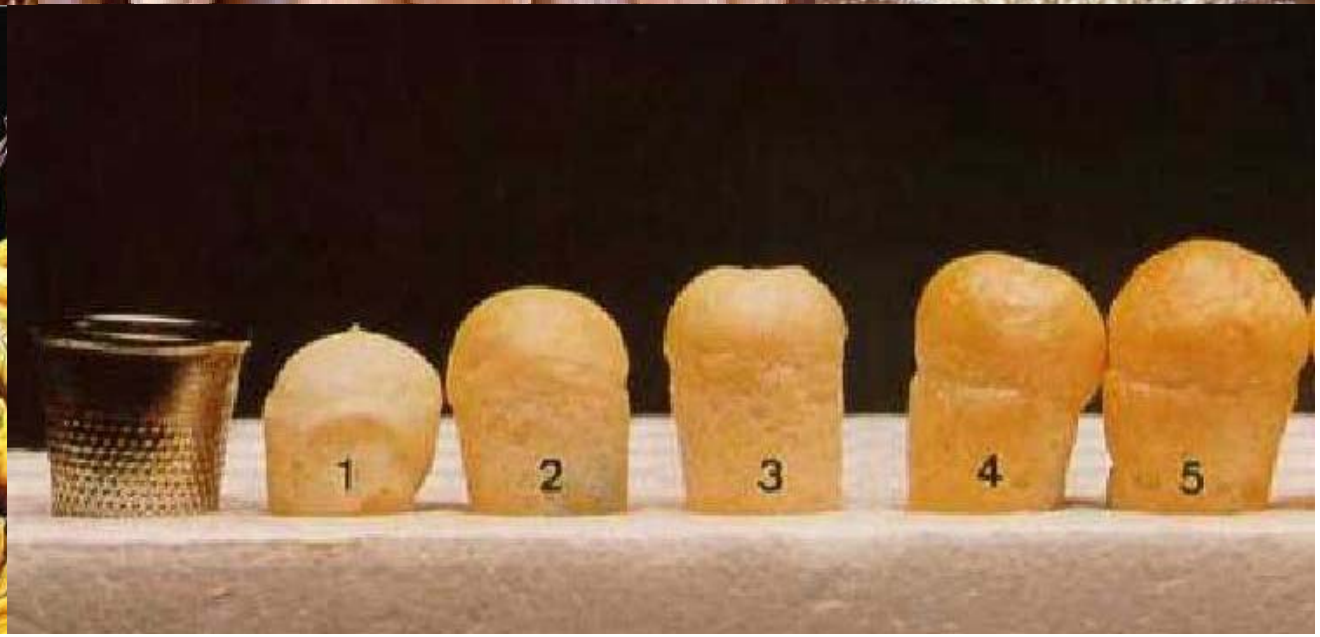
- Yields relatively high in spite of the drought and heat stress
- N fertilizer increased yield by about 12 bu/acre
  - Highest yield at recommended rate of urea
  - No benefit from EEFs with spring-applied N
- Yields were lower with Agrotain Plus than with urea at seeding
  - Surface application wasn't used effectively
- No difference between split application and spring-banded



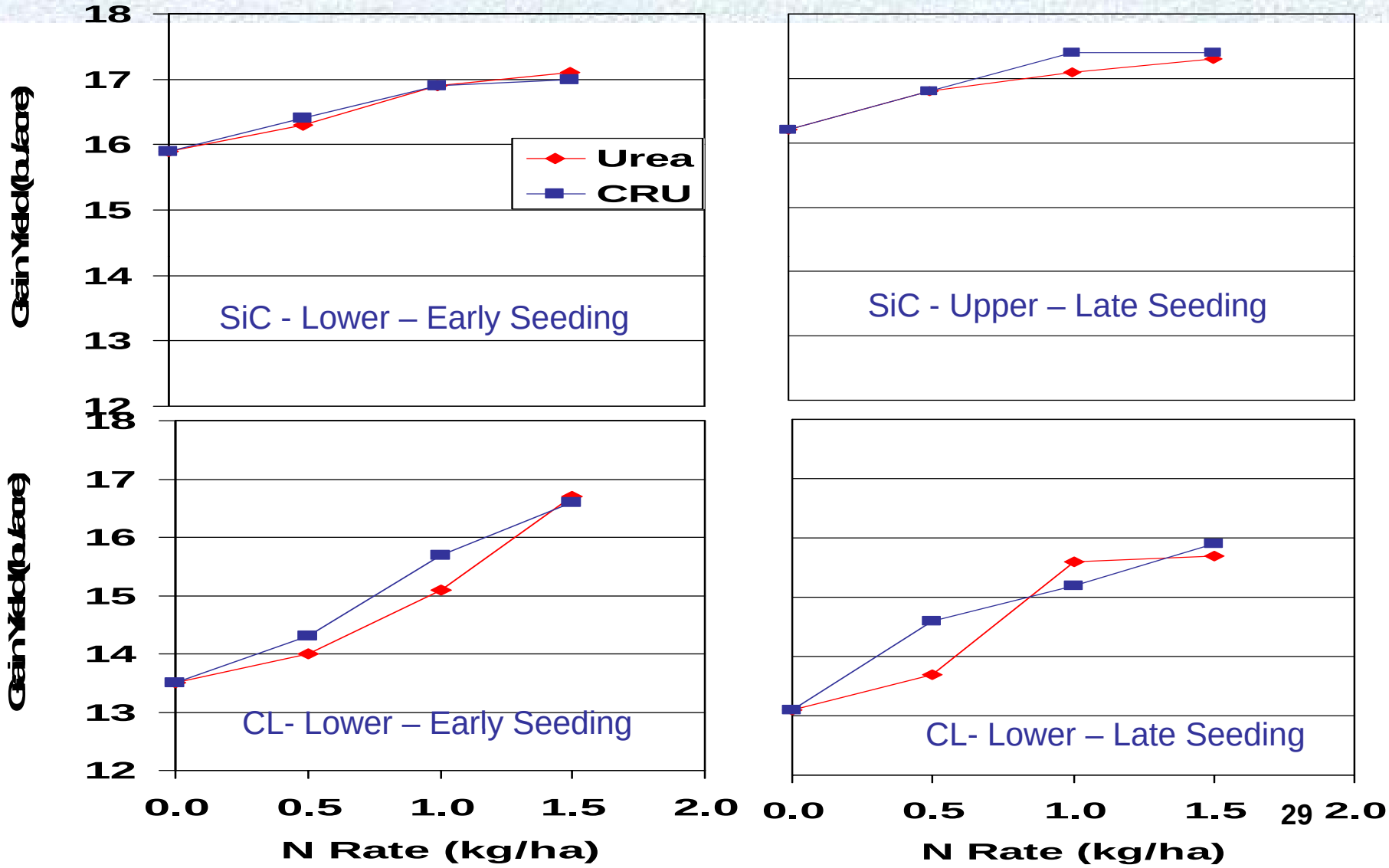
High protein content is needed for good bread and pasta





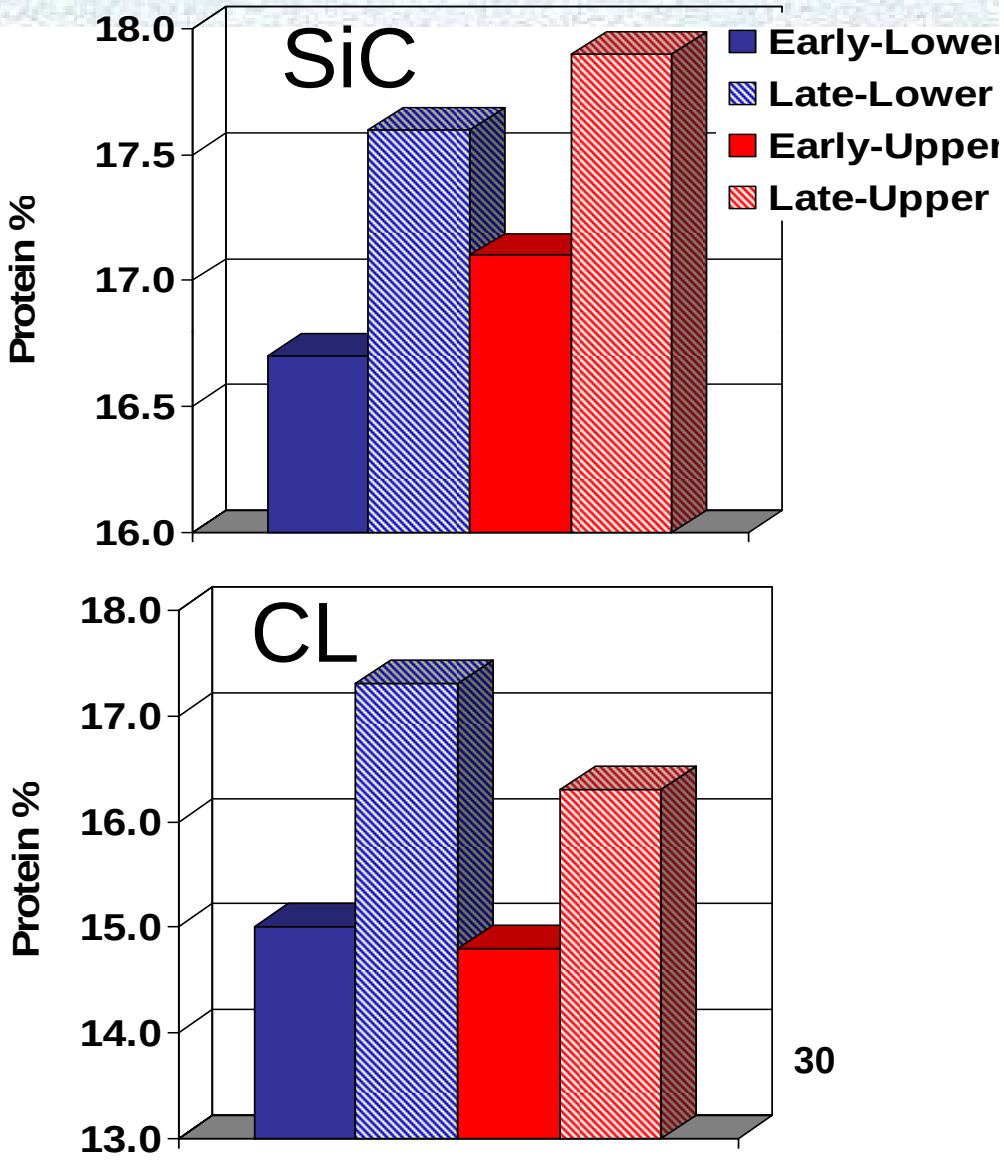


Protein Content was High and Increased with N

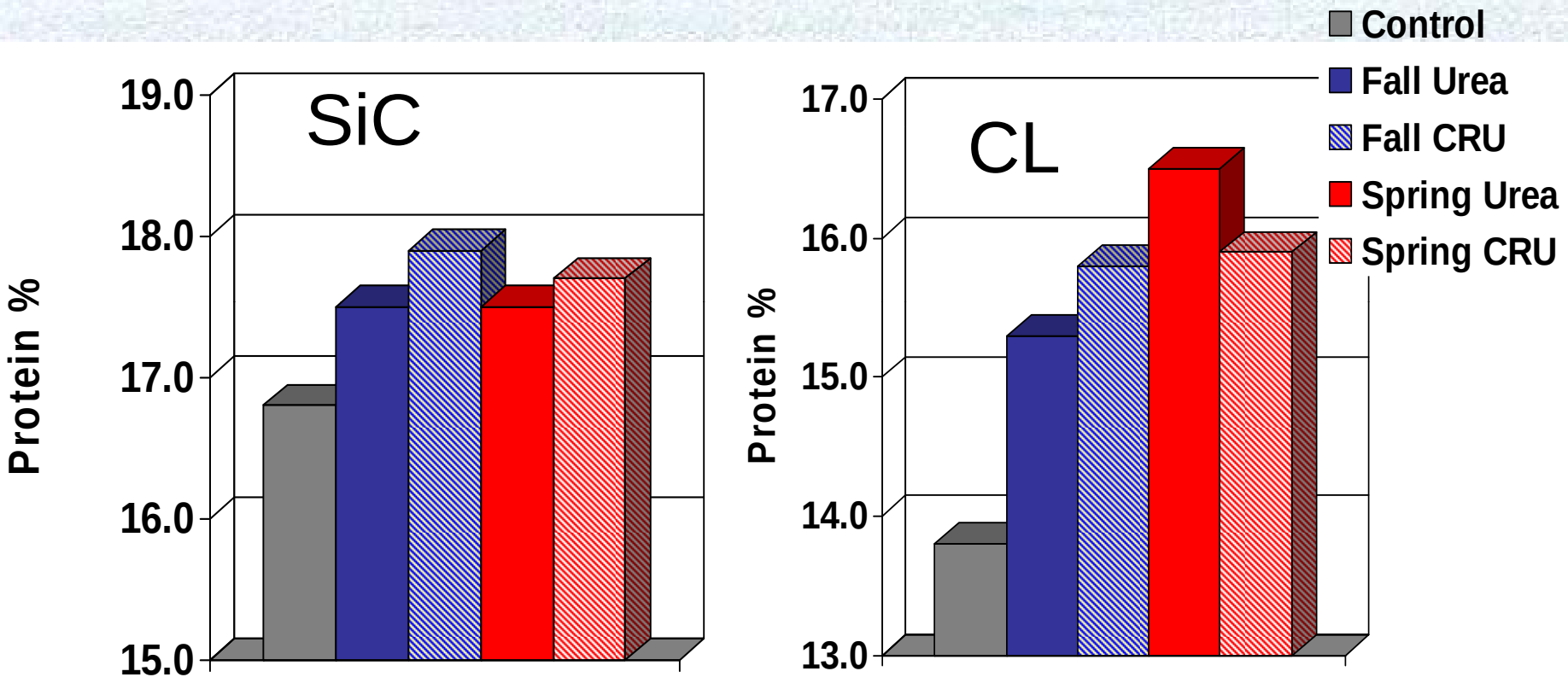


Protein content was affected by seeding date and slope position

- Higher protein with late seeding
  - Greater late season drought stress and lower yield
- Drier upper slope position gives higher protein on SiC
- Lower slope gave higher protein on CL
  - Mineralization from higher OM?



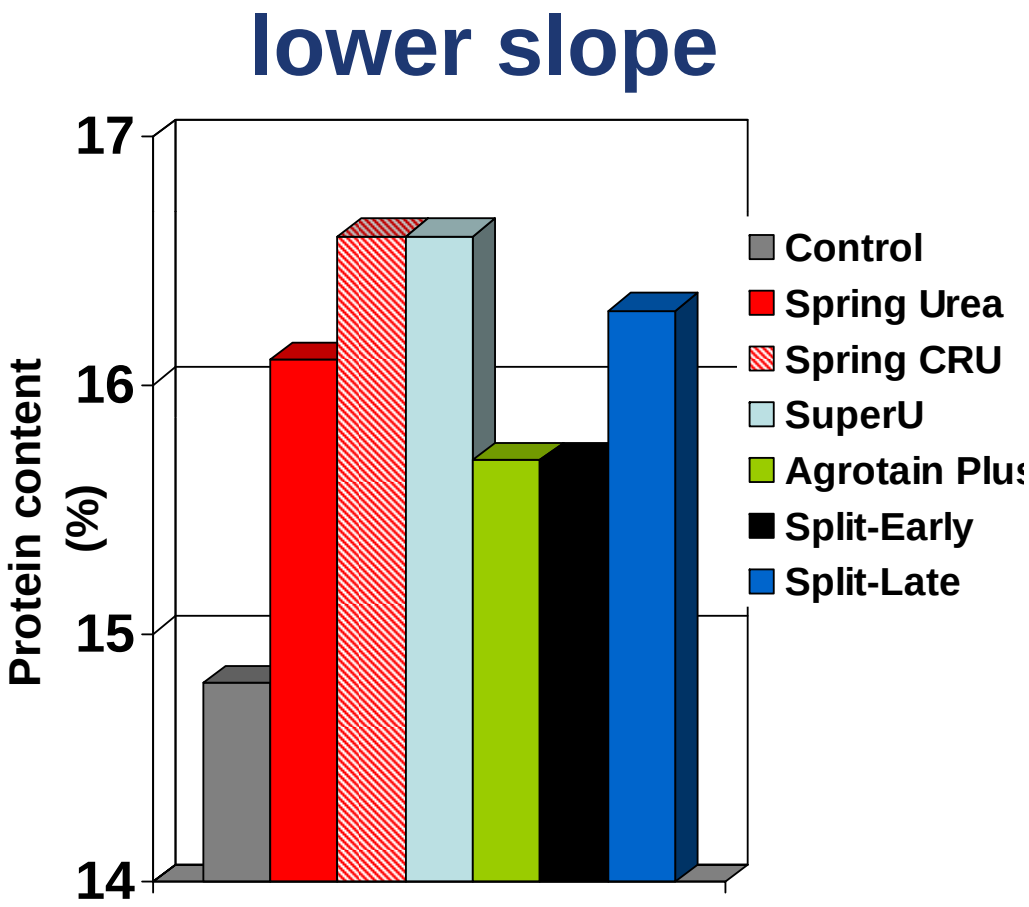
On the upper slope on both soils



- Fall CRU produced higher protein than fall urea
  - CRU reduced losses and increased late N supply

At the Clay Loam site

- N application increased protein content by about 1.5 percentage
- SuperU and CRU tended to improve protein over urea (P<0.07), but only at the lower slope position
- Agrotain Plus and early split applications produced lower protein
  - "stranding" of N at the surface?
  - Surface application wasn't used effectively
- Late split application gave higher protein than early split



Summary

- Early seeding consistently increased crop yields at both sites
- Lower slope produced higher yield at the CL soil while upper slope had higher yield at the SiC soil
- SiC was not responsive to N fertilizer
  - High N supply from soil led to high yields and very high protein content

Summary

- With fall application, CRU increased yield as compared to urea
- With spring application, no benefit of use of enhanced efficiency fertilizers over urea on grain yield
  - Losses may have been low due to dry conditions
- CRU and SuperU increased protein at times
  - Enhanced late season availability

Summary

- Surface application were not efficiently used in 2008
  - Frequently reduced protein content
  - Stranding of N at soil surface may have reduced availability
  - Related to absence of rainfall in July and August
- Relationships among tissue N, Spad and GreenSeeker data and yield are still being analyzed


Thank you to the Fluid Fertilizer Foundation, Agrium, Agrotain International, Agvise Laboratories and AAFC-MII for their support of this project
The End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