Soils Handout – compiled by Marisha Auerbach
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"The history of every nation is eventually written in the way in which it cares for its soil."
- Franklin Roosevelt

What is soil?

– organic matter
– air
– water
– minerals
– A complex ecosystem of macro- & micro-organisms known as the soil food web. The soil food web is made up of a diversity of organisms including the tiniest one-celled bacteria, algae, protozoa, fungi, nematodes, earthworms, insects, small vertebrates, and plants.

What makes a soil fertile?

Characteristic	**Significance**	**How to create this in your soil**
Aeration	Ability for the soil to breathe	Compost, Earthworms, Keyline Planning
Structure	Soil Particles (sand/silt/clay content)	Organic Matter,
Permeability	Ability to drain	Organic Matter, addition of sand
Temperature	How long it takes for your soil to warm up	Organic Matter, Mulch,
Nutrient Content	Ability to hold nutrient in the soil	Organic Matter, Mulch
Nutrient Holding Capacity	Ability to convert nutrients into a soluble form	Healthy soil food web, Organic matter, Mulch
Water Holding Capacity		Organic Matter, Mulch, Keyline
pH	Acid or alkaline, most plants like a pH of 6.5	Organic Matter, Limestone, Wood Ashes
Stability	Ability to resist erosion	Organic Matter, Mulch

Important notes:

It takes 10,000 years to build 1 inch of topsoil. We are losing 8% of topsoil per year globally.
In the long term, tilling destroys soil structure and the aerobic/anaerobic cycles of the soil food web. It creates a quick flush of nitrogen as the soil organisms are activated by the increase in oxygen. The soil nutrients can be quickly flushed out by the rain unless they are put into a more stable form. Carbon binds with the oxygen, made available by tilling, and turns into greenhouse gases and is released into the atmosphere.

Please, mulch your garden to honor the precious ecology of the soil food web, the communities of organisms that live in our soils and produce the fertility needs.

What nutrients are necessary in soil and what do they offer plants?

Nutrient	Offerings	Where does it come from?
Nitrogen (N2)	Vegetative plant growth, protein building, genetic coding, enzymes	Urine, manure, legumes, water plants, nitrogen fixing plants, lightening
Phosphorous (P)	Root, fruit, and flower development, transfer of energy from sunlight to plants,	Bird manures, rock phosphate, seeds, bones of vertebrates (esp. fish), bone meal, bat guano
Potassium (K)/ Potash	Control of pests and diseases, cold hardiness, thickens cell walls	Ashes, leafy materials, kainite, bone meal, urine, manures, green manures, burnt plants, compost
Calcium (Ca)	Cell division, root tip growth, genetic coding , neutralizing imbalances of other nutrients	Oyster shells, Egg shells, Limestone, Dolomite, Gypsum,
Magnesium (Mg)	Chlorophyll, activates enzymes	Limestone, Dolomite,
Sulphur (S)	Production of flavor and odor compounds and protein, reduces pH, makes iron, zinc, and trace elements available in soils,	Elemental Sulphur, Volcanic mineral deposits, Swamps, Anaerobic bacteria,
Boron (B)	Transport of sugars in plants, pollen formation, cell wall structure	Euphorbia species
Silicon (Si)	Cell wall formation	Horsetail

Nutrient Deficiencies

Appearance	Nutrient	Remedy
Older leaves turn yellow, some fallen, stems become spindly, slowed growth	Nitrogen (N)	Urine, composted manure
Purple tint to small leaves, new leaves are pale, leaf tips look burnt, poor flowering or fruiting	Phosphorous (P)	Chicken manure tea, guano
Weak stems, susceptible to disease, leaf rust, old leaves look scorched	Potassium (K)	Ashes, urine, composted manure,
New leaves are distorted, poor form to flower buds, poor root establishment with soil, leaf curl, blossom end rot in Solanancea	Calcium (Ca)	Oyster shells, egg shells, crushed bone, limestone, gypsum Note: too much calcium can inhibit other nutrients
Slow growth, leaves turn yellow beginning with outer edge, twigs are brittle	Magnesium (Mg)	Epsom Salts, Limestone
New growth is pale or yellow, old growth stays green, stunts growth, more common in dry weather	Sulfur (S)	Gypsum

Why Mulch?

– Protects and provides food for the soil food web
– Prevents erosion
– Discourages weeds
– Warms the soil
– Increases water storage and reduces evapo-transpiration
– Encourages biological activity

Compost:

– Balances PH
– Prevents Erosion
– Improves Soil Structure
– Enhances Water holding Capacity
– Balances Soil Temperature
– Enriches and Feeds Soil Microbes
– Increases Plant Nutrients
– Enhances Nutrient Holding Capacity

How to build a compost pile:

1) Choose a handy location for your pile. Remember, you want to access your pile frequently enough to know if it smells bad. If it smells bad, something needs to be adjusted. Make sure your compost is located near a water source.
2) Gather as much organic material as you can for building the pile
3) Greens (see chart below) help the microorganisms in the compost pile grow, breed, and multiply fast.
4) Browns (see chart below) supply the energy and food that the microorganisms need to thrive.
5) An ideal size for a home compost pile is 3 ft x 3 ft x 3 ft.
6) It is recommended to layer the carbon and the nitrogen in the compost pile at a 25:1 ratio. Since you will be working with materials that vary in composition, I find it best to get to know what a good compost pile feels like. In a couple days, if your pile smells bad or you have small bugs swarming the pile, then you have too much nitrogen (green stuff). Add some carbon and it will settle down.

Remember, it is the natural state of these ingredients to rot as time passes. You can control this process to glean the results in a concentrated manner for your garden or you can let the debris rot in place. Compost piles come in all shapes and sizes. Each is specific to the beings who interact with it. If you leave food waste around your garden, you will find that fruit flies will come in to help break it down. The balance of greens and browns is necessary for healthy decomposition.
I add a nutrient supplement into my compost pile from our local organic supply store, Black Lake Organic. The supplement is known as Bloom. One can also add Biodynamic Preparations and other amendments at the time of building your pile.
You compost pile is rich and black when it is fully broken down. You will no longer see any distinguishable materials within your pile. Apply and enjoy your fertilized garden!

Greens – Nitrogen-rich freshness	**Browns – Carbon laden crunchies**
Grass Clippings	Leaves
Coffee Grounds	Cardboard
Food Scraps	Paper
Manures	Woody Stalks of Plants
Weeds (preferably without seeds)	Sawdust
Hair	Dryer Lint
Fresh Green Leaves	Straw
Fruit Rinds	Wood Ash

Worm Bins

Many gardeners choose to have a worm bin near their kitchen for decomposing food scraps. Decomposition happens at a quicker pace as the large concentration of earthworms consumes the food scraps in the bin. Worms need to breathe so it is crucial to drill holes in your worm bin to enhance air circulation. I prefer worm bins that have a tap, to extract the juices that are secreted by the worms. This is called worm tea and can be applied as a diluted liquid to your plants.

A worm bin needs bedding (or carbon) to cover the food scraps and promote the preferred habitat for worms. I have covered my worm bin with shredded newspaper or leaves.

Troubleshooting a worm bin is much like troubleshooting a compost pile but on a smaller scale. If it smells or has fruit flies, add more carbon.

You will be able to see when the food scraps and paper in your worm bin are fully broken down. Then it is ready to apply to your garden.

I suggest having two worm bins. As one is finishing off, you can begin to use the other one.

Resources:

Compost This Book. Christopher, Tom and Marty Asher. Sierra Club. 1994.

Designing and Maintaining Your Edible Landscape Naturally. Kourik, Robert. Metamorphic Press. 1986.

The Nature and Properties of Soils. Brady, Nyle C. and Ray R. Weil. Prentice-Hall Inc. 1996.

Roots Demystified. Kourik, Robert. Metamorphic Press. 2008.

Teaming with Microbes: A Gardener's Guide to the Soil Food Web. Lowenfels, Jeff and Wayne Lewis. Timber Press. 2006.

Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System. Appelhof, Mary. Flower Press. 2006.