Soils Management

Andrew Ristvey

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Today we will:

- Discuss the importance of healthy soils
- Soil properties, physical, chemical and biological that one can manage for soil health
- How organics play a role
- How these factors provide a better environment for plants
- How to determine your amendments
Soils for Plants

- Most grow best in a moist well drained loam
- How can we achieve this type of soil?
- What do we need to consider to create a healthy root environment?
Soil Health

Physical
- Soil Type
- Structure & aeration
- Water infiltration & retention

Chemical
- Available nutrition
- CEC
- AEC
- Optimal pH

Biological
- Diversity
- Nutrient cycling
- Broad ecology (all forms of symbiosis)
Soil’s Physical Properties

Physical Properties of Soil by volume
Phases – solid, liquid, gas

- 47% Mineral
- 25% Water
- 3% Organic
- 25% Air
- 15% Residuals
- 10% Biomass
- 75% Humus
Soil Management

- Soils can be dynamic
- Health can depend on management
  - Structure
  - Water Holding capacity/Aeration
  - Nutrient holding capacity
  - Organic content
Soil Management

- Soils can be dynamic
- Health can depend on management
  - Structure
    - the arrangement of the primary soil particles (sand, silt, and clay) and other soil materials into discrete aggregates
Granular (high permeability)

Blocky (moderate permeability)

Platey (low permeability)

Aggregated (high permeability)

Columnar/prismatic (moderate permeability)

Massive (low permeability)
Soil’s Physical Properties

Physical Properties: Texture
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Silt</th>
<th>Sand</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt loam</td>
<td>70%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>20%</td>
<td>65%</td>
<td>15%</td>
</tr>
<tr>
<td>Clay</td>
<td>15%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Loam</td>
<td>40%</td>
<td>20%</td>
<td>40%</td>
</tr>
</tbody>
</table>
Soil Management

- Soils can be dynamic
- Health can depend on management
  - Water Holding capacity/Aeration
Soil Management

- Soils can be dynamic
- Health can depend on management
- Nutrient Holding Capacity

![Soil Texture Pyramid Diagram]
Soil Management

- Soils can be dynamic
- Health can depend on management

- Organic content

  How organics improve soil health?
  - physically
  - chemically
  - biologically
Organic Amendments

- Physical improvement
  - Clay soils
    - No chemical means to improve clay soils
    - Addition of gypsum?
    - Clay soils need aeration/permeability
    - Organics improve structure and create an environment for continual improvement
Organic Amendments

- Physical improvement
  - Sandy Soils
    - Organics improve water holding capacity
    - Immediately improve structure and create an environment for continued improvement
Organic Amendments

• Chemical improvement
  • With any soil, organics improve fertility
    • Increase cation exchange capacity
    • Increase buffer capacity
      (resist pH change)
Organic Amendments

• Biological
  • Increase in biological activity
    • Added carbon jumpstarts soil ecology
      • Increase in microorganism activity
        • Bacterial/Fungal - nutrient cycling
        • Increase in beneficials
        • Further improving soil structure
    • Better environment for roots
Nitrogen Cycle

- Nitrogen Fixation
- Nitrification
- Assimilation
- Ammonification
- Denitrification
- Functionality via soil biology
Organic Amendments

- Make sure organic is well composted
- Non-composted organics will decrease nitrogen availability
- Use a reliable organic source
- High mineral salt content, concentrated micronutrient content
Micro nutrient issues

SOIL ANALYSIS REPORT

Date Received: 06/01/2010  Date Of Analysis: 06/02/2010  Date Of Report: 06/03/2010

Analytical Method(s):
Mehlich 3

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Field ID</th>
<th>Lab Number</th>
<th>Organic Matter</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Magnesium</th>
<th>Calcium</th>
<th>Sodium</th>
<th>pH</th>
<th>Acidity</th>
<th>C.E.C</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>% Rate</td>
<td>Mehlich 3</td>
<td>Reserve</td>
<td>Mg</td>
<td>Ca</td>
<td>Na</td>
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<td></td>
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<td></td>
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<td>ppm Rate</td>
<td>Rate</td>
<td>ppm Rate</td>
<td>ppm Rate</td>
<td>ppm Rate</td>
<td></td>
<td>meq/100g</td>
<td>meq/100g</td>
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<tr>
<td>SPR510</td>
<td>18859</td>
<td></td>
<td>1.9 L</td>
<td>30 L</td>
<td>L</td>
<td>68 L</td>
<td>75 L</td>
<td>1291 H</td>
<td>6.2</td>
<td>6.83</td>
<td>1.0</td>
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<td>MD = 60</td>
<td>MD = 136</td>
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</table>

<table>
<thead>
<tr>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
<th>Iron</th>
<th>Copper</th>
<th>Boron</th>
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</thead>
<tbody>
<tr>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
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</tr>
<tr>
<td>S</td>
<td>Zn</td>
<td>Mn</td>
<td>Fe</td>
<td>Cu</td>
<td>B</td>
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<tr>
<td>VL</td>
<td>1.6</td>
<td>201</td>
<td>113</td>
<td>1.2 M</td>
<td>0.6 M</td>
</tr>
</tbody>
</table>

Symbols: % (percent), ppm (parts per million), lbs/A

This report applies to sample(s) tested. Samples are not a comprehensive analysis of the soil in the area tested.
Getting nutrients to the roots: Changing soil chemistry

- **Acid Soils**
  - Lime – Calcium and Magnesium oxides and carbonates (dolomitic or calcitic)
  - Dolomitic lime adds both calcium and magnesium
  - Calcitic lime only adds calcium
  - Low ratios (3:1) of Ca to Mg – use Calcitic Lime
  - High Ratios of Ca to Mg (more than 6:1) use Dolomitic Lime
Getting nutrients to the roots: Changing soil chemistry

- **Alkaline Soils**
  - Agricultural sulfur –
    - biological process – slow

  ![Chemical reaction diagram](image)

  - should not be done in the colder months
  - rate dependent on soil type and pH
Getting nutrients to the roots: Changing soil chemistry

- **Alkaline Soils**
  - Tons of Sulfur needed per acre to change pH to 6.5

<table>
<thead>
<tr>
<th>Original Soil pH</th>
<th>Sandy Soil</th>
<th>Clay Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5</td>
<td>0.7 - 1.0</td>
<td>1.0 – 1.3</td>
</tr>
<tr>
<td>8.0</td>
<td>0.5 - 0.7</td>
<td>0.7 – 1.1</td>
</tr>
<tr>
<td>7.5</td>
<td>0.2 - 0.3</td>
<td>0.4 – 0.5</td>
</tr>
</tbody>
</table>
Getting nutrients to the roots: Changing soil chemistry

- **Alkaline Soils**
  - Agricultural sulfur
  - Iron Sulfate
  - certain fertilizers
  - do not use aluminum sulfate
Getting nutrients to the roots:
Other soil chemistry problems

• **Gypsum**
  - Calcium Sulfate – deals with sodic soils
  - Helps leach/disperse sodium = sodium sulfate
  - Adds calcium without affecting pH

• **Epsom Salts**
  - Magnesium Sulfate
  - Adds magnesium without affecting pH
Getting nutrients to the roots: Other soil chemistry problems

• **Chelated Iron**
  – Allows iron to be available in soils with a pH above 6.5…some formulas above pH 7.5
  – Expensive – a quick fix but does not solve the problem

• **Toxicities**
  – Sometimes nutrient concentrations are too high
  – Change the pH?
  – Add other nutrients to counter balance
Summary

- **Soil health is dependent on soil management**

- **Organic amendments**
  - instrumental in immediate and future improvement
  - not all organic amendments are the same

- **Management also plays a role**
  - Know your soil characteristics first
  - Soils tests are your first step
  - Avoid compaction
  - Use high quality organics from a reliable source
Questions?

Contact me
Andrew Ristvey
aristvey@umd.edu
Summary

➢ Soil health is dependent on soil management

➢ Organic amendments
  • instrumental in immediate and future improvement
  • not all organic amendments are the same

➢ Management also plays a role
  • Know your soil characteristics first
  • Soils tests are your first step
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  • Use high quality organics from a reliable source
Questions?

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Organic Fertilizers

- Animal-based
  - Usually higher in N
  - Relatively quick release - useful in cool weather
  - Include:
    - Blood meals
    - Feather meals
    - Fish emulsions
    - Shellfish composts
Organic Fertilizers

- Plant-based
  - Less concentrated, lower percent of nitrogen ≤ 7%
  - Need to be applied at higher rates
  - Slower release of N – should be applied when warm
  - Biological activity releases nutrients
  - Include:
    - Alfalfa meal
    - Corn gluten
    - Cottonseed meals
    - Kelp extracts
    - Compost teas
Organic Fertilizers

- Manure-based
  - Good source of nutrients (N and P)
  - Relatively available for plants
  - Must be well composted
  - Can burn if over-applied
  - Include:
    - Cow & Chicken Manures
    - Bat Guano
    - Sea-Bird Guano
    - Milorganite - biosolids
Other Soil/Media Amendments

Other non-organic (mineral-based) amendments (fertilizers), some rich in micronutrients

✓ Rock Phosphate for phosphorus
✓ Green Sand for potash
✓ Azomite – micros
✓ Other OMRI listed nutrient sources
Other Considerations

- Using non-commercial (home-made) compost or municipal compost
  - Need a nutrient analysis for every batch
  - Check electrical conductivity before use
  - Be very careful about using in potting media

- Nutrient Management
  - Composts contain N and P
  - Must account for that in Maryland
  - Turf law requires P Fertility Index Value
Other Considerations (in Maryland)

- Phosphorus may only be applied when a soil test indicates that it is needed or when a lawn is being established, patched or renovated.

- Natural organic or organic products containing phosphorus may not exceed 0.25 pound of phosphorus per 1,000 sq ft with an annual maximum of 0.5 pound of phosphorus per 1,000 sq ft. These products may not be applied when soils test at "optimum to excessive" for phosphorus levels.
Properties Affecting Nutrient Availability

- Chemical Properties - pH
  - p = potential or power
  - H = hydrogen

- pH and hydrogen ion concentration are inversely related

- As pH decreases, hydrogen ion concentration increases.
H₂O
Date Received: 06/01/2010

<table>
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</table>

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), mS/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts mS/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by A&L Eastern Laboratories, Inc.
Properties Affecting Nutrient Availability

➢ Chemical Properties – Cation Exchange Capacity (CEC)

The ability of a soil or substrate to provide a nutrient reserve

It is all the exchangeable cations the soil or substrate can adsorb

The CEC of a soil depends on colloids and pH

The higher the CEC of a soil the better buffering capacity
So which nutrients exist in what form?

**Cations**
- ammonium – NH₄⁺
- potassium – K⁺
- calcium – Ca⁺²
- magnesium – Mg⁺²
- iron – Fe⁺², Fe⁺³
- zinc - Zn⁺²
- manganese Mn⁺², Mn⁺³
- copper – Cu⁺²
- nickel – Ni⁺²

**Anions**
- nitrate – NO₃⁻
- phosphate – H₂PO₄⁻, HPO₄⁻²
- sulfate - SO₄⁻²
- chlorine – Cl⁻
- molybdate – MoO₄⁻²
- borate - H₃BO₃
Properties Affecting Nutrient Availability

- **Chemical Properties – Colloids and CEC**

  Colloids - very small particles in soil that are chemically reactive (charged) – humus, clay

  ![Diagram showing charges and attractions between particles like Fe++, Mg++, Mn++, H+, K+, Ca++, etc.](image)
A humus particle...
On a humus molecule...

Cation Exchange dependent upon negative charged particles

Fig. 1—Model-type structure for soil organic matter (Stevenson, 1972).
On a humus molecule...

Fig. 1—Model-type structure for soil organic matter (Stevenson, 1972).

Negative charges provide the potential for Cation Exchange
On a humus molecule...

Fig. 1—Model-type structure for soil organic matter (Stevenson, 1972).
On a humus molecule...

Fig. 1—Model-type structure for soil organic matter (Stevenson, 1972).

Cation Exchange provides a bank of exchangeable cations
On a humus molecule...
On a humus molecule...
On a humus molecule...
On a humus molecule...