

- ### Outline of today's seminar...
- Background info about foliar fertilizers
 - Physiology of nutrient uptake through leaves
 - Foliar nutrient uptake studies
 - Cost analysis of foliar nitrogen products

Water soluble complete

Water soluble nitrogen

Are these foliar fertilizers ?

Why would you use foliar fertilization?

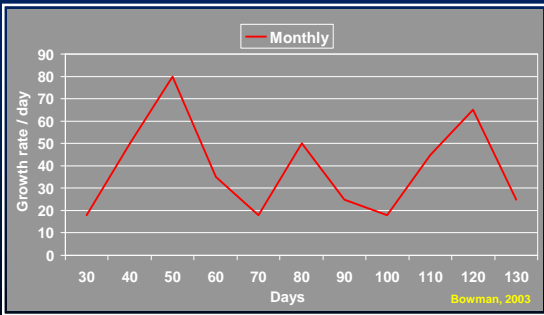
Benefits of Foliar Fertilization on Putting Green Management

- Ease and accuracy of application
- Provide more consistent growth
- Provide nutrients during periods when root physiology is compromised
- Provide secondary benefits, when incorporated with biostimulants
- Improved uptake efficiency
- Environmental safety

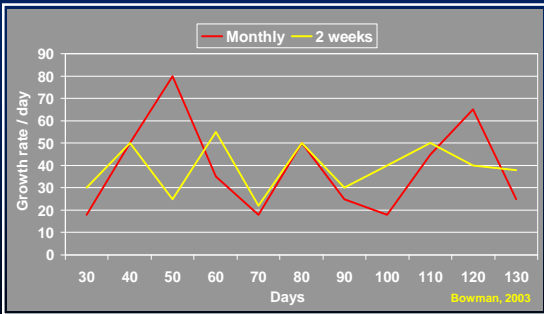
Frequent spoon-feeding will produce more consistent growth than infrequent applications of fertilizer

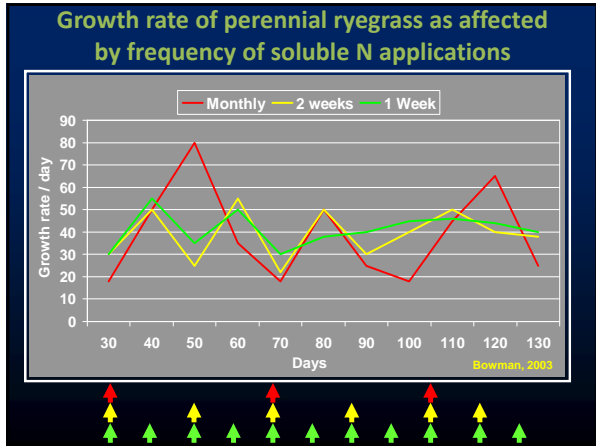


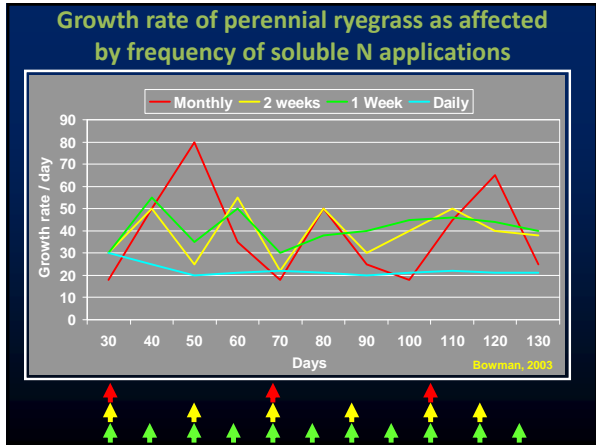
Growth rate of perennial ryegrass as affected by frequency of soluble N applications




Growth rate of perennial ryegrass as affected by frequency of soluble N applications







Some opening thoughts about nutrient uptake...

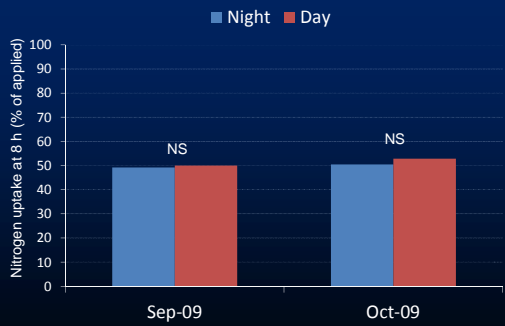


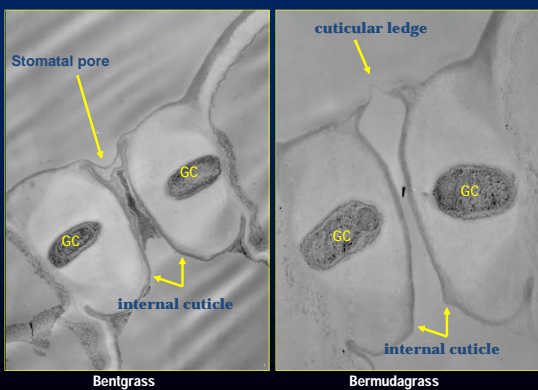
- Grasses were not designed to absorb nutrients through the leaves
- Capacity for absorption is much greater in roots compared to leaves
- Some nutrients can only be moved to areas of need via root uptake

What are the barriers to nutrient absorption through the leaves ?

- Assumed that the primary ports of nutrient entry are:
 - Stomates
 - Cuticular wax

Stomatal effects on nitrogen uptake





How does foliar fertilization affect nutrient movement in the turf?

Nutrients that can be absorbed through the leaves

<u>Macronutrients</u>	<u>Micronutrients*</u>
<ul style="list-style-type: none">• Nitrogen + + +• Phosphorous +• Potassium + + +	<ul style="list-style-type: none">• Zinc• Iron• Boron• Sulfur

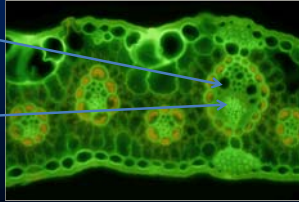
* Often applied as chelates

What about other nutrients?

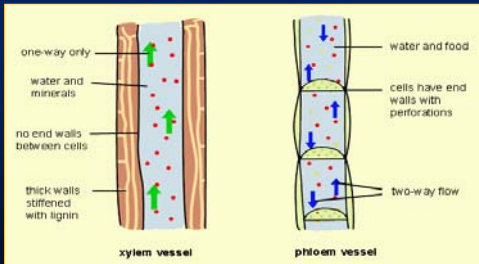
<ul style="list-style-type: none">• Calcium• Silicon• Manganese• Magnesium	} All can be absorbed by leaves
---	---------------------------------

Once absorbed, how are nutrients moved in the plant?

- Xylem
–up
- Phloem
–up or down



Botany Basics



Xylem – non-living cells

- Transport water and nutrients by mass flow

Phloem – living cells



- Require **active loading and unloading** processes to move nutrients

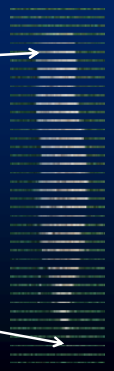
Xylem vs. Phloem movement of nutrients

- Xylem
– All nutrients
- Phloem
– High mobility
 - Sugars, amino acids
 - K, P, Mg, S, Na, Cl
- Intermediate mobility
 - Fe, Zn, Cu, Mo, Mn
- Low mobility
 - Ca, Si

Foliar applications of these elements will only affect the leaves that are sprayed

Where is calcium needed?

- Cell division – crowns 
- Cell division – roots –
– highest need occurs at the root tip 



Time for some Q&A...

**Recent studies
regarding foliar
fertilization of
turfgrass**

University of Arkansas

Chris Stiegler

- Does season affect nutrient uptake on creeping bent or bermudagrass greens?
- Do different N sources affect uptake?
- Is foliar N lost due to volatilization



USDA-sponsored
Research You Can Use

Foliar Nutrient Uptake by Cool-Season and Warm-Season Turfgrasses

University of Arkansas research lends insight into understanding turfgrass foliar feeding.
BY JAMES C. STIEGLER, MICHAEL D. RICHARDSON, DOUGLAS E. KARCHER, AND AARON J. PATTON

Foliar Nitrogen Uptake Following Urea Application to Putting Green Turfgrass Species

J. Chris Stiegler, Michael D. Richardson,* and Douglas E. Karcher
Crop Science 51:1253-1260 (2011)

Field-Based Measurement of Ammonia Volatilization Following Foliar Applications of Urea to Putting Green Turf

J. Chris Stiegler, Michael D. Richardson,* Douglas E. Karcher, Trenton L. Roberts, and Richard J. Norman
Crop Science 51:1767-1773 (2011)

University of Arkansas

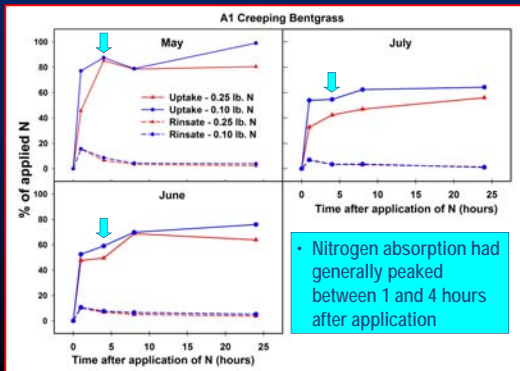
Foliar Fertilization Research

- Two putting green research areas
 - ‘Penn A1’ *Agrostis stolonifera*
 - ‘Tifeagle’ *Cynodon dactylon* x *C. transvaalensis*
- Treatments applied from May to September
 - Two N rates (0.1 and 0.25 lb. N 1000 ft²)
- Measurements include:
 - Sequential sampling of plant uptake over time (0, 1, 4, 8, and 24 h)
 - Tissue and rinsate 15N analysis
 - Volatilization over 24 h

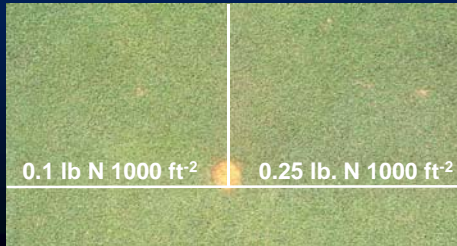
Reasoning behind the sampling frequency

- Applied nutrient immediately after mowing (8am)
- At 4 hours (12 pm), superintendent would consider syringing greens
- At 8+ hours (>4 pm), irrigation scheduling would begin
- At 24 hours, mowing

How much foliar-applied N gets into the leaf tissue?



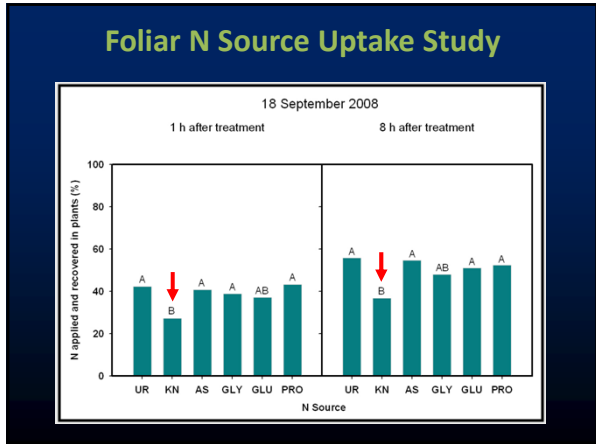
Another possible reason... Higher rates lead to some leaf desiccation / burn and can reduce uptake

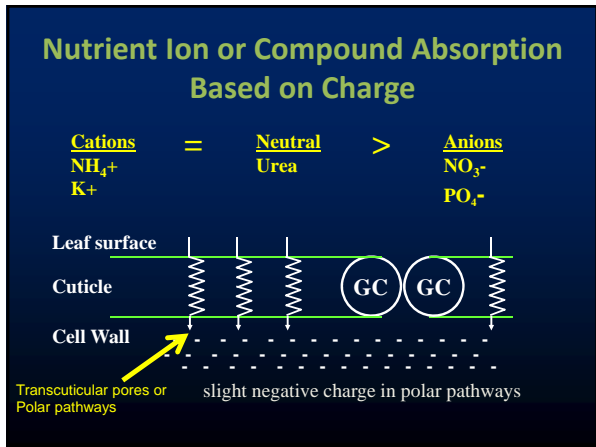


Does N form affect uptake of foliar-applied N?

Foliar N Source Uptake Study

- Various forms of inorganic and organic N included in specialty foliar products
 - Little is currently known about absorption efficiency of these individual compounds
- Similar research methodology employed
 - ¹⁵N-labeled compounds
 - Urea, ammonium sulfate, potassium nitrate
 - Glycine, glutamic acid, proline
 - ‘Penn G2’ *Agrostis stolonifera*
 - Lower application rate (0.1 lb N 1000 ft⁻²)
 - Sampled at 1 and 8 h after application



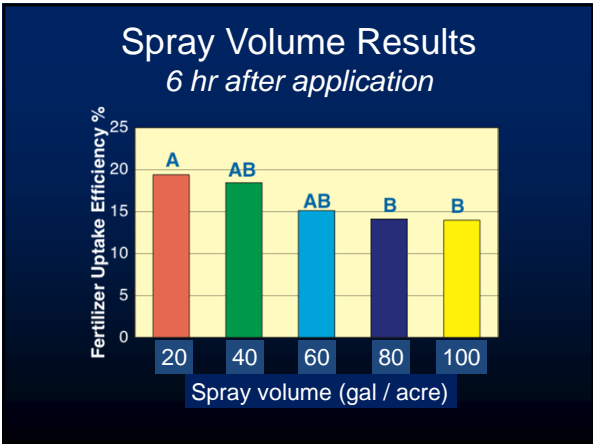


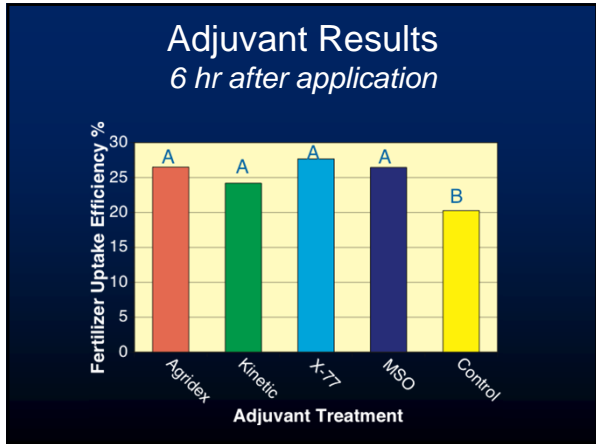
Are there cost & true differences among foliar products?

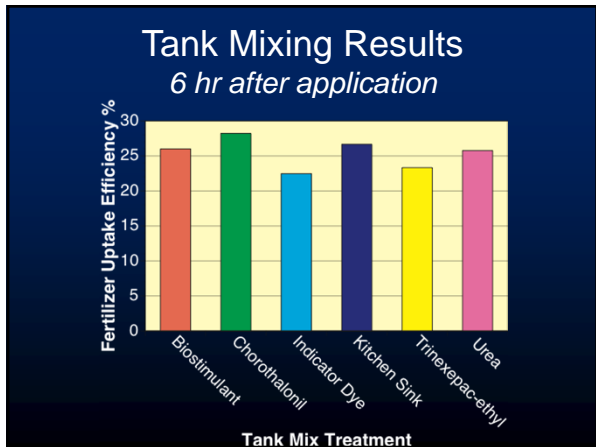
How do spray volume, adjuvants, and tank mixing affect N uptake?

Foliar Nitrogen Uptake Efficiency of Creeping Bentgrass as Affected by Spray Volume, Adjuvants, Tank-Mixing, and Fertilizer Formulation

Shelby Henning
Bruce Branham
Richard Mulvaney
University of Illinois-Urbana Champaign







- ### Summary Points
- The goal of foliar fertilization is nutrient uptake through foliage (low application rates!)
 - 60 to 80% foliar uptake measured when urea applied to putting green turf
 - % uptake not affected by season, as long as turf is actively growing
 - % uptake increases w/ decreasing spray volume, adjuvants, and was not affected by tank mixing
 - Volatilization negligible on putting green turf when typical N rates applied
 - Uptake and turf quality similar between urea and specialty foliar fertilizer products

Acknowledgements





Thanks –
any questions ??

Mike Richardson
University of Arkansas
mricha@uark.edu
<http://turf.uark.edu>
