Soil Health

P-Patch TIPS are reference documents that address topics related to the development and ongoing management of P-Patch Community Gardens.

Tip

PP402

5/31/22

Organic gardening and soil

Organic gardening is a process that promotes and enhances biodiversity, natural biological cycles and soil biological activities that restore, maintain, and enhance ecological harmony through natural methods. Building and maintaining healthy soil is the best way to do this.

Successful organic gardens are not accidental. They are a result of planning, constant care and attention to how things grow. As you plan your garden, consider the size of your plot, your commitment level, and your growing goals. What are your primary interests? Fresh greens, tomatoes, or maybe flowering perennials? Plan your soil nutrients and plant needs to fit your goals.

What does healthy soil do for plants and thus for us? Healthy soil:

- is medium for plant growth containing necessary drainage, nutrients and healthy microorganisms,
- recycles nutrients and organic matter,
- supplies and maintains more appropriate moisture levels compared to poor soil,
- sequesters carbon, and;
- creates habitat for essential soil organisms.

Quick guide to this tip sheet

1. Who, what and why about soil
2. Discover ways to learn about the health of your soil
3. Learn best practices for gardening in urban soils
4. Explore what it means to ‘build soil’ and the methods to do so
5. What nutrients do we feed our soil that in turn feeds us
6. Prepare your P-Patch plot for winter

Biological components of soil – Organisms in the soil are alive and make the soil a dynamic place.

- They consume and excrete, producing the essential building blocks of nutrients. These organisms participate in a process that digests organic matter into a more absorbable product called *humus.
- They support soil *tilth by creating pockets of air within the soil. It's a lot like the biological filter that gets created on the bottom of a pond or fish tank.

The players-

- Bacteria, nematodes, worms, micro arthropods, macro arthropods, algae
- Fungi and mycorrhizae accumulate moisture and nutrients, and share them symbiotically with plants. They also consume carbon held by plant material. Some scientists even think the mycorrhizae form a soil "cloud internet" by sharing resources and information via hormones and aromatic signals, a form of plant communication. Most fungi and mycorrhizae are aerobic organisms; they can survive brief periods of dry conditions but will fail in water saturated or anaerobic conditions.

***Humus:** The fragrant, spongy, nutrient rich material resulting from decomposition of organic matter. – The Soul of Soil

***Tilth:** The physical quality or condition of soil, similar to the health of a living organism.– The Soul of Soil. The structure and quality of soil, from the medieval monastic tradition, used to describe the cultivation of wisdom and spirit.– Tilth Garden Guide

Discover ways to learn about the health of your soil

Physical properties of soil

- Soil pH affects how well different plants are able to absorb nutrients.
- *Texture affects how well soil drains or compacts. Ideally, we want a soil that drains well, but still holds some moisture. Discover your soil texture:
  - Dig down about 1-2 feet with a shovel to collect a sample.
  - Put a good cup of material in a large glass jar with water with a drop of dish soap, mix well and let settle overnight.
  - The level of different materials will settle and give an idea of how much of each is in your soil.
- Macronutrients – the big players are Nitrogen, Phosphorus, Potassium, etc. and their levels are affected by compost and/or humus. You can have too much of a good thing!
- Micronutrients – minerals like Boron, Copper, Iron…We want to have all the good stuff and little of the toxic stuff.

* **pH**: the concentration of hydrogen ions in a solution that determines its level of acidity or alkalinity. A pH of 7.0 is neutral; lower numbers indicate acid, and higher numbers indicate alkaline conditions.—The Soul of Soil

***Texture:** The proportions of sand, silt, and clay in a particular soil.—The Soul of Soil

Tips about soil from what is or isn't growing in the garden

One way to learn about your soil is to look at the plants already flourishing in the garden. Below are plants you will see if you have the following soil conditions:

- **Acid soil:** sorrels, docks, horsetail, hawkweed, knapweed
- **Lack of organic matter/soil compaction:** field mustard, morning glory, quack grass, chamomiles, horsetail, nettles and other tap rooting plants
- **Mineral deficiencies or imbalance and neglected soils:** common burdock, mullein, some clovers
- **Soil compaction**: lambs quarters, plantain, chickweed, buttercup, dandelion, nettle, pigweed, mallows
- **Too wet/too dry:** buttercup, horsetail, mullein

Getting a Sense for your soil nutrient health

Before you begin building your soil you first need to know the existing soil composition.

> "If weeds grow there, I can make a garden." -Mr. Jackson

Soil macro and micro nutrient testing

Although not required, P-Patch strongly recommends you do a soil test on your plot/site. These tests check the levels of macronutrients such as Nitrogen, Phosphorus, and Potassium, pH level (acidity) and micronutrients. ***We encourage individuals to work with other gardeners and volunteer leadership if possible.***

Soil Test Instructions will vary depending on where you have the test done. Two resources P-Patchers frequently use are King Conservation District (KCD) and the University of Massachusetts (UMass.). Please see reference section at the end of the TIP sheet.

Jar Testing Soil Type

Urban soils

Seattle is an urban center with urban issues. Soils differ around the city and are not necessarily completely native soils but mixed with soils that have a legacy of *alteration. One of these issues is contamination. Soil contamination is also not just an urban issue, farmland in rural areas may be affected, too.

Soil can be affected with any combination of petroleum, heavy metals, chemicals, or biological elements. Chips, compost, and soil can hold contaminants. Petroleum, heavy metals and chemicals can be airborne and fall out of the air into the soil. Contaminants may be naturally occurring and/or they may come from our own uses of pesticides, herbicides, and chemical fertilizers.

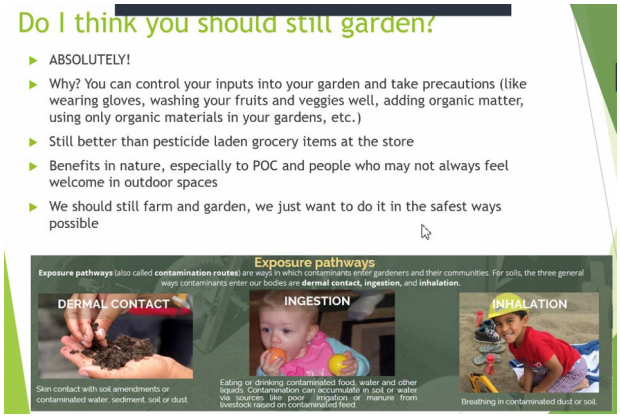
Testing for contaminants can be helpful, confusing, expensive, and misleading. If testing is not carefully selected, samples are not properly collected, results can be wrong. Before testing for contaminants carefully research to understand what and why you are testing and always research testing labs and their techniques. If you are concerned about the need to purchase inputs, such as soil and compost from a company that tests for contaminants and research where any grass clippings and chip originate ***The P-Patch Program does not allow *biosolids of any kind to be used in the gardens.*** ***Biosolids-*** *Organic matter recycled from sewage, especially for use in agriculture. - Oxford Language Dictionary*

Best practices for the land:

- Top dress area with clean, uncontaminated soil, compost, manure, or peat moss.
- Adjust soil pH to near neutral. Most metals are more bioavailable in more acid soils and can harm plants if pH is too low.
- Mulch walkways and other areas to reduce dust and soil back-splash onto crops, reduce dust, or grow grass or other ground cover.
- Don't grow edible produce directly adjacent to buildings, where lead levels are likely highest.
- Build raised beds with clean soil to grow food crops in contaminated areas.

Best practices for the gardener:

- Wear gloves while gardening.
- Wash vegetables, peel root crops before eating.
- Remove your outdoor shoes as you enter your home.
- Vacuum your indoor living spaces regularly.
- Keep your pets groomed.



Slide: Malone, M., 2021. Seeking justice, eating toxics: overlooked contaminants in urban community gardens. Agriculture and Human Values. https://doi.org/10.1007/s10460-021-10236-8

Malone, M. 2020. "Garden Safe" brochure. University of Washington Bothell

One goal is to minimize eating, breathing or ingesting contaminants.

What is soil building?

- Soil is a diverse living habitat, an ecosystem, which we are managing for our benefit, primarily by benefiting the growth of plants.
- Soil is the topmost layer on the surface composed of humus (decayed plant material) and rock material (minerals).
- Among the soil particles we have water, air and micro organisms.
- In nature, the composition of soil depends on the slow layers of accumulation of material depending on season, climate and topography; for gardening purposes we are creating organic, favorable environments quickly for the plants we wish to grow.

Methods to building soil health

Cover crops:

- Provide nutrients, erosion control and competition to weed growth.
- Build soil's organic matter and humus content and improve structure. Chop the cover crop down and turn it into the soil 2 weeks before you plant.
- Increase microbial activity and biomass in topsoil and provide food for soil microbes and earthworms which are vital to plant health.
- Increase water infiltration from rainfall and irrigation.
- Increase nutrient availability: cover crops extract nutrients from the subsoil and deposit them in the topsoil, thereby increasing their availability. An example is nitrogen fixation.
- Provide habitat, prey, nectar and pollen for beneficial insects.
- Break up the subsoil, clay layers and plow soles for increased water and air penetration.
- Fall cover crops include: fava beans, annual rye, annual crimson clover, vetch, field peas, corn, sorghum.

Inoculate: A very important relationship exists between the legume plants and a group of soil bacteria. This symbiotic relationship allows the bacteria to live in specialized nodules on the roots of the legume plant, consuming carbohydrates from the plant and providing the plant with nitrogen. Without these bacteria, legumes do not fix nitrogen! Most soils do not contain very many, if any, of these bacteria. In order to ensure good nitrogen fixation by the legume, it is necessary to inoculate the legume with the proper strains of the bacteria prior to

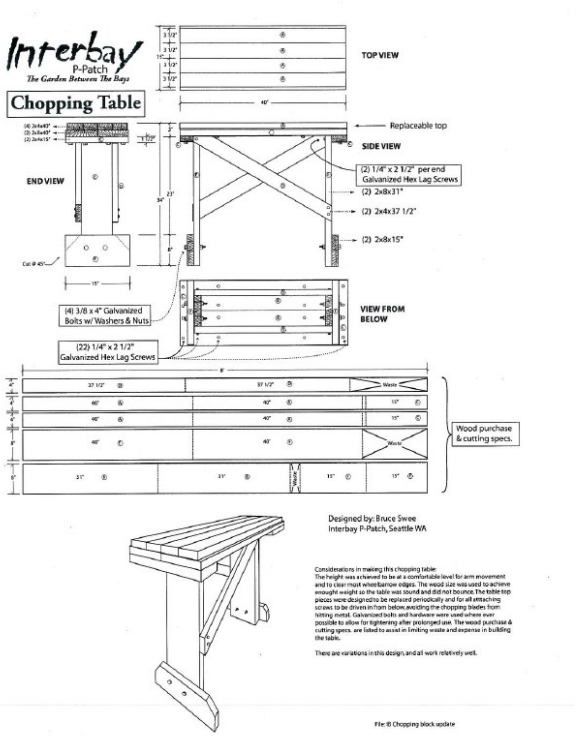
Mulching is an efficient method to cover and build your soil. Mulch is made up of composted, partially composted or un-composted organic materials applied on top of the soil. Depending on season, mulches include: chopped items that you were growing (exception: diseased plants, tomatoes at the end of the season that tend to harbor pathogens), leaves, coffee grounds, coffee chaff, and straw. Additional use of mulch is to hold nutrients and moisture

One Example is sheet composting/mulching under cover

- Up to 50% "green" materials: grass clippings, espresso grounds, seaweed, vegetable pulp from a juice bar, any garden debris expect seed heads and diseased plants which should be hot composted or disposed of in yard waste off site
- 50-100% "brown" materials: brown leaves, rotted sawdust or shavings from untreated wood, rotted straw, old pine needles (especially recommended as berry mulch), rotted burlap, rotted cotton clothes, dryer lint
- Mix materials together six to 18 inches deep on top of garden bed.
- Cover with some material that lets water through but reduces light (burlap bags/or other porous natural fiber sheeting).
- This system works like a worm bin if you want to bury low C:N ratio "greens" into the pile during the winter.
- When removing garden material, leave the roots, which are full of sugar to decompose in the soil. By spring old roots have become a vast network of underground passageways for oxygen and new roots.

Composting

The two methods to make compost are Cold vs. Hot. Hot composting makes efficient use of bins and is the quickest way to garden-ready compost. Cold composting is best for those who do not have the time needed for hot composting. Cold composting is an add-as-you-go method that requires at least a year to form usable compost. Rewards are rich soil, strong healthy plants, increased pest and disease resistance, fewer weeds, better water retention, slow release nutrients, mycorrhizal fungi, flavorful sweet vegetables and beautiful flowers and berries.



Hugelkutur is a vertical style of layering materials, usually with woody tree clippings and logs at the bottom. This method reduces or eliminates tilling of soil to maintain soil tilth and prevent a dry dusty surface that easily blows away in the wind.

NOTE: Sheet mulching, composting and Hugelkultur can become habitat for rodents if not actively managed.

Dynamic accumulators: Using plants to build soil

Certain plants (often deep-rooted ones) will draw up nutrients from the lower layers of the soil, and these nutrients will be deposited in the plants' leaves. When the leaves fall in autumn and winter and are broken down, those stored nutrients are then incorporated into the upper layers of the soil where other plants will benefit from their decomposition. This is a natural method of increasing soil fertility. **NOTE:** many of these plants are very invasive, please foster them with care and work toward full removal once they have done their work.

1. Yarrow, *Achillea millefolium* **K, P, Cu**
2. Chives, *Allium schoenoprasum* **K, Ca**
3. German Chamomile, *Chamaemelum nobile* **K, P, Ca**
4. Chicory, *Cichorium intybus* **K, Ca**
5. Lupines, *Lupinus spp.* **P, N**
6. Watercress, *Nasturtium officinale* **K, P, Ca, S, Fe, Mg, Na**
7. Sorrels, Docks, *Rumex spp.* **K, P, Ca, Fe, Na**
8. Savory, *Satureja spp.* **P**
9. Chickweed, *Stellaria media* **K, P**
10. Comfreys, *Symphytum spp.* **K, P, Ca, Cu, Fe, Mg**
11. Dandelion, *Taraxacum officinale* **K, P, Ca, Cu, Fe**
12. Clovers, *Trifolium spp.* **P, N**
13. Stinging Nettle, *Urtica dioica* **K, Ca, S, Cu, Fe, Na**
14. Vetches, *Vicia spp.* **K, P, N**

Abbreviation Key
Ca = Calcium
Co = Cobalt
Cu = Copper
Fe = Iron
K = Potassium
Mg = Magnesium
N = Nitrogen (in this case, these plants are ***nitrogen fixers***)
Na = Sodium
P = Phosphorus
S = Sulfur

Formula to calculate compost or soil needed to cover an area at pre-determined depth:	**Example:** To cover **3,000 square feet 3 inches** deep:
_____ (Enter Inches of compost to apply)	___3___ (Enter Inches of compost to apply)
X 3.1	X 3.1
= _____ yards compost needed per 1,000 sq. feet	= ___9.3___ yards compost needed per 1,000 sq. feet
X _____ (enter X 1,000s square feet to cover)	X ___3___ (enter X 1,000s square feet to cover)*
= _____ yards of compost needed	= ___27.9___ yards of compost needed
	** One acre = 43,560 sq. feet, so use 43.5 (X 1,000)*

Add macronutrient amendments

Measures are based per 100 Ft.^{2}

NOTE: what you add should be related to your soil tests, especially the pH of your soil; it is possible to over-amend...be careful.

Nitrogen sources: promotes good leaf development.

Cottonseed meal (5/6 pounds)	Dry chicken manure (15/20 pounds)
Dry steer manure (35/40 pounds)	Dried blood meal (2.5/3 pounds)
Coffee chaff (20/25 pounds)	Fishmeal (3/5 pounds)

Phosphorus sources: promotes healthy roots & fruit formation

Rock Phosphate: (slow acting - long lasting) (10/15 pounds)

Potassium sources: to help plants resist disease

Granite dust (10 pounds)	Greensand (10/15 pounds)
*Wood ashes(3 pounds)	Seaweed (kelp meal) (12 pounds)

**caution - only ashes from clean wood fires*

Lime: will help to reduce soil acidity and make nutrients more available - 5/10 pounds.

Lime should be applied in Fall/Winter well before planting time in desired area.

Other things to consider are composted animal manure, biochar, compost tea.

One of the ***P-Patch requirements is to prepare the garden space you are stewarding for winter by November 1st of every year.*** Bare soils leach minerals and nutrients in the winter rains; soil erodes, and weeds prosper and spread. Fall and winter are the time to GROW your SOIL. IT is SOIL that grows your food! In addition caring for the soil in the winter can have a positive impact on climate change by sequestering carbon. Organic gardening and care for the soil is an act of regenerative agriculture.

Option #1: Keep it Planted. Many gardeners have hardy lettuces, beets, carrots, chard, garlic, leeks and brassica family plants (broccoli, Brussel sprouts, kale, and mustards). Absent a hard frost, these plants will produce all winter. Use mulch around winter vegetables to discourage weed growth and protect plants and soil from extreme weather, dehydration and to keep the soil a bit warmer. Plants grow slower, but the leaves and shoots become sweeter as the plant produces more sugar to protect itself from the cold. And don't forget, October (November is ok too!) is garlic and shallot planting time.

Option #2: Sow Cover Crops. Garden stores have a variety of green manure or cover crops. Cover crops are also called green manure because when turned into your soil in the spring they feed nitrogen and organic matter into the soil as they decompose. Cover crops are best sown between August and mid-September; they will make your garden green all winter. **NOTE:** P-Patch has stepped back a bit in the timeline for getting a winter cover crop established. It seems that over the past few years, cover crops are not as successful if not established a bit earlier. In the spring as you need areas of your plot, chop up the cover crop, use it as mulch, or turn it into the soil, allow it to decompose for a week or so, and then plant. Favorite cover crops include Crimson Clover, which in March/April produces stunning crimson flowers beloved of bees—it's also easy to dig in. Winter Field Peas are fun and effective. Winter Rye feeds a lot into your soil but can be difficult to dig in. Many gardeners are fond of Fava Beans and Rye and Vetch mixes. In years with colder, freezing weather, many plots with just Fava Beans as a cover will lose out as the Favas melt in freezing weather.

Option #3: Mulch. There are many forms of mulch. One way is sheet composting, the basics of sheet composting are to mix equal parts brown and green organic material to cover bare soil. Greens include spent and non-diseased plant material; browns are dried plant material and leaves. Layer the greens and brown materials up to a foot or more for additional weed control. It is then recommended to cover layered material with burlap bags or other porous natural fiber sheeting. Covering keeps the mulch layer evenly moist and creates a cozy environment for critters that decompose the plants. Covering soil with burlap or other porous natural fiber sheeting alone does nothing for your soil or weed control. Other mulch materials are leaves, leaf mold or straw. Mulching with natural debris creates a dark upper surface so composting critters can work vertically to decompose the mulch and allow water to percolate through and gently enter the soil, preventing compaction and erosion. In the spring you can push this pile around, easily clearing soil needed to plant spring crops. Any mulch not decomposed and turned into the soil can continue being used as mulch or collected and used in your gardens communal composting system.

Option #4: Try all the above. Cover crops and mulches are fine between winter crops. A stripping of cover crop, mulch and winter hardy plants is a great combination, making it easier to turn in and rotate space in the spring.

Resources:

Information

- Garden Hotline soil resource sheet - **SOIL RESOURCES FOR EDIBLE GARDENING** or (206)-633-0224
- Organic Gardening 101
- The Soul of Soil– A Soil-Building Guide for Master Gardeners and Farmers by Grace Gershuny and Joe Millie
- Mound Gardening/Hugelkultur
- Biochar

Soil Testing and Best Practices

- King County Conservation District
  - Free King County Resident (KCD) Soil Tests
  - YouTube video: How To Take A Soil Sample For Testing
- University of Massachusetts Soil Testing Lab or kyarrows@umext.umass.edu
- Dirt Alert, Healthy Actions-WA Department of Ecology and En español

Compost/Soil Purchasing

- King County Compost Wise Quick Guide
- SPU Compost Give Aways
- Zoo Doo (Manure from herbivores at the Seattle Zoo call 625-POOP for availability, let them know you are getting for a group of gardeners at a/your P-Patch.
- Organic Compost, GreenBlenz Compost Organic in bulk, this source is not available in bags
- GROW has a discount coupon at local businesses for P-Patch Gardeners

Manure sources: *Caution - un-composted horse, goat, chicken or other manures often contain weed seeds, can burn plants if applied directly.*

- King Conservation District-Manure Match

Soil Contamination

- Malone, M., 2021. Seeking justice, eating toxics: overlooked contaminants in urban community gardens. Agriculture and Human Values. https://doi.org/10.1007/s10460-021-10236-8
- Soil_Contaminants Best Practices.pdf
- https://ecology.wa.gov
- https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Dirt-Alert-program/Gardening-tips
- Former orchard lands
- Tacoma Smelter Plume
- Health and Environmental Effects of Cement Plant Emissions