Making Turf The Best It Can Be; Good Nutrition and Good Environment

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CORNELL Turfgrass

How do you measure a fertilizer response in a turf setting?

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How do you measure a fertilizer response in a turf setting?

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How do you measure a fertilizer response in a turf setting?

- **Aesthetics characteristics:**
  - **color: dark green**
  - **shoot density: dense**
  - **uniformity: consistent**

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How do you measure a fertilizer response in a turf setting?

- **Aesthetics characteristics:**
- **Functional characteristics:**

  *** withstand traffic stress (wear, compaction)**

  *** recuperate from damage(insects, diseases, traffic, heat/drought /cold)**

  *** remain dense to prevent erosion and runoff**

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How do you measure a fertilizer response in a turf setting?

- **Aesthetics characteristics:**
- **Functional characteristics:**
- **Growth or yield:**

  not directly! Unless you are in seed or sod production

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Why must nutrients be applied?

- Nutrient fate-gasous loss
- Plants remove nutrients – leave the system
- Nutrients become unavailable
- Nutrients leach or runoff – leave the system
- Apply when plant demand >> plant avail.

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Nitrogen

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It's Hockey Time, thank God !!!

- Two most hated things:
  - Other teams goalie (sieve)
  - Refs

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Cornell Hockey Cheer

I am Blind, I am Deaf, I want to be a ref!!!

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Role of Nitrogen

Required in high amounts in tissue:

- **2 to 6% of N, dry weight**

- **Vital roles: chlorophyll, amino acids, proteins, nucleic acids, enzymes and vitamins**

- **Affects on shoot and root growth, density, color, and tolerance/recovery from stresses**

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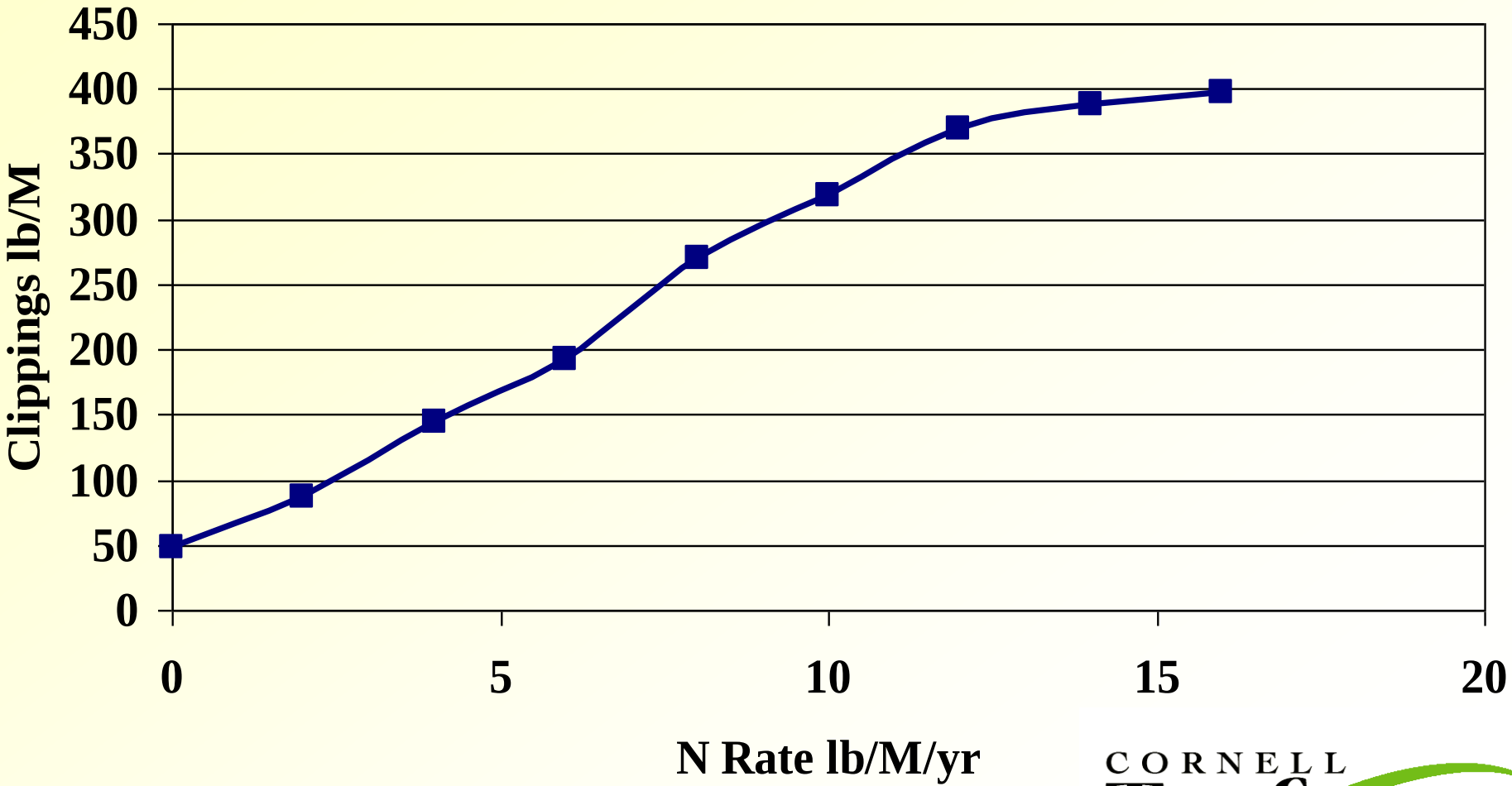
Turf's Perpetual Hunger for N



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Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant

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Nitrogen status of the plant

Slightly deficient turf can utilize more nitrogen

From Bowman & Paul, 1988)

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Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant
- Timing of application (season)

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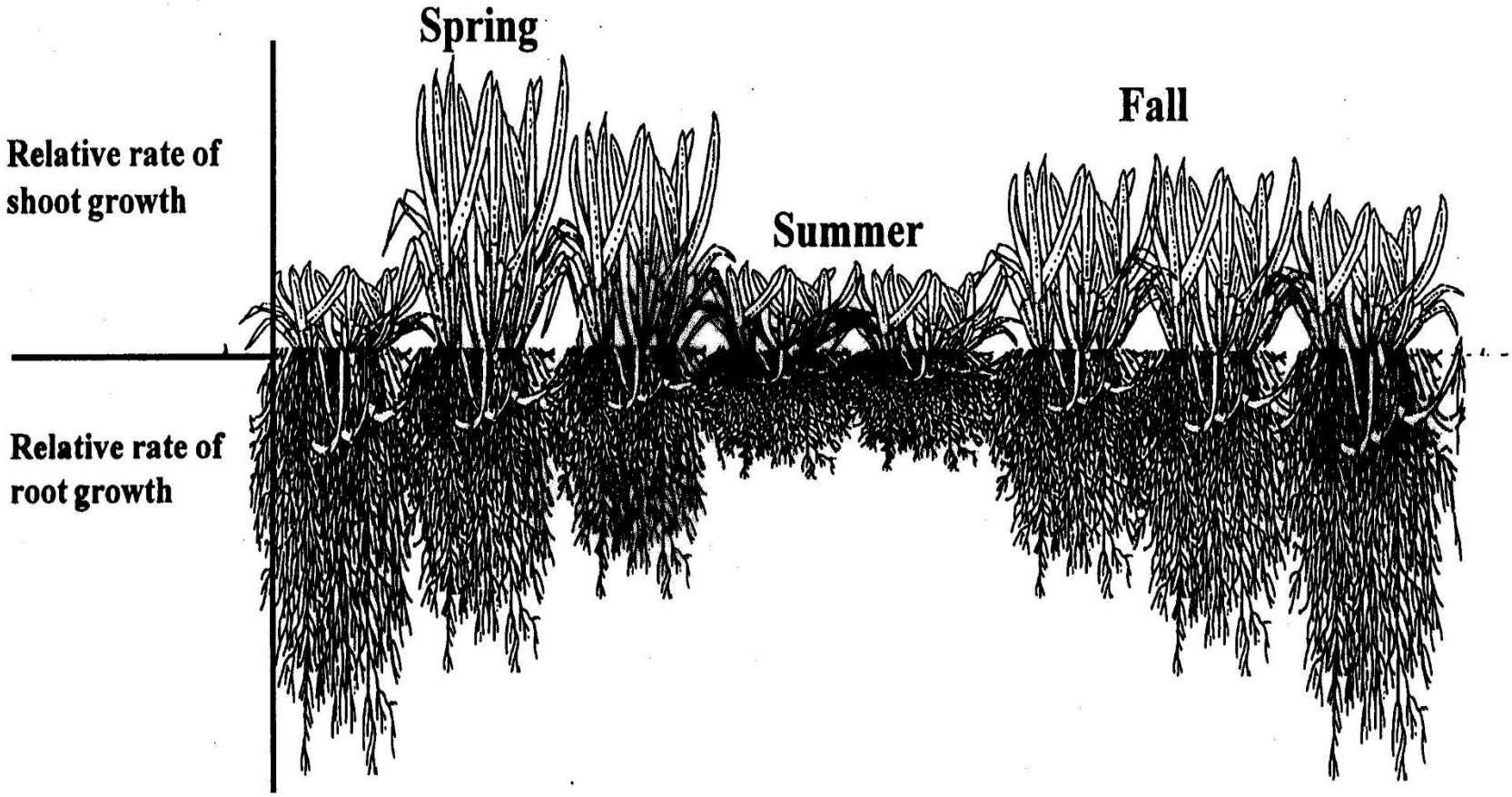
Timing of application (for cool-season grasses)



Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant
- Timing of application (season)
- Clipping management

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Clipping management

- When clipping returned: equal amount of N found in the plant from clipping recycling, soil and fertilizer N.
- When clipping removed: half of N in plant from soil and half from fertilizer N.
- Up to 25% more N is needed when clipping are removed.

From Starr & De Roo (1981), Kentucky bluegrass/ fine fescue turf fertilized with ^{15}N ammonium sulfate

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Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant
- Timing of application (season)
- Clipping management
- Species and cultivar differences

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Species and cultivar differences

If you gave grass all the N they could use, how much would they take up?

Species	range*	Average
Kentucky blue	4-6	5.1
Perennial rye	4-9	7.2
Tall fescue	4-7	5.4

*** mmoles N/ g/hr**

From Liu et. al., 1993)

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Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant
- Timing of application (season)
- Clipping management
- Species and cultivar differences
- Nitrogen source

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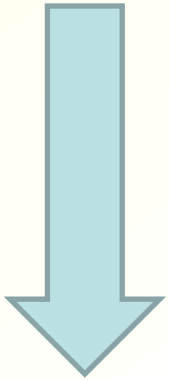
Nitrogen source

Nitrogen Source	% recovered in clippings	Solubility
Urea, am. Sulfate	48	high
Methylene urea	42	
IBDU	47	
Biosolid (Milorganite)	29	
Ureaformaldehyde	22	low



From Hummel & Waddington, 1981, Kentucky bluegrass

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Factors affecting nitrogen recovery in the turfgrass plant

- Nitrogen status of the plant
- Timing of application (season)
- Clipping management
- Species and cultivar differences
- Nitrogen source
- Soil and age

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Soil

Soil

texture	clipping	soil (roots)	leachate
	---------- % of applied N -------		
Sand	8	82	10
Sandy loam	52	45	3
Silt loam	92	6	2

Petrovic (2004) creeping bentgrass fairway turf

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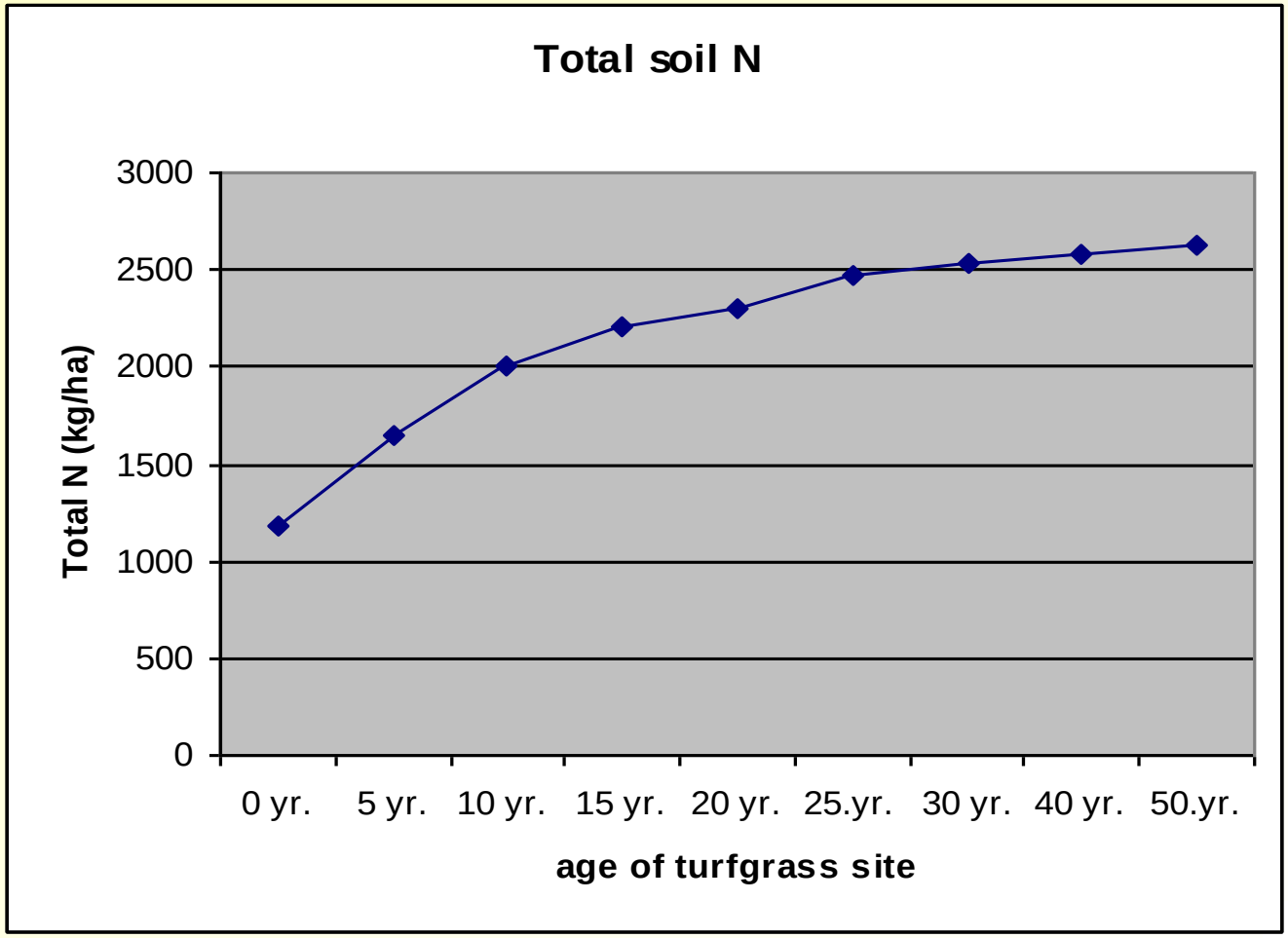
Soil and age



2 lbs N/1000 sq.ft/ yr stored in soil

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Nitrogen Fertilization Program

- Nitrogen Sources

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Nitrogen Sources

QUICK RELEASE

soluble, readily available

MODERATE RELEASE

some readily available

SLOW RELEASE

water insoluble, coated, slowly available, controlled release

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MODERATE RELEASE

- sulfur coated urea
- IBDU on acid soils
- some natural organic sources
- methylene urea

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CHARACTERISTICS OF MODERATE RELEASE N

- moderate initial response
- some extended response
- less leaching potential than quickly available sources
- moderate to high costs

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CHARACTERISTICS OF SLOW RELEASE NITROGEN FERTILIZERS

- extended availability
- applied at higher rates less frequently
- low solubility
- minimal environmental losses
- low initial availability

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Natural Organic Fertilizers

processed by-products of

***animal production*:**

dried blood, bone meal, manure, feather meal, bio-solids, fish

***plant by-products*:**

cotton seed meal, corn gluten meal

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ADVANTAGES OF NATURAL ORGANIC FERTILIZERS

- low chance of foliar burn potential
- little risk of N leaching groundwater
- contain both macro and micronutrients
- improve soil microbial activity

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ADVANTAGES OF NATURAL ORGANIC FERTILIZERS

- some disease suppression
- potential to reduce thatch
- long term improvement in soil properties

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DISADVANTAGE OF NATURAL ORGANIC FERTILIZERS

- low nitrogen analysis
- high cost per pound of nitrogen
- blended not homogenized
- may apply nutrients when not needed
- could lead to P runoff
- cost of labor - application

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DISADVANTAGE OF NATURAL ORGANIC FERTILIZERS

- odor
- difficult to handle
- availability of nutrients depends on temperature
- limited cool season response
- uniformity of application
- inconsistent nutrient release and turf response

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Challenges of an Organic Soil Fertility Program

Most of the nutrients are released by microbial activity (limited by temperature and moisture)

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Slow-release Fertilizers

- Natural/Organic fertilizers
- Coated fertilizers
- Uncoated fertilizers

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Slow-release: General information

- Release rates vary
  - Weeks to years
- Release mechanisms dependent on
  - Temperature
  - Soil Moisture
  - pH

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Fertilizer Source	What happens to the release when …				
	Temp is low	Temp is high	pH is low (<5)	Soil Moisture is low	Soil Moisture is high

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Fertilizer Source	**What happens to the release when …**				
	Temp is low	Temp is high	pH is low (<5)	Soil Moisture is low	Soil Moisture is high
Inorganics and urea	**Same**	**Same**	**Same**	**Can burn**	**Can leach**
Natural organic	⬇	⬆	⬇	⬇	**Same**

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Synthetic organic (UF, MU)	⬇	⬆	⬇	⬇	**Same**

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Synthetic organic (UF, MU)	⬇	⬆	⬇	⬇	**Same**
Sulfur coated N	**Same**	**Same**	**Same**	⬇	**Same**

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Inorganics and urea	**Same**	**Same**	**Same**	**Can burn**	**Can leach**
Natural organic	↓	↑	↓	↓	**Same**
Synthetic organic (UF, MU)	↓	↑	↓	↓	**Same**
Sulfur coated N	**Same**	**Same**	**Same**	↓	**Same**
Polymer coated N	↓	↑	**Same**	↓	**Same**

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Synthetic organic (UF, MU)	⬇	⬆	⬇	⬇	**Same**
Sulfur coated N	**Same**	**Same**	**Same**	⬇	**Same**
Polymer coated N	⬇	⬆	**Same**	⬇	**Same**
IBDU	**Same**	**Same**	**Same**	⬇	⬆

Fertilizer Source	Release rate under optimal conditions
Inorganics and urea	1 – 3 weeks
Natural organic	1 – 6 months
Sulfur coated N	1 – 2 months
Polymer coated N	Variable (weeks to all year)
Ureaform	1 – 2 years
Methylene Ureas	2 – 4 months
MDU/DMTU	1 – 2 months
IBDU	1 – 4 months

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Nitrogen Fertilization Program

- Nitrogen Sources
- Standard program of Application

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Nitrogen
Fertilization Program for Ontario Lawns

# of yearly apps	Late Spring	Early Summer	Late Summer	Late Fall
1	-	-	X	-
2	X	-	X	-
3	X	-	X	X
4	X	X	X	X

X= application at 0.5 kg N/100 sq. M

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Nitrogen Fertilization Program

- Nitrogen Sources
- Standard Program of Application
- **Single application rates**

  water soluble sources: trace (fertigation)

  spray: 0.1-0.7 lb. N/1000 sq.ft

  dry: up to 0.7 lb. N/1000 sq.ft.

  Slow release: 0.5-2.5 lbs. N/1000 sq.ft

- **High (2.5lbs N/1000 sq.ft.) in spring**

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Nitrogen Fertilization Program

- **Single application rates**

  water soluble sources:

  sands up 0.4 lbs N/1,000 sq.ft

  Others soils: up to 0.7 lbs N/1,000 sq.ft.

Any more there is too much N leaching!!!

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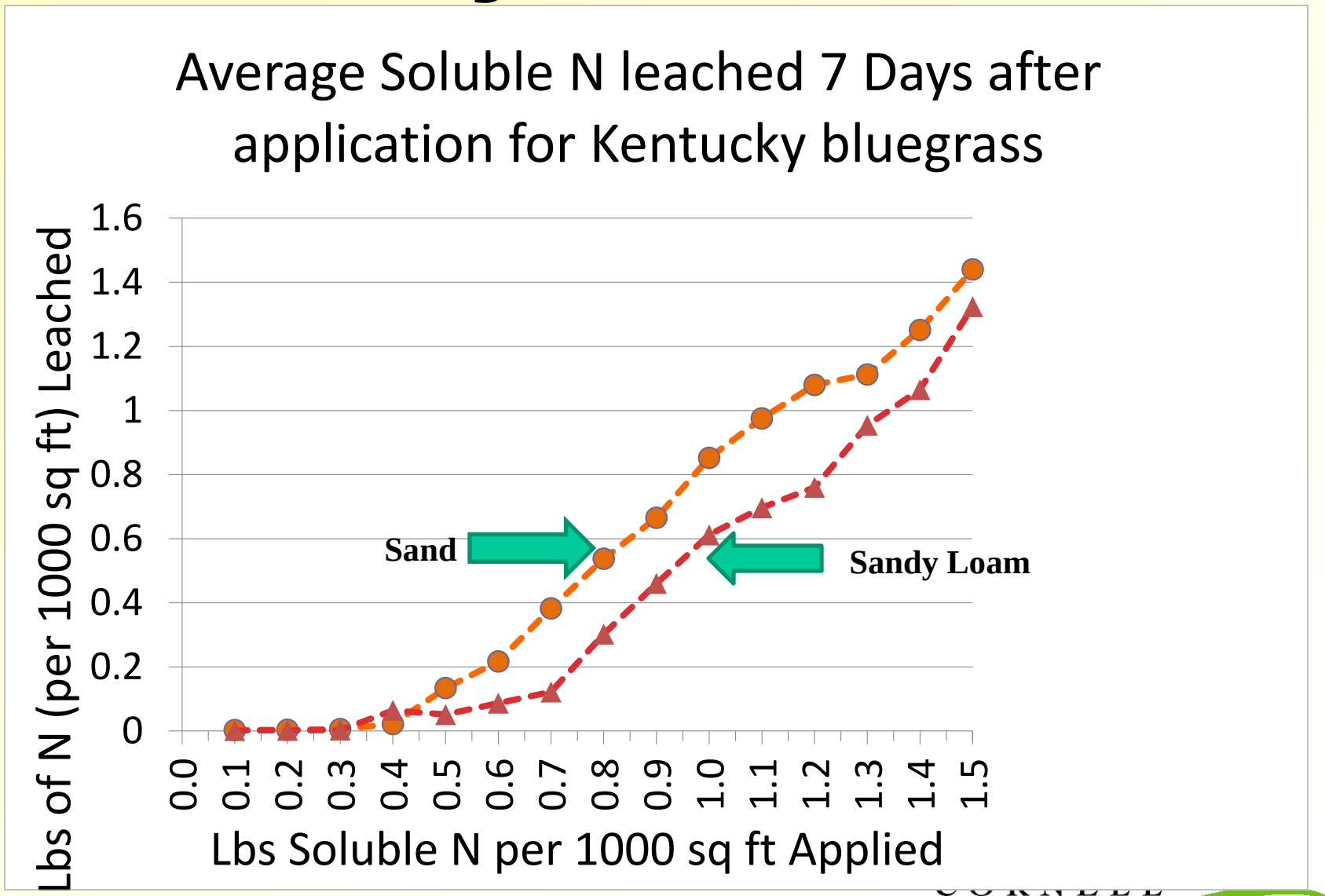
Study results:



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Nitrogen Fertilization Program

- Nitrogen Sources
- Standard Program of Application
- Single application rates
- Soil and Tissue testing

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Soil and Tissue testing

- Soil testing for N: not done for turf, why?
- Tissue testing: sufficiency range

Grass	% N
Bermudagrass	4.0-6.0
Creeping bentgrass	4.5-6.0
Perennial ryegrass	3.3-5.1
St. Augustinegrass	1.9-3.0

From Mills and Jones, 1996

Tissues testing often coupled with fertigation

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Nitrogen application methods

Fertilized during half time?

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Nitrogen application methods

Love the technique!!!

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When You're Putting Fertilizer on Your Lawn,

Remember to Keep it on Your Lawn.

We put fertilizers and pesticides on our lawns. Sprinklers and rain wash them away, and they can wind up in our lakes, streams and the ocean. Fertilizers in water can cause too much algae to grow. Algae use up the oxygen that fish need to survive. If used improperly, pesticides can harm plants and animals in water.

It's a pattern that you can help prevent. Consider alternatives to these products. Use pesticides and fertilizers sparingly. Please visit www.epa.gov/region2 to find out what else you can do.

EPA United States Environmental Protection Agency

Thanks to the Washington State Department of Ecology, King County and the cities of Bellevue, Seattle and Tacoma for the use of this image.

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Phosphorus

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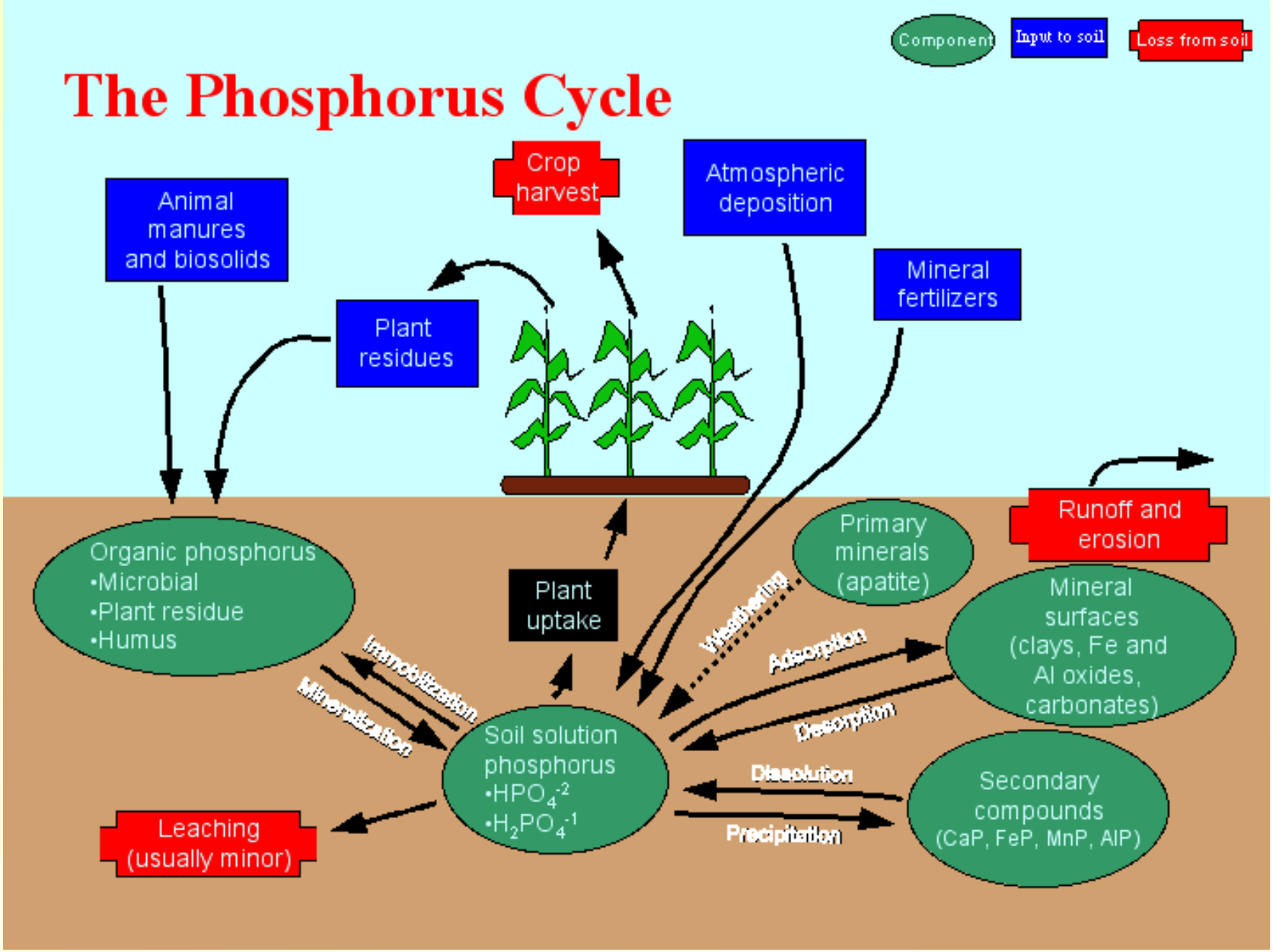
Don’t you just love the refs!



Source: Mississippi State Extenstion

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The Primary Macros: Phosphorus

- Functions
  - ATP energy currency of the cell
  - Membrane components
  - DNA components
- Deficiency symptoms
  - Reduced growth
  - Dark, purple color

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Phosphorus deficient corn

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The Primary Macros: Phosphorus

- Management
  - P very insoluble in soil
    - Availability is a function of root surface area
  - During establishment root system is not extensive, therefore P is not readily available and fertilizer will speed growth
  - After root system is established – responses to P rarely seen and deficiencies (purple color are even more rare)

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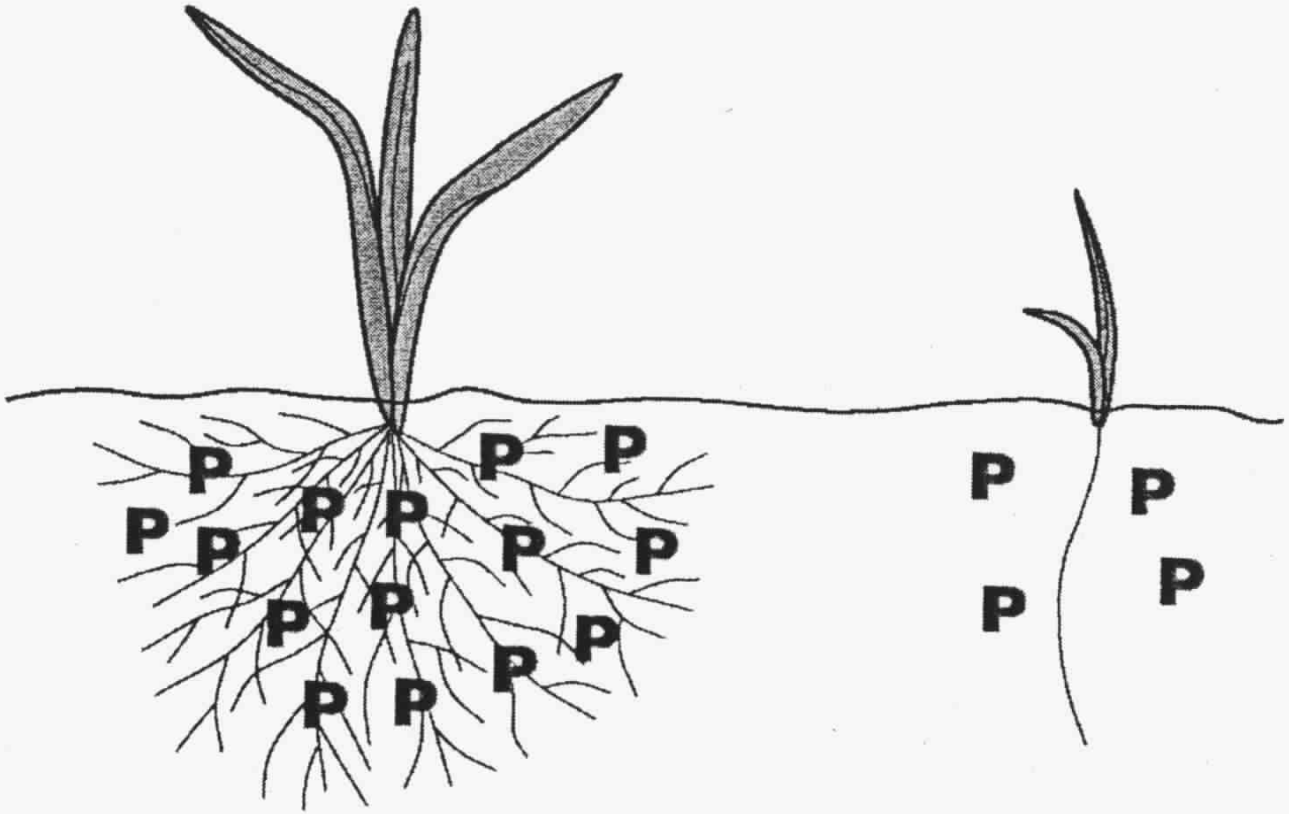

Figure 7.5 Phosphorous is relatively immobile in the soil and does not readily move to the roots of germinating seedlings.

From: Christians, 2003

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The Primary Macros: Phosphorus

- Management
  - P availability is also sensitive to pH
  - Maximum P availability in soil is at pH 6.5

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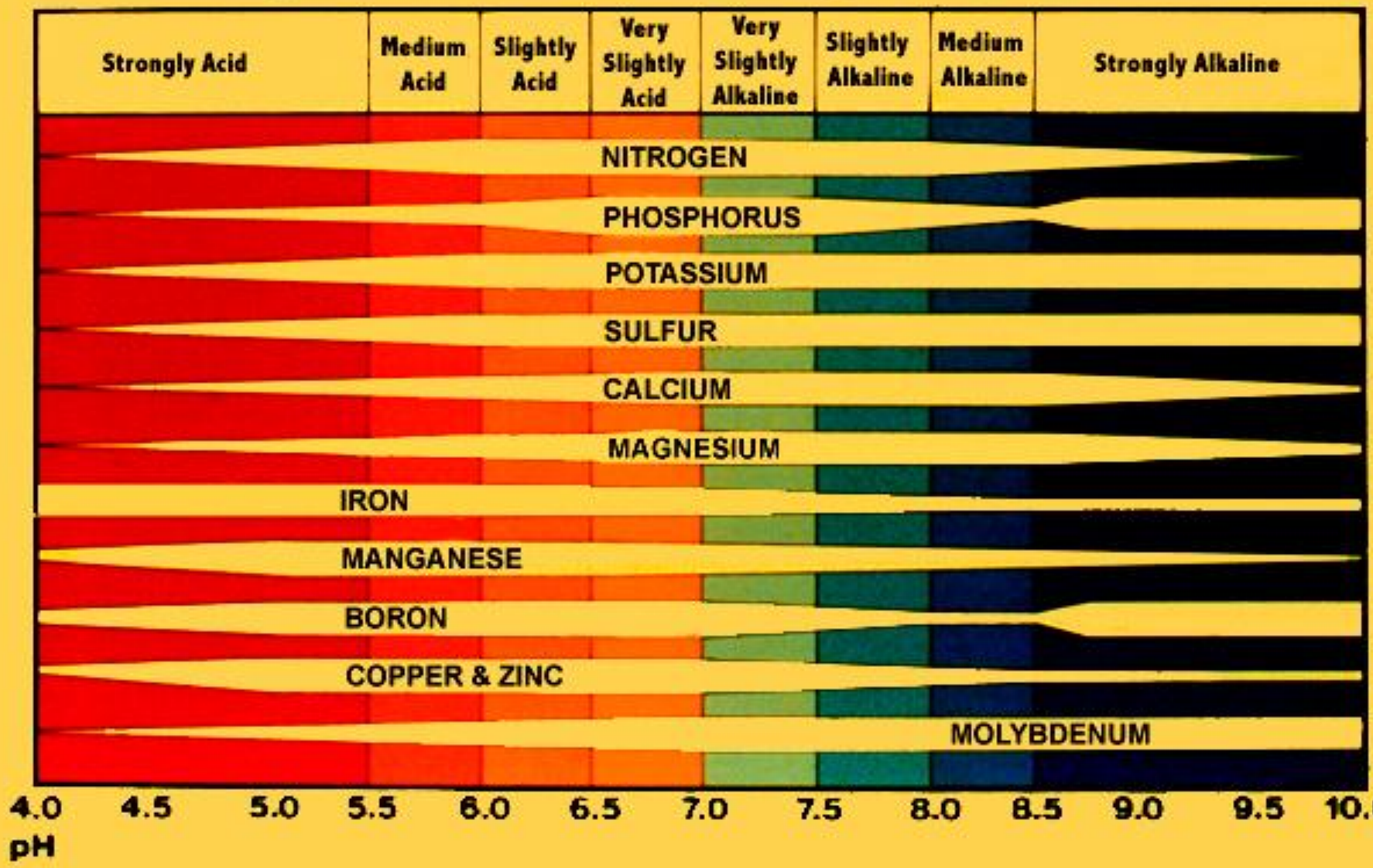
How Soil pH Affects Availability of Plant Nutrients



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Phosphorus Fertilizer Sources

- Rock Phosphate
  - Primary Mineral Apatite $Ca_{10}F_2(PO_4)_6$
  - P availability can vary from 0-5-0 to 0-17-0

- Superphosphate (0-20-0)
  - Rock phosphate treated with sulfuric acid (also sulfur and calcium source)

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Phosphorus Fertilizer Sources

- Triple superphosphate (0-46-0)
  - Rock phosphate treated with phosphoric acid (also calcium source)

- Ammoniated phosphates
  - Phosphoric acid treated with NH_3
  - Monoammonium phosphate (MAP) 11-48-0
  - Diammonium phosphate (DAP) 18-46-0

  - Most Natural organics-can be high in P compared to N

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Potassium

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The Primary Macros: Potassium

- Functions
  - Water regulation
    - Cell growth
    - Opening and closing of stomata
  - Activates enzymes
  - Regulates cell pH
- Deficiency symptoms
  - Reduced growth
  - Yellow leaf margins

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Potassium deficiency in corn

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The Primary Macros: Potassium

- Management
  - K held on cation exchange sites in soil
  - Recent research suggests turfgrass requires less potassium than previously thought
  - What has been said of K….
    - Improves drought tolerance
    - Improves cold hardiness
    - Increases rooting
    - Resistance to dollar spot
    - Wear tolerance

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Potassium-suppression of germination

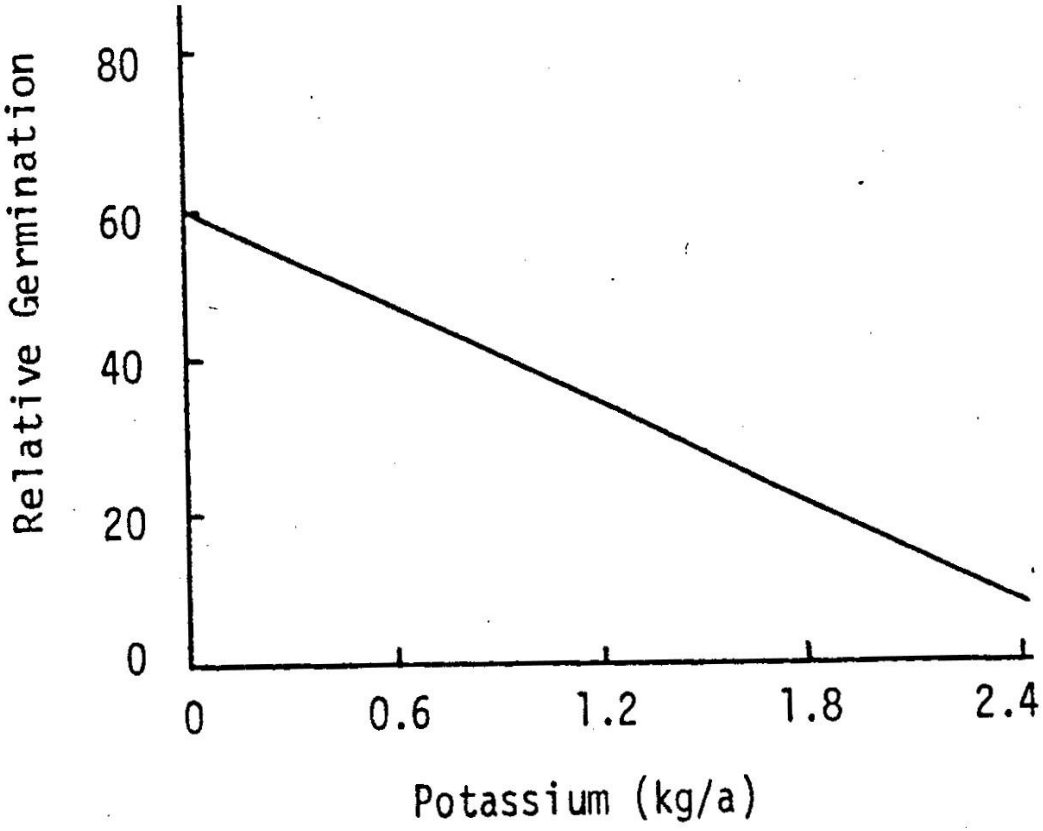

Figure 144. The effect of potassium applications on relative blue-grass germination (Site C; test C2; 30 August 1978).

Tu

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Potassium Fertilizer Sources

- Potash – burn wood, leach ashes with water and evaporate water to get K salts, mostly K_2CO_3 (natural)

- Most K fertilizers are taken from salt mines (natural if minimally processed)
- KCl – potassium chloride – muriate of potash (0–0–60)
  - Inexpensive
  - High Salt Index

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Potassium Fertilizer Sources

- K_2SO_4 – potassium sulfate – sulfate of potash (0–0–50)
  - Lower salt index
  - For establishment look for this source

- KNO_3 – potassium nitrate (13–0-44) or calcium nitrate (Chelian nitrate)
  - Very high salt index!
  - Expensive, specialty use only

Limited organic forms

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Summary of the big 3

- Nitrogen management is extremely important
- Phosphorus is important at establishment
- Potassium is of less importance than we thought – although continue to maintain soil test levels

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Soil Testing
Soil Sampling

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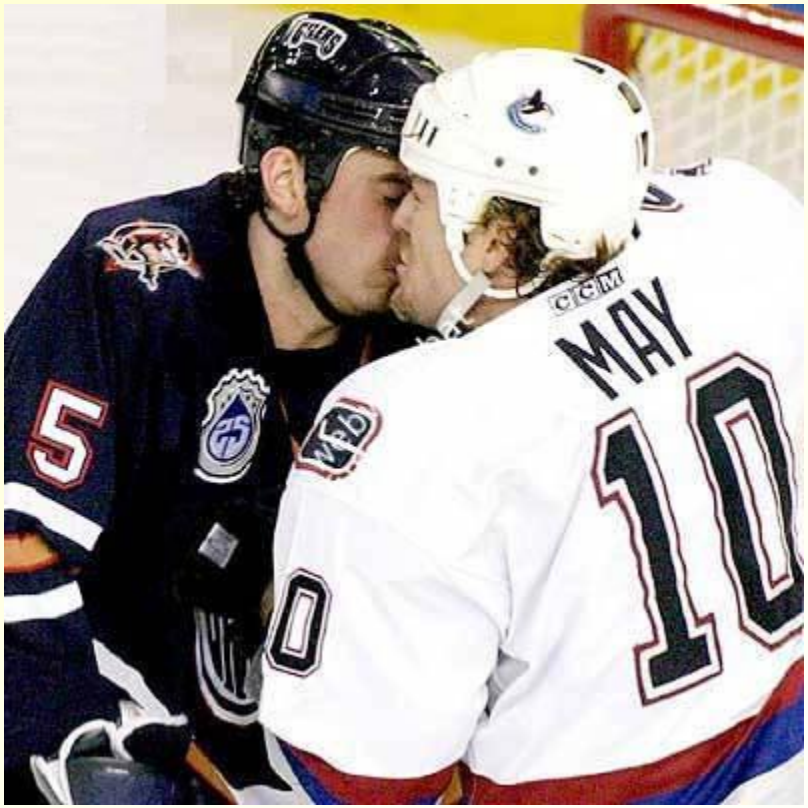
There is a lot of love between hockey players!



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Soil Testing

Why?

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Why do we care?

Soil chemical testing:

- **is part of a fertilization program,**
- **determine the amount of nutrients (especially phosphorus, potassium, …) and lime/sulfur needed to produce a healthy turfgrass stand.**

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Why do we care?

Soil testing:

- Can be used to diagnose problems related to nutrients, salts and soil pH.

- Organic matter level, does the soil need more organic matter or N release?

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Why do we care?

Soil testing:

- also may be used as a best management practices to reduce the risk of phosphorus runoff and protect the environment.

Many state law, local laws

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What does a soil test do?

- Measures the amount of nutrients **readily available** (in soil water) and what can be supplied by the soil during a growing season (**reserve**).

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Why does a soil test do?

- Readily available-supplies a 1-2 days
- The amount of reserve nutrients is based on:
  - -parent material (K, Ca, Mg…)
  - -cation exchange capacity-clay and organic matter
  - -pH

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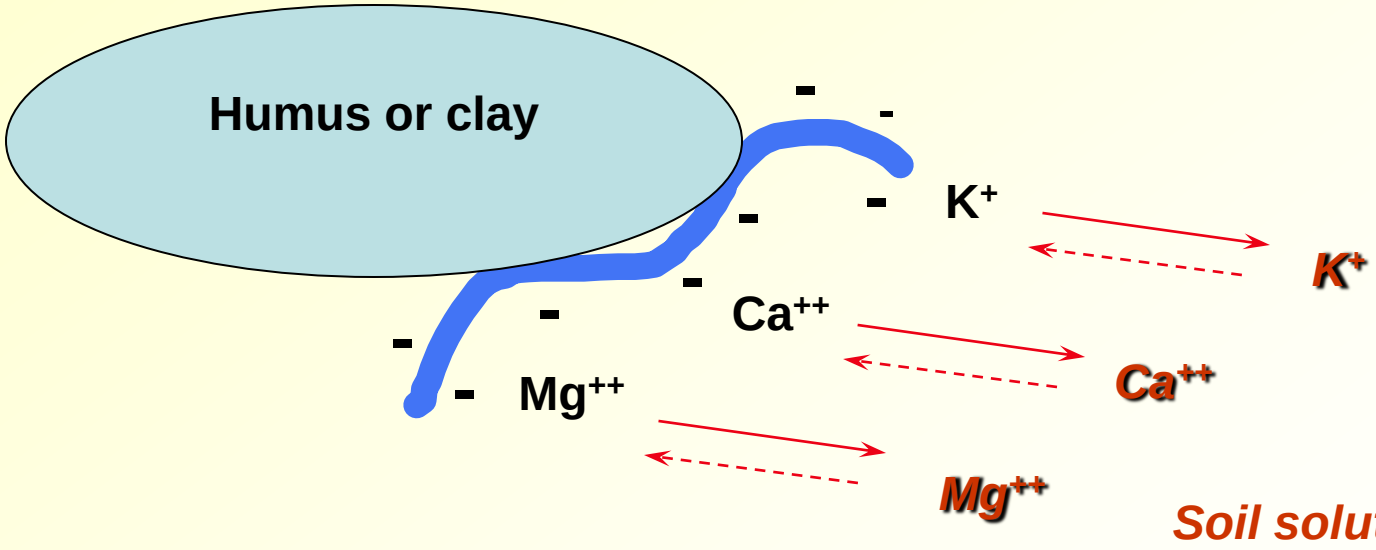
Nutrient reservoir:

Cation exchange capacity



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What does a soil test do?

- **Amount of nutrients found based on extraction method-**

Water or weak salt- only what is in the soil solution

Acids: the stronger the acid more reserve nutrients are measured

Amount may vary from lab to lab!!

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Where do soil test work best?

- **Soils with a CEC above 6 (meq/100 g or cmol/kg)**
- **Non-sandy soils!**

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Where do soil test work best?

- Soils with a CEC above 6 (meq/100 g or cmol/kg)
- Non-sandy soils!

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Soil sampling

PROPER SOIL SAMPLING is the key!

- Follow the direction from the lab
- use a tool that can do the job
- remove thatch and plant debris
- ***sample at a uniform depth***
- take 15-20 samples from a uniform area (composite sample)
- half pint is needed
- mix in plastic bag or plastic bucket

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BEST TIME FOR SAMPLING

- before planting
- allow time to get results back
- sample same time each year,
- Sample every 2 or 3 years unless you have a problem
- If possible, wait 2-4 weeks after applying fertilizer before sampling

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FOR THE BEST RECOMMENDATION

- Take a good representative sample

- provide detailed background information

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Turfgrass and the environment: how to best manage it

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Someone having a bad day?

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Phosphorus Management

- Produce dense plant to reduce runoff (keep out sparse weeds, insects and diseases).
- A proper N fertilization program is essential!

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Phosphorus Management

- Dense turf reduce runoff
- **Avoid treating impervious surfaces (driveways, sidewalks and roads don't need to be fertilized!!)**

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When You're Putting Fertilizer on Your Lawn,

Remember to Keep it on Your Lawn.

We put fertilizers and pesticides on our lawns. Sprinklers and rain wash them away, and they can wind up in our lakes, streams and the ocean. Fertilizers in water can cause too much algae to grow. Algae use up the oxygen that fish need to survive. If used improperly, pesticides can harm plants and animals in water.

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Phosphorus Management

- Dense turf reduce runoff
- Avoid treating impervious surfaces
- **A good fertilization program often reduces runoff by increasing plant density and water infiltration rate**

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Phosphorus Management

- Dense turf reduce runoff
- Avoid treating impervious surfaces
- Fertilization often reduces P runoff, soil test to determine P need
- **Soil testing for P level, apply only when needed!**

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Phosphorus Management

- Dense turf reduce runoff
- Avoid treating impervious surfaces
- Fertilization often reduces P runoff
- Soil testing for P level
- **be careful with animal composts, many contain high amounts of phosphorus (especially when used as a soil amendment)**

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Phosphorus Management

- Dense turf reduce runoff
- Avoid treating impervious surfaces
- Fertilization often reduces P runoff
- Soil testing for P level many not be an effective tool in reducing P runoff
- be careful with animal composts, many contain high amounts of phosphorus (especially when used as a soil amendment)
- **Remove tree litter (leaves and flowering parts) from storm drain system**

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Phosphorus Management

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- Soil testing for P level
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- Remove tree litter from storm drain system
- **Use low P winter deicing materials**

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- Remove tree litter from storm drain system
- Use low P winter deicing materials

check the P content of the salt and traction materials you are using

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Nitrogen

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What is he doing?

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Management Options to Reduce Impacts from Nitrogen

- **Sources**
- **Rates of application**
- **Timing-seasonality**
- **Irrigation**
- **Age of site with long term impacts**

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Management Options to Reduce Impacts:Nitrogen

- **Sources-use slow release when possible- but only effective in reducing leaching in wet years**

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Management Options to Reduce Impacts:Nitrogen

- **Sources-use slow release when possible**
- **Rates of application-low as practical (especially with water soluble fertilizers like urea)**

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Management Options to Reduce Impacts:Nitrogen

- **Sources-use slow release when possible**
- **Rates of application-low as practical**
- **Timing-seasonality-caution in late fall (greatest time for N leaching if soils are unfrozen)**

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Management Options to Reduce Impacts:Nitrogen

- **Sources-use slow release when possible**
- **Rates of application-low as practical**
- **Timing-seasonality-caution in late fall**
- **Irrigation-use water wisely, base on evapotranspiration (ET) values**

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Things you need to know on how to be a great environmental manager

- Maintain for dense planting !
- Know your site (soils, slopes, compaction, soil test levels, org. matter)
- Know your materials that you are using
- Follow IPM practices to better pest control and less pesticide use
- Think of the environment in your decision making process

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Diseases suppressed by natural organic fertilizers and compost:

Yellow patch **Pythium root rot**

Pink patch **Typhula blight (gray snowmold)**

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Nutrition and Pest Problems

Low Nitrogen	High Nitrogen
Annual grassy weeds	brown patch
Dollar spot	ground ivy
Rust	snow mold
red thread	leaf spot
Many broadleaf weeds	
Anthracnose	

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Best Management Practices?

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Good Practices

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Questions?

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