Low-Input Composting

by Steven Wisbaum. *Revised September 2021*

Composting is considered both an art and a science, and as such there are many methods for making compost, and also many competing theories as what is the best method. In particular, for turned-windrow compost operations, high-frequency turning is sometimes promoted as being essential to making high quality compost. However, there's also significant scientific and anecdotal evidence that indicates that compost of equal or even better quality can be made using just a minimal number of turns. And while it's true that frequent turning will in-fact speed up the compost process, the benefits of minimal turning, or "low-input" composting, includes:

1. Saving money on labor, fuel, and equipment maintenance and repair.

2. Conserving water.

3. Reducing of the release of unpleasant odors, VOC's, ammonia nitrogen, and carbon (as CO2).

However, to realize these benefits and produce high quality compost, the process must still be carefully managed to provide optimal conditions for the micro-organisms that are essential to the decomposition process. Some of these key management strategies include:

1) **Using the widest variety of raw materials as possible.**

2) If the raw materials consist primarily of plant material, **incorporating a small amount of finished compost, animal manure and/or biologically active topsoil.**

3) **Ensuring the moisture content of the mix starts out between 65 and 70%**, which is essential to initiate the decomposition of dense, woody materials, and is also key to moderating pile temperatures, which in-turn reduces the evaporation rate and conserves moisture.

4) **Regularly monitoring the interior of the pile to ensure proper moisture content, and to look for changes in color, odor, and particle size.**

5) **Monitoring the internal pile temperature** with a compost thermometer, while keeping in mind that temperature alone is an imperfect indicator of DESIRABLE biological activity, since

a pile containing excessively dry, carbonaceous ingredients (e.g. Horse manure, yard debris, wood chips, etc.) will also get very hot, but not necessarily because of the activity of microbes associated with producing high quality compost.

6) **Preventing excess moisture conditions inside a pile** that create anaerobic conditions due to insufficient oxygen, and the production of nutrient-laden leachate. Aside from starting out with a proper mix of wet and dry materials, the most cost-effective method to prevent excess moisture conditions during the compost process is to protect piles from excess rainfall with “breathable”, macro-porous compost covers (also known as compost "fleece") such as ComposTex. ComposTex is made of 100% UV-protected polypropylene fibers that allow the fabric to shed rainfall while remaining completely permeable to oxygen and carbon dioxide. And by preventing saturated/anaerobic conditions and trapping odor-containing vapors on and within the fabric, compost covers can also reduce unpleasant odors. However, to both minimize the labor required to manage the covers and to avoid premature degradation of the fabric due to unnecessary exposure to UV-light, it’s recommended that compost covers only be used when needed to protect active piles from excess rainfall, and/or just to cover curing and finished compost.

7) **Adding water to the pile if the moisture content drops below 55% or 60% during the active composting stage.** This is most efficiently done while the compost is being turned, however, an overhead sprinkler system can also be used to wet the entire surface of the pile until the interior of the pile is sufficiently moist. Conversely, using a "drip" system will typically result in the water simply "channeling" down through the pile in narrow bands, thereby only wetting a relatively small percentage of the pile contents, with most of the water escaping from the bottom of the pile as “leachate”.

8) **Using optimal pile width** taking into consideration the characteristics of the materials being composted, the advantages and disadvantages of wider, versus narrower piles, and the equipment being used to turn the piles. Specifically:

    i) Since very little decomposition occurs on the surface of a pile, for a given volume of material, a short, wide pile will have a smaller surface-to-volume ratio compared to a long narrow pile made with the same volume of material. In other words, a short, wide pile will have a smaller percentage of ingredients on the surface where there’s minimal biological activity, and a larger percentage of the ingredients inside the pile where the majority of the biological activity is occurring.

ii) A wider pile will also have greater insulation properties, thereby releasing less moisture and odiferous compounds compared to a narrower pile.

iii) Conversely, the ability of oxygen to be pulled into a pile by convective forces and diffusion, and for CO2 to migrate out of the pile, is dependent both on the width of the pile, as well as particle size and moisture content. Consequently, when a pile contains a relatively large percentage of ingredients that have a high bulk density and/or are wet (e.g. food waste, wet, dense manure, etc.), narrower piles offer increased potential for "passive aeration".

9) **Providing a minimal number of well-timed, thorough turns to:**

i) Mix the drier, less-digested outer material with the wetter/more digested inner materials, thereby ensuring all the ingredients have sufficient exposure to the most biologically active areas within the pile.

ii) Restore porosity within the pile, which is reduced over time as the pile settles and particle size decreases.

iii) Break up larger clumps of material.

iv) Add moisture, as needed.

Why Frequent Turning is NOT Necessary To Produce High Quality Compost:

The purported benefits of frequent turning include: ensuring high oxygen and low carbon dioxide levels inside the pile; preventing excessive temperatures; increasing the quantity and/or diversity of beneficial microbes, and; improving compost quality. However, as described below, through both field observations and scientific studies, it's been shown that frequent turning is NOT in-fact the best way to achieve these goals and can actually be counterproductive. Specifically:

1. It's been observed that the majority of the oxygen added to a pile during turning is depleted relatively in only a matter of hours by microbial activity. So, a pile would actually have to be turned continuously to maintain these high oxygen levels, unless there are other ways to achieve adequate gas exchange, which there are.

2. While it's true that excessive temperatures (e.g. over 155 degrees F.) can suppress beneficial microbes and even cause a pile to catch on fire, excessive temperatures can instead be avoided by ensuring adequate moisture levels. In-fact, trying to reduce excessive pile temperatures by frequent turning actually has the opposite effect by increasing the evaporation rate, and thereby reducing the potential for moisture to moderate temperatures. Therefore, by turning less frequently, moisture will be conserved and temperatures will decrease naturally as the decomposition process reaches an equilibrium with the amount of oxygen that can enter the system naturally through "passive aeration".

3. While it's true that strictly aerobic microbes will die when oxygen concentrations drop below certain critical levels, many aerobes can simply reduce their metabolic activity and/or switch temporarily into an anaerobic state. And even though a small percentage of beneficial aerobic microbes will die in the oxygen-depleted core, a sufficient number of aerobes will survive in the outer layers of a pile to readily repopulate the pile as oxygen levels are restored during turning and through passive aeration.

Relationship of Turning to Compost Quality:

There are many parameters/characteristics that determine compost quality, including: microbial diversity and concentration; particle size/bulk density; nutrient content; odor; presence of weed-seeds; presence of phytotoxic substances; presence of pathogens; maturity; etc. However, as described in more detail below, frequent turning is not a determining factor for any of these parameters:

1. **Beneficial microbes:** There's little, if any, independent scientific data showing that compost made using frequent turns has higher concentrations of beneficial microbes compared to compost made with a minimal number of thorough turns.

2. **Nitrogen content:** In addition to increasing moisture loss, turning also releases nitrogen in the form of ammonia, which consequently reduces the amount of nitrogen in the finished compost. Therefore, the finished compost from a pile that was turned less frequently will likely have a higher nitrogen content compared to a pile that contained the same ingredients that was turned more frequently.

3. **Phytotoxic Substances:** Although some phytotoxic substances (e.g. sulfides, volatile organic acids, etc.) may be produced due to anaerobic conditions that could develop

between turns in the inner core of a pile, these compounds are readily broken down when aerobic conditions are restored after turning, and/or during the "curing" phase.

4. **Weed Seeds:** While some weed seeds are killed by heat in a compost pile, weed seeds are also destroyed by decomposition (rotting), and/or sprouting followed by agitation. Therefore, compost operators using only a minimal number of turns can achieve the same degree of weed seed destruction as compost operators who turn more frequently.

5. **Pathogens:** Pathogens are killed both by high temperatures inside a pile, as well as predation and competition by other microbes. Therefore, assuming a compost pile is proactively managed to ensure optimal microbial activity, reaches temperatures of at least 131 degrees F for extended periods of time, and is thoroughly turned 3 to 5 times, there will likely be no measurable difference in pathogen survival rates in a pile that has been turned frequently, versus in a pile that has only had a minimal number of properly timed, thorough turns.

Using the low-input methods described above, Steven Wisbaum has produced thousands of tons of high quality compost through his business Champlain Valley Compost Co. based in Northwest Vermont. He has also been the largest worldwide distributor of ComposTex compost covers since 1996.

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