Compost Quality, Lecture Notes
Soils 201; 4/26/05
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Topics covered:

I. Compost quality
II. Getting the pile hot
III. Compost curing

I. Compost Quality Overview

i. Health issues
   1. Heavy metals, human pathogens

ii. Horticultural issues
   1. Important "quality" parameters: Plant growth response, nutrient content, pH and soluble salts, man-made inerts, sensory (color and odor), maturity and stability, particle size, weed seed , plant pathogens.

b. Minimum Standards – WAC 173-350-220; Solid Waste Handling Standards

i. Heavy metals
   1. Maximum allowable quantities of specific metals. A defined amount of compost to be added per year is understood.

Metal			Limit (mg/kg dry weight)
Arsenic	As	$\leq$	20
Cadmium	Cd	$\leq$	10
Copper	Cu	$\leq$	750
Lead	Pb	$\leq$	150
Mercury	Hg	$\leq$	8
Molybdenum	Mo	$\leq$	9
Nickel	Ni	$\leq$	210
Selenium	Se	$\leq$	18
Zinc	Zn	$\leq$	1400

ii. Human Pathogens
   1. Human Pathogens of concern: E. coli 0157:H7, Salmonella, Staphylococcus, Bacillus, Clostridium, Lysteria, as well as roundworms and tapeworms
   2. Composters must follow PFRP (Process for the Further Reduction of Pathogens). PFRP is a time, temperature, and turning prescription and a measurement. EPA requires compost pile be kept for 3 days at 55 C(131 F) and that the pile be turned 5 times in 15-20 days. Static piles: 55 C for 3 days with insulation.
   3. example: Turn windrow pile 4 times + original building in 16-18 days
   4. PFRP requires: <1000 most probable number/g of fecal coliform bacteria.
      <3 most probable number/ 4g of Salmonella

iii. Other Parameters
    1. pH: 5-10 (range)
    2. sharps: 0
    3. Nitrogen content: must me reported
    4. Biological stability: as outlined in US Composting Council Test Methods for the Examination of Composting and Compost.

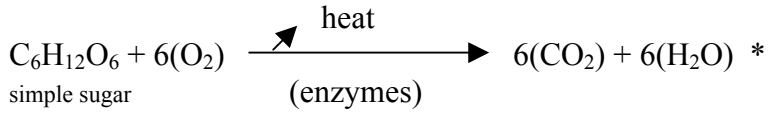
c. WAC 173-350-220 exempts backyard or on-farm composters. Community garden programs are also exempt. Government wants to encourage backyard and small-scale systems.

d. Other Standards
    i. Interim Guidelines for Compost Quality, 1994, WA Dept. of Ecology
        1. The composting industry requested standards/certification for horticultural parameters. Guidelines were a "carrot" approach not a mandandory "stick" approach. Adopted as rules February 10, 2003 (WAC 173-350-220 – Solid Waste Handling Standards).
    ii. Compost Industry readily adopted PFRP guidelines because a hot pile speeds decomposition and also reduces weed seeds and plant pathogens, which improves horticultural parameters.
    iii. Other sources of chemical pollution (things to watch out for!!!)
        1. Lead acid batteries, household batteries, oil based paint, photographic supplies, gasoline cans, herbicides, pesticides, treated wood.

II. Getting the Pile Hot

a. Compost Systems
    i. Windrow (see handout, *Compost Systems*)
    ii. Static Pile Active Aeration (see handout, *Compost Systems*)
    iii. Combination of windrow and aeration
    iv. In-vessel systems
        1. With Gore-Tex cover

b. Why do compost piles get hot?
    i. Decomposition is an exothermic reaction (releases heat)
    ii. Simple sugars, starches, fats and proteins are most easily broken down.



*The equation for decomposition of a simple sugar. The reaction releases heat as a byproduct. Enzymes are required to break the chemical bonds of the sugar molecule. These enzymes are produced by microorganisms, especially bacteria and fungi. Though water and nitrogen are not listed in this simplified version of decomposition, these are often the limiting factors for a backyard pile to get hot. Both water and nitrogen are necessary for microorganisms to produce the enzymes that make the reaction possible. Feed the microbes and they do the work!

iii. 5 necessary elements to get a hot pile:
    1. Pile size, C:N, Water, O_2 (bulk density), surface area
iv. Microbial populations change when the pile gets hot (see handout, *Generalized Microbial Population Dynamics During Composting*)
    1. Mesophilic: 10-45 C (50 – 113 F)
    2. Thermophilic: 45 – 70 C (113-158 F)
    3. Thermotolerant: Survive in spores to 60 C (140 F). For example, *Actinomycetes* and *Bacillus*. Don't contribute to decomposition at high temperature but will recolonize the pile first at more ambient temperatures.
    4. Bonus, Psychrophiles: 0 – 25 C (32 – 77 F)
v. Hot composting (Thermophilic) phase usually lasts from 30-60 days, but can last much longer.

III. **Compost Curing**

a. The high temperature phase is over when, after turning and mixing, there is no further increase in temperature and respiration (CO_2 released/time) slows. The compost is considered stable.
    i. Stability: Resistance of compost organic matter to degradation. Organic matter is in a form that makes it difficult for microorganisms to break down.
    ii. Maturity: a general term that describes the fitness of the compost for a particular end use.

b. Colonization by mesophilic bacteria, fungi, nematodes and microarthropods
    i. Primarily be organisms that survived the heating phase (thermotolerant) and from the pile edges. Also organisms introduced from wind, rain splash, insects.
    ii. Human pathogens and plant pathogens are mesophiles and do not survive the heating phase. Those that do cannot compete with the mesophiles in recolonizing the pile, with the exception of some plant pathogens (*Rhizoctonia*). Longer cured compost is more disease suppressive because there is a diverse population of microorganisms. The pile can be cured for too long, but this would probably take many years.

c. Chemical changes during curing
    i. Temperature decreases
    ii. Total N % w/w increases
    iii. C:N decreases (because CO_2 is still given off, decreasing total C)
    iv. NH_3-N decreases (ammonia nitrogen)
    v. NO_3-N increases (nitrate nitrogen)
        1. Nitrification: Ammonia is oxidized to nitrite then oxidized to nitrate, through nitrification, by nitrifying bacteria.
        2. Ammonium toxicity can cause stunting and burning. Most grasses, annuals, herbaceous perennials and vegetable absorm N as nitrate. Ericaceous species, blueberries, azaleas, rhodys, absorb all of their N as ammonium.

d. Moisture during curing: should be >40% w/w. below this level, fungi will be the primary colonizers. Moisture encourages bacteria. Diversity is good!!