SOM
Soil organic matter

You’ve been hearing about how SOM

• Improves soil physical properties
  – Aggregation
  – Decreases bulk density
  – Water infiltration
  – Water holding capacity
    » (up to 400 x its weight)

• Improves soil fertility
  – Cation exchange capacity
  – Source of nutrients
  – pH buffering capacity
    » Next week

You also heard a little about those who live in soil

First remember that SOM is food

• As you get ready for Thanksgiving, think of all of those soil micro and macro flora that are doing the same
• And remember that not all food is the same

Who eats this food?

• Microbes
  – Fungi, antinomycetes, bacteria
    – 2,000 - 25,500 kg ha
• Earthworms, nematodes..
  – 140 - 2200 kg ha
Third level consumers

- Ground beetles (carabid) 8-20 mm
- Psuedoscorpion 1-2 mm
- Predatory mite 0.5-1 mm
- Rove beetles (staphylinid) 10 mm
- Ant (Formicid) 5-10 mm

Second level consumers

- Whiteworms
- Potworms (Enchytraeids) 10-25 mm
- Land snails and slugs 2-25 mm
- Earthworms 50-150 mm
- Beetle mites 1 mm
- Millipedes 20-80 mm
- Rotifera 0.1-0.5 mm
- Protozoa 0.01-0.5 mm
- Soil flatworms (Turbellarians) 70-150 mm
- Mold mite (Acarina)
- Featherwinged beetles (Ptiliids) 1-2 mm
- Springtails (Collembola) 0.5-5 mm

Bacteria
- initial breakdown of organics
- may be initially 80-90% of activity
- accounts for the heat generated

Actinomycetes
- somewhere between bacteria and fungi
- breakdown of cellulose
- responsible for “earthy” odor

Fungi
- similar role as actinomycetes
- active in cellulosic/lignaceous compounds
- activity increases when undisturbed

Now more detail about what SOM consists of and its behavior

- Plant matter
  - living / dead
- Larger animals
  - Worms, nematodes....
- Microbial biomass
- Animals
  - Wastes
  - Remains
- Organic compounds
SOM starts with plant material

- Carbon is the basis for all life forms
- Carbon fixed through photosynthesis is why we are here
- Plant material is the primary source of soil organic matter

Plant material consists of

- Leaf tissue
- Fruit/ reproductive
- Roots
  - 15 - 40% of total plant biomass
- Where it is and what it consists of will determine how it is eaten

Where it is:
Material left on soil surface

- Bigger pieces
- Less accessible
- Slower to decompose

Material in soil or incorporated into soil will be eaten more quickly

What it is

- Elemental composition
- Types of compounds

- Water
- Carbon
- Oxygen
- Hydrogen
- Sugars and starches (1-5%)
- Soluble carbohydrates (10-30%)
- Lignins (10-30%)
- Proteins (5-15%)
- Fats, waxes, tannins (1-8%)

- Sugar and starches
- Soluble carbohydrates
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- Types of compounds
- Elemental composition
Groups of organic matter

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Sugars, starches, glycocon, pectin, fatty acids, and glycerol</th>
<th>Readily decomposable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amino acids, nucleic acids, protein</td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>Hemicellulose, cellulose, Chitin</td>
<td>Slower to degrade</td>
</tr>
<tr>
<td></td>
<td>Low molecular weight aromatics and aliphatics</td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>Lignocellulose, Lignin</td>
<td>Usually resistant</td>
</tr>
</tbody>
</table>

From Steiniford, E.I. Diversity of Composting Systems.

Sugars

- $C_6H_{12}O_6$
- Readily decomposed
- All organisms

Lignins

- Decomposition only accomplished by specialized population of soil microorganisms
- Antinomycetes, fungi

Some materials are harder to eat and will decompose more slowly

- Mature plant tissue
- Woody debris
- Young leaves
- Roots

During decomposition:

Organic compounds decompose at different rates.
Let’s talk about eating

• When you eat a portion of the food (carbon) is released as energy
• Remainder is incorporated into body tissue

Proper ratio of Carbon to other nutrients

• Nitrogen is most crucial and generally most limiting
• C:N 24:1 is appropriate for SOM
• C:N in microbial biomass is 8:1

If C:N is appropriate

The carbon cycle

If C:N is < 24:1

• You will have excess N
• N will be available for plant growth
• You will have a healthy and large population of microorganisms

If C:N is > 24:1

• You will have deficient N
• N will not be available for plant growth
• Plants may be stunted and chlorotic due to N deficiency
• You will have a reduced population of microorganisms

Some C:N ratios

• Sawdust 600:1
• Alfalfa hay 13:1
• Corn stover 61:1
• Wheat straw 80:1
• Manure 20:1
• Biosolids 7:1
Ratio of C to other nutrients is also important

- As microbes eat the C, they often release N as well as other nutrients (P, S, K …)
- Also when they die, their biomass is a source of these nutrients
- This source of nutrients and means of nutrient cycling is often the primary source of nutrients for plants
- This process is generally called mineralization

What happens to the food?

HUMUS - Black gold

A complex aggregate of amorphous substances, formed during the microbial decomposition or alteration of plant and animal residues and products synthesized by soil organisms; principal constituents are derivatives of lignins, proteins and cellulose; humus has a high capacity for base exchange (CEC), combining with inorganic soil constituents, and for water absorption.

As lignins are decomposed

- Generally only partially decomposed
- Remaining portions will be somewhat altered in their structure
- Will polymerize
- Series of types of SOM with humus the most complex and most stable

Types of SOM
Fulvic acid

What it looks like

Composting: a way to get humus

• Deliberate stabilization of organic matter
• Done to decrease volume
• Provide soil amendment
• Break down toxics

Relation between SOM and tree growth

• In wetter soils productivity decreases with SOM
• In dryer soils productivity increases with SOM
• Big difference in total vs. active organic C. (active involved in nutrient cycling)
• <1% to over 10% total C, active C in solution or on exchange sites is 10-100 µg/g
• At an ecological level, the relationship of SOM and tree growth may be extraordinary
• Web of detrital feeders may be important to producing the organic compounds that allow maximum tree growth, or conversely may moderate the production of critical O-compds
• Completely controls the rate of mineralization

Major soil processes impacted by microbial transformations (Tate, 1987)
Population Dynamics During Composting

![Graph showing population dynamics during composting](image)