Better Yields Through Better Soils

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UNIVERSITY OF MARYLAND EXTENSION | MASTER GARDENER

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UNIVERSITY OF MARYLAND EXTENSION

GROW IT · EAT IT
A MASTER GARDENER PROGRAM

UNIVERSITY OF MARYLAND

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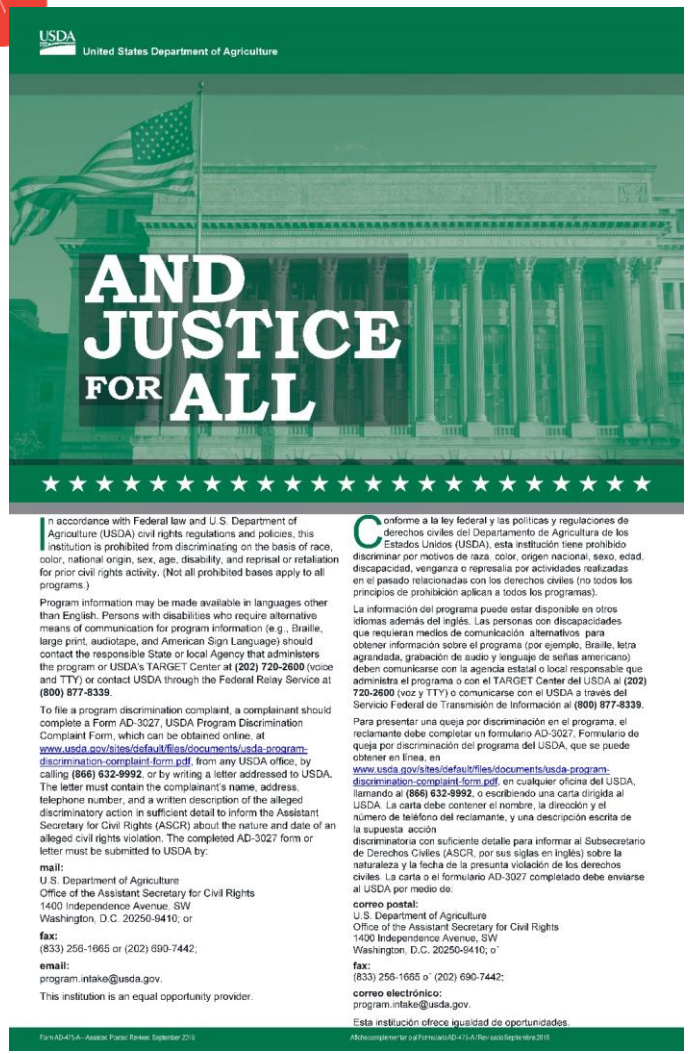

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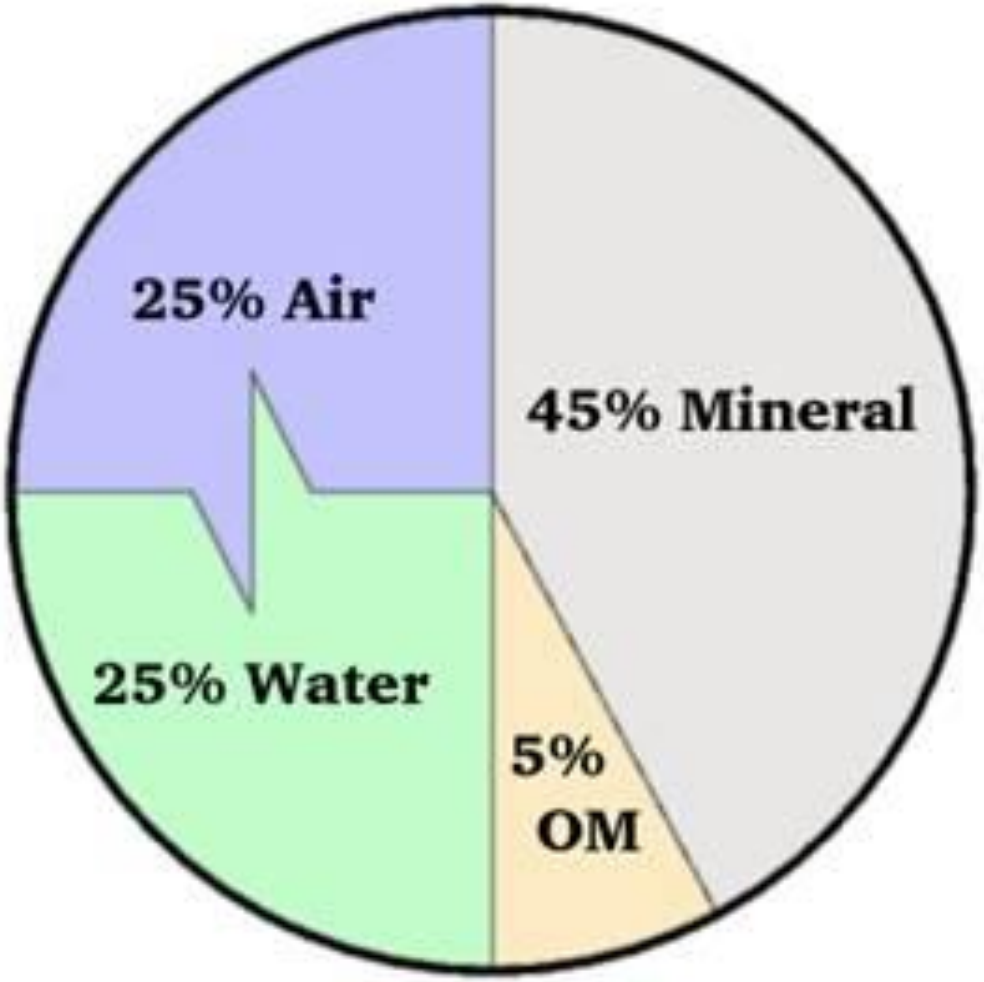
What is Soil

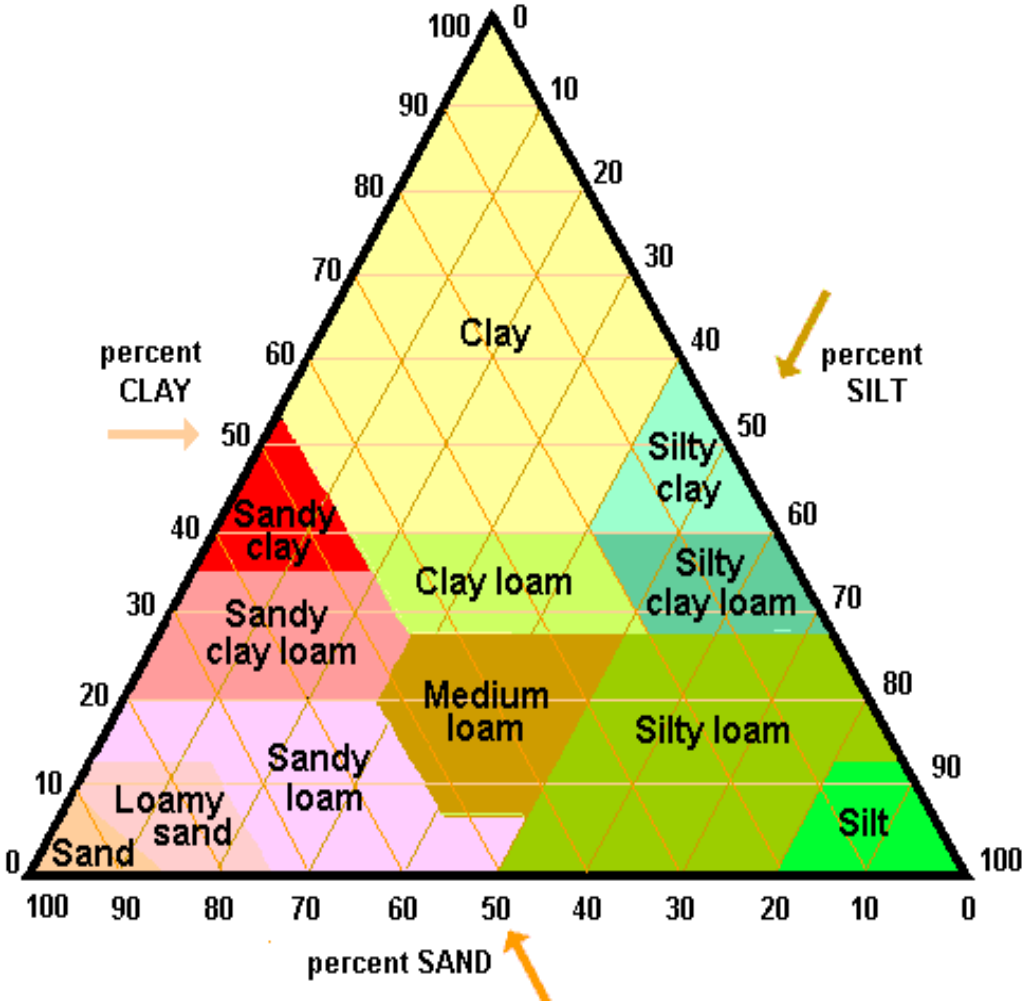
- Soil contains 4 major components



What are the mineral solids in soil

- Mineral solids in soil fall into three classes
  - Sand, which is gritty, size from .05 – 2 mm
  - Silt, feels like flour, size from .002-.05 mm
  - Clay, sticky when wet, size > .002 mm
- Most soils are mixtures of minerals of various sizes.
- Soil texture describes the proportion of sand, silt and clay in soil.
- Soil texture is an unchangeable property and is not altered by soil management.

Soil triangle



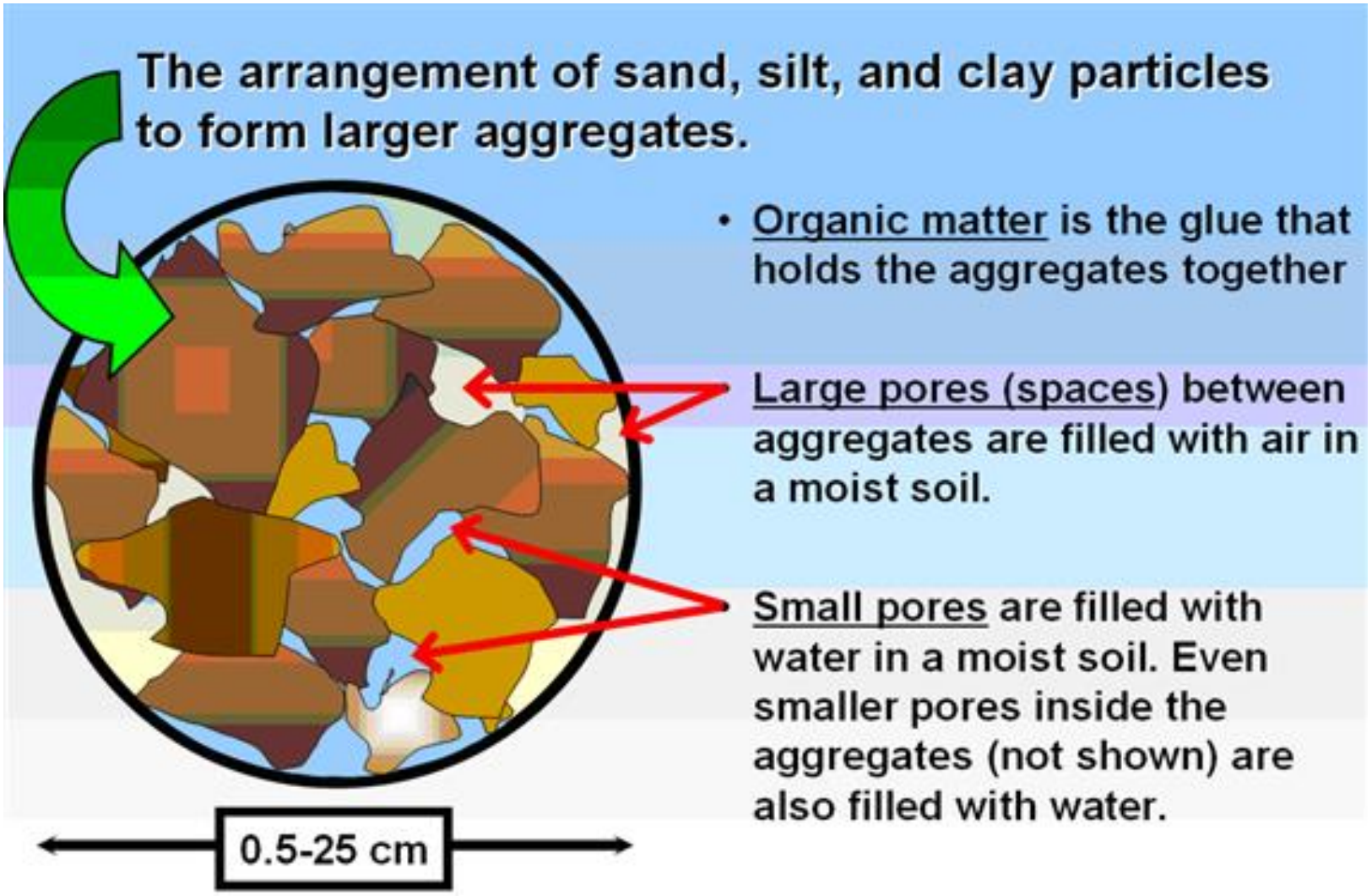
Effects of soil properties

- Soils made up of mostly sand(>50%, sand, loamy sand and sandy loam) have low water and nutrient holding capacity but lots of air space
- Soils made up of mostly clay(>60%, clays, sandy clays and silty clays have high water and nutrient holding capacity and little space for air
- Soils with a mixture of properties have moderate water and nutrient holding capacity and adequate air spaces
- Since we can't change soil texture, how can we improve our soils?

Soil structure

- The productivity of soil can be change by changing a soil's structure
- Soil structure is the arrangement of soil particles into clumps or aggregates
- Organic matter plays a "pivotal" role in cementing soil particles together
- A granular or crumb structure is desirable in topsoil

Soil aggregate



Components of organic matter

- Humus makes up about 75% of OM
  - It is a stable product of decomposition and increase a soils ability to hold water and nutrients
  - By cementing soil particles together, it impacts the number and size of the pores in the soil
    - Macro (large) pores drain water and aid in the flow of gases (O2 & CO2) into the soil
    - Micro (small) pores retain water after drainage and store it for plant use
  - Increasing OM improves soil structure insuring plants have adequate water and oxygen in the root zone

Humus (cont.)

- Micro pores hold the soil solution which is made up of water and other materials
- Soil solution is the source of nutrients for plants
  - Fertilization increases nutrients in solution
  - Plant uptake decreases nutrients in solution
  - Breakdown of plant residues and organic nutrient sources increase nutrient levels
- Plant growth is optimized by maintaining adequate water and nutrients in soil solution

Biomass

- Biomass is the living component of soil
  - Worms, bacteria, fungi, etc.
- Function of biomass
  - Nutrient cycling – digest residues, use what they need and leave waste in plant-available form – mineralization
  - Creation of bio pores – larger organisms improve soil structure as they move through the soil
    - E.g. Worms create channels for water flow

Residues and by-products

- Residues and by-products include crop residues, dead roots, bodies of biomass and materials that roots and creatures release into the soil
  - Residues provide nutrients and energy for soil biomass
  - Residues with C/N > 25 use N from soil solution
- The sticky, gummy by-products of decomposition hold soil particles together in clumps or aggregates

Take away

- OM improves soil structure
  - Humus holds soil solution (water and nutrients)
  - Provides residue for soil organisms
    - Soil organisms cause mineralization
    - Mineralization is changing organic materials containing NPK into an ion forms plants can use
  - Sticky, gummy by-products glue particles together creating aggregates
    - Aggregates and other soil particles create spaces of different sizes which permit soil to hold soil solution (water and nutrients) and gases

Take away (cont.)

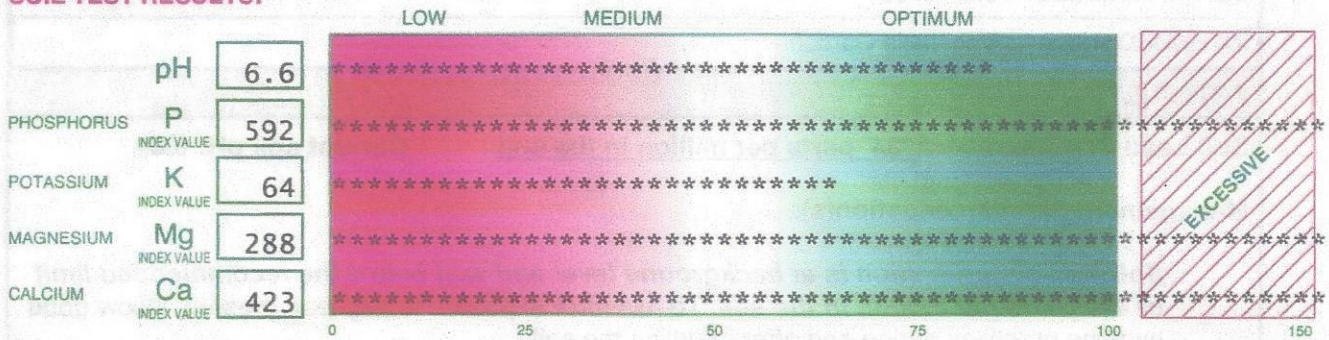
- U of MD recommends 6” of compost for new gardens, 2 to 4 inches if OM levels are low < 4 and 1” for existing gardens
- Object is to raise OM content in soil and create a reservoir of residues for biomass to mineralize
- Objective is to add OM to improve soil structure

Healthy soil

- First rule get a soil test
  - Send a soil sample to a soil testing lab
    - Test for lead and OM
    - Cost about $17
    - Follow lab recommendations for amending soil
  - Understanding your soil test report
    - Nutrients
    - pH level
    - % Organic Matter
    - Cation Exchange Capacity (CEC) >10
- Ask Extension

Soil Test

SOIL TEST RESULTS:



B	Mn	Zn	SO_4-S	% ORGANIC MATTER	SOL. SALTS MMHOS/CM	BUFFER pH	% Phosphorus Saturation	CEC meq/100gm	% Base Saturation	ENCLOSURES
	LBS/ACRE									
5.1	42.1	82.0	30.1	12.0+		7.62	100.0	27.6	89.0	1,13

SUGGESTED FERTILIZER PROGRAM:

CROP: FLOWER BEDS

YIELD GOAL: N/A

LIME T/A	LIME TYPE	N LBS/A	P_2O_5 LBS/A	K_2O LBS/	S LBS/A	B LBS/A
**********	**********	****SEE	BELOW**********			

1. Apply 1 lb of N per 1000 square feet of garden area. This can be supplied by 3 lbs ammonium nitrate (34-0-0) or 2.5 lbs of urea (46-0-0). If these two fertilizers are not available, select an alternate source that is low in P as soil levels of P and K are already in the "Optimum" or "Excessive" range.

   Apply recommended fertilizer to the soil surface and rake in just before planting.

2. Next growing season - follow the maintenance fertilizer programs for flowers in Soil Test Note 13 (enclosed).

Reading The Soil Test

- Results
  - Fertilizer recommendations
  - 2.5# of 46-0-0 or 3# of 34-0-0 per 1000 sqft
  - Per 100 sqft. .25# or 4 ounces of 46-0-0 or .3# or 4.8 ounces of 34-0-0
  - For 4 x 8 bed, 32/100 times amount
    - .32 times either 4oz. = 1.28 oz or 4.8oz. = 1.53 oz
  - For 12 ft x 15 ft garden, 180/100
    - 1.8 times 4 oz = 7.2 oz or 4.8oz. = 8.6 oz
- Use a kitchen scale to weigh out amounts

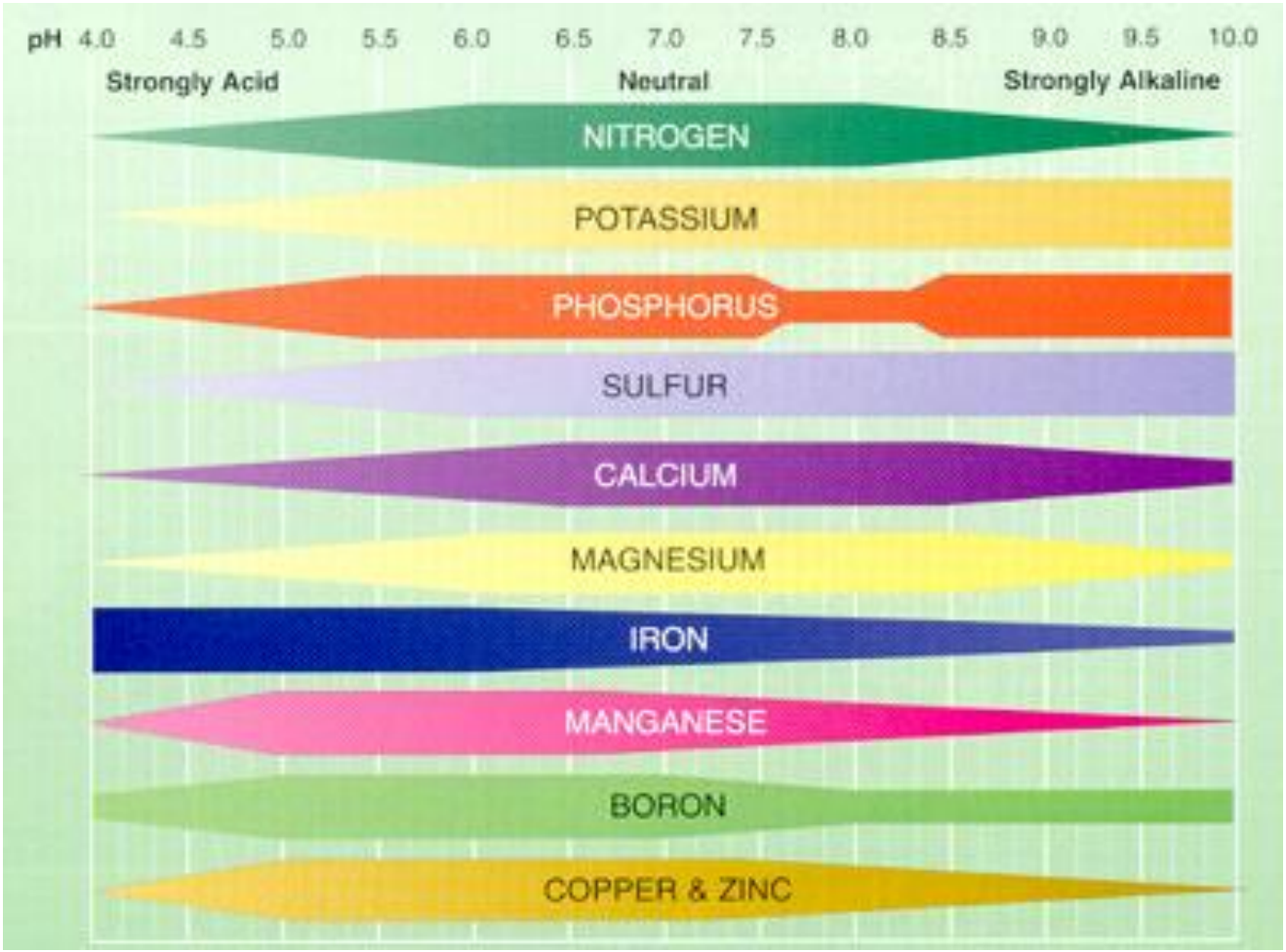
Tons to teaspoons

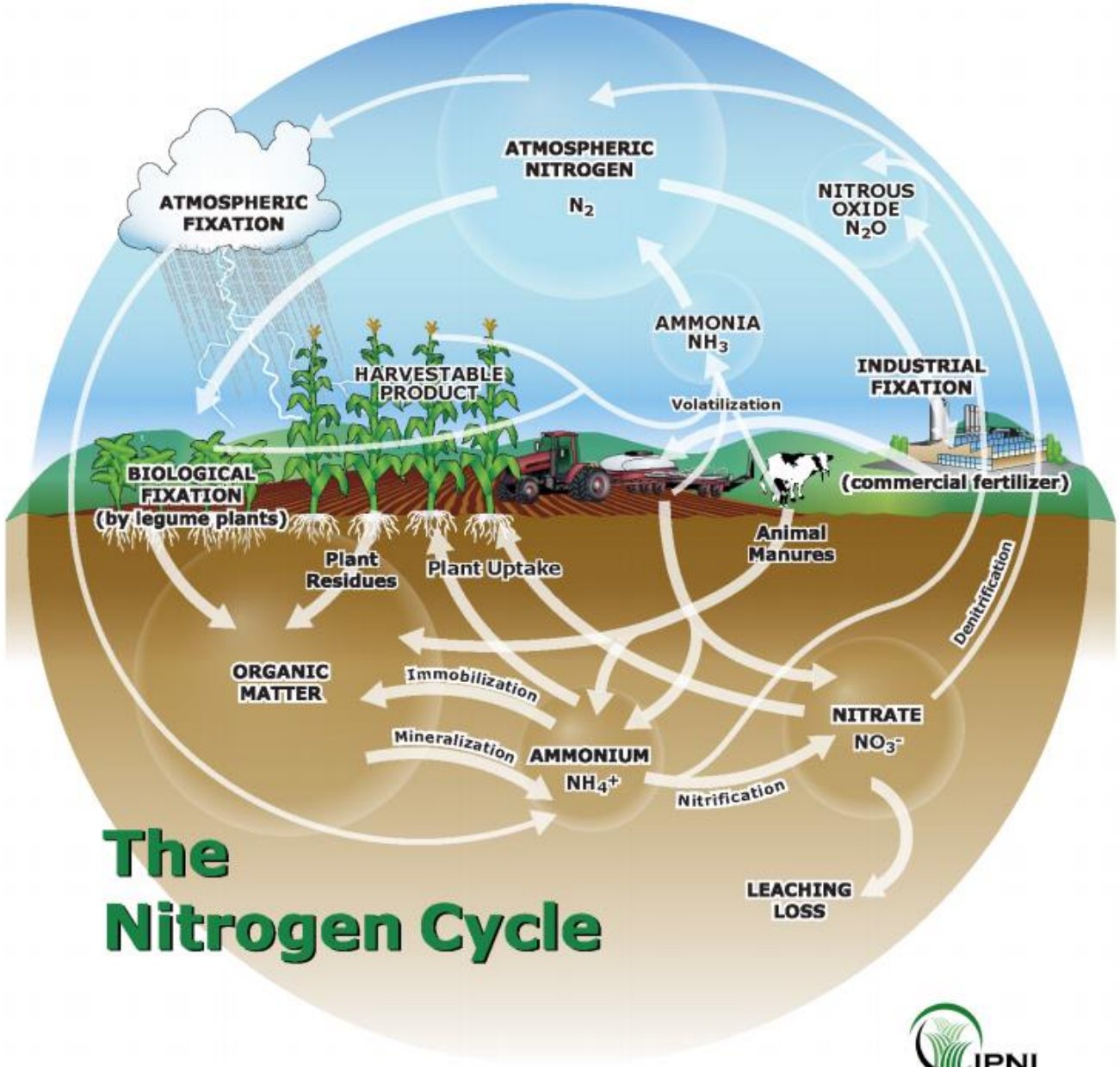
- Don’t have a kitchen scale, reference information on UMD’s soil test webpage.
- UCONN 1C of urea = ⅓ lb. or 5.3oz.
  - 1C = 16 Tbs. or 5.3oz
  - 1.28oz. ÷ 5.3oz. X 16 Tbs = 3.8Tbs or ≈ ¼C
  - 7.2oz. ÷ 5.3oz. X 16 Tbs = 21.6Tbs or ≈ 1⅓C
- Search “tons to teaspoons of fertilizer calculator”

Healthy soil

- pH (potential hydrogen)
  - Vegetables - 6.2 < pH < 6.8 is optimal
  - Soils in this pH range allow the optimum uptake of macro and micro nutrients
  - Lime raises pH
  - Ferrous sulfate or sulfur lowers pH
- Soil lab will tell you what and how much to apply
- Questions about soil tests can be sent to Extension at Ask Extension

pH and nutrient uptake





IPNI
INTERNATIONAL PLANT NUTRITION INSTITUTE

Nitrogen cycle

- Plants only take up mineralized N
  - Ammonium ion
  - Nitrate ion
- These forms of N come from two main sources
  - Fertilizers
    - Inorganic - readily available to plants
    - Organic forms - must be mineralized by the biomass to create ammonium and nitrate ions
  - Organic residues containing N
    - must be mineralized by the biomass to create ammonium and nitrate ions

Mineralization

- Soil biomass is temperature sensitive
  - Slow in cold and cool weather
  - Rapid in hot weather
  - For each 1% OM .067 lbs of N released per 100 sqft.
- In spring and fall organic gardeners should use
  - Fish emulsion NPK 5-0-0 90% immediately available
  - Blood meal NPK 12-0-0 50% immediately available
- In summer, soybean meal, cotton seed, etc.
- See Fertilizer Basics
- See Fertilizing Vegetables

Side Dressing

Broccoli

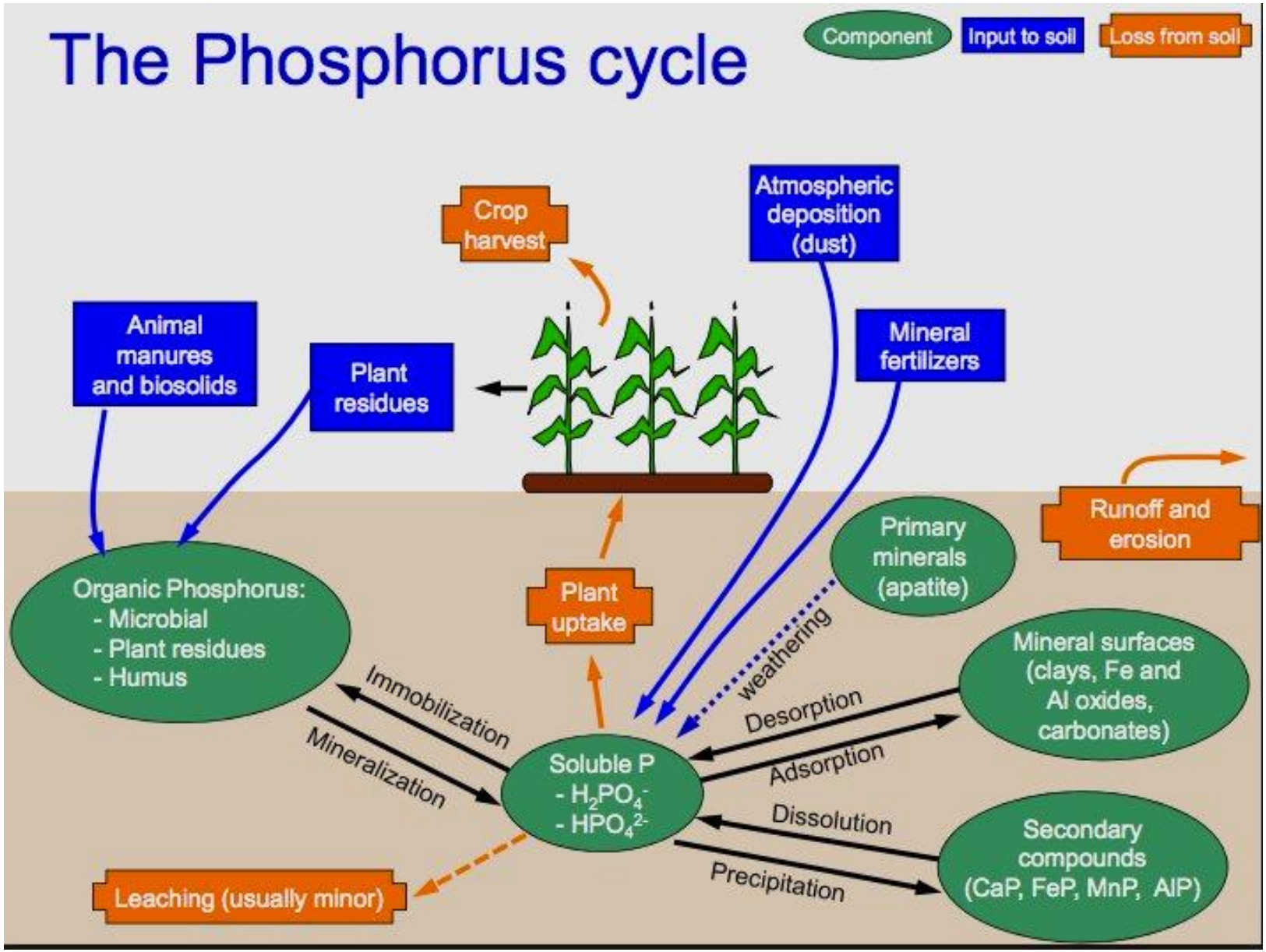
- **Fertilizing** – Broccoli is a heavy feeder. Mix compost into the soil and fertilize at transplanting; side-dress three weeks later and when central head has been cut (¼ lb. of 10-10-10 per 10 ft. row). This will help produce later but smaller heads from side shoots.

Peppers

- **Fertilizer needs**: Light-medium feeder. Use starter fertilizer for transplants; side-dress with ¼ lb. of 10-10-10 or equivalent per 10 ft. of row after first fruits set.

Brussels Sprouts

- **Fertilizing** – Heavy feeder. Side-dress with a balanced fertilizer 2 to 4 weeks after planting or when plants are 12 inches high.


The Phosphorus cycle
Component
Input to soil
Loss from soil
Crop harvest
Atmospheric deposition (dust)
Animal manures and biosolids
Plant residues
Mineral fertilizers
Runoff and erosion
Primary minerals (apatite)
Plant uptake
Organic Phosphorus:
- Microbial
- Plant residues
- Humus
weathering
Immobilization
Mineralization
Desorption
Adsorption
Mineral surfaces (clays, Fe and Al oxides, carbonates)
Soluble P
- $H_2PO_4^-$
- HPO_4^{2-}
Dissolution
Precipitation
Secondary compounds (CaP, FeP, MnP, AlP)
Leaching (usually minor)

Phosphorous Cycle

- Maryland soils generally contain sufficient P
  - Only add P if called for by soil test
- Plants can only uptake P in ion form
  - Inorganic fertilizers
  - Mineralization by biomass
- Phosphorous movement
  - Leaching is minor except in sandy soils
  - Runoff can be a major problem in fertile soils.

- Online references at www.extension.umd.edu/hgic
  - Soil Test
    - Understanding your soil test report
  - Soil, Fertilizer, Mulch and Compost
  - Fertilizer Basics
  - Fertilizing vegetables
  - Vegetable facts
  - Cover crops
- Questions Ask Extension

Cover Crops

- Legume plants
  - Fix nitrogen in the soil
  - Stabilize soil during the winter
- Cereal cover crops
  - Mine nutrients with extensive root systems
  - Stabilize soil
  - Oats are winter killed
- Forage radish
  - Breaks up clay soil
  - Winter killed

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