Improving Soil with Amendments and Testing

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April 8, 2017
Evanston Civic Center
Workshop Outline

- Soil Basics –
- Soil Testing –
- Enhancing Soil Structure –
- Questions –
Soil Basics

- Good topsoil is a healthy mix of physical, chemical, and biological components
  - Soil texture
  - Organic Matter
  - Nutrients
  - Microbiology
  - Moisture
Soil Texture

- Soil texture refers to the proportion of physical components of the soil:
  - Sand
  - Silt
  - Clay

  -- Texture is typically expressed as a combination of the components (e.g., silty clay; sandy loam)
Organic Matter

Organic matter is anything that is living or was once alive.

Functions include:
- Water holding capacity and drainage
- Air circulation
- Resistance to compaction
- Holds cations and anions
- Provides fertility
Microbiology is Important

- Microbes make the soil and maintain it
  - 20,000 to 30,000 in a teaspoon of healthy soil
  - Bacteria, fungi, protists, animals, and plants cooperate and compete in a healthy soil
  - Most are beneficial
What does good topsoil look (or smell) like?
Why amend soils?

Increase organic matter, balance nutrient ratios, and improve the soil food web

- **Increase organic matter** – Add compost, mulches, and/or cover crops
- **Balance nutrient ratios** – Add fertilizers, conditioners
- **Improve the soil food web** – Add microbial inoculants, soil from other ecosystems, worms
Why test soil?

- What is soil testing? Can I do it myself?
- What can it tell me?
Do I need to test my soil?

- Is it likely to be contaminated?
- Do I have the right soil texture?
- Do I need to know the concentration of nutrients?
- How much fertilizer should I add?
Soil Analytical Testing

- **Physical**
  - Gradation, organic content

- **Chemical**
  - \[ \text{pH} \text{ (target is 7 – 7.5)} \]
  - Nutrients (N – nitrogen; P – Phosphorous; K – potassium; Mg – magnesium; Ca – calcium)
  - Metals
  - Ionic balance (cations and anions)
Taking a Soil Sample
Nutrient Analytical Laboratories

- A & L Great Lakes Laboratories, Inc.
  - www.algreatlakes.com
- Illinois Extension Service (additional labs)
  - http://urbanext.illinois.edu/soiltest/
## Example of Soil Nutrients Testing

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Desired Level *</th>
<th>MC – 14</th>
<th>Relative Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (K)</td>
<td>100 mg/kg</td>
<td>538 mg/kg</td>
<td>Very High</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>200 mg/kg</td>
<td>239 mg/kg</td>
<td>High</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>280 mg/kg</td>
<td>770 mg/kg</td>
<td>Very High</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>&gt; 2000 mg/kg</td>
<td>5650 mg/kg</td>
<td>High</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>&lt; 70 mg/kg</td>
<td>28 mg/kg</td>
<td>Low</td>
</tr>
<tr>
<td>pH</td>
<td>7.0</td>
<td>7.4</td>
<td>High</td>
</tr>
<tr>
<td>Organic Matter</td>
<td></td>
<td>13.4 %</td>
<td>High</td>
</tr>
<tr>
<td>Desired ratios:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mg is 14% of Ca;</td>
<td></td>
<td>13.6 %</td>
<td>Good</td>
</tr>
<tr>
<td>P to K ratio: 1:1;</td>
<td></td>
<td>0.44</td>
<td>Low</td>
</tr>
<tr>
<td>CEC (cation exchange capacity)</td>
<td></td>
<td>36.2</td>
<td>Good</td>
</tr>
<tr>
<td>* Lab recommended adding Nitrogen (N);</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 lbs/1000 sq ft.</td>
</tr>
</tbody>
</table>
Plant Macronutrients

- N: Nitrogen
  - Important for leafy growth

- P: Phosphorus
  - Root growth, flowers and fruits

- K: Potassium
  - Root structure and overall plant health; disease resistance
Plant Micronutrients

- Calcium
- Magnesium
- Sulfur
- Zinc
- Manganese
- Molybdenum
- Iron
- Copper
- Boron

Deficiency Chart of Micronutrients

- **Boron**: Discoloration of leaf buds. Breaking and dropping of buds.
- **Calcium**: Plant dark green. Tender leaves pale. Drying starts from the tips. Eventually leaf buds die.
- **Sulphur**: Leaves light green. Veins pale green. No spots.
- **Iron**: Leaves pale. No spots. Major veins green.
- **Manganese**: Leaves pale in color. Veins and venules dark green and reticulated.
- **Copper**: Pale pink between the veins. Wilt and drop.
- **Zinc**: Leaves pale, narrow and short. Veins dark green. Dark spots on leaves and edges.
- **Molybdenum**: Leaves light green/ lemon yellow/orange. Spots on whole leaf except veins. Sticky secretions from under the leaf.
- **Magnesium**: Paleness from leaf edges. No spots. Edges have cup shaped folds. Leaves die and drop in extreme deficiency.
- **Potassium**: Small spots on the tips, edges of pale leaves. Spots turn rusty. Folds at tips.
- **Phosphorus**: Plant short and dark green. In extreme deficiencies turn brown or black. Bronze colour under the leaf.

The colour represented are indicative. They may vary from plant to plant.
**Amendments vs. Fertilizers**

- **Fertilizers**: Feed the plants directly; have an N–P–K rating

- **Amendments**: Work indirectly… they feed the soil and microbiome; the soil then feeds the plants

- Some products function as both

- ...So what should I use?
The Long Answer:

It depends on your soil...

Greensand  Rock Phosphate  Leaf Mulch
Vermicompost  Manure  Seaweed
Lime  Mycorrhizae  Guano
Azomite  Bone Meal  Sulfur
Blood Meal  Gypsum  Peat
Perlite  Dolomite  Sand
The Short Answer:

KEEP CALM AND FOCUS ON COMPOST
Soil Amendments Can...

- Increase organic matter
- Modify pH
- Modify texture
- Increase nutrients
- Increase beneficial microbes
To increase organic matter, add...

- Compost (homemade or purchased)
- Manure (cow, horse, pig, chicken, rabbit, etc.)
- Leaf mulch (composted leaves)
- Peat moss
To modify pH...

- Ideal soil pH is about 6.5
- To raise pH
  - Lime (agricultural lime or dolomitic lime)
  - Wood ash
- To lower pH
  - Sulfur
  - Peat moss
  - Coffee grounds
To increase macronutrients...

- **Nitrogen**
  - Manure
  - Seed meals
  - Blood meal, feather meal, fish meal

- **Phosphorus (Phosphate)**
  - Rock phosphate
  - Bone meal
  - Guano
  - Keep soil pH balanced

- **Potassium (Potash)**
  - Wood ash
  - Greensand
  - Azomite
  - Seaweed/kelp
To increase micronutrients...

- **Seaweed/kelp**
  - Trace minerals, potassium

- **Greensand**
  - Glauconite: marine potash, silica, iron, 22 trace minerals

- **Rock phosphate powder**
  - Phosphorus, limestone, clay, trace minerals

- **Azomite**
  - Trademarked, volcanic ash/ancient seabed deposit in Utah, silicate high in trace minerals

- **Lime, dolomite or gypsum**
  - Calcium, magnesium (dolomite), sulfur (gypsum)
To increase beneficial microbes...

- Compost (and compost tea)
- Vermicompost
- Manure
- Mycorrhizae supplement
- Soil from a healthy garden
New Gardeners Program—Example Soil Test Results

- Bulk planting mix from local supplier
  - Alkaline pH: between 9.1–9.4
  - Low calcium: between 2050–2650 ppm
  - High sodium: between 1412–2299 ppm
  - Organic matter, potassium, phosphorus, magnesium ok

- To remedy:
  - Add gypsum to increase calcium without increasing pH; calcium will also help replace sodium in soil
  - Add sulfur and/or peat moss to lower pH
  - Always follow product directions… More is NOT better! Err on the side of not enough. It’s easier to add more than to mitigate excess.
Big Box Store Packaged “Soils”
Big Box Store Packaged “Soils”

- Pre-mixed soils
  - Potting Soil
  - Raised Bed Soil
  - Garden Soil

- Soil Mixing
  - Topsoil
  - Soil conditioner
  - Compost/manure
  - Peat moss
Composting

- Quality: What goes in, comes out
- Keep it simple (or not)
  - Equal “brown” and “green”
  - Jump start with good topsoil
  - Mix occasionally
  - Nothing greater than 6 in. long
Cover Crops

- Loosen compacted soil
- Add organic matter
- Fix nitrogen in soil
- Sequester carbon in soil
- Prevent weed growth

Prepare soil for crops
Plant in fall or early spring
The Goal

- Keeping your soil full of life and healthy!
Questions and Discussion
Recommended Reading

*Building Soils Naturally: Innovative Methods for Organic Gardeners*
By Phil Nauta
[info@acresusa.com](mailto:info@acresusa.com)

*Teaming With Microbes: The Organic Gardener’s Guide to the Soil Food Web*
By Jeff Lowenfels and Wayne Lewis

*The Ultimate Guide to Soil: The Real Dirt on Cultivating Crops, Compost, and a Healthier Home*
By Anna Hess