Soil Health and Composting

* **Dirt vs Soil**
	+ Dirt=clay, sand, and minerals. No life. Sterile.
	+ Soil=community of fungi, bacteria, microorganisms, and dirt.
* **Why is healthy soil important?**
	+ It’s the foundation of the existence of all terrestrial beings
	+ Topsoil and soil organic matter have declined globally over recent decades
		- Largely due to overgrazing, large-scale agricultural tilling, and monocropping.
		- Soil degradation played a key role in the demise of past civilizations, including Mesopotamia, Rome, and Greece.
	+ It affects and is reflective of the health of soil microbes, fungi, plants, and the creatures/people who consume them.
	+ Soil that is healthy is less likely to support pathogens that can cause harm to plants
* **Common soil-borne pathogens and soil-related issues**
	+ Root weevils and earwigs
		- Solution: beneficial nematodes
	+ Fusarium, Pythium, Rhizoctonia (can manifest as pre or post emergent damping off, browning xylem, rotting roots, yellowing, and/or stunted growth)
		- Solution: minimum 3-year crop rotation, good drainage, resistant varieties, *Trichoderma* biofungicides.
	+ Bacterial and fungal (Pythium and Fusarium) blights
		- Solution: more Calcium! This strengthens cell walls against invaders
	+ Grey mold and Myrothecium fungus (can manifest as crown rot, stem rot, or leaf spot; a potent cellulose decomposer, the species *verrucaria* is used as a biocide against nematodes and weeds).
		- Can be abated with decreasing N:K ratio (i.e. less N, more K)
	+ Iron chlorosis (iron deficiency) can be caused by high pH (alkaline) soils
		- can also make plants more susceptible to spot fungi
		- creates favorable conditions for scab in potatoes
	+ Nutrient deficiencies and symptoms
		- Zinc—small, dense, chlorotic (but not curled) new leaves
		- Boron—‘black heart’ in beets; brittle, distorted new growth
		- Nitrogen—light green/yellow leaves; thin/shortened stems
		- Potassium—thin stems; leaves yellowing with dried edges
		- Phosphorus—thin/short stems; leaves purple/blue tinted
		- Calcium—new leaves distorted with curled margins
* **What makes healthy soil?**
	+ Macronutrients: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium
	+ Micronutrients: iron, zinc, boron, manganese, copper, molybdenum, and chlorine. \*necessary in smaller amounts but very important.
	+ Organic matter—anything naturally produced by living things.
	+ Relationships between plants and microbes/fungi.
		- Plants produce ‘exodates’ or carbohydrates, sugars, proteins, and fats through photosynthesis.
			* When plants are spoon fed the nutrients they need, they don’t invest in exodate production or build relationships with fungi and bacteria.
		- Fungal hyphae (mycelia) procure minerals and nitrogen from soil
		- Bacteria produce hormones for plant growth and health by processing plant exodates. These can even be specifically engineered to what the plant needs and vice versa!
	+ Balance between nutrients and a cycle of accumulation and depletion
		- Plants take minerals and nutrients from soil during growth, contribute nutrients when they decay.
		- Large amounts of un-composted biomatter in soils can harbor more pathogens.
	+ Nitrogen cycles
		- Ammonium (NH4+)
			* Usable form of N made by mineralization of organic N
		- Nitrate (NO3-)
			* Ammonium may undergo nitrification to make Nitrate
			* Usable by plants and anaerobic bacteria
			* May be leached by rain due to its negative charge
		- These are the forms of N found in common fertilizers; compost must be processed via mineralization/nitrification, meaning it is released slower and builds relationships between plants and bacteria in the soil.
* **Why does pH matter?**
	+ Nutrients often have a positive or negative charge, and need a place to attach (securely but not too strongly) in order to be available to plants or their soil partners
	+ Low pH=micronutrient availability (high H+ concentration displaces large molecules/nutrients from soil surface and weakens small, highly charged metals’ bonds)
	+ High pH=macronutrient availability (low H+ concentration forces small, highly charged metals bind too tightly to soil particles for plants to access)

Composting Guide

 Think of composting as cultivating a healthy habitat for the microorganisms and insects that break down organic matter. They want food, water, and, ideally, oxygen. It is possible to compost anaerobically, but without access to air processes take longer and will probably smell bad (this is why you turn a pile).

 If you’ve ever seen fruit get moldy or meat starting to rot then you’ve witnessed some of the chemical changes generated by the most important decomposers: fungi and bacteria. Since you didn’t eat that peach, a fungus is going to, and in the process of its metabolism it produces food for bacteria, which further decompose organic matter into usable nutrients for plants.

 Composting happens naturally on the forest floor, which we mimic and hasten in the compost bin to keep pace with our consumption. With this in mind, composting can seem more logical and approachable.

Daily Maintenance

 Collect scraps in the kitchen—now that we have a closed composter virtually nothing is off limits. **Cooked/processed foods, meat, breads, and dairy are welcome contributions to closed composting systems (protected from rodents).** Open composting systems (piles, open bins, etc.) can accept vegetables/fruits, coffee grinds and filters, yard debris, and uncooked scraps. These are your **nitrogen** sources, used by microorganisms to build proteins.

 Collect leaves, paper towels, dried plant matter, torn up cardboard to-go containers,and/or newspapers. This is your **carbon** source, the energy source for many microorganisms and also a binding agent to hold nutrients in your compost. (Make sure to-go cups and containers don’t have a thin plastic layer).

 **\*\*Cut up food scraps and shred carbon sources as much as you can be bothered to do so to aid in timely decomposition\*\***

 **Never add kitchen scraps without also adding a carbon source or turning it into the pile.** Placing a layer of brown/carbon matter on top can reduce flies and smells, as well as helping to maintain a good carbon to nitrogen ratio. There is a broad range of ratios that will work just fine, so don’t fret over exactly how much to add—just shoot for roughly **equal weights** of kitchen scraps and a carbon source. (This could mean adding a greater *volume* of the carbon source, like paper towels, since they’re lighter than kitchen scraps).

 It is also a good idea to add a few handfuls of your native soil to your compost pile to start it off with a healthy dose of your local microbes. You may also add other soils, such as those from planting containers no longer in use. Depleted soils can be revitalized in a compost pile.

 Plan on turning your compost pile at least once a week.

Troubleshooting

 **Smells:** unpleasant odors are not inherent in composting. These are generally the byproduct of anaerobic bacteria, which take over in the absence of oxygen and produce useless organic acids and other metabolites that are not only offensive to the nose but can also be harmful to plants if this compost is applied to a garden. **Turning your pile and/or installing an aeration apparatus**, such as a plastic pipe with holes drilled in it every six inches or so, should keep your pile smelling pleasantly earthy.

 **Bugs:** if you are concerned about the bugs you see in your pile—fear not! **Most bugs you see are good** and acting as physical decomposers (opposed to chemical decomposers—the microbes) breaking down organic matter into tiny pieces for further processing by microbes. Beneficial insects you may see in your pile include: mites, centipedes, ear wigs, pill bugs, worms, flies, spiders, slugs, and beetles.

 **Slow going:** it may not seem like your pile is breaking down fast enough, and this could be caused by several factors. Foremost is the **size of the pile—a minimum of one cubic yard** (three square feet) is needed to build and retain the heat needed to effectively decompose your pile. Other contributing issues include aeration, moisture, and layering techniques/carbon:nitrogen ratios. Turning a pile multiple times per week will increase the temperature. Keeping the pile moist, not wet, is crucial to keep microbes alive—remember water is life! And ultimately, if your ratio is off, or if your pile is packed with large or dense items, such as sticks, whole fruits/vegetables, or sheets of cardboard, you will be waiting for compost for a year or more.

References

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