Evaluating Soil Biological Properties for a Better Understanding of Soil Health

http://www.organicgardeninfo.com/soil.html

Lance Gunderson
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Phospholipid Fatty Acid (PLFA)

- Cell membrane
- Quantifiable
- Represent living biomass
- Degrade quickly upon death
- Influenced by environment and land management
- Snapshot in time

http://biology.clc.uc.edu/courses/bio104/lipids.htm
PLFA Cont.

- PLFA Biomarkers
  - Unique fatty acids
  - Functional groups

- Coupled with other analyses
  - Soil moisture
  - pH
  - Fertility

<table>
<thead>
<tr>
<th>Functional Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Bacteria</td>
</tr>
<tr>
<td>Gram (+)</td>
</tr>
<tr>
<td>Actinomycetes</td>
</tr>
<tr>
<td>Gram (-)</td>
</tr>
<tr>
<td>Rhizobia</td>
</tr>
<tr>
<td>Total Fungi</td>
</tr>
<tr>
<td>Arbuscular Mycorrhizal</td>
</tr>
<tr>
<td>Saprophytes</td>
</tr>
<tr>
<td>Protozoa</td>
</tr>
<tr>
<td>Undifferentiated</td>
</tr>
</tbody>
</table>
PLFA Results

• Living Microbial Biomass - HOW MUCH (Total PLFA ng/g of soil)
• Functional Group Diversity Index
• Breakdown of organisms in % of total biomass
• Community Composition Ratios
  • Fungi: Bacteria
  • Predator: Prey
  • Gram +: Gram -
Interpreting PLFA

- Higher biomass and diversity are better
- No standard ranking established
- Dependent on soil type, climate, etc.

<table>
<thead>
<tr>
<th>Total Biomass</th>
<th>Diversity</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 500</td>
<td>&lt; 1.0</td>
<td>Very Poor</td>
</tr>
<tr>
<td>500+ - 1000</td>
<td>1.0+ - 1.1</td>
<td>Poor</td>
</tr>
<tr>
<td>1000+ - 1500</td>
<td>1.1+ - 1.2</td>
<td>Slightly Below Average</td>
</tr>
<tr>
<td>1500+ - 2500</td>
<td>1.2+ - 1.3</td>
<td>Average</td>
</tr>
<tr>
<td>2500+ - 3000</td>
<td>1.3+ - 1.4</td>
<td>Slightly Above Average</td>
</tr>
<tr>
<td>3000+ - 3500</td>
<td>1.4+ - 1.5</td>
<td>Good</td>
</tr>
<tr>
<td>3500+ - 4000</td>
<td>1.5+ - 1.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>&gt; 4000</td>
<td>&gt; 1.6</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
When and How to Use PLFA

• Comparing two different systems
• Tracking change over time
• Troubleshooting problems
• Actively growing plant community

Solvita Soil Respiration

- Lab vs Field Techniques
- How much CO2-C is produced in 24hrs
- Represents microbial biomass and potential for activity and nutrient cycling
- Related to a soil’s fertility, texture and organic matter content

http://solvita.com/soil
### Soil Condition and Soil Care

**Based on the Haney-Brinton Respiration Test**

<table>
<thead>
<tr>
<th>Test Result ppm CO₂-C</th>
<th>N-Mineralization Potential</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 100</td>
<td>High N-Potential soil. May provide sufficient N for entire crop.</td>
<td>Soil is well supplied with organic matter. Biomass &gt;2,500 ppm</td>
</tr>
<tr>
<td>61 - 100</td>
<td>Moderately-high. This soil has limited need for supplemental N.</td>
<td>Ideal state of biological activity and adequate organic matter level.</td>
</tr>
<tr>
<td>31 - 60</td>
<td>Moderate Level. Supplemental N is most likely indicated.</td>
<td>Requires new applications of stable organic matter. Biomass 1,000 ppm</td>
</tr>
<tr>
<td>6 - 30</td>
<td>Moderate-Low - will not provide sufficient N for most crops</td>
<td>Low in organic structure and microbial activity.</td>
</tr>
<tr>
<td>0 - 5</td>
<td>Little biological activity; requires significant fertilization.</td>
<td>Biomass &lt; 100 ppm. Put into intensive green manure or other long-term cover crops.</td>
</tr>
</tbody>
</table>

http://solvita.com/soil
Haney Test or SHNT

The Haney Test or Soil Health Nutrient Tool was designed to help answer the following questions:

What condition is your soil in?
- Going beyond just fertility

Is your soil balanced?
- To benefit soil microbes

What can we do to help?
- No-till, living cover, redirect focus...SOIL ECOLOGY and plant/microbe/soil interactions
Haney Test Approach

- Soil Fertility
- Microbial Component
- Water Extractable C
- Soil Organic N and P
- C:N Balance

Address Soil Health Issues

Re-evaluate
H3A Extract

• An extractant that mimics soil solution by using 3 commonly produced organic acids leaked from living plant roots to temporarily change soil pH and increase nutrient availability.

Plant Available
• Nitrate
• Ammonium
• Phosphate
• Potassium
• Calcium
• Iron
• Aluminum

Totals
• Phosphorus
• Organic Phosphorus
Water Extract

Extractable
- Organic C
- Total N
- Nitrate
- Ammonium

Calculated
- Organic N
- Organic C:N
- Mineralizable N
- Organic N Release
- Soil Health Score

- Microorganisms have the greatest access to nutrients and food that are either suspended, dissolved, or solubilized in soil water.

- Therefore, the water extract represents what the microbes see in their soil environment.
% SOM vs. WEOC

- % SOM reflects the **quantity** of organic C and is the house that soil microbes live in.
- WEOC reflects the **quality** of organic C and is the house’s refrigerator.
Water Extractable Organic N (WEON)

- Pool of organic N that is available to microbes
- Sources include: SOM, cover crops, plant residues, manure, composts, compost tea
- Lower risk of N loss compared to NO3 and NH4
- Organic N is a safety deposit box for your soil’s N and the microbes are the key to get your return on investment
C:N Balance

- Organic C and N have to be balanced to get the highest potential return from the WEON pool.
- **Above 20:1 = No net N-mineralization**
  - N is limiting and remains tied up in microbial biomass.
- **Ideally 8:1 to 15:1**
  - Microbes release inorganic or plant available N and P to feed the plants
Soil Health Score (SHS)

- Current health level of your soil system
- SHS – (Solvita 1-day CO2-C/C:N) + WEOC/100 + WEON/10
- Combines 5 independent measures
- We like to see this value above 7
- Achieve C:N balance first and then work on building the pools of WEOC and WEON as a way to help increase microbial biomass/activity to drive nutrient cycling.
- Cover crop recommendation based on SHS and C:N ratio
Interpreting the Haney Test

• Start with the SHS
• Use SHS equation to determine high and low points
• Balance C:N ratio first if needed
• Increase intensity with organic C and N inputs to drive up score
• If possible, establish ranges on and around your own farm.

N Management

- Tradition evaluation = NO3
- Haney Evaluation = NO3 + NH4 + Organic N Release

Nitrogen Savings by using the Haney Test

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional evaluation, lbs N/A</td>
<td>14.1</td>
</tr>
<tr>
<td>Haney Test N evaluation, lbs N/A</td>
<td>37.8</td>
</tr>
<tr>
<td>Nitrogen Difference, lbs N/A</td>
<td>23.6</td>
</tr>
<tr>
<td>N savings, $/A</td>
<td>15.11</td>
</tr>
</tbody>
</table>
When and How to Use Haney

**Soil Health**
- Any time of year
- After making big management changes
- Once per year or every other year
- Track change over time >3 yrs

**Nutrient Mgmt.**
- Prior to fertilizer application
- When trying to reduce input costs
- Min. once every year
Questions?

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