Control of the Composting Process: Product Quality

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Topics that will be covered

• Composting process parameters critical to quality control

• Impacts of low versus high moisture content on compost microorganisms and compost quality

• Nuisance fungi, molds and their control
Key Composting Process Parameters

- Temperature
- Moisture content
- Aeration, porosity, oxygen
- pH
- C/N Ratio
Aging of Pine Bark in tall windrows or piles. Fresh bark is difficult to wet! Thus, it often is too dry for high rate decomposition.

Although heat still is produced, little is lost due to limited evaporation of water and because dry organic matter does not conduct heat well. As a result, temperatures increase in local spots until charring and eventually fires occur.
Problems caused by Charred Composts:

• Charred organic matter does not support the growth of beneficial microorganisms.

• Thus, pesticides have to be applied

• Charred products absorb and fix some pesticides making them less effective

• Growers are aware of this. Result: low market value for charred products!
Temperature Control

• Under ideal conditions, most of the energy produced as heat during composting is removed through evaporation of water.

• A low compost moisture content (< 40 %) results in an increase in temperature because less heat is lost as a result of evaporation of water.

• **Result:** Water management holds the key to compost temperature control. Even in very large piles, temperature control is possible by adding water during timely turning.

• **Turning and watering play major roles in fire prevention.**
Moisture Content

• **Optimum**: 50 - 75 % (w/w); it depends on what is being composted!

• **Too high**: Results in fermentation (silage), putrefaction, *odors!!!!!!!!*

• **Too low**: Dust, charring, fires, nuisance fungi, allergies and poor plant growth and no disease suppression during utilization. Result: **Low market value and liabilities.**
Optimum Moisture Content (ctd.)

- Hay (preservation) < 5%
- Moldy hay…and fires 15 - 34%
- Composting 34 – 65%
- Silage > 65%
Impact of Moisture content and Temperature on Microorganisms active during Composting, Curing and......Utilization

• Temperature: zones vs microorganisms in compost piles

• Moisture content: 1) nuisance fungi, 2) plant growth inhibition, 3) plant diseases
Each temperature zone in a compost pile has its own characteristic microflora.

- $< 40 \, ^\circ C, 100 \, ^\circ F$; Soil microorganisms and fauna.
- $40-60 \, ^\circ C, 100-140 \, ^\circ F$; Fungi and bacteria.
- $40-60 \, ^\circ C, 140-160 \, ^\circ F$; No fungi, mostly bacteria.
Fungi recolonize the 40-60 zone white zone within 1-2 days after turning.

Fungi in the white zone are not the same as those that cause problems during utilization.
Normal Ecological Succession of Microorganisms active during Composting and Curing

- Pathogens and most beneficial microorganisms are killed by natural heating during composting as high temperature compost microorganisms increase in populations.

- After composting, during curing and utilization, high temperature compost microorganisms die as temperatures decline to below 105°F.

- Soils microorganisms colonize the food base in compost as temperatures decline below 105°F and immediately after its utilization.

- Under drought conditions, composts tend to become dry and many nuisance fungi become the predominant colonizers.

- This poses many problems.

- Water management is a key factor in compost quality!
Problems caused by low moisture content, dry composts:

- Fires and dust problems during composting
- Nuisance fungi in mulches and on compost-amended soils/potting mixes
- Inconsistent initial plant growth in compost-amended soils and potting mixes
- Failures in disease control
Nuisance Fungi (e.g. stink horn) in mulches

High temperature fungi in hot, dry composts or mulches, die within hours after application due to low temp stress. They are replaced by many different types of fungi that produce masses of mycelium that repell water. After heavy rains, bacteria colonize the now wet substrate, induce fruiting in the fungi and toadstools appear as a result.
Slime molds grow as parasites on fungi in dry mulches and sporulate thereafter. The higher the wood content in mulches, the more severe the nuisance fungus problem!
Impact of moisture content in bagged mixes on plant growth and disease.

Dry composts can cause severe utilization problems!
Effect of two *Trichoderma* strains on growth of nuisance fungi in potting mixes.
Summary of disadvantages of low moisture during composting

- High temperatures (> 160 F) lead to fires in dry compost (< 45 % moisture).
- The decomposition process (rotting) is slow when the moisture content declines below 45 % (process takes longer).
- Fungi (molds) are the most active organisms in dry composts (<34% moisture).
- Dust, allergies, nuisance fungi and poor compost quality and plant diseases become issues.
How can these problems be avoided?

• 1) Maintain optimum **composting** process parameters.

• 2) Maintain optimum **curing** process conditions.

• 3) Optimize natural colonization of compost by beneficial microorganisms during utilization.

• 4) Utilize specific biocontrol agents.

• 5) Pay attention to watering and turning!
Composting Methods: Pros & cons., Quality Control, etc.

- **Windrows**: classic proven method that generates best products but... 1) more surface area, 2) more particle size reduction, 3) higher costs and 4) more odors for some applications.

- **Aerated piles**: many excellent options; limited turning & water addition potential.

- **Wedge / Stack systems**: often severely criticized but can produce high quality product at low cost with little odor if turned and watered. Least understood of these three options.
Organic farmer using 2 % clay as an additive. Advantage: better crumb formation during curing, etc. Disadvantage: costs, cover needs, weather, etc.
Fresh Aire Organic Farms, Union City, OH

Yard wastes and manures in windrows:

Yard wastes and manures in windrows: water addition brings process control.
Stack Method, ANL, Sydney, Australia (400 cubic meters/stack), a potting mix producer.

Water Management is the critical issue; it avoids fires!
Wedge System at KB, Columbus, OH, a mulch and top soil producer. The wedge system has been used for a century in the paper and more recently the bark, mulch and greenwaste industries.

To avoid fires, water **must** be added during grinding to raise the initial moisture content to 60-65%. It must be **maintained** above 50% thereafter.
Wedge or large pile composting can produce quality mulch products if fires are prevented as shown by this research!

Fresh YW ......0.3- 0.9 % N
Composted YW....1.7+ %N

After 7 months of composting in a wedge (two turns), the concentration of N in the compost exceeds 1.7 % which is similar to that in forest litter!

Stability for mulches: < 1.0 mg CO2 g OM-1 h-1

The compost applied as a 3 inch mulch suppresses root rots and feeding by leaf chewing insects. Tree growth and resistance to pests mimics that in hard wood forests!!

Water Management during Curing and Storage

- Gradually increase height of storage piles shaped as wedges or stacks.

- Maintain a moisture content > 45% and temperatures <160°F to reduce charring and fires.

- Move materials into windrows 14 days before marketing and make the necessary moisture adjustments.