Garden Soil 101

What is soil?

- A mixture of mineral and organic material that is capable of supporting plant life.
- **Geo**sphere-**Bio**sphere-**Atmo**sphere interface

Why is soil important?

- Supports plant life
- Cleans water
- Habitat for billions of soil organisms
- Nature's recycling system

Basic soil properties: (all inter-related)

- Physical
- Chemical
- Biological

Think of soil as a city, with its physical properties of buildings, forests, roads, rivers, sidewalks, houses, etc.; chemical properties of air and water quality and storm water; and biological properties of diversity of people and wildlife.

The soil's physical properties affect:

- Which plants/animals can grow/live
- How water moves through it
- How pollutants get processed
- How many nutrients are available

Physical Properties: Texture

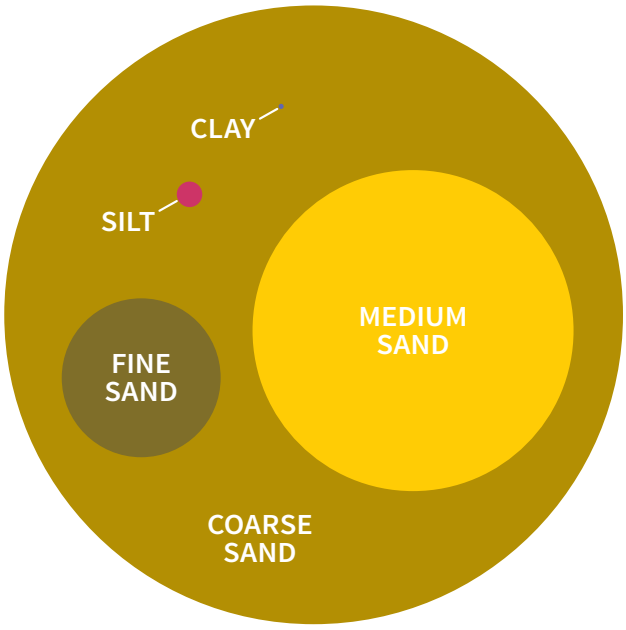
Ratio of Sand, Silt, and Clay—What does it feel like?

Texture refers to the size of the particles that make up the soil. The terms sand, silt, and clay refer to relative sizes of the soil particles. Sand, being the larger size of particles, feels gritty. Silt, being moderate in size, has a smooth or floury texture. Clay, being the smaller size of particles, feels sticky.

The Size of Sand, Silt and Clay

Name	Particle Diameter
Clay	below 0.002 millimeters
Silt	0.002 to 0.05 millimeters
Very fine sand	0.05 to 0.10 millimeters
Fine sand	0.10 to 0.25 millimeters
Medium sand	0.25 to 0.5 millimeters
Coarse sand	0.5 to 1.0 millimeters
Very coarse sand	1.0 to 2.0 millimeters
Gravel	2.0 to 75.0 millimeters
Rock	greater than 75.0 millimeters (~2")

Comparative sizes of sands, silt and clay



How Texture Affects Soil Properties

Texture	Aeration/ Porosity	Ease of Water Infiltration	Ability to Hold Nutrients	Water-Holding Capacity	Ease of Working
Loam	medium	medium	medium	medium	medium
Clay	poor	poor	excellent	good	poor
Silt	medium	medium	medium	medium	medium
Sand	excellent	good	very poor	very poor	good

Physical Properties: Structure

Ratio of space used by the components of soil (minerals, air, water, organic matter)

Ideal soil for growing crops: 50% pore space, 45% mineral and 5% organic matter

Structure affects soil properties:

- Water holding capacity
- Available oxygen to plant roots
- Ability to support the biology (microbes to mammals)

To improve your soil's structure avoid walking on it and add organic matter either by amending with compost or manure, mulching or planting cover crops.

Chemical Properties: Nutrients

The largest part of a plant's diet are the major nutrients:
Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), and Sulfur (S)

Plants also need micro nutrients in small amounts: Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), Methyl bromide (Mb)

Nitrogen is responsible for producing leaf growth and green leaves.

Phosphorous is important for plant growth, seed and flower development and early root growth.

Potassium (potash) is important for fruit formation

Nutrients must be available for plants to be able to take up—soil can contain both available and not-available forms. Microbial community is what converts organic matter into available nutrients.

Organic matter vs. fertilizer

Organic matter is food for plants and the microbial community, but it is not always readily available. Fertilizers are in a form that is readily available for plants

Organic fertilizers vs. conventional—the source is different but they act similarly in the soil.

Organic gardeners can use fertilizers too! But the source should be an organic one.

Use organic matter to create a "balanced diet" for your soil. Just like people shouldn't live on take-out, fertilizers shouldn't be your garden's sole source of nutrients.

Role of fertilizers

In our cool wet spring (and sometimes summer!) the soils are often not warm enough for the soil microbial community to make available nutrients from stable organic matter, even if we have added plenty of compost.

This is when it's important to add nutrients in an available form—fertilizers (**not necessary when using TAGRO)

You can get balanced organic fertilizers that add a little of everything

Or you can get fertilizers that are more specific for particular nutrients

- **Nitrogen (N)**—Bloodmeal, Alfalfa
- **Phosphorus (P)**—Bonemeal
- **Potassium (K)**—Greensand, Kelp, Wood Ash

Chemical Properties: pH

pH is a balance between OH– and H+ ions in the soil (on a scale from 1–14)

Most vegetables like a pH of between 6–7

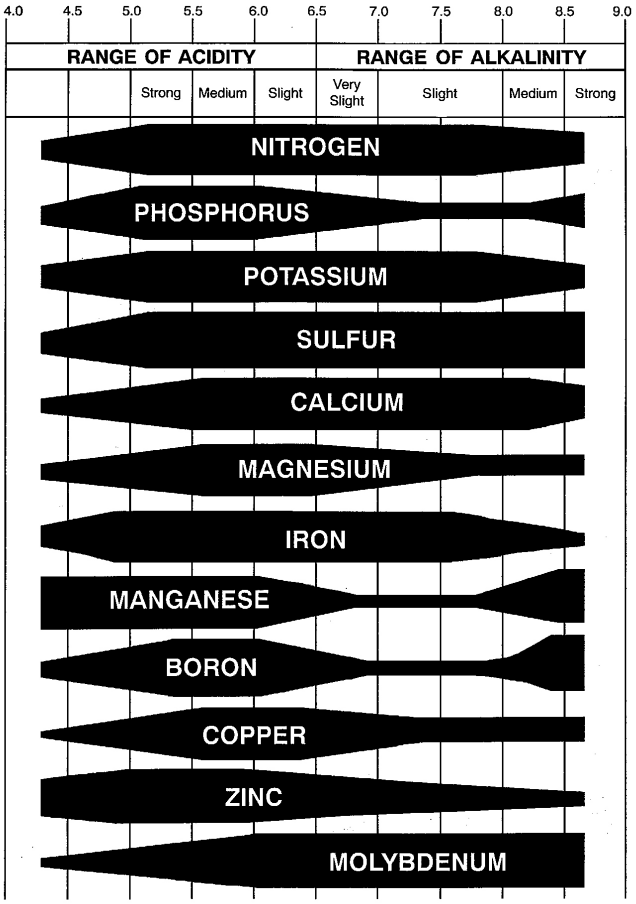
Soil pH affects:

- the availability of nutrients for plants
- also affects activity of soil microorganisms

How can we influence pH?

pH will not usually be too high in our climate

- Add lime to the soil to raise pH—every 3 or so years, in the fall
- Add organic matter, which acts as a buffer



Chemical Properties: Colloids

- The smallest of soil particles—exist in clay and humus
- Electrically charged and highly reactive
- Colloids determine soil's ability to clean water and hold nutrients for plants

Add organic matter to increase the amount of soil colloids (nutrient holding capacity).

Biological Properties: Biology

The living components of soil (Bacteria, fungi, nematodes, worms, arthropods, mammals)

The living microbes and animals transform nutrients from unavailable to available and improve soil structure.

Add organic matter to increase the amount of life in the soil

Why is it important to add organic matter?

- Improves soil's ability to absorb water and prevents erosion by reducing runoff
- Improves soil's water holding capacity
- Provides food and habitat for beneficial organisms like earthworms
- Buffers soil pH at neutral
- Supplies well-balanced slow-release nutrients
- Supplies micronutrients that are not available in most commercial fertilizers
- Prevents leaching of nutrients by providing sites where nutrients can bind, but still be available for plant uptake
- Reduces the need to buy expensive commercial fertilizer
- Aerates the soil, increasing pore space for good air and water flow
- Improves structure and drainage of soils (especially clay soils)
- Improves sandy soils by increasing water and nutrient holding capacity
- Helps to keep soil cooler in the summer and warmer in the winter by insulating it—this can prolong the growing season!

What does this mean for your garden?

Starting out: In ground vs. raised bed

In Ground

Pros	Cons
• Affordable • Uses available resources (the soil in your yard) • Greater water holding capacity	• Too much water in the ground! • Harder to improve challenging soil • Soil contamination could be a concern

Raised Beds

Pros	Cons
• Control over the soil • Better drainage • Easier to work in and around • Easier to rotate plants and isolate problems • No soil contamination • Attractive	• Must bring in soil • Construction materials can be costly • Soil dries out faster

Raised bed construction priorities?

- Cost
- Durability
- Aesthetics
- Available resources

Common materials:

- Fir/Hemlock lumber
- Cedar
- Trex
- Treated lumber
- Stone
- Scavenged materials

Filling your raised beds: What to choose?

The topsoil you buy is often not really topsoil but a mineral–based soil you can use as starting point (sand/silt/clay).

You can improve it but you will need to add lots of organic matter.

Organic matter (which kind?)

- Biosolids (Tagro)
- Compost (make your own or buy it)
- Manure
- Worm castings
- Leaves
- Cover crops

Biosolids (treated sewage)

Tacoma's TAGRO is an amazing product

- A little about the process—dual digestion
- Class A vs. Class B—highly regulated
- Totally safe for vegetable gardening
- Different products—potting soil vs. mix
  - **Tagro Mix:** Soil amendment—mix it in with your existing soil
  - **Tagro Potting Soil:** Designed to be used alone—fill raised beds with it

Compost

Buy it:

Cascade Compost is the composted yard waste from Pierce County and City of Tacoma residents

- Add to your raised bed
- Topdress in the fall

Make it:

- Size of pile—about a cubic yard
- Water—as damp as a wrung out sponge
- Air—need good oxygen to get the 'right bacteria'
- Feedstocks (correct ratio of browns/greens)

Manure

- Use aged or composted animal manure
- Horse manure can be very weedy because horses only digest about ¼ of all the grass and grains they consume.
- Cows have 4 stomachs so their manure is more digested, and has less weed seeds in it.

Cover crops

Plants that you grow for the purpose of adding organic matter—often nitrogen fixing plants (they take nitrogen from the air and add it to the soil).

- Grow them in the winter or when you would otherwise have bare soil.
- Just sow seeds, let the plants grow, and then till under a couple weeks before planting.
- Good cover crops include: fava bean, vetch, buckwheat (for summer), rye, clover

Mulch

Enriches and protects soil, helping provide a better growing environment.

- One of the simplest and most beneficial practices you can use in the garden.
- Mulch is simply a protective layer of a material that is spread on top of the soil.
- Mulches can either be organic (grass clippings,

straw and bark chips), or inorganic (stones, brick chips and plastic).

Both organic and inorganic mulches have numerous benefits.

- Protects the soil from erosion
- Reduces compaction from the impact of heavy rains
- Conserves moisture, reducing the need for frequent waterings
- Maintains a more even soil temperature
- Prevents weed growth

Mulch—Interbay Method

As an over-winter method for building humus-rich soil, it would be difficult to improve on the "Interbay Mulch" (named after the community garden in Seattle where it was developed) for effectiveness. Interbay-mulched soil, according to lab tests, is "uniquely active." Over a winter, an Interbay Mulch will give you a large volume of humus as well as a rich diversity of bacteria, fungi, protozoa, beneficial nematodes, microarthropods, beetles, millipedes and worms. Living soil is key to successful organic gardening. Grow lush healthy disease and weed free gardens after just one winter.

Interbay Mulch is basically various organic matter culled from the urban waste stream piled on top of your soil and covered with damp burlap. And it's all free! We have found organic matter decomposes faster on top of the soil than it does if you till it in as long as it is covered and kept moist.

Why the burlap?

Covering organic matter with burlap fools nocturnal, light-avoiding organisms into working for you 24 hours a day. Burlap will diffuse and soak up rain preventing it from driving into the mulch; it also inhibits evaporation, keeping organic materials uniformly moist. Birds are unable to forage in the mulch so worms and other organisms flourish and multiply. Burlap covers the mulch but is also part of the habitat cultivating a rich variety of fungi and providing a home for beetles, spiders worms and the like. Burlap permeability allows needed oxygen to reach all parts of the mulch.

What do I use for mulch under the burlap?

First and foremost the debris from your garden. Chop up your corn, bean and squash plants. Tomato plants, etc. (Many of us don't even worry about seeds because of ongoing top dressing mulches during the growing season. If you are concerned about seeds or diseases, put those plants in the hot composting holding cages) Think the same "brown" and "green" mix used for hot composting, approximately 50-50. The more variety in materials the better.

What are some examples of "Browns"?

Leaves are easily obtained in the fall. Dried cornstalks. Straw is a good brown; even better if it is rotted. You can also add rotted burlap, cotton dryer lint, shredded paper, and season with a few pine needles. Woody material should be limited to rotted material that you can smoosh between your fingers.

What about "greens"?

Practically anything that doesn't burn when you put a match to it. Garden debris, green corn stalks, fresh grass clippings, coffee grounds (leave a bucket at your favorite espresso cart), juice bar pulp, spent grain and hops, seaweed, grape pressings, apple pomace, tea, and so on. Any kind of organic manure is good.

Should I add compost?

Using compost as part of the mix is a great way to get the system jumpstarted. One wheelbarrowfull of rough compost per hundred square feet is sufficient to get things going. Using burlap that was used last year is also a good way to inoculate your mulch. The used sacks are full of dormant organisms just waiting to go to work.

How much material should I use?

Depending on your soil needs, the mulch will be 6 to 18 inches deep. Make sure all materials are damp before covering with burlap.

Do I just walk away and leave it for the winter after covering with burlap?

Check for moisture during the winter. If materials dry out decomposition comes to a halt. You can also feed your mulch during the winter like a worm bin. Adding materials once the mulch is active makes it work even better. You will have fun checking your mulch through the winter. The biology is fascinating. You will have given birth to billions of trillions of organisms. Some you can even see! When can I plant in the spring? If you start your mulch in October you should have rich humus to plant into by March. If you started with 12" of mulch you will end up with 2-3 inches of soil-energizing humus. Do I till it in or just plant into it? Gardeners do both successfully.

Soil Texture Triangle

The Soil Texture Triangle gives names associated with various combinations of sand, silt and clay. A coarse-textured or sandy soil is one comprised primarily of medium to coarse size sand particles. A fine-textured or clayey soil is one dominated by tiny clay particles. Due to the strong physical properties of clay, a soil with only 20% clay particles behaves as sticky, gummy clayey soil. The term loam refers to a soil with a combination of sand, silt, and clay sized particles. For example, a soil with 30% clay, 50% sand, and 20% silt is called a sandy clay loam.