Building and Maintaining Healthy Soils

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Soil Health

• capacity of a soil to function sustainably

• holistic assessment of soil
  – biological
  – chemical
  – physical
Characteristics of Healthy Soil

• fertile but not excessive in nutrient status
• holds adequate water for plant growth
• allows rainfall or irrigation to infiltrate yet provides adequate aeration
• has good tilth
• has surface protection
• contains an adequate population of beneficial organisms
• contains a minimal population of pathogenic organisms
What is a fertile soil?

• one that provides an adequate supply of all nutrients throughout the entire growing season

• test soil to determine if soil is too acidic and major nutrients are in inadequate supply
  – lime first, then add other nutrients when needed
soil acidity: the adverse condition in the soil solution in humid regions
### Soil Tests and Their Interpretation

<table>
<thead>
<tr>
<th>Soil Test Category</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>very low, low</td>
<td>nutrient will limiting plant growth</td>
</tr>
<tr>
<td>medium</td>
<td>nutrient may not be limiting; addition of nutrient advisable</td>
</tr>
<tr>
<td>sufficient, optimum or high</td>
<td>nutrient supply is OK; no more is needed</td>
</tr>
<tr>
<td>high, very high or excessive</td>
<td>nutrient supply is more than adequate; no more is needed</td>
</tr>
</tbody>
</table>
Soil test results

**A&L EASTERN AGRICULTURAL LABORATORIES, INC.**

**REPORT NUMBER:** 0000-5000-001

**CUSTOMER NUMBER:** 00001

**SEND TO:** JOE GARDENER
1234 SMITH RD.
ANNAPOLES, MD 21401

**GROWER:**

**SAMPLES SUBMITTED BY:** JOE GARDENER

**Sample Number:** 1  
**Page 1**  
**Lab Number:** 07103  
**Date Received:** 6/1/2006  
**Date Reported:** 7/1/2007

### Soil Test Results

<table>
<thead>
<tr>
<th>TEST RESULTS</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Magnesium</th>
<th>Calcium</th>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
<th>Iron</th>
<th>Copper</th>
<th>Boron</th>
<th>Sodium</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P</strong></td>
<td>33</td>
<td>50</td>
<td>49</td>
<td>231</td>
<td>16</td>
<td>1.7</td>
<td>0.1</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>K</strong></td>
<td>7</td>
<td>7</td>
<td>8.7</td>
<td>1.5</td>
<td>4.7</td>
<td>13.3</td>
<td>40.5</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

### Soil Fertility Recommendation

- **LIME**
  - SOIL pH
  - NITROGEN
  - PHOSPHATE
  - POTTASCH
  - MAGNESIUM
  - SULFUR
  - ZINC
  - MANGANESE
  - IRON
  - COPPER
  - BORON

- **FERTILIZER (lbs. per 1000 sq. ft.):**
  - **SULFUR**
  - **NITROGEN**
  - **PHOSPHATE**
  - **POTTASCH**
  - **MAGNESIUM**
  - **SULFUR**
  - **ZINC**
  - **MANGANESE**
  - **IRON**
  - **COPPER**
  - **BORON**

*Figure x. Soil test report with annotation*
Are Macronutrients Out of Balance?

• consider using fertilizer separates
  – contain 1 or 2 nutrients only
    • 0-46-0 (triple superphosphate) for phosphorus boost
    • 0-0-60 (muriate of potash) for a potassium boost
FIGURE 3-8 The soil triangle is redrawn to show fine-, medium-, and coarse-textured soils. An exception is very fine sandy loam, which is considered medium textured.
Harsh Reality!

• textural groupings set the stage for many physical properties
  – parent material
  – time

• management can ameliorate extremes to a certain extent
<table>
<thead>
<tr>
<th>Property</th>
<th>Fine Texture</th>
<th>Medium Texture</th>
<th>Coarse Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Water Capacity</td>
<td>medium</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Nutrient Holding Capacity (CEC)</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
<tr>
<td>Infiltration &amp; Percolation</td>
<td>slow</td>
<td>medium</td>
<td>fast</td>
</tr>
<tr>
<td>Crusting</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
<tr>
<td>Compaction</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
</tbody>
</table>
Soil Aeration – the interplay between water and air
Different Pores Perform Different Functions

- **macropores (large pores)**
  - drain quickly after rain or irrigation
  - allow rapid infiltration of rainfall and replenishment of oxygen in the root zone

- **mesopores (medium-sized pores)**
  - “storage pores”
  - hold water in a form most plants can use

- **micropores (very small pores)**
  - water is held too tightly to be use to most plants
Protect the Soil Surface – Why?

- minimizes erosion
- protects soil aggregates
- conserves moisture
- moderates soil temperature
Protect the Soil Surface – How?

• protect soil from direct impact of rainfall
  – encourage a complete crop canopy
  – mulch

• plant a cool season cover crop

• minimize bare soil all seasons of the year!
Soil Tilth

• a soil property that assesses the suitability of soil to support plant growth

• a physical condition of a soil that relates to its ease of tillage, the impedance of seedling emergence and root penetration
Practically speaking, what does good tilth look like?

• compaction is absent in the entire root zone
• soil does not crust after a rain
• soil is firm when dry and friable (crumbly) when moist
• drains well after rainfall
Compaction

• bulk density high enough or pore space low enough to negatively impact plant growth

• bulk density >1.6 grams per cubic centimeter or pore space <40% will restrict root growth

• information on either is difficult to obtain
Many subsoils in Maryland Piedmont are high in bulk density and low in porosity.
Tips for Maintaining Good Tilth

• add organic matter
  – food for heterotrophs (most soil creatures)
  – amendments
  – cover crops**
    • warm and cool season choices

• use mulch
  – moderates temperature and moisture content
  – protects soil from crusting and erosion

• minimize extreme tillage
  – rototilling
Enhance the Presence and Activity of Beneficial Organisms

• provide adequate organic carbon sources as much of the year as possible

• plant cool season cover crops
Minimizing Presence of Pathogens

• rotate species

• understand pathogen behavior

• provide adequate carbon nutrition for beneficial organisms
How Can you Assess the “Health Status” of Your Soil?

• Are the major macronutrients in the optimal range based on soil test?
• Is it friable and crumbly when moist?
• Is root growth restricted in the subsoil?
• Does water pond after significant rainfall?
• Do rills form during rainfall?
Want to Know More?

• simple assessments tools and procedures
  – penetrometer (<100 psi, 100-200 psi, >200 psi and >300 psi)
  – slake test
  – questionnaire (Weil with NRCS)

• extensive laboratory tests
  – Cornell Soil Health Assessment
Soil Health Mantra

Soil is a living factory of macroscopic and microscopic workers who need food to eat and places to do their work. USDA-NRCS