# Topic- Chemical Fertilizers

## Soil Fertility and Fertilizer Use (SOIL-502)


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# *Fertilization*

The practice by which essential plant nutrients are supplied as part of the turfgrass cultural program.  It’s inexpensive and rapid, and provides tremendous bang for the buck.

# Extra Credit Presentations

- 8 minute presentation
- Any turf topic - Must OK with me
- Must inform me by Friday, Oct. 13
- Must attend all presentations
- Must use audiovisuals (slides, computer, etc)
- Do not wait until the week before!

# *Fertilizers:*

Any material which supplies one or more of the essential plant nutrients

# *Essential Nutrients*

CHOPKNS CaFe ClZn MoB
CuMn Mg

See Hopkins Cafe Closin'

Mob comin' with machine gun

- C,H,O - from air and water
- N,P,K - macronutrients, most often supplied from fertilizers
- Ca,Mg,S - macronutrients usually adequate in the soil
- Fe,Mn,Cu,Zn,B,Mo,Cl - micronutrients, usually adequate in soil, except for Fe

# Nutrient Balance Concept

Input → Available Nutrient Pool → Output

**Input**

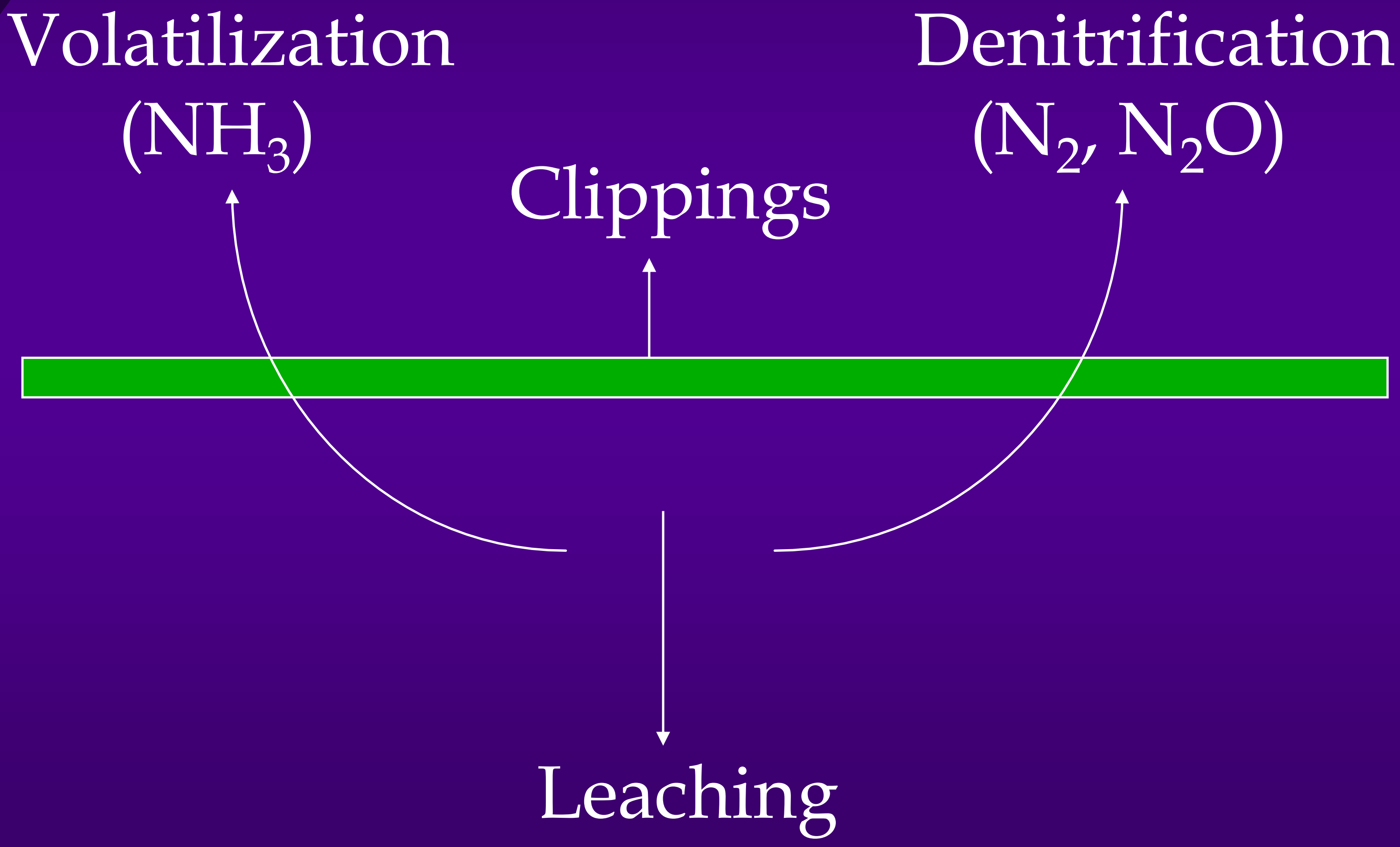
Mineralization
Organic matter
Fertilizers
Atmospheric deposition

**Available Nutrient Pool**

**Output**

Losses
Plant uptake
Microbes

# *Nutrient Losses*



# *Fertilizer Analysis*

- Minimum guaranteed composition of the fertilizer
- Defines how much N, P and K are present
- Gives the information as three percentages, eg. 10-10-10 or 21-0-0

# *Actual vs. Stated Composition*

- N-P-K on the bag, expressed as a percent, doesn’t really mean the amount of N, P and K!

# *Analysis*

- N is presented as N.  If the bag says 21% N, then there is 21% by weight of actual N.  A 50# bag contains 50X0.21, or 10.5# of actual N.  No conversion is necessary for N.

# *Analysis*

- P is not presented as percent <u>actual</u> P! The number on the bag is really the percent of $P_2O_5$ in the bag. $P_2O_5$ is heavier than P, so the percentage on the bag looks bigger!  It really overestimates the amount of actual P in the bag.

# *Conversion*

- To convert from $P_2O_5$ to P, multiply by 0.44. For example, a 50# bag of 10-10-10 (N-P-K) contains 10% $P_2O_5$, or 5# of $P_2O_5$. How much actual P is in the bag? 5# $P_2O_5$ X 0.44 = 2.2# actual P

  <u>This is really important to understand for calculations</u>

# *Analysis*

- K also is not presented as percent actual K! The number on the bag is really the percent of $K_2O$ in the bag. $K_2O$ is also heavier than K, so the percentage on the bag looks bigger! It really overestimates the amount of actual K in the bag.

# Conversion

- To convert from $K_2O$ to K, multiply by 0.83. For example, a 50# bag of 10-10-10 (N-P-K) contains 10% $K_2O$ , or 5# of $K_2O$. How much actual K is in the bag? 5# $K_2O$ X 0.83 = 4.15# actual K

# Nitrogen

- Required in greatest amounts for plant growth
- Tool to control growth
- Normal range in tissue is 3-5% by dry weight.  In other words, 100 grams of dry tissue contains 3-5% N.  This will depend on species

# Excess Nitrogen

- Excess shoot growth
- Reduced root growth
- Increased disease
- Decreased carbohydrates
- Decreased stress tolerance
- Population shifts

# Nitrogen Deficiency

- The most common deficiency
- Growth slows dramatically
- Oldest leaves first become chlorotic (lose their dark green color, become yellowish), while newest leaves stay green.  This is because the N is transferred from the oldest, expendable leaves to the newest, most valuable leaves

# Functions of N in the Plant

- Component of amino acids, proteins, enzymes, and nucleic acids (DNA, RNA)
- Component of chlorophyll and some hormones
- Component of secondary products: nicotine, defense compounds, osmotic agents (help regulate plant water relations)
- Mobile within the plant - old leaves transfer N to young leaves.  Old leaves become chlorotic first

# *Nitrogen Carriers*

- Plants absorb and utilize N in several different forms, including $NH_4$, $NO_3$, and urea.
- Which is the best form? Which does the plant prefer? Turf seems to like them all.
- Other forms must be converted to $NH_4$, $NO_3$ to be absorbed.

# *Quickly Available N*

- Very soluble
- Tendency to burn
- Rapid response
- Short response
- Cheap
- Minimal temperature dependency
- High leaching potential

# Quickly Available N

- Ammonium nitrate 33-0-0
- Ammonium sulfate 21-0-0
- Ammonium phosphates
  - mono-ammonium phosphate 11-48-0
  - di-ammonium phosphate 20-50-0
- Potassium nitrate 13-0-44
- Urea (organic?) 46-0-0

# *Slowly Available N*

- Slow initial response
- Longer response than quick release
- Some, but not all, are dependent on temperature for N release
- Low burn potential
- Moderately expensive to expensive
- Less N leaching

# *Types of Slow-Release N Fertilizers*

- Ureaformaldehyde, UF
- Methylene Urea, MU
- Isobutylidinediurea, IBDU
- Sulfur coated urea, SCU
- Polymer coated urea, Reactive layer coated urea, RLC

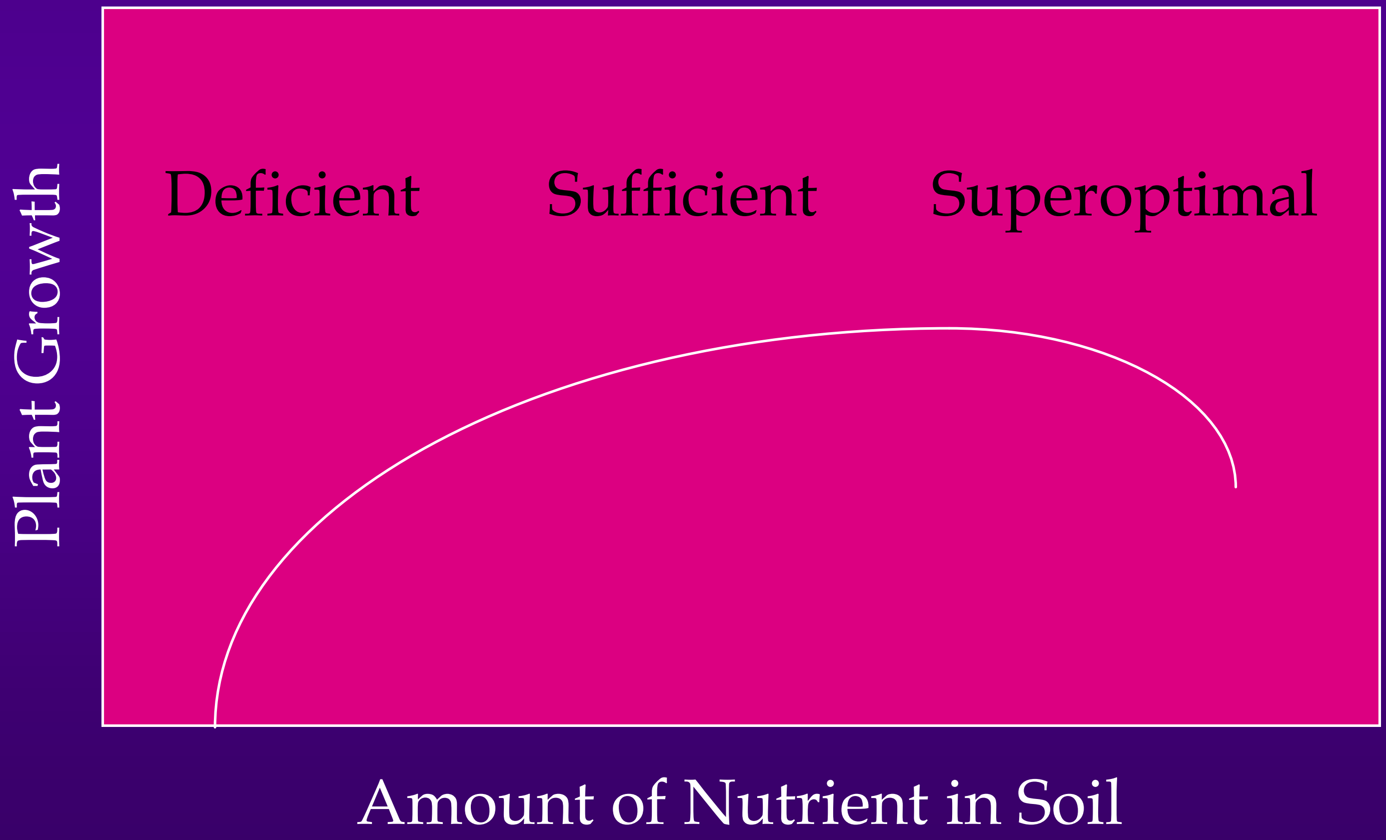
# Salt and pH Effects of Fertilizers

| Fertilizer | %N | Salt Index | Acidity (-) or Basicity (+) |
|---|---|---|---|
| Ammonium Nitrate | 34 | 100 | -1.7 |
| Ammonium Sulfate | 21 | 109 | -5.2 |
| Calcium Nitrate | 15 | 147 | +1.3 |
| Urea | 46 | 54 | -1.8 |
| Potassium Nitrate | 13 | 178 | +2.0 |
| Urea Formaldehyde | 38 | Low | -1.8 |

# *Phosphorus*

- Component of nucleic acids, ATP
- ATP transfers energy in reactions
- Required for meristem activity
- Involved in conversion of carbohydrates
- Stored in seeds as phytin
- Mobile within plant - older parts can transfer to meristems
- Tissue levels = 0.2-0.6%

# Soil Nutrient Levels (for all but Nitrogen)



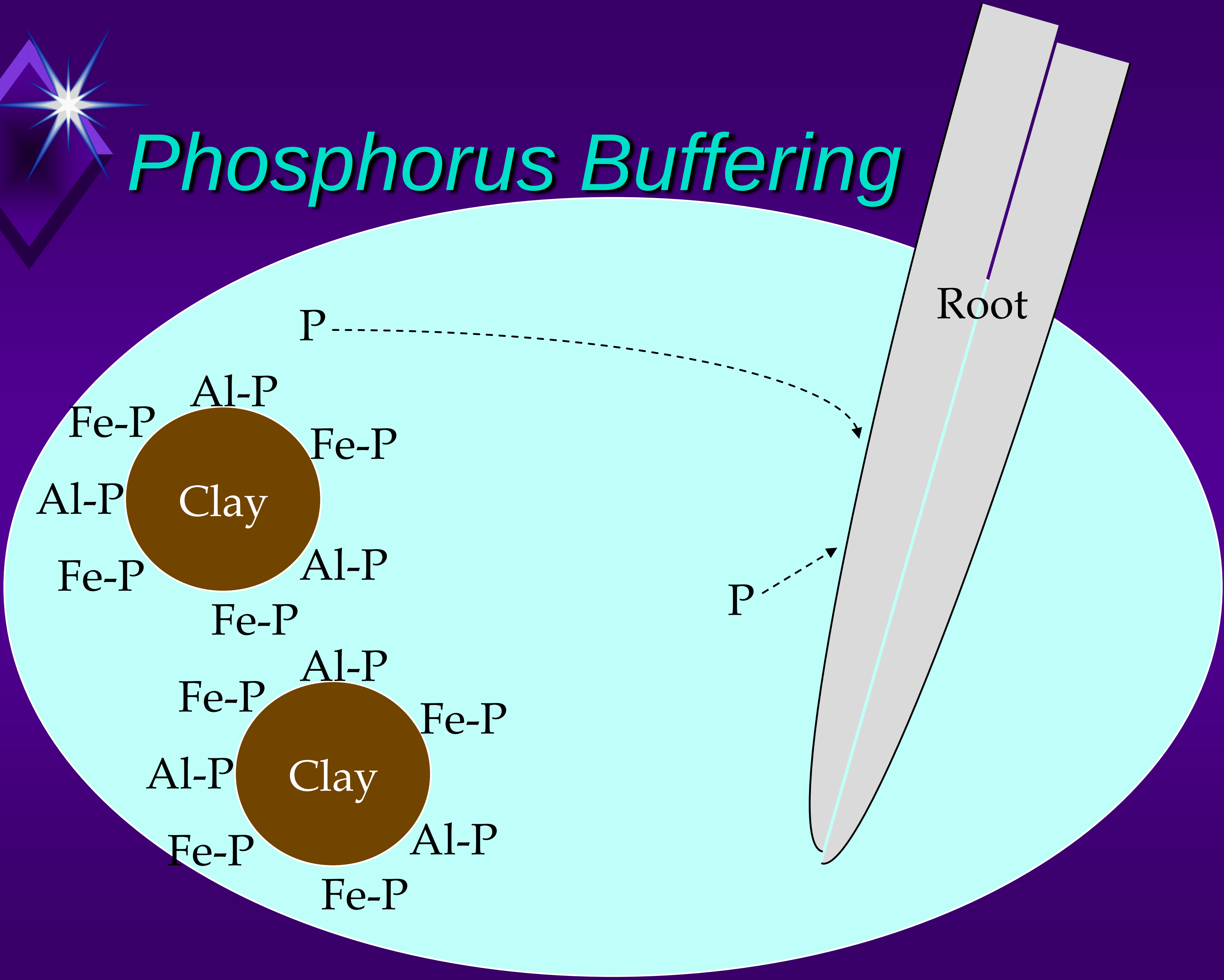
# Phosphorus Deficiency

- Growth is dramatically slowed
- Leaves turn very dark blue/green or even somewhat purple
- Rare because turf is very efficient at extracting P from the soil.  Over time, turf can actually increase the amount of P that is available by storing it in the organic matter

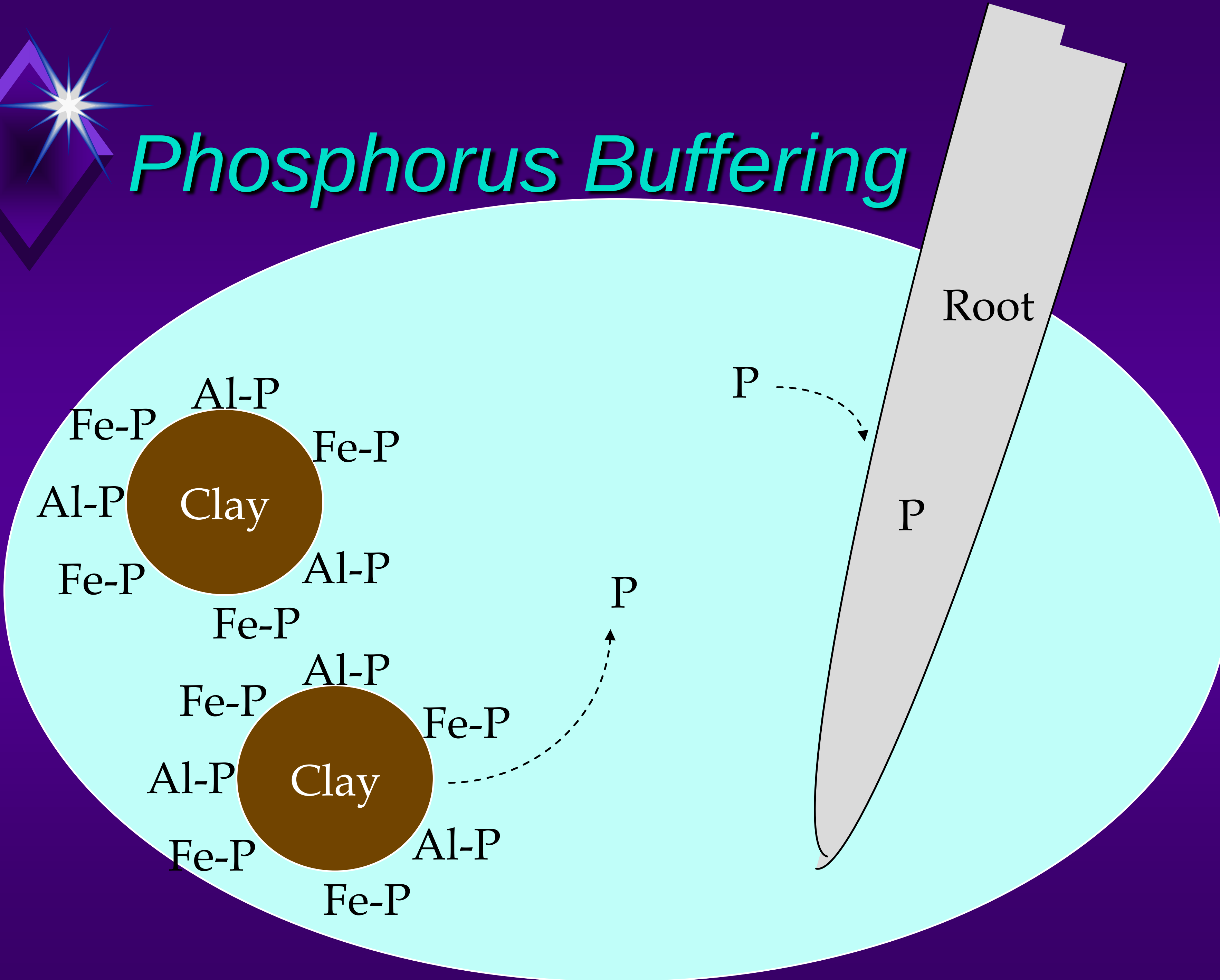
# *Soil Phosphorus*

- Many soils contain considerable P, but most is unavailable to the plant. Plants absorb the anion phosphate, $HPO_4^{2-}$
- P forms insoluble molecules when it binds with Fe or Al. This is especially a problem with low pH soils. Thus, P is not very mobile in the soil
- Soil solution contains very small amounts of P, yet the turf usually obtains adequate amounts. How?

# Phosphorus Buffering



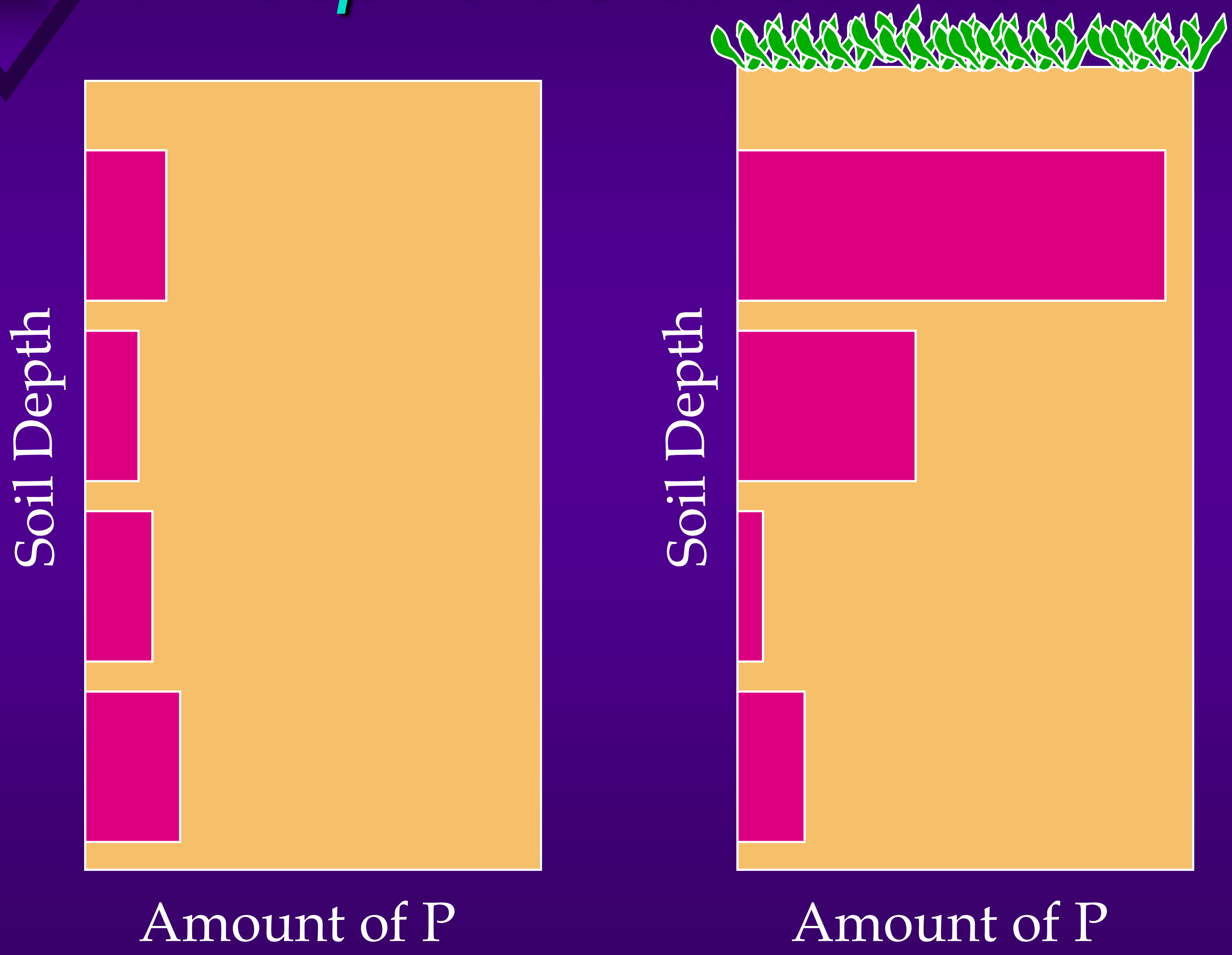
# Phosphorus Buffering



# Turfgrasses Mine Phosphorus

- Roots are continuously absorbing P from the soil solution.  The P is continuously being replaced from the buffering system. P is transferred to the canopy, and is ultimately deposited back on the surface when leaves die.  It is released to the soil, but being immobile, it binds near the surface.

# Turfgrasses Concentrates Phosphorus at Surface



# *Sources of Phosphorus*

- Rock phosphate ores, mined, and processed with acid
  - superphosphate - 20% $P_2O_5$
  - triple superphosphate - 45% $P_2O_5$
  - monoammonium phosphate - 48% $P_2O_5$ , 11% N
  - diammonium phosphate - 50% $P_2O_5$, 20% N

# *Potassium*

- Unique because it isn't incorporated into some molecule in the plant. It exists in its ionic, $K^+$ form, in solution in cytoplasm
- Tissue levels of 1.5 - 4.0%
- Functions as a catalyst for biochemical reactions
- Functions in maintaining <u>turgor</u>
- Functions in carbohydrate synthesis
- Deficiencies hard to diagnose

# *Adequate Potassium*

- Increases root growth
- Increases disease and environmental stress tolerance (?)
- Increases wear tolerance
- It sounds like a magic elixir! But the beneficial effects are realized only when compared to K deficient conditions. There is little benefit from adding K to an already sufficient soil!

# Potassium Sources

- KCl, muriate of potash - 0-0-60
- $K_2SO_4$, potassium sulfate - 0-0-50
- $KNO_3$, potassium nitrate - 13-0-44
- Sulfur coated potassium
- Polymer coated potassium

- Potassium binds to cation exchange sites, but may leach from sandy soils

# *Calcium*

- Available as the cation $Ca^{2+}$
- Constituent of cell walls
- Not mobile in the plant
- Supplied with lime ($CaCO_3$) or gypsum ($CaSO_4$)
- Rarely deficient, except under extreme acid soil conditions

# *Magnesium*

- Available as the cation, $Mg^{2+}$
- Involved in energy transformations
- Important component of the chlorophyll molecule
- Supplied using dolomitic lime ($CaCO_3$ + $MgCO_3$) or MagAmP, (magnesium ammonium phosphate)
- Rarely deficient, except under extreme acid soil conditions

# Sulfur

- Available as the anion $SO_4^{2-}$
- Component of amino acids, proteins
- Supplied in:
  - ammonium sulfate, $(NH_4)_2SO_4$
  - potassium sulfate $K_2SO_4$
  - superphosphate
  - gypsum, $CaSO_4$
  - elemental sulfur - used to acidify soils

# Sulfur Deficiency

- Rare
- Similar to N deficiency, with older leaves turning chlorotic yellow, newer leaves remaining green.  This is because S is mobile in the plant, and can be transported out of older leaves and into newer leaves if the need arises.  Thus the older leaves become yellow.

# *Micronutrients*

- Most are involved as catalysts in enzyme reactions
- Most are basically insoluble at high pH
- Solubility increases as the soil becomes more acidic

# *Iron*

- The one micronutrient that is likely to be deficient, or at least the turf is likely to exhibit deficiency symptoms
- Symptoms are chlorosis, sometimes severe, of the youngest leaves. Fe is not mobile in the plant, so it is not transferred from old to young leaves.

# *Causes of Iron Chlorosis*

- alkaline soils, pH > 7.5
- too much P in soil
- too much lime applied
- wet soils
- cold soils
- roots are inactive or damaged

# Correcting Iron Chlorosis

- Fast acting Fe salts - ferrous sulfate is often spray applied to turf foliage at a rate of 2-4 grams of fs per 1000 sq. ft. This is quick but short lived
- Iron chelates (claws) are organic compounds that bind Fe and keep it available to the plant for extended periods.  They're expensive, slower acting, but last longer.

# *Fertilizer Programs*

- Most are based on several to many granular applications each year
- Timed to the major growth periods for each grass
- Applied using drop spreaders or rotary (centrifugal) spreaders
- Pick the right spreader for the job. Avoid applying material too close to water features or on hardscape

# Spreaders


# *Fertigation*

- Fertigation is newer concept, in which nutrients are injected into the irrigation line at every irrigation (usually) and delivered with the water. “Spoon-feeding” a little every day
- Can also inject acid or lime to help control pH problems
- Burning is not usually a problem because of the low amounts, but for safety, good idea to irrigate just enough to wash the fertilizer off the foliage

# *Fertigation Problems*

- Requires new hardware - pumps, storage tanks, controllers
- Fertilize only when irrigating - what about a rainy period?
- Fertilizer coverage is only as good as the water coverage, only as good as the irrigation system.  This is not a problem with most new systems, but can be with some of the older designs

# Foliar Feeding

- Liquid fertilizers spray-applied to the foliage at higher rates - 0.25-1.0#N/1000 sq ft.
- Commonly used in home lawn care industry
- Increased potential for burn - can’t use the soluble fast release forms
- Uptake by foliage is fairly inefficient, so material should be watered in, clippings returned