Lab 6. Composting

The first part of this week's lab will take place at Cornell's Compost Facility on Stevenson Road. We will tour the facility and collect samples of compost at different stages of decomposition. *Your task will be to assess the readiness of the compost to be applied to soil by observing a number of physical properties and by using a bioassay.*

Objectives

- Relate the process of organic matter decomposition to compost management
- Assess the readiness of compost to be applied to soil
- Conduct a bioassay

Reading

12.5 Composts and Composting
http://www.cce.cornell.edu/tompkins/compost/ Tompkins County Cornell Cooperative Extension Compost Education Program

Principles of Composting

Loss of electrons results in oxidation and gain in electrons results in reduction. Soil microbes oxidize organic compounds, and in the process release essential minerals such as nitrogen, phosphorus and sulfur which plants need. In aerobic conditions, this oxidation process is called respiration. During respiration, oxidation produces carbon dioxide, water and energy. In addition, oxidation releases the mineral ions attached to the organic compound. Plants and other soil organisms take up these inorganic compounds. The organisms utilize the energy gained from respiration to grow and maintain themselves producing carbon dioxide which escapes from the soil into the atmosphere where it can be used in the process of photosynthesis, the reverse of respiration.

If oxygen is not available, some microorganisms cannot continue to grow and reproduce. Other microorganisms, anaerobes, take over under low oxygen conditions and utilize nitrate, sulfate, carbonate and ferric ions to oxidize organic compounds. This process is called anaerobic respiration, or fermentation, and it does not produce as much energy as aerobic respiration. The by-products of fermentation usually have a strong unpleasant odor. Organic acids, alcohol, methane, and other gases can be released through these reactions.

Another important part of decomposition is the C:N ratio. Soil organisms require a specific balance of carbon and nitrogen in their food source. A favorable C:N ratio results in mineralization. Mineralization is the process that releases elements important for the growth of the organisms from organic compounds in their inorganic forms. The inorganic form of the element is available to plants and other organisms. These released inorganic minerals increase overall soil fertility.

The opposite of mineralization is immobilization, which is the conversion of an element from the inorganic to the organic form. Immobilization occurs when microbes use inorganic forms of minerals as nutrients and incorporate them into their cellular components. In the organic form, the element is not available to the plant. Microorganisms may require more nitrogen for growth than the decomposing residue is providing during mineralization. In this case they begin to scavenge for nitrogen, thereby depleting the existing supply for plants. A good rule of thumb to remember is that a C:N ratio less than 20:1 results in mineralization of N, and therefore increases soil fertility. A C:N ratio greater than 20:1 results in immobilization of N, and therefore lowers soil fertility. Keep in mind that mineralization and immobilization apply to all minerals, not just nitrogen.

Decomposition occurs naturally in soil. Composting is managed decomposition of organic matter which occurs in piles, bins or windrows. The conditions in these systems are conducive to creating humus and generate considerable heat. If set up correctly, compost piles should experience temperatures as high as 50 – 75°C during the decomposition phase. Soil organisms that prefer moderate temperatures, or mesophiles, carry out most of the decomposition. They generate heat as a by-product and raise the temperature of the pile sufficiently for the thermophiles. The thermophiles carry out the hot composting, which results in the very high temperatures which kill any non-thermophilic organisms. Aeration provides the necessary oxygen for the thermophiles to continue their decomposition. The compost then decreases in temperature during the final curing phase, and mesophilic organisms recolonize the compost.

Exercise A Quick test for field assessment of compost

Materials

- bucket
- four plastic bags
- four soil cans
- trowel
- white paper
- compost thermometer
- infrared thermometer

Steps in the field

1. Use the trowel to collect at least three samples from different depths of each windrow. Your bucket should be at least one quarter filled. Mix the samples in the bucket.
2. Take a sub-sample of your composite sample. Label the can with the day, group number and windrow age in table 3. You will weigh this back in the lab and oven dry to calculate water content.
3. Half fill plastic bag with sub-sample and label using the same sample ID code. You will use this sample for Exercise B.
4. Place sub-sample on white sheet of paper and rate the color of compost according to table 1. Record in table 2.
5. Rate odor of compost according to table 1 and record in table 2.
6. Take the temperature of windrow A. Make sure to completely insert the compost thermometer. Get as close to the center of the pile as possible. Record in table 2. Measure the surface temperature of the windrow using an IR thermometer – do this on the surface where you used the compost thermometer, not the hole where you collected compost for later evaluation.

Steps in the lab

1. Bring cans back to the teaching lab. Weigh samples and record weights (table 3). Make sure to record your data and leave a clearly labeled table by the scales for later data collection.
2. Open can, place lid on bottom of can and insert cans in soil oven.
3. Weigh soil cans and record weights after 48 hours.
4. Empty soil into marked bucket, weigh empty cans and record weights. Clean out cans and place in marked bucket.
5. Fill out the rest of table 3 and carry out the appropriate calculations (see instructions in lab 5).

IMPORTANT

Make sure to record all the data on your data sheet by the scales. When all the groups are done we collect the tables to compile for the class.

Exercise B Quick test for germination and root elongation

(adapted from U.S. Composting Council, Test Methods for the Examination of Composting and Compost)

Materials

- bags of compost from windrows
- weighing paper and scale
- four 150 mL beakers labeled with treatment
- stirring rod
- distilled water
- filter paper
- four screens
- 6 labeled petri dishes (include your sample ID code)
- cucumber seeds
- ruler
- field pH kit
- graduated cylinders

Steps

1. Take pH readings of each compost using the field pH kit.
2. Weigh out 30 g of compost. Place the compost in the appropriate labeled beaker. Repeat for each compost sample.
3. Add 160 mL distilled water to the beaker. Repeat for each compost sample.
4. Mix well and let sit 15 minutes. Stir every few minutes and squeeze compost material in container with a clean rod.
5. Filter mixture through a screen into the appropriate Petri dish. Repeat for each compost sample, a control, and a salt treatment.

6. Add 10 mL of compost extract to the corresponding Petri dish. In place of compost extract, add distilled water or distilled water plus NaCl (10% w:v solution) to Petri dish.
7. Use Parafilm to seal the Petri dish and place it in the growth chamber.
8. Record (table 4) seed germination and root length for 5 consecutive days and on the sheet posted on a clipboard in the growth chamber.
9. Calculate relative germination rate and root elongation as shown below. Record in table 4 and the sheet posted in the growth chamber.

IMPORTANT

Make sure to record all the data on your data sheet by the growth chamber.

When all the groups are done we collect the tables to compile for the class.

GR = A/B*100 where:

GR = relative germination rate of treated seed compared to control (percent per day)

A = average time in days required for 80% germination of treated seeds

B = average time in days required for 80% germination of distilled water control seeds

RE = C/D*100 where:

RE = relative root length of treated seed relative to control (percent per day)

C = average root length in mm of treated seeds

D = average root length in mm of distilled water control seeds

Tables

Table 1 Compost Ranking

Rating	Color	Odor
1	Black	earthy, soil-like, no odor
2	Dark brown	moldy, musty, mildew, swampy
3	Med. brown	fruit, licorice, slight pine or ammonia, burnt
4	Light brown	sour, rotting grass. manure, vinegar, ammonia
5	Yellow-green	fresh yard debris, fresh manure, wet leaves, hay

Table 2 Field data collection

<table>
<tr><th colspan="2">Day</th><th colspan="2">Windrow</th></tr>
<tr><th>Color rating</th><th>Odor rating</th><th>Internal T (°C) Compost thermometer</th><th>External T (°C) IR thermometer</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

Table 3 Compost water content

Day	Windrow
Windrow age	
Soil can ID	
Weight (g) of wet soil + can	
Weight (g) of dry soil + can	
Weight (g) of soil can	
Weight of wet soil (W_{wet})	
Weight of dry soil (W_s)	
Weight of soil water (W_{water})	
Gravimetric water (θ_m)	
Volumetric water (θ_v)	

Table 4 Data collection for germination and root length

	Daily germination (# seeds/day)						Daily average root length (mm)						GR	RE
Sample ID code	1	2	3	4	5	Days to 80% G	1	2	3	4	5	Ave.		
Control														
NaCl														

Assignment

Using the data you collected (tables 2, 3 and 4), assess the readiness of the four different composts for land application and/or use in a greenhouse system. What management strategies is the Cornell composting facility using to ensure the production of high quality compost? What modifications or additions would you make to these strategies based on the results of your compost testing?

<u>This is your second complete lab write up</u>. So you are expected to compose a lab report that follows scientific writing protocols. This includes:

- Title with author
- Introduction
- Methods
- Results
- Discussion
- Conclusions
- References

Consider all the data collected. Explain its characteristics/behavior and their consequence to the evaluation of the compost material for use.