Understanding Nutrient Fate

Cale A. Bigelow
Purdue Agronomy

Sustaining a Healthy Turf Requires Regular Feeding/Fertilization

Healthy Plants Require 17 Elements for Proper Growth

- They are divided into three major categories:
  - Elements supplied by air and water
    - Carbon, Hydrogen, Oxygen
  - Elements supplied by the growing media and used in large quantities (**macronutrients**)
    - Nitrogen (N), Phosphorous (P), Potassium (K), Sulfur, Magnesium, and Calcium
  - Elements supplied by the growing media and used in small quantities (**micronutrients**)
    - Iron, Zinc, Manganese, Molybdenum, Boron, Copper, Chlorine, and Cobalt?

PURDUE UNIVERSITY TURFGRASS SCIENCE

How Much Fertilizer is Used in Golf Turf?

Accepted for publication 21 October 2009. Published 3 December 2009.

Golf Course Environmental Profile Measures Nutrient Use and Management and Fertilizer Restrictions, Storage, and Equipment Calibration

Clark S. Throssell, Greg T. Lyman, Mark E. Johnson, and **Greg A. Stacey,** Golf Course Superintendents Association of America, 1421 Research Park Drive, Lawrence, KS 66049; and **Clark D. Brown,** National Golf Foundation, 1150 S. US Highway 1, Suite 401, Jupiter, FL 33477

Corresponding author: Clark S. Throssell. cthrossell@gcsaa.org

Throssell, C. S., Lyman, G. T., Johnson, M. E., Stacey, G. A., and Brown, C. D. 2009. Golf course environmental profile measures nutrient use and management and fertilizer restrictions, storage, and equipment calibration. Online. Applied Turfgrass Science doi:10.1094/ATS-2009-1203-01-RS.

Abstract

The golf industry lacks comprehensive national data on the property features, management practices, and inputs associated with golf courses. To develop a national golf course environmental profile, a survey was sent to 16,386 superintendents at US golf facilities to determine their nutrient use, trends in nutrient use, nitrogen sources used, soil amendment and turfgrass supplement use, and fertilizer restrictions, storage, and equipment calibration. Of these surveys, 15.6% were returned. Analysis of data indicated a representative sample of golf facilities in the US was received with the exception of facility type. Data were weighted for facility type. Summed over all golf course components and all golf facilities, a total of 101,096 tons nitrogen were applied to 1,311,000 acres; 36,810 tons phosphate were applied to 1,131,000 acres; and 99,005 tons potash were applied to 1,260,000 acres in 2006. Only 9% of 18-hole golf facilities reported restrictions on fertilizer use required by a government or tribal authority, and 18-hole facilities calibrated their fertilizer application equipment before application 67% of the time. These results provide an accurate portrayal of golf course nutrient use and establishes a baseline for comparison with results from future surveys to monitor industry change over time.

PURDUE UNIVERSITY
TURFGRASS SCIENCE

How Much Fertilizer is Used in Golf Turf?

Accepted for publication 21 October 2009. Published 3 December 2009.

How much???

Summed over all golf course components and all golf facilities, a total of **101,096 tons nitrogen** were applied to 1,311,000 acres; **36,810 tons phosphate** were applied to 1,131,000 acres; and **99,005 tons potash** were applied to 1,260,000 acres in 2006.

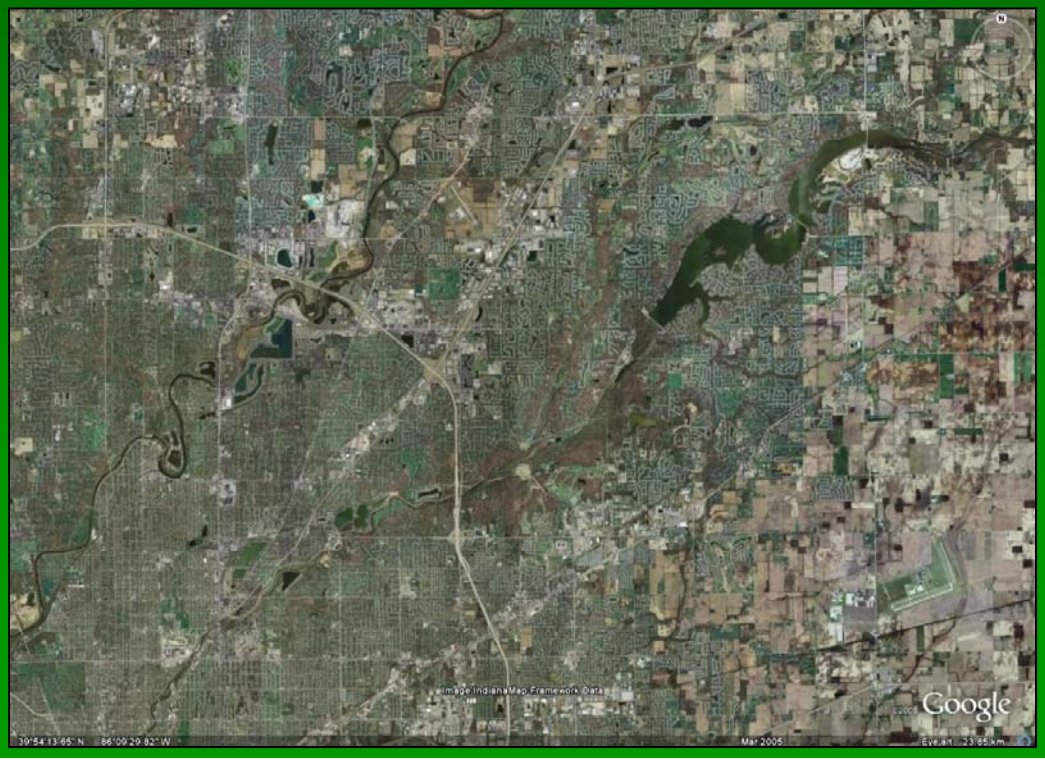
and 18-hole facilities calibrated their fertilizer application equipment before application 67% of the time. These results provide an accurate portrayal of golf course nutrient use and establishes a baseline for comparison with results from future surveys to monitor industry change over time.

PURDUE UNIVERSITY TURFGRASS SCIENCE


Public Perception (Right or Wrong) is
That Turfgrass is a MAJOR Contributor
to Declining Water Quality

Watershed Scale Impacts

- Both sediment and nutrient runoff, from urban and suburban expansion (as well as other sources!!!) have been implicated in elevated nutrient loads such as nitrogen (N) and phosphorus (P) to surrounding water bodies.




Turfgrass and Water Quality


Turfgrass and Water Quality

So Which of These Nutrients Can "Move" and Which Are We Most Concerned With?

- Three major categories of nutrients :
  - Elements supplied by air and water
    - Carbon, Hydrogen, Oxygen
  - Elements supplied by the growing media and used in large quantities (**macronutrients**)
    - Nitrogen, Phosphorous, Potassium, Sulfur, Magnesium, and Calcium
  - Elements supplied by the growing media and used in small quantities (**micronutrients**)
    - Iron, Zinc, Manganese, Molybdenum, Boron, Copper, Chlorine, and Cobalt?

PURDUE UNIVERSITY TURFGRASS SCIENCE

Where Do Nutrients Go?

Input:

Fertilization

Atmospheric deposition

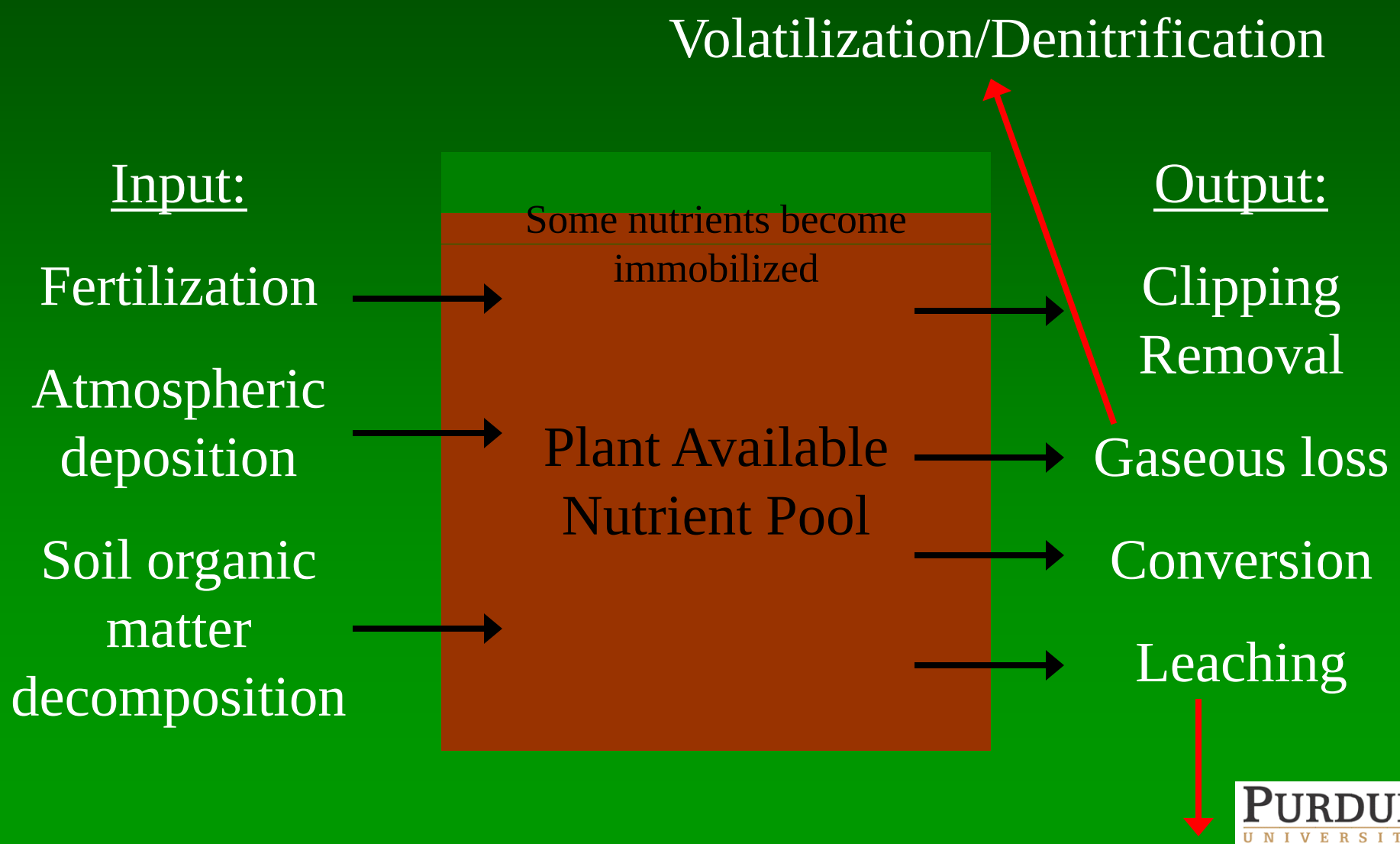
Soil organic matter decomposition

Some nutrients become immobilized

Plant Available Nutrient Pool

PURDUE UNIVERSITY
TURFGRASS SCIENCE

Where Do Nutrients Go?



PURDUE UNIVERSITY
TURFGRASS SCIENCE

Factors Affecting Nutrient Movement and Potential Loss

- Turfgrass species and cultivar
  - Shoot density, root density, rooting depth
- Soil type
  - Permeability, compaction, thatch
- Environmental conditions
- Water: Rainfall, Snow melt, Supplemental irrigation practices
- Nutrient source, application rate/timing and “release technology”

PURDUE UNIVERSITY TURFGRASS SCIENCE


Soluble Nutrient Movement?


Runoff losses for nutrients applied to mature turf are negligible
Photo: G.E. VanScoyoc

Important Studies (Nitrogen)

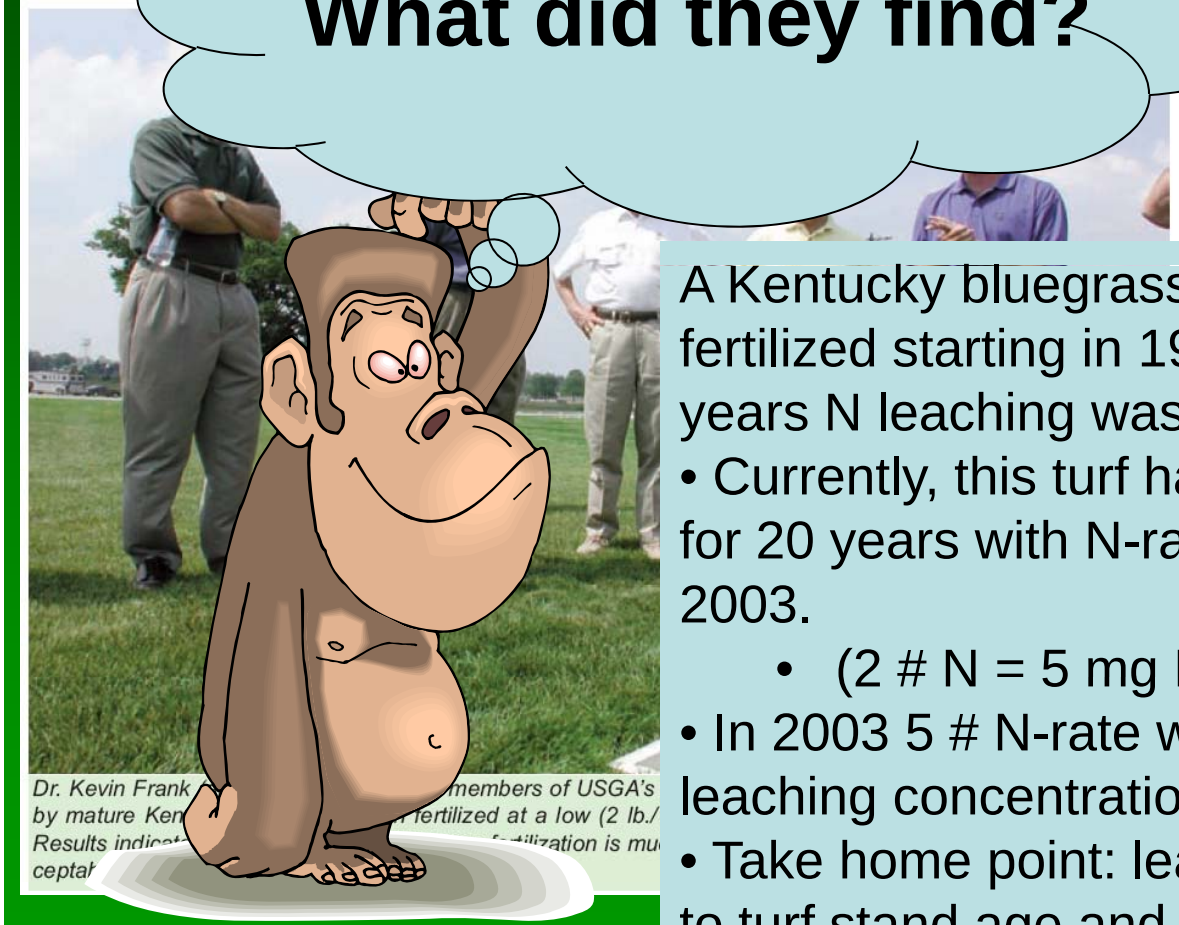
Dr. Kevin Frank (above right) explains to members of USGA's Research Committee the efficiency of nitrogen use by mature Kentucky bluegrass when fertilized at a low (2 lb./1000 ft²/year) and a high rate (5 lb./1000 ft²/year). Results indicate that the high rate of nitrogen fertilization is much more than the turf needs and can result in unacceptable levels of nitrate-nitrogen in leachate.

Since the summer of 1998, percolate samples have been collected from the same monolith lysimeters and analyzed for nitrate-nitrogen (NO_3-N).

PURDUE UNIVERSITY
TURFGRASS SCIENCE

Important Considerations (Nitrogen)

What did they find?

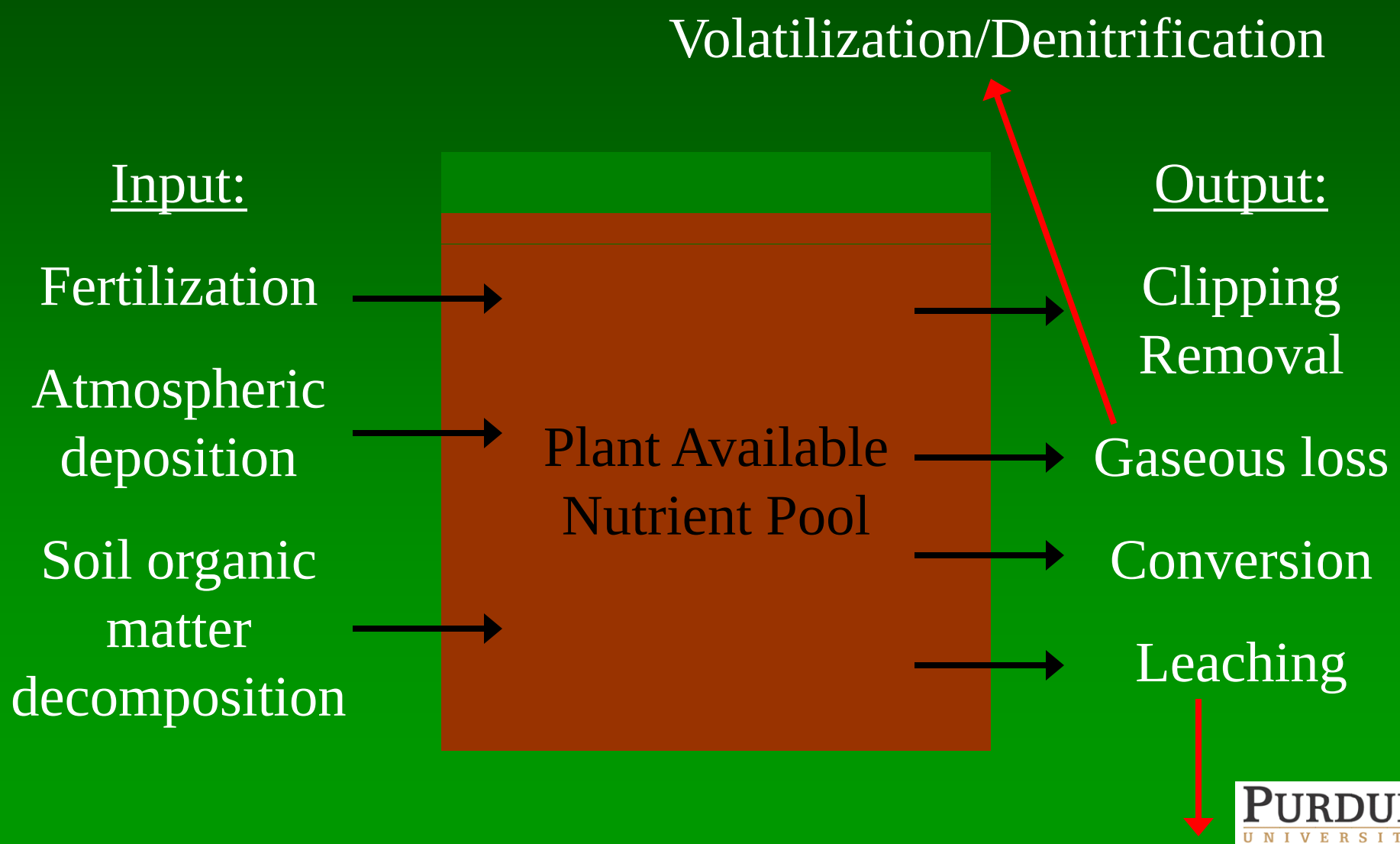


Dr. Kevin Frank [illegible] members of USGA's
by mature Ken[illegible] fertilized at a low (2 lb./
Results indicat[illegible]tilization is mu
ceptab[illegible]

A Kentucky bluegrass lawn turf was initially fertilized starting in 1991 and during the first two years N leaching was minimal.

- Currently, this turf has been continuously fertilized for 20 years with N-rates 2 and 5 # N yr^{-1} thru 2003.
  - (2 # N = 5 mg L^{-1}, 5 # N = **> 20** mg L^{-1})
- In 2003 5 # N-rate was changed to 4 # N and leaching concentrations fell to 8 mg L^{-1}.
- Take home point: leaching potential changes due to turf stand age and applied N. Carbon and nitrogen soil dynamics are complicated…

Where Do Nutrients Go?



PURDUE UNIVERSITY
TURFGRASS SCIENCE

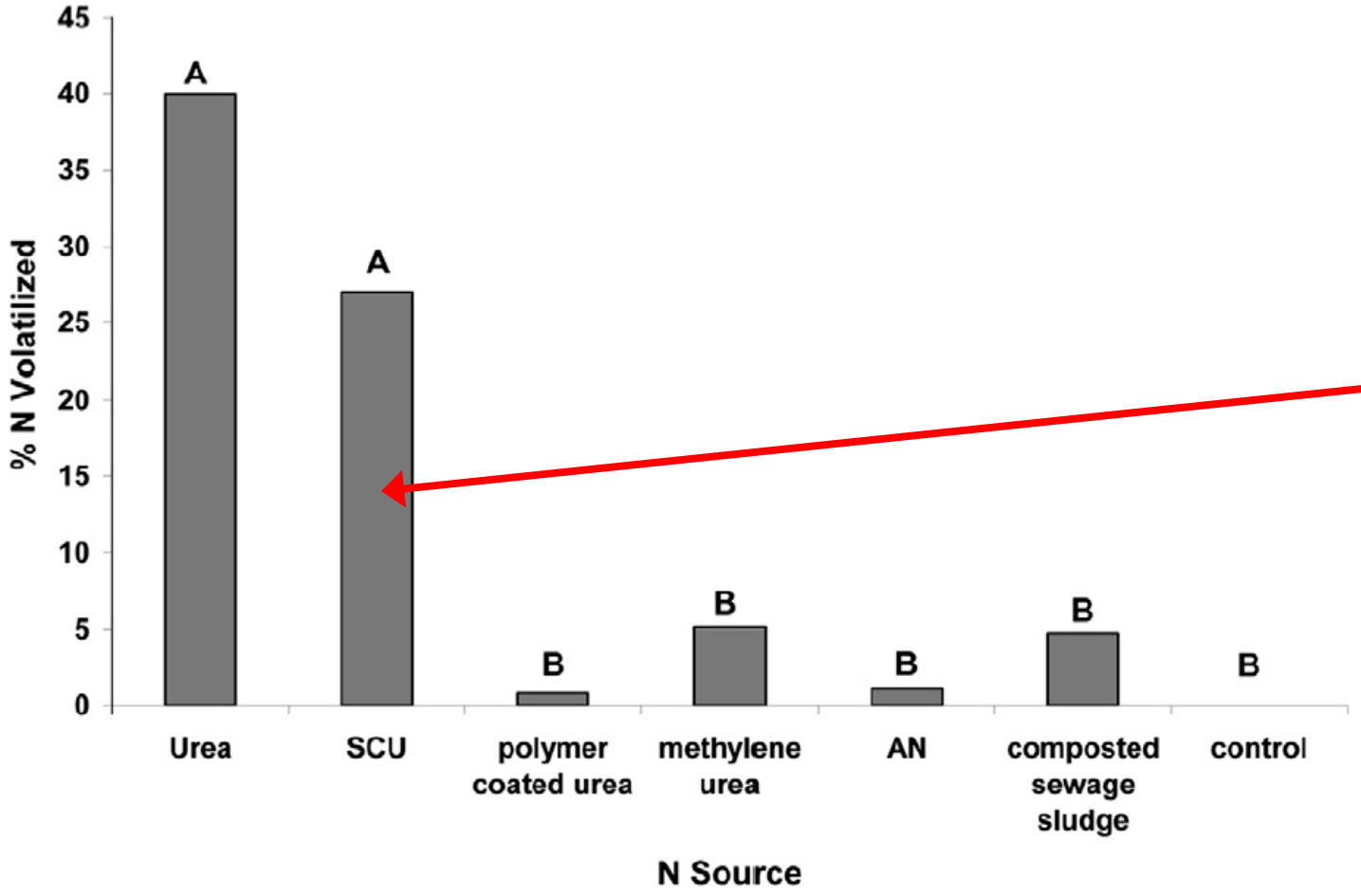
Nitrogen Best Management Practices

1. Proper timing (actively growing turf)
2. Appropriate rate for intended response
   - Avoid excess
3. Nitrogen source/product selection?
   - Utilize slow or controlled release N sources when possible? (coated nutrient products, biosolids, natural organics, etc.)

PURDUE UNIVERSITY
TURFGRASS SCIENCE

Fertilizer Products-N Volatilization

From: Knight, Guertal and Wood: Crop Science, 2007

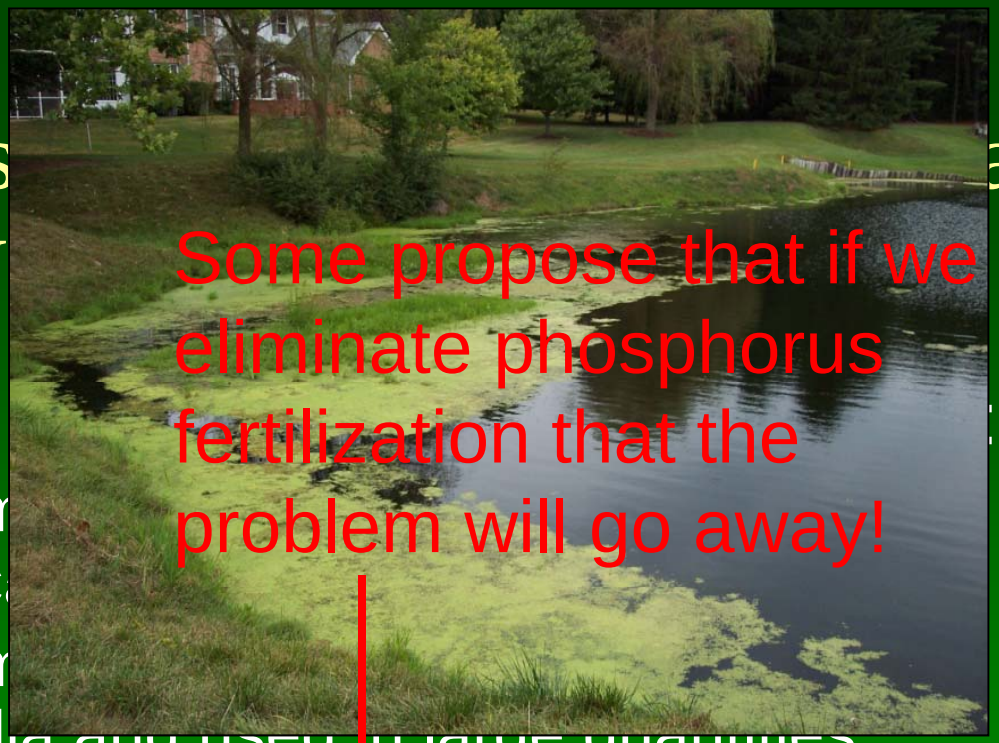


Why?

Figure 5. Total cumulative N loss due to NH_3 volatilization over a 10-d period as affected by N source, Exp. 1. Columns with different letters are significantly different from each other at $\alpha = 0.05$. AN, ammonium nitrate; SCU, S-coated urea.

PURDUE UNIVERSITY TURFGRASS SCIENCE

So Which of Thes…and Which Are W…



- Three …
  - Elem…
    - C…
  - Elem… media and used in large quantities (**macronutrients**)
    - Nitrogen, Phosphorous, Potassium, Sulfur, Magnesium, and Calcium
  - Elements supplied by the growing media and used in small quantities (**micronutrients**)
    - Iron, Zinc, Manganese, Molybdenum, Boron, Copper, Chlorine, and Cobalt?

PURDUE UNIVERSITY TURFGRASS SCIENCE

Sustaining a Healthy Turf Requires Regular Feeding/Fertilization


Similar Research at Purdue on
"Establishing" Turf
From: Bigelow, Nemitz, Smith and Camberato


Similar Research at Purdue on
"Establishing" Turf
Biggest risk is on bare soil or establishing turfgrass areas prone to erosion.
From: Bigelow, Nemitz, Smith and Camberato

Soil Phosphorus Content in Clippings Removed vs. Returned

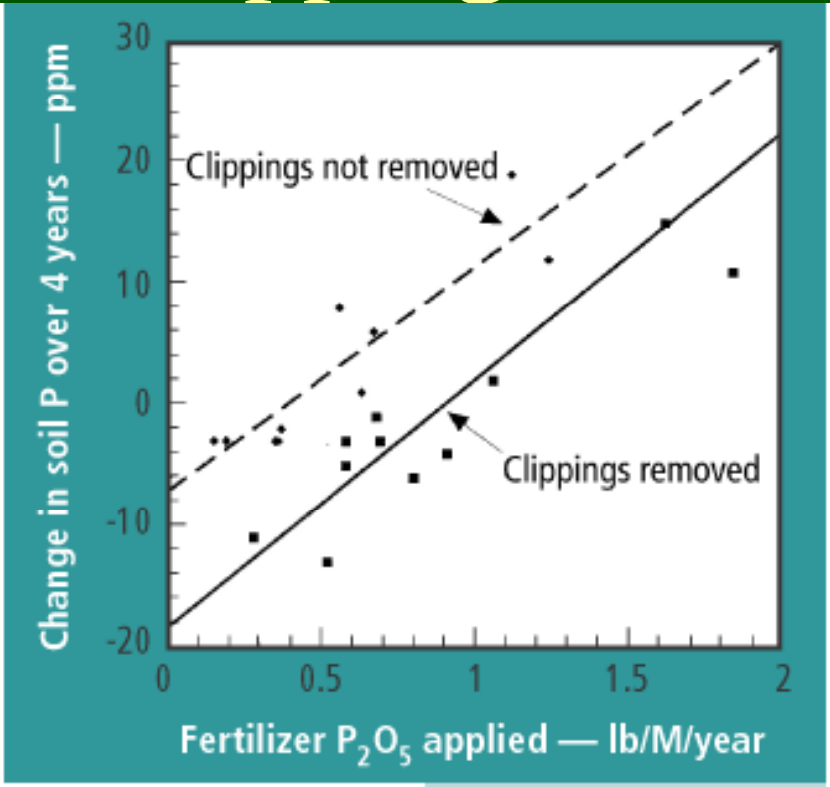


Figure 4. Influence of the annual rate of phosphorus application on the changes in soil test phosphorus after four years for a Kentucky bluegrass lawn with and without clipping removal.

Data: Kussow, Univ. WI

- Clippings removed, it takes about 1 lb. P_2O_5/1000 yr^{-1} to maintain soil test P levels
- Clippings returned it takes half or 0.5 lb. P_2O_5/1000 yr^{-1}

PURDUE UNIVERSITY TURFGRASS SCIENCE


Public Perception (Right or Wrong) is
That Turfgrass is a MAJOR Contributor
to Declining Water Quality


Warm-Season Grasses?
St. Augustinegras lawn image: Nativegreen.net
04/07/2009

FDACS

Florida Department of Agriculture and Consumer Services

FDACS – Fact Sheet

July 1, 2010

What You Should Know About Florida's Urban Turf Fertilizer Rule

On December 31, 2007, The Florida Department of Agriculture and Consumer Services adopted the final statewide Urban Turf Fertilizer Rule RE-1.003(2) FAC. The purpose of the rule was to limit the primary plant nutrient content of (N-P-K) in fertilizers, primarily nitrogen and phosphate for urban turf and lawns.

Specialty Fertilizer Products labeled for turf and lawns:

Florida's Urban Turf Rule requires Specialty Fertilizer Products labeled for turf or laws to limit the amount of nitrogen and phosphate.

Nitrogen: A maximum of 0.7 lbs of readily available nitrogen per 1000 sq. ft. at any one time based on the soluble fraction of nitrogen formulated in the fertilizer. A maximum of 1 lb total (N) per 1000 sq. ft. to be applied at any one time, not exceeding the annual nitrogen recommendations in the Fertilizer Guidelines for Established Turf Grass Lawns in Three Regions of Florida.

St. Aug 09

Specialty Fertilizer Products labeled for turf and lawns:

Florida's Urban Turf Rule requires Specialty Fertilizer Products labeled for turf or laws to limit the amount of nitrogen and phosphate.

Nitrogen: A maximum of 0.7 lbs of readily available nitrogen per 1000 sq. ft. at any one time based on the soluble fraction of nitrogen formulated in the fertilizer. A maximum of 1 lb total (N) per 1000 sq. ft. to be applied at any one time, not exceeding the annual nitrogen recommendations in the Fertilizer Guidelines for Established Turf Grass Lawns in Three Regions of Florida.

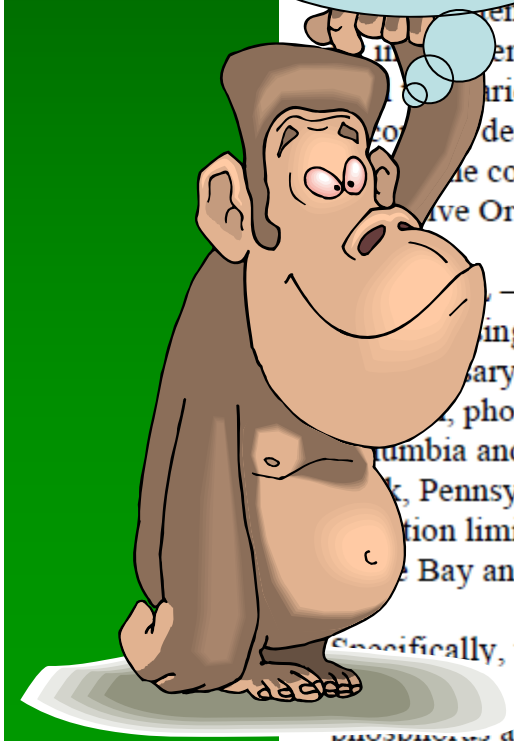
Phosphate: A maximum of 0.25 lbs P_2O_5 / 1000 sq. ft. per application & not exceed 0.5 lbs P_2O_5 / 1000 sq. ft. per year. Application rates above these levels would require a soil sample of the application site to justify an increase in P_2O_5.

The Maximum Coverage must be prominently displayed on the front of the bag stated in square feet. Example: This bag covers 5000 sq. ft.
Fertilizer products will require the following precautionary statement: "Do not apply near water, storm drains or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to your lawn / garden, and sweep any product that lands on the driveway, sidewalk, or street, back onto your lawn / garden."

Fact Sheet

Chesapeake Bay

What did they decide?



Limits, 185.9 million pounds of N, 12.5 million pounds of P and 6.45 million pounds of sediment. In essence a 25, 24 and 20 % reduction in N, P and sediment, respectively.

Take Home Messages

- A healthy turf needs to be fed !!!
- Essential plant nutrients DO MOVE !!!
- Excess nutrients can contaminate ground and surface water = pollution
- Right or wrong, our industry has a **negative perception** regarding responsible nutrient and pesticide use
- What can we (you) do?

PURDUE UNIVERSITY
TURFGRASS SCIENCE

Responsible Managers Have a Nutrient Management Plan

Fundamentals of a plan

1. CLEARLY define your fertilizer program goals and expectations
2. Determine any existing nutrient amounts
   - "Don't guess soil test!"
   - Do NOT apply unnecessary nutrients
3. Fill in (supplement) the nutritional plant needs
   - Proper rate, Appropriate source, Proper application timing (actively growing)

PURDUE UNIVERSITY
TURFGRASS SCIENCE


Public Perception (Right or Wrong) is
That Turfgrass is a MAJOR Contributor
to Declining Water Quality


If the Public Will Not Listen find
Someone who Will !!!


Home of the Boilermakers
UNIVERSITY