Impacts of Compost Maturity/Stability on Product Quality

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Definitions

• **STABILITY**: refers to the decomposition level of organic matter in compost. It is best defined by the rate of respiration of compost towards the end of the high temperature decomposition process. % ash, VS or OM also can be used but these tests most are useful for comparative purposes within a specific type of compost.

• **MATURITY**: refers to many properties of composts which include stability, soil-like odor due to being colonized by mesophiles, plant growth response, etc.
TOPICS

• Problems caused by lack of quality control over compost stability/maturity: Examples.

• Role of Compost stability maturity in pathogen and plant disease suppression.

• Compost salinity/ fertility impacts.

• Interactions of composts with soil physical properties
Example 1: Acute Toxicity caused by Sour Tree Bark Mulch

Byproducts of fermentation (predominantly acetic acid) generated in anaerobic pockets in high C/N composts killed the grass! Cause: inadequate aeration in compost or storage piles and the compost was immature!
Toxicity would have been avoided 1) if the compost had been applied 2-3 wks before planting due to conversion of ammonium to nitrate N in the soil or 2) if a more mature compost had been used.

Example 2: Low C / N composites

Immature composted dairy manure killed transplants (value of $1,000,000 / acre) planted 24 hr after compost application.
Role of Compost Maturity / Stability in Pathogen and Disease Suppression

- Fresh organic matter supports pathogen growth and aggravates animal as well as plant diseases.

- Composted organic matter provides disease suppression through sustenance of biocontrol agents.

- Pyrolyzed organic matter and humic acids (end product of decomposition) do not support biological control!
Taxus: missing plants in heavy low lying soil killed by *Phytophthora* and by *Thielaviopsis* in sandy foreground.

Disease losses are worst on erodible, low in biological activity soils.

Mineralized soils: historical perspectives

The 1960’s; The peak of chemical agriculture, mineralized soils,...and pesticide use!
Release of zoospores from a *Phytophthora* sporangium in a conducive to root rot, dark peat potting mix.
Phytophthora zoospores germinating in water from a dark peat potting mix; the same process occurs in mineralized soils!

Note small, mostly spherical bacterial cells. The morphology (shape) of these microorganisms predicts 1) soil quality is poor and 2) biocontrol agents are limiting.
Substitution of peat with composts began in 1954. Natural suppression of root rots was observed immediately!
Natural suppression of apple Phytophthora collar rot on seedlings in a compost mix

Spring et al., 1980, Phytopathol. 70:1209-1212
Natural lysis (destruction) of *Phytophthora* sporangia in a composted bark potting mix

Suppressive soils harbor high populations of *Pseudomonas*, *Bacillus*, and other bacterial genera and fungi that inhibit plant pathogens and provide biological control.

20 uM
Example of natural root rot suppression in container systems

Aged Pine Bark  60 - 65%

Fibrous Sphagnum Peat 15%

Composted Biosolids 8 - 12%

Silica Sand/Expanded Shale  5 - 10%
Example of a Container Medium NaturallySuppressive to Pythium and Phytophthora Root Rots

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine Bark (aged or composted)</td>
<td>60 - 65%</td>
</tr>
<tr>
<td>Fibrous Sphagnum Peat</td>
<td>15%</td>
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</table>
Natural root rot suppression.

Note skepticism in eyes of grower!
Seven-yr-old Taxus crop transplanted at 1-1.5 yr intervals to sustain natural suppression of root rot. Fungicides are not used even though Taxus is highly susceptible to Phytophthora.

50 L containers
Container Mix Physical Property Requirements for natural root rot suppression:

• 1) Drainage: > 0.5” per min.

2) Aeration: 25% APS in 20 cm tall pots

3) Available water: as much as possible

Lesson: Drainage is critical!
# Soluble Salts Requirements

<table>
<thead>
<tr>
<th>Saturated Paste Extract</th>
<th>2 : 1 Dilution</th>
</tr>
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<tbody>
<tr>
<td>Below 2</td>
<td>0.15 to 0.50</td>
</tr>
<tr>
<td>3 to 4</td>
<td>0.50 to 1.80</td>
</tr>
<tr>
<td>4 to 8</td>
<td>1.80 to 2.25</td>
</tr>
</tbody>
</table>

- Satisfactory if soil is high in organic matter, but too low if soil is low in organic matter.
- Satisfactory range for established plants, but upper range may be too high for some seedlings.
- Slightly higher than desirable.

No biocontrol if salinity exceeds crop demands!!
Potting Mix Compost Quality Guidelines

- Stability: $< 1.0 \text{ mg CO}_2 \text{ g OM}^{-1} \text{ h}^{-1}$
- $\text{NH}_4$ content: $< 100 \text{ ppm}$
- Salinity: $< 8-10 \text{ mmhos cm}^{-1}$
- Moisture content $> 50\%$ (w/w).

Composts that cannot meet these criteria must be applied to soils.
Comparison of fresh vs composted wood mulches.

Treatments: 1) Shredded wood, 2) Composted wood, 3) Control, ....and + and – fertilizer.
(Herms et al, 2002)
The soil under the wood mulch was blue because it remained wet well into the summer,...the compost made the soil friable!
Phytophthora root rot was suppressed by composted but not by fresh wood wood.
Why are diseases increased by fresh organic matter?

- Fresh OM releases organic nutrients and supports pathogen growth (animal as well as plant).
- Free nutrients (glucose, etc.) suppress production of antibiotics and enzymes by biocontrol agents required for parasitism of pathogens.
- Fresh OM binds water and maintains a high soil moisture content under the mulch late into spring.
- Result: Stimulation of root rots; no biocontrol.
Why does composted OM suppress disease?

• Composted OM supports growth of microorganisms but competition prevails.

• Therefore, antibiotics and enzymes involved in parasitism of pathogens are produced.

• Composted OM is friable, supports drainage but also water retention.

• Result: natural disease control.
A 1956 paper first showed that Phytophthora root rot is stimulated by fresh sawdust. Many publications have confirmed this. Why did this grower use sawdust to kill the crop? Answer: Lack of knowledge of soil organic quality impacts among agricultural scientists and growers.
How long do compost treatments last?

- It depends on the type of material from which the compost is prepared:
  
  - Bark: 2-3 yrs
  - Manures: 1-2 yrs
  - Food wastes: 2-6 months

- Lignin and protected cellulose are the key substrates that determine longevity
How to assess this aspect of soil health?

- The quantity of particulate soil organic matter (POM) in soil predicts soil quality and biological control.

- The rate of FDA hydrolysis and the quantity of microbial biomass in soil best predict natural root rot suppression.
B) Compost Salinity/ Fertility Impacts

- High salinity composts cannot be utilized in container media.

- They must be applied as soil amendments in the fall or in the spring to allow for leaching of salts (high salinity increases Phytophthora root rots) or before salt tolerant, root rot resistant crops such as graminae, corn, etc.
Prevention of Ammonium Toxicity

• Conversion of ammonium N to nitrate does not occur until temperatures in compost curing piles decline to below 37 C (98 F). Nitrifying bacteria require 2-3 weeks of low temperature to detoxify low C/N but otherwise stabile composts. This process is known as curing.

• Nitrifying bacteria also do not colonize potting mixes to effective populations until 3 wks after formulation.

• Advise: Do not overload potting mixes or low in CEC sandy soils with high NH4 composts.
  • In potting mixes use no more than 5-10 % (v/v) composted manures.

• On sandy low CEC soils apply compost 2-3 weeks before planting or use low ammoniacal N, mature composted manure just before planting.
Fusarium Wilt Diseases, a special case!

- High ammonium to nitrate N nutrition ratios in hydroponic, potting mix as well as in field soil systems aggravate Fusarium wilts.

- Low C/N composts even when properly stabilized aggravate Fusarium wilt diseases. They negate efficacy of biocontrol agents, even of those that induce systemic resistance to disease.

- **Conclusion:** Use high C/N composts (bark, green waste) or low doses of highly mature low C/N composts for crops sensitive to Fusarium wilts! Monitor nitrate/ammonium ratio!
Interactions between compost stability and soil physical properties

- Partially decomposed cotton residues decrease soil compaction (40 cm depth) more effectively than composted cotton residues (Y. Avnimelech, 1980’s).

- In general, however, fresh residues cause short term stand and yield losses on many crops which can be overcome by composting or minimum tillage practices (Wang et al, 2005).
Summary

• Composts provide control; fresh organic matter does not.

• High salinity destroys suppression.

• Excess fertility (particularly N) increases foliar diseases (fire blight) even though other diseases (collar rot) is suppressed. Watch Fusarium wilts!

• Question: What should be known about composts to obtain positive effects consistently?
Summary of Value-Added Marketing Requirements

• Control over 1) inputs, 2) the composting, 3) curing and 4) storage processes is essential. The entire process must be consistent from batch to batch!

• Knowledge of compost performance based on appropriate analyses is essential!

• Composts must consistently meet or exceed high value market demands.
Key References
