Compost Processing and its Relationship to Compost Quality

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Presentation Goals

- Introduce the process of composting, its key features and management
- Describe how compost processing can affect the stability of the final compost product
- Present basic end-user tools for quality assessment
- Provide resources for learning more about composting
Composting

- The **controlled “aerobic” decomposition of solid organic matter**
  - The process is **controlled/managed** to facilitate the breakdown and stabilization of organic matter by microorganisms
  - **Management** includes promoting **air movement** through the pile of solid organic matter.
    - **Oxygen** in the air supports an **aerobic microbial community**.
    - **Aerobic microbial activity** results in heat generation. Proper pile management may result in temperatures that kill pathogens and weeds.
Key Features of Composting Systems

Feedstocks
Size reduction and mixing
Composting
Stabilization (curing)
Screening and blending

The collective management of all features impacts the final compost product

http://organic.tfrec.wsu.edu
Types of Processes

- Common types
  - Turned Windrow
  - Aerated Static Pile
  - In-Vessel

- Process selection depends on factors including
  - Neighbors
  - Feedstocks
  - Land available
  - Water available
  - State regulations
  - Cost

http://www.northlandchippers.com

http://ascotenvironmental.co.uk/

http://www.o2compost.com
Stages of Composting

- Phases are typically characterized by temperature
  - Self-heating phase
    - Temperatures range from ambient to 50°C (122°F)
    - Microorganisms decompose readily degradable organic matter
    - Rapid growth and heat generation
  - Thermophilic phase
    - Temperatures are >50°C
  - Cooling-maturation phase
    - After thermophilic phase
    - Readily degradable matter depleted

Why is quality an issue?

Composting: The controlled aerobic decomposition of solid organic matter

or

Composting: a means of solid waste disposal
The desired quality of compost is a function of its intended use.

High Quality

Low Quality

Product collected prior to maturation phase

Product collected well into cooling and maturation phase

Temperature

self-heating phase
thermophilic phase
cooling and maturation phase

time

landfill
land
field
top
sod
home
container
cover
reclamation
crops
soils
production
gardening
media
National Organic Program
Composting Standards

“Composted plant or animal materials must be produced through a process that establishes an initial carbon-to-nitrogen (C:N) ratio of between 25:1 and 40:1 and achieves a temperature between 131°F and 170°F. Composting operations that utilize an in-vessel or static aerated pile system must maintain a temperature within that range for a minimum of 3 days. Composting operations that utilize a windrow composting system must maintain a temperature within that range for a minimum of 15 days, during which time the materials must be turned five times.”

(http://www.ams.usda.gov/)
Metrics of Quality

• Example from US Composting Council Seal of Testing Assurance report

• Measurements include:
  – Nutrients
  – Organic matter
  – Soluble salts
  – pH
  – Particle size
  – Stability
  – Maturity (phytotoxicity)
  – Pathogens
  – Trace metals
<table>
<thead>
<tr>
<th>Compost Parameters</th>
<th>Reported as (units of measure)</th>
<th>Test Results</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Nutrients:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Total N</td>
<td>1.0</td>
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<tr>
<td>Phosphorus</td>
<td>P$_2$O$_5$</td>
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<td>0.73</td>
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<tr>
<td>Potassium</td>
<td>K$_2$O</td>
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<tr>
<td>Calcium</td>
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<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>0.34</td>
<td>0.57</td>
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<tr>
<td>Moisture Content</td>
<td>%, wet weight basis</td>
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</tr>
<tr>
<td>Organic Matter Content</td>
<td>%, dry weight basis</td>
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<tr>
<td>pH</td>
<td>units</td>
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<tr>
<td>Soluble Salts</td>
<td>dS/m (mmhos/cm)</td>
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<tr>
<td>Particle Size or Sieve Size</td>
<td>% under 9.5 mm, dw basis</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

**Stability Indicator (respirometry)**

| CO$_2$ Evolution                   | mg CO$_2$-C/g OM/day            | 1.2          |
|                                   | mg CO$_2$-C/g TS/day            | 0.39         |

**Stability Rating:** Very Stable

| Maturity Indicator (bioassay)      |                                |              |
| Percent Emergence                  | average % of control           | 100          |
| Relative Seedling Vigor            | average % of control           | 100          |

| Select Pathogens                   | PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a) | Pass | Fecal coliform |
| Trace Metals                       | PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3. | Pass | Salmonella |
|                                  |                                                                    | Pass | As,Cd,Cr,Cu,Pb,Hg |
|                                  |                                                                    |      | Mo,Ni,Se,Zn    |
Metrics of Quality

• Operator’s measurement of quality indicators shows good intentions for producing quality product

• Reports provide a “snapshot” in time of a very heterogeneous process
  – The report results might not represent the material delivered to the end-user
Why is process management important?

- Composting rate is affected by water and oxygen levels in the process.
- The extent of decomposition (stability) is affected by water management and oxygen level.
Water Management

- **Too little water** can significantly lower microbial activity and the decomposition process.
- **Too much water** can reduce the flow of air through the pile. This reduces the activity of aerobic microorganism and slows down decomposition.

Total microbial activity measured after 7 days of decomposition. *Very little activity is detected at moisture lower than 30% dry basis.*
Water Management

- Two green waste compost samples were collected from two commercial compost producers in the Central Valley.
- The product from the facility that used a windrow turner that sprayed compost with water as it was turned was more stable than compost watered only on the outside of the pile.

Microbial activity measured on final compost products (compost stability).
Aeration

- Oxygen levels in the pile play a large role in the rate of decomposition.
- The rate of oxygen supply required for decomposition depends on feedstock composition.

Microbial activity measured on final compost products (compost stability). Food waste compost was unstable despite being composted in ASP and windrow for 50+ days.
Compost Stabilization in Soil

- Unstable composts will continue to decompose upon amendment to soil.
- Delaying planting may reduce phytotoxicity associated with unstable compost.
- Time delay depends on:
  - Threshold tolerance to phytotoxicity.
  - Stability of compost.
  - Amendment level.
  - Soil temperature and moisture.

Phytotoxicity predicted from Aslam et al. 2008.
End-user Tools to Assess Quality

Review site inspections by the Waste Board. Has the site had permit violations?

- Odor history
- Moisture challenges
  -- fires
  -- excessive leaching
Visiting the Facility

- Assess the potential for mixing of raw materials with finished compost
- Evaluate strategies for removing compost contaminants (plastic and glass)
- Determine if an odor problem exists
  - Odors like rotten eggs, sour milk, cabbage are a sign that the process is oxygen limited. Longer stabilization times may be needed for the final product
Pile Management

• Pile dimensions
  – “Very tall” (>6-7 ft) piles of fresh material are difficult to aerate. Is bulking sufficient?
  – Very wide piles/slabs are difficult to aerate. Is forced aeration used?
  – Piles in silage bags should have forced aeration
Resources

• California Integrated Waste Management Board
  – http://www.ciwmb.ca.gov/Organics/CompostMulch

• On-Farm Composting Handbook

• National Organic Program

• US Composting Council
  – http://www.compostingcouncil.org

References:


Questions?