**Want Great Plants — it all Begins with the Soil**

The essential requirements for outdoor gardening are sun, soil, seeds, plants, and water. Ask any long-time gardener what their secret is in growing healthy, tasty fruits, vegetables, and pretty flowers from year to year. Their answer is the always the same—successful gardening begins with the soil. Good soil is a must, it is the foundation of any flourishing garden.

How to get and sustain good soil from year to year may not be the most exciting part of gardening, in fact, talking about science-based ways to improve soil may seem dull. But it can be interesting the more you learn. Once you apply the appropriate soil management practices, your improved soil will help all your plants, including edibles, perform and taste their best.

Keep in mind that over the decades soil scientists have done extensive research about the physical and chemical properties of soil and how these properties impact plant health and growth. Farmers and home gardeners alike have learned from the data that plants can be positively or negatively affected by soil texture, pH and soil nutrients. Below, we’ll take a closer look at the physical and chemical properties and tie them into how to best manage the soil in your backyard.

**Soil Properties — Soil Texture**

Look at our intermountain landscape. Observe the plants that historically have grown here compared to other parts of the country. In Colorado our landscape is naturally more hospitable to plants like Ponderosa pine, sagebrush, and fescue grasses. Our lack of widespread lushness and vegetation is due to our dry climate and dry soils. It can be said that vegetable gardening, and gardening in general, can be challenging in Colorado. This is due to the combination of our parched soils, which are high in mineral content, low yearly rainfall along with our difficult soil structure.

Not to worry—these issues can be easily solved!

Ideal soil, also referred to as loamy soil, has the appropriate balance of what makes up soil in the first place. Think of the soil properties as percentages of a round pie. About 50% of soil is pore space—the tiny pathways occupied by air (25%) and water (25%). O.M., short for organic matter is around (5%), while mineral particles—silt, sand, clay, plus living organisms (45%) make up the other 50%. When all these constituents are not balanced, plant growth and health can be compromised. Let’s break the pie down further.

The three different mineral particles (sand, silt, clay) determine soil texture, or how easily your spade goes into the soil. Colorado soils are a mixture of all three particle sizes. Most of our landscapes along the Front Range are cursed with excessive clay, the smallest of the particles. Clay soil is thick and heavy, almost fudge-like, so when you dig up a shovel full, it sticks to the blade as a blob.

Because the pore space is small in clay soils, plant roots have a difficult time growing down and through the mass of fudge, so to speak. When clay soil is wet, it drains more slowly and any added water may run off or plants can drown resulting in issues like yellowing leaves, stunted growth, even death.

Conversely sandy soils, which can feel gritty, have very porous large sized particles. They are quick draining and need more frequent watering and added nutrients. Gardens can have a combination of clay and sandy soils or more of one of the types.

Silt particles are in between clay and sand. They have good drainage so plant roots can move and grow.

Loamy soil is what we are striving for in our backyard gardens, especially when growing edibles. The soil pie percentages are as they should be (or close); the soil drains well; there’s room for roots to develop and grow well. It feels adequately crumbly, is dark in color and there shouldn’t be any strong manure or similar smell. Plus, there are lots of microbial life with living organisms. Seeing red wigglers in garden soil is a good thing!

The 5% of the soil pie—organic matter, is a bio-diverse ecosystem and greatly beneficial to the soil and to gardeners. Microbes are the workhorses in soil. They are the tiny (like earthworms), mostly unseeable living organisms (like fungi) that eat and break down organic waste including leaves, garden clippings and more. They convert what they consume into organic matter, which we call humus, that improve the soil structure (also called tilth). Soil organisms also help make nutrients available to plants. This web of life in our soils is truly fascinating, read more at The Living Soil in the resources listed below.

Unfortunately, most Colorado new landscapes, or ones that have never been gardened before, have less than 3% organic matter and often tend to be very clayey in soil structure. The challenge to new gardens and gardeners is to work toward improving the soil structure, organic matter levels, manage and understand the pH and nutrient needs for plants.

**Soil Properties —pH and Nutrients**

Science has also taught us the importance of the pH level in our soils. Think of the pH scale as the alkalinity (sweetness) or acidity (sourness) of your soil. The pH scale runs from 0 to 14. 7 is considered neutral. Colorado soils are often higher than 7, so are considered more alkaline. In contrast East Coast soils are generally below 7 and more acid. Plants prefer to grow in a pH level between 6.5 to 7.

Knowing the pH level matters. When the pH level is too high minerals become bound to certain soil particles and can interfere with the plants ability to access specific nutrients from the soil. A soil test from a lab measures soil pH. Changing pH in a garden is not simple. The advice to add additional sulfur in actuality neutralizes the high calcium carbonate levels in Colorado soil and will not lower pH. The best recommendation is to continue improving the soil “pie” appropriately and slowly over time.

Soil in and of itself contains nutrients that plants need and use, these include the big three—nitrogen, phosphorous, potassium plus secondary and micronutrients like magnesium, calcium and sulfur, iron, zinc, copper and more (seventeen in total). Added nutrients for the plants to use can be provided, and often are provided by the addition of fertilizers, which can be derived from organic sources, like fish meal, or manufactured formulations like Miracle Grow. Fertilizer is only needed when the plant is deficient in the nutrient or nutrients. Fertilizers will not compensate for poor drainage from bad soil texture, overwatering, weed competition, inadequate sunlight, etc.

**Improving Soil**

Improving soil texture does not happen overnight, it can take several growing seasons. Gardeners are patient by nature, so consider it a badge of honor when your garden soil is getting there.

Whether you have overly sandy or clayey soil, one of the best ways to improve the texture and drainage issues is to add organic matter (O.M.) which eventually breaks down and becomes humus. Humus, as described above, is the result of decomposed organic matter (a word used interchangeably with soil amendment, compost, manure, and decomposing living matter like leaves or grass). Then the microorganisms break down the organic matter releasing nutrients to the soil to feed the plants.

Humus has the added bonus of binding the three different soil pore sizes which improves pore space. That means clay pores open up, resulting in better soil drainage and air to plant roots, while sandy soil pores are reduced which improves holding moisture and nutrients.

**How Much Amendment and Fertilizer Should we Add?**

The remedy to poor soil structure is to add soil amendment. However, many gardeners are in the habit of adding amendments every year—purchased in bags, by the cubic yard, compost made at home, or aged manure from farms or zoos in the hope of improving soil structure and adding more organic matter and nutrients to the soil. This certainly makes good sense. However, there are limits.

Fertilizers, which are sold in dry, granular, or liquid form add nutrients to plants and are also often added every year to planting beds and around plants in the hopes of improving plant growth or health. Again, this makes sense up to a point.

Too much of anything, including organic matter and fertilizer, is not good for the soil or plants. Excesses in either can interfere with air, water and nutrient penetration to the soil and possible ground water contamination. Too much organic matter can rob plants of nutrients during the soil decomposition process. Excessive manures can “burn” plant roots. Animal-based composts can contain high levels of salt.

Too much of one or more fertilizer nutrients can interfere or create imbalances with other nutrients. Plant nutrient update is tied into the pH level as well. Excesses of some micronutrients like zinc, copper and boron can be toxic to plants.

Before indiscriminately adding soil amendments and fertilizer products each year it is a good idea to run a soil test to see what your soil needs. The test can be done in the fall after the growing season or in the spring before planting begins.

A soil test is also highly recommended for brand new planting beds or new lawns where it is important to establish a baseline on salt levels, soil pH, soil texture, O.M. and other nutrient levels including nitrogen, phosphorus, and potassium. A soil test is also a good marker for the growing potential of your plants and edibles. If plants didn’t perform the previous season, it could be attributed to too much organic matter, not enough nitrogen or any of the many possibilities.

If additional organic matter is recommended from a soil test, or if it is a new lawn or perennial area, the rule is to add one inch of animal-based compost, or two-three inches of plant-based compost (choose one or the other). Just spread the soil from the bag or pile over the entire area you’re planting in and mix (shovel and turn) the compost well into the top six to eight inches of the existing soil.

If the soil is difficult to turn and mix down six to eight inches, use proportionally less compost. Avoid going beyond twenty-five percent amendment to seventy-five percent existing soil.

For vegetable and annual planting beds cut these rates in half next year and discontinue once the O.M. (organic matter) reaches five percent. Run a soil test every few years as an on-going guide to what to add or not each year.

Some options to get away from dealing with in-ground challenging soil conditions is to build berms or use containers or raised beds. The same rules apply to raised beds filled with bagged or bulk soil amendments—run a soil test.

If a soil test reveals high levels of nutrients or salts or both, try hosing water over the soil, berm, or raised bed several times to wash excesses away. Adequate drainage is important under berms and raised beds, so any leached nutrients are not being absorbed back into the upper soil profile.

**Other Tips**

This garden rule never changes—do not dig or plant in wet soil, especially clay. Never walk on wet soil either, you will compact the soil and limit oxygen to the plants. You will regret every step.

Unlike growing edible plants, native plants can grow fairly well in clay soils. However, they appreciate well-draining soil conditions, so some added amendment and small aggregate will aid in better drainage. Their organic matter needs are less than the maximum five percent recommended for edibles plants. Native plants require about three percent organic matter.

**Resources**

Inexpensive home soil test kits are sold at garden centers. They do not provide as much in-depth information as a professional soil lab. They are handy and quick guides to use. Check with your GCC sales associate for more information.

Read about and download the instructions and form to complete for a soil test from Colorado State University in Ft. Collins. Click on horticultural applications for gardeners. <http://www.soiltestinglab.colostate.edu/> Or, check online for other reputable soil testing labs in the area.

Fertilizing the Vegetable Garden - <https://extension.colostate.edu/topic-areas/yard-garden/fertilizing-the-vegetable-garden-7-611/>

The Living Soil <https://cmg.extension.colostate.edu/Gardennotes/212.pdf>

Soil Amendments <https://cmg.extension.colostate.edu/Gardennotes/241.pdf>

Soil Testing: It’s a good thing <http://csuhort.blogspot.com/2014/02/soil-testing-its-good-thing_24.html>

How Your Soil Test Results are Like a Margarita <http://csuhort.blogspot.com/2014/03/how-your-soil-test-results-are-like.html>

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