Intro to Soils and Soil Fertility
"...and we can save 700 lira by not taking soil tests."
What is Soil?

- Provides air, water and nutrients to plants
- Soil provides mechanical support to plants
- Consists of weathered materials, decaying organic matter, air and water
How is soil formed?

- Decomposing animals and plants
  - Fungi and bacteria feed on the material to break it down until it is released into the soil

- Rocks and minerals break down through weathering (freezing, thawing) and mechanical forces to create soil texture.
TOPSOIL = roots, bacteria, organic matter, fungi, insects, and earthworms

SUBSOIL = roots, bacteria, fungi, insects, and earthworms

PARENT MATERIAL = limestone, bedrock, or other mineral substance
Average soil contains

- 45% Mineral
- 5% Organic Matter
- 25% Air
- 25% Water
Soil Texture

- Different sized mineral particles give soil its texture
  - Sand
  - Silt
  - Clay

Worms help water flow through the soil!
Soil Texture

- Sand is largest particle size, allowing for more air and water to movement
- Clay soils are heavy and hold a lot of water
- Loamy soils are intermediate between sand and clay – both water holding capacity and fertility
<table>
<thead>
<tr>
<th>Soil Texture &amp; Associated Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
</tr>
<tr>
<td>Sandy Loam</td>
</tr>
<tr>
<td>Clay</td>
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<table>
<thead>
<tr>
<th></th>
<th>Fast</th>
<th>Moderate</th>
<th>Very Slow</th>
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Growth Factors

What do plants need to grow?

- Light
- Water
- Nutrients
- Oxygen
- Carbon Dioxide
- Temperature
What is an Essential Plant Nutrient?

- All the nutrients needed to carry out growth and reproductive success – a full life cycle
  - Omission of the element will result in abnormal growth
  - The element cannot be replaced or substituted
  - The element must exert its effect directly on growth

(Aronn and Stout, 1939)
Soil Fertility

- There are 17 known elements that are essential for plant growth
- Plants require nutrients that are not created through photosynthesis
  - H, O, C Plants get from air and water
- Macronutrients
  - N, P, K High amounts
  - Ca, Mg, S Lesser amounts
- Micronutrients
  - Fe, Mn, B, Mo, Cu, Zn, Cl Small amounts
Plant Nutrients

- Can be added to soil through commercial fertilizer (i.e., 12-12-12), animal manure or compost
- To know the amounts to apply, you need a soil test
- Excesses and deficiencies can cause poor plant growth or death
Nitrogen

- Most of soil nitrogen is in the form of organic matter
- Promotes growth and color
- Excess causes excessive growth, weak stems
Growth dwarfed and thin: overall plant is light green in color and turning yellow in the late season.
Phosphorus

- Primary source: specific minerals and OM

- Promotes seed development, reproduction, cell division

- Enhances root development and water uptake by the roots

- Excess may lead to deficiencies in other nutrients
• The first symptoms are downward curling of the leaf.

• The interveinal tissue becomes a paler green and eventually dies.

• There may be a marginal scorch on the older leaves.

Phosphorus (P)
Potassium

- Source in soil: minerals
- Increases winter hardiness, reduces diseases, important in ripening of fruits and vegetables
• Leaves are smaller, dark olive green and have a dull appearance.

• There is a tendency for the leaves to curl downward and the leaf petioles to become darker red.

• Brown spots develop interveinially on the under surface of the leaves.

Potassium (K)
What’s pH all about?

- pH is determined by soil type
- Can effect plant growth and nutrient availability
- Different plants have different soil pH requirements
- Can be adjusted through soil amendments
Soil pH Ranges

Range of pH common for humid-region soils

Range in pH for arid-region soils

Range in pH for most inorganic soils
Applying Lime to raise soil pH
MANAGEMENT
what are your soil uses?

- SOIL TEST -
  DON'T GUESS!
- What are the needs of your plants?
  - pH
  - Fertility
- Compaction
- Soil Depth
- Slope
Horticulture/Gardening
Greenhouses, Homeowners

- Potting mixes have specific nutritional requirements
- Plants in pots are different than growing in the ground
  - Water!
- Soil testing just as important for homeowner
  - will save money in the long run
What to do now?

- What are you going to grow?
- What are the specific fertility needs of that crop?
- Have soil tested
- Determine pH, soil texture and fertility needs (deficiencies/excesses) based on results
- Follow recommendations
- Have fun!
Guidelines for Soil Sampling
Overview

- Soil test values are no better than the soil samples you collect.
- Proper soil sampling procedures must be followed to obtain meaningful test results for fertilizer decisions.
Guidelines

- The best guideline for determining fertilizer needs is a reliable analysis of a soil sample that is representative of the field.
- Proper procedures must be followed to collect representative soil samples.
Why Soil Test?

♦ Determine the average nutrient status in a field

♦ Obtain a measurement of nutrient variability in the field
Objectives of Soil Sampling

- Correct fertilizer nutrient use can result in:
  - increased yield
  - reduced cost
  - reduced potential water pollution.
Increased Crop Yield
Law of the Minimum - Liebig’s Law

Justus von Liebig, generally credited as the “father of the fertilizer industry”, formulated the law of the minimum:

If one crop nutrient is missing or deficient, plant growth will be poor, even if the other elements are abundant. Liebig likens the potential of a crop to a barrel with staves of unequal length. The capacity of this barrel is limited by the length of the shortest stave (in this case, nitrogen) and can only be increased by lengthening that stave. When that stave is lengthened, another one becomes the limiting factor.
Liebig's Barrel Analogy
Reduced Production Cost
Reduce Potential Water Pollution

An example of a clean stream.
Define Management Units

- A management area is an area that can and will be managed separately from any other.
- If different field areas have different soil types, past cropping histories, or different production potentials, these areas should be sampled separately.
Develop management units based on history, topography and future crop production practices.
Sample the management unit

- Collect 15-20 cores in a clean plastic bucket.

- Take sample from throughout the entire area of the unit

- Avoid sampling areas such as windbreaks, old fence lines, wet areas or areas near lime rock roads etc.
Odd areas in the field (eroded spots, turn rows, abandoned farmsteads, or feedlots) must be avoided or sampled as separate areas. Soil samples from these areas can change the test results for the rest of the field.
Sampling the management units
Proper Sampling Depth

- Surface (tillage layer) samples are used for determining soil pH, lime need, organic matter, phosphorus, potassium, sulfur, and zinc.
- Soil test correlations and calibrations for these tests are based on surface samples.
- Usually the tillage layer is considered to be the 0-6 inch or the 0-8 inch depth. It is best to use the same sampling depth from year to year so soil test values can be more accurately compared.
General Guidelines

- Proper random sampling can provide an accurate picture of the average nutrient level in the field.
- Grid sampling can provide an opportunity to obtain even more information. If individual samples from a grid sampling pattern are analyzed separately, they can be used to produce nutrient level maps of the field.

A. Samples collected at random

B. Samples collected in grid pattern

\* = Surface sample only (0-8" depth)
\x = Surface + subsurface samples
Take Continuous Cores

- As soil cores are collected, the entire core for the desired depth should be placed in a plastic pail for mixing. Separate pails are needed for surface cores and each subsurface depth sampled. Soil cores in each pail are then thoroughly mixed and a subsample placed in a separate bag or box which has been labeled for the sample area in the field, and for the depth of sample.
Thorough mixing is essential.
Don’t forget to label worksheet and bag.
• Ship no more than is required by the lab
• Usually one pint or less.
• Fill out all information sheets as completely and accurately as possible
# Soil Analysis

**Client:** POT PIE FARM  
**Address:** P.O. BOX 84  
**City:** ST. MICHAELS  
**State:** MD  
**Zip:** 21663

**Test Results:**

<table>
<thead>
<tr>
<th>Test</th>
<th>Results</th>
<th>Ratings</th>
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<tbody>
<tr>
<td>Soil pH</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Buffer pH</td>
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<td></td>
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<tr>
<td>Phosphorus (P)</td>
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<td>LEAKERE</td>
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<tr>
<td>Potassium (K)</td>
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<td>Calcium (Ca)</td>
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<tr>
<td>Boron (B)</td>
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<tr>
<td>Copper (Cu)</td>
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<td>Zinc (Zn)</td>
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<td>Sodium (Na)</td>
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<td>Soluble Salts</td>
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<tr>
<td>Organic Matter</td>
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<td>NO3-N</td>
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**Soil Test Ratings:**

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<tr>
<th>Test</th>
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<th>Low</th>
<th>Medium</th>
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**Soil Fertility Guidelines:**

**Crop:** FLOWERS  
**Yield Goal:** 1  
**Rec Units:** LB/1000 SQ FT

<table>
<thead>
<tr>
<th>(lbs)</th>
<th>P</th>
<th>Pb</th>
<th>K2O</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
<th>B</th>
<th>Cu</th>
<th>Zn</th>
<th>Fe</th>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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**Crop:** GARDEN  
**Yield Goal:** 1  
**Rec Units:** LB/1000 SQ FT

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<td>0</td>
<td>0</td>
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<td>1</td>
<td>4</td>
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<td>0</td>
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**Comments:**

- **FLOWERS**
  - The soil pH is too high for the plants indicated. Apply 15 lbs. sulfur/1000 sq ft in spring and fall. Water thoroughly before making additional applications of elemental sulfur. If grass is chlorotic (yellow), a foliar iron source may hasten color improvement.

- **GARDEN**
  - To convert the fertilizer recommendations from lbs/1000 sq ft to lbs/acre, multiply by 44.
  - Adjust N rate up or down according to climatic conditions and management practices.
  - Garden. Incorporate recommended lime, phosphate, potash, and half of nitrogen prior to planting. Side dress with the remaining N about 5 weeks later.
SOIL ANALYSIS

Lab Number: 29699  
Field Id: N  
Sample Id: 1  

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<tr>
<td>Magnesium (Mg)</td>
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<tr>
<td>Iron (Fe)</td>
<td>60 LEACRE</td>
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<tr>
<td>Zinc (Zn)</td>
<td>25.0 LEACRE</td>
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<tr>
<td>Soluble salts</td>
<td>3.0 % NEM-400</td>
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<tr>
<td>Organic Matter</td>
<td>3.6 % NEM-400</td>
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SOIL TEST RATINGS

- Very Low
- Low
- Medium
- High
- Very High

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SOIL FERTILITY GUIDELINES

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Yield Goal: 1
Rec Units: LB/1000 SQ FT

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Crop: GARDEN
Yield Goal: 1
Rec Units: LB/1000 SQ FT

- To convert the fertilizer recommendations from lbs/1000 sq ft to lbs/acre, multiply by 44.
- Adjust N rate up or down according to climatic conditions and management practices.
- Garden. Incorporate recommended lime, phosphate, potash, and half of nitrogen prior to planting. Sidedress with the remaining N about 8 weeks later.
Don’t Guess
Soil Test