Compost Effects on Soil Quality

Mary Stromberger
Assistant Professor, Soil Microbiology
Dept. Soil and Crop Sciences, CSU
Application of composted waste

A nation that destroys its soil destroys itself – F.D. Roosevelt

• Chemical and physical nature of compost
• Effects on soil physical, chemical and biological properties
• Effects on plants
The Nature of Compost

- Is complex!

- Source of stable, humus-like organic matter
# Mature compost properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0 – 8.4</td>
<td>In acidic soil, alkaline compost can raise pH</td>
</tr>
<tr>
<td>Soluble salts</td>
<td>0 – 10 mmhos/cm</td>
<td>Excess salts can be phytotoxic</td>
</tr>
<tr>
<td>Nutrient content (N+P₂O₅+K₂O)</td>
<td>2 – 5 %</td>
<td>Additional fertilizer may be needed if &lt; 2%</td>
</tr>
<tr>
<td>Organic matter</td>
<td>30 – 70%</td>
<td>Varies widely; affects application rate</td>
</tr>
<tr>
<td>Moisture content</td>
<td>40 – 50%</td>
<td>Higher moisture = increased handling and transportation costs</td>
</tr>
<tr>
<td>C:N ratio</td>
<td>&lt; 12:1</td>
<td>N immobilization may occur at &gt; 25:1</td>
</tr>
</tbody>
</table>
Effects on soil physical properties

- Improved soil structure
- Greater water-holding capacity
Soil structure

- Increased soil porosity
- Reduced soil bulk density
- Increased gas exchange and water permeability
- Greater water-holding capacity
Improved aggregation

Microaggregate
53-250 μm

particulate organic matter

fungi

Macroaggregate
> 250 μm

bacteria
Improved root zone environment

Reduced wind and water erosion
Effects on soil chemical properties

- Modifies and stabilizes soil pH
- Increases cation exchange capacity (CEC)
- Provides nutrients
Soil pH

- Depending on its pH, compost may raise or decrease soil pH.
- Organic matter has the ability to buffer pH change.
Increases cation exchange capacity

*Probably occurs as a polymer

M = Polyaivalent cation (e.g., Fe, Al, Zn, Cu)
Increases cation exchange capacity

Organic matter

Soil solution

K⁺

Ca⁡⁺⁺

Mg⁡⁺⁺
Provides nutrients

- Source of N, P, K and micronutrients
- Organic nutrients are mineralized over time

\[
\text{Organic N} \rightarrow \text{NH}_4^+ \rightarrow \text{NO}_3^- 
\]
Effects on soil biology

- Stimulates microbial growth and activity
- May change species composition in soil
- Promotes earthworms
- May suppress plant diseases
### Microbial properties with the potential to respond to compost

<table>
<thead>
<tr>
<th>Microbial Biomass</th>
<th>Enzyme activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>C and N</td>
<td>dehydrogenase</td>
</tr>
<tr>
<td>Total biomass</td>
<td>phosphatase</td>
</tr>
<tr>
<td>bacteria</td>
<td>urease</td>
</tr>
<tr>
<td>fungi</td>
<td>arylsulfatase</td>
</tr>
<tr>
<td>Biomass/total soil organic C</td>
<td>N mineralization potential</td>
</tr>
<tr>
<td>Soil respiration</td>
<td>Nitrification potential</td>
</tr>
<tr>
<td>Respiration/biomass</td>
<td>Microbial diversity</td>
</tr>
</tbody>
</table>
Example: Microbial Enzyme Activity
8 months after compost addition to soil

Arylsulfatase

μg p-NP h⁻¹ g⁻¹ soil

0 30 90 270 t/ha

Phosphatase

μg p-NP h⁻¹ g⁻¹ soil

0 30 90 t/ha
Example: effects on bacterial community structure
Implications for plants?

- Greater microbial biomass and activities can
  - increase availability of nutrients to plants
  - promote formation and stabilization of soil aggregates and better soil structure
Implications for plants?

• Possible link between microbial community composition and suppressiveness of soils to plant disease

*Phytophthora* being colonized by *Trichoderma*
Plant Disease Triangle

- Pathogen
- Host Plant
- Environment