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Soil and Plant Health via Compost / Composting

Ronald D. French and Luz M. Serrato-Diaz

Department of Plant Pathology and Microbiology
Texas AgriLife Extension-Texas A&M System
Amarillo, Texas
http://sickcrops.tamu.edu

In partial fulfillment of TDA Specialty Crop Block Grant Program, Project # SCFB-1011-07

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Soil

- A natural body comprised of solids (minerals and organic matter), liquid, and gases.
- Characterized by horizons or layers.
- Topsoil (Major zone of root development for plants)
- Subsoil (Harder for plant roots to penetrate, less reservoir for nutrients and moisture)

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Mineral Soils

- Low in Organic Matter (1%-6%)
- Major types: Sand, Silt, Clay
  - ie. Sandy loam, silty clay, clay loam
- In contrast, organic soils have >50% Organic Matter (ie. swamps, marshes)

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3 Categories of Soil Qualities

- **Physical** (structure): water holding capacity, infiltration, porosity, texture
- **Chemical**: nutrient content, salinity, pH, organic matter, mineral content.
- **Biological**: biomass, biological activity, disease suppressiveness.

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Role of Soil Organic Matter

- Improves water holding capacity
- Source for Phosphorous and Sulfur
- Primary Source for Nitrogen
- Main source of energy for soil organisms
- Binds mineral particles in granules (tilth)
- Primary source for humus in soils

(humus=stable organic fraction after decomposition of residues is finalized)

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Soil Organic Matter (OM)

- In organic systems, primary source of plant nutrients.
- Made of decomposed plants/animals
- Broken down by soil microbes
- Organic particles can hold water better than mineral particles.
- Needs replenishment. (with what?)

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Compost

- Organic residues which have been mixed, piled, and moistened, with or without addition of fertilizer and lime, and generally allowed to undergo thermophilic decomposition until the original organic materials are substantially altered or decomposed.

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Why add Compost?

- In summary: creating a healthier soil translates into healthier plants!

- Compost assists with the 3 categories of soil qualities: Physical (water holding capacity, texture), Chemical (nutrients, organic matter), and Biological (biological activity, disease suppressiveness)

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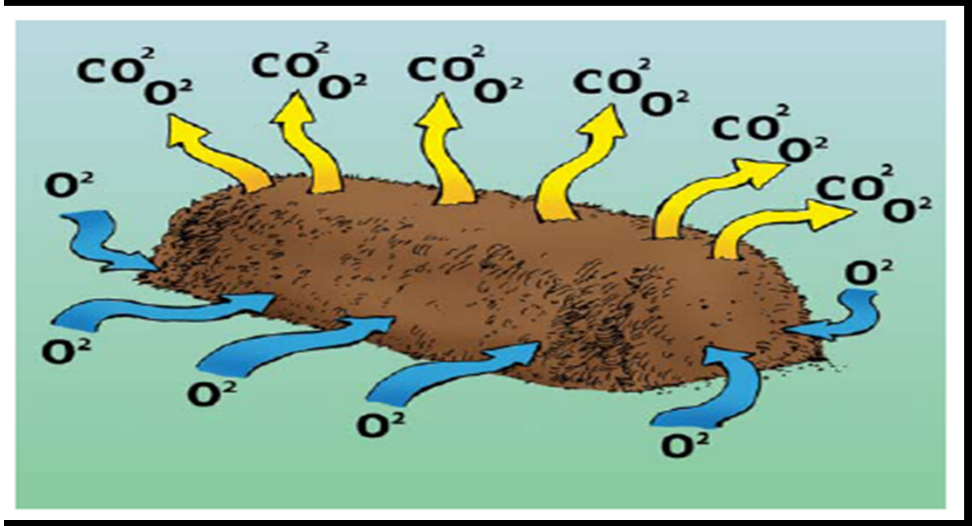
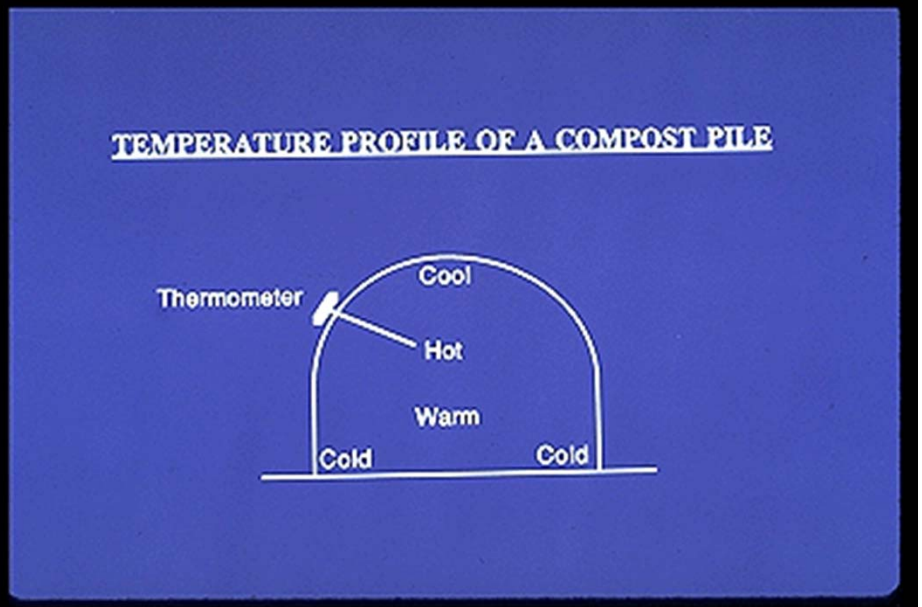
Compost





Ideal temperatures for composting are between 90º F (32ºC) and 150º F (65ºC) . High temperatures can help kill weed seeds and disease organisms, but temperatures above 150º F (65ºC) will also kill the decomposers and slow the process. (Richard et al., 1989)

http://compost.css.cornell.edu

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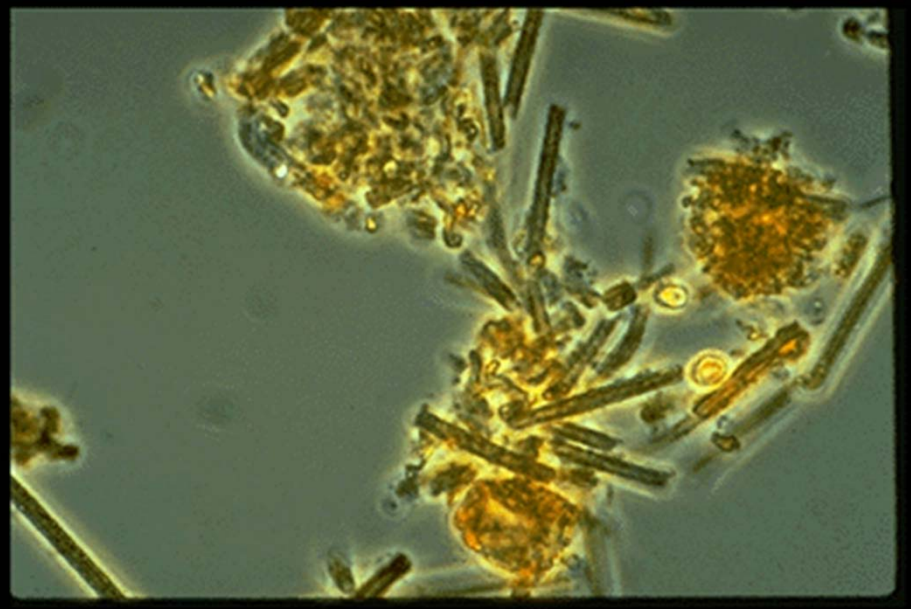

Composting is a microbiological process. Many organisms have evolved to use decaying matter as their food source. Although they are too small for us to see, they are responsible for most decomposition.

David Emerson

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Actinomycetes spp.

- Gram-positive filamentous prokaryotes.
- Use extracellular hydrolytic enzymes to utilize organic compounds.

http://commons.wikimedia.org/wiki/File:Streptomyces_sp_01.png

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Fungi and molds are also important. White rot fungi are well adapted to decompose woody materials like chipped brush.

Richard et al., 1989

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Soil Amendments

- Compost (yard waste, vegetable/fruit)
- Manure (chicken, cattle)
- Fish meal, seaweed, sludge, green manure.

Florida Gardener, 1999

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What's in compost?

Materials	pH	Moisture (%)	Nitrogen (%)	Phosphorous (%)	Potassium (%)	C:N
MSW Compost	7-8	30-50	1.2	0.3	0.4	17-40
YTW Compost	7-8	30-50	0.5-0.8	0.1	0.3	21-43
YTW/BS Compost	7-8	30-50	1-3	2.5	0.2-0.5	>15
Poultry Manure	7.5-10	15-80	1.5-4	0.7-3	1-4	7-10
Biosolids	7-12	6-99	1-6	0.5-4	0.1	7-13

MSW=Municipal Solid Waste (Trash/Garbage)
YTW=Yard Trimming Waste
BS=Biosolids (Treated Sewage by aerobic process)

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General Compost Quality Guidelines

Crop	pH	Particle Size	C:N ratio
Seedling mixes	5.0-7.6	< 1/4 inch	15:1
Containers (nurseries)	5.0-7.6	< 1/2 inch	20:1
Nursery Field Crops	5.0-8.0	< 1/2 inch	20:1
Landscapes	5.0-8.0	< 1/2 inch	20:1
Mulches	5.0-8.0	< 1 inch	20:1
Vegetable Crops	5.0-8.0	< 1 inch	20:1
Turfgrass	5.0-8.0	< 1/4 inch	15:1
Fruit Crops	5.0-8.0	< 1 inch	20:1
Agronomic field crops	5.0-8.0	< 1 inch	20:1
Forests	5.0-8.0	< 1 inch	Up to 30:1

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Soluble Salts

- Compost made from food scraps, manures, and biosolids can be high in soluble salts (SS).
- As SS levels increase, more difficult for plants to extract water from soil.
- SS is measured as electrical conductivity in units such as Decisiemens per meter (dS/m)

Monica Ozores-Hampton, 2007

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Soluble Salts (contin.)

- SS above 2 dS/m can affect salt sensitive plants
- SS above 4 dS/m can be a problem for many plants
- Rainfall will leach SS out of compost piles over time
- Can dilute SS with dirt, soil, bark, etc

Monica Ozores-Hampton, 2007

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Low Tolerance (<2 dS/m)

Beans, Cabbage	Sugar and Red maples
Onions, Peas	Scotch pine
Carrots, Peppers	Norway spruce
Celery, raddish, turnips	Barberry
Sweet corn	Boxwood
Lettuce, peas	Camelia
Most tree fruit and berries	Crepe Myrtle, Azaleas

Monica Ozores-Hampton, 2007

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Medium Tolerance (2-4 dS/m)

Broccoli, melons	Blue spruce
Cauliflower, tomato	Pines
Cucumber, Squash	Cypress
Pumpkin	Cottonwoods
Boxelder	Honey locust
Firs	Privet,
Oaks, Walnuts	Roses, Kentucky bluegrass

Monica Ozores-Hampton, 2007

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High Tolerance (4-6 dS/m)

Asparagus	Flowering jasmine
Beets	Day lillies
Tall fescue	Rosemary
Buffalograss	Mondo grass
Bermudagrass	Pittosporum
English Ivy	Indian hawthorne
Virginia Creeper	Oleander

Monica Ozores-Hampton, 2007

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Pathogen Suppressive Soil

- Soil where a pathogen does not establish or persist.
- Soil where a pathogen establishes but causes little or no damage.
- Soil where a pathogen causes disease for a while but the disease becomes less important.

Graham and Mitchell, 1998

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Two Types of Suppression

- General Suppression- soil microbes compete against the pathogen.
- Specific Suppression- individual or selected microbes against the pathogen.

Graham and Mitchell, 1998

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Soilborne Plant Pathogen

- Pathogens which persist (survive) in soil and in plant residues on the soil for extended periods of time.

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Compost: Mechanisms of Disease Suppression

- Production of antibiotics by beneficial microorganisms.
- Parasitism of plant pathogens by microorganisms.
- Activation of induced systemic resistance (ISR).
- Production of toxic or stimulatory compounds from compost.
- Successful competition for nutrients by microorganisms.
- Changes to soil conductivity and pH.
- Changes to soil physical properties.

Hoitink and Boehm, 1999

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Yard Waste Compost

- In a study by Ben-Yephet and Nelson (1999), leaf compost was better than municipal biosolids against *Pythium aphanidermatum* at 82º F (28ºC) or above.

- In a study by Tuitert et al.(1998), garden waste compost proved beneficial against *Rhizoctonia solani*.

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Yard Waste Compost

- *Phytophtora nicotianae* (Black Shank)
  - Widmer, et.al. (1998) found suppression on citrus in pots, but not in field with MSW compost at 20 t/ac
- *Rhizoctonia solani* (damping off)
  - Lewis, et.al. (1992) found suppression in peas with biosolids compost at 17 tons/acre
- *Phytophthora capsici* suppressed in chili peppers with biosolids compost at 48 tons/acre (Dickerson, 1996)

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Pathogen Inactivation during Composting

- After 75 min of heat treatment at 117 F (47 C), population of chlamydospores of *P. nicotianae* dropped to below 1 ppg.

- Chlamydospores of another species, *P. ramorum,* were not capable of germinating after one hour at 131 F (55 C).

Coelho et al., 2000; Garboletto, 2003

J.R. Sidebottom et al, 2007. NCSU.

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Pathogen Suppression

- In California, wood decaying fungi produce the enzymes cellulase and laminarinase which may dissolve the hyphae of the root rotting fungus *Phytophthora cinnamomi*.

Coelho et al., 2000; Garboletto, 2003

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Conclusions

- Good compost should be free of soilborne plant pathogens.
- Higher and diverse microbe populations in compost could help in suppressing soilborne plant pathogens.

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Thank You. Any questions?