Building Healthy Soil

Based on a handout by Sheilia Canada CPD, CMG

At a Glance

Healthy Soil Needs:

Organic material
Balance of nutrients
Life (plants, beneficial fungi, worms, etc.)
Little to no compaction-room for water and air flow, growth of roots

Types of Soil:

There are tests you can perform at home to determine your soil type
Sandy-drains quickly
Clay-retains liquid

Amendments:

No-till cultivation
Biological organisms
Fertilizer
Compost
Mulch
Manure
Cover crops, or "Green Manure"

What makes soil healthy?

Plants grow in soil, not dirt. Soil contains nutrients, dirt doesn't.

Healthy soils consist of:

- Organic Material (or OM)-presence can be detected by smell, texture, and color
- Nutrients-we will cover how to test your soil shortly
- Life-plants, insects, fungi, nematodes, and invisible bacteria; life needs water and oxygen
- Little or no compaction-pores leave room for oxygen and water; this also leaves room for the development of larger root mass-another contributor to healthy soil

Anaerobic vs Aerobic

Anaerobic means living without air (oxygen), and such conditions do not yield healthy soil. Aerobic means "requiring air", where air means oxygen. Aerobic soil is healthy soil.

Roots generally require about 10% oxygen in order to thrive. Creating a planting area with healthy, lightly-compacted soil and adequate drainage reduces the risk of anaerobic conditions, regardless of planting depth.

Loosely-compacted soil permits greater respiration during weather cycles and improves drainage within the soil, provided there is an outlet for water to flow.

Know your soil type

Poor soil grows weak plants that are much more susceptible to pests and disease. Knowing your soil's structure, as well as its prevalent or lacking nutrients lends insight into how your plants will perform. The first part of understanding how your soil behaves is knowing the structure or composition of the soil. There are three basic types: sand, silt, and clay.

Physical Texture of Soil

A simple test to perform for determining your soil type is texture pressure. The following flow chart explains the process for this test.

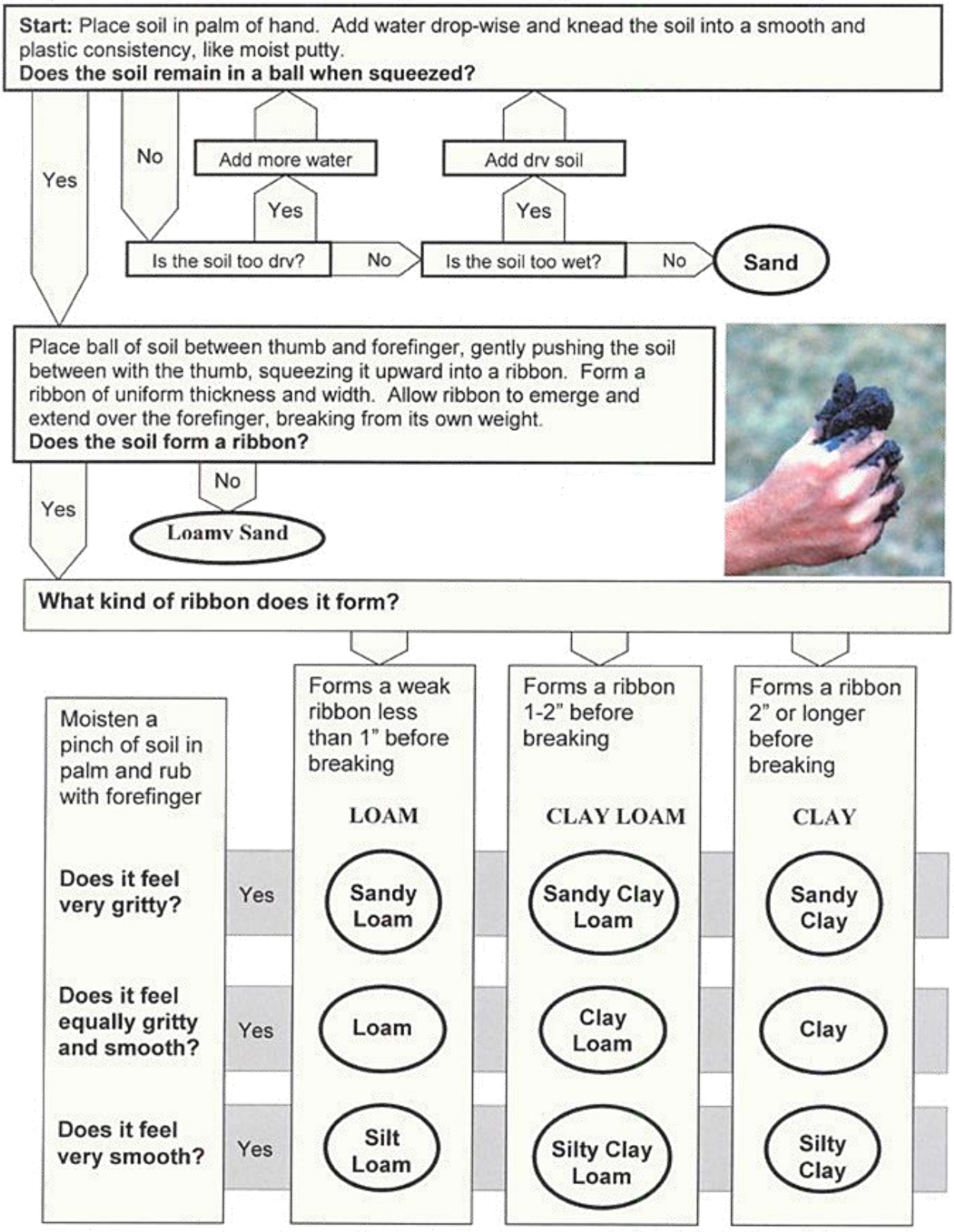

Image Source: www.ext.colostate.edu

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Soil Sample Test

For a more accurate breakdown of your specific soil type, you can perform a simple soil test. Follow these steps:

1. You will need: 1 tall, wide mouth canning jar with a lid, roughly two handfuls of the soil from your sample area, and water
2. Put 2 handfuls of soil in the jar
3. Next, fill the jar ¾ of the rest of the way full
4. Put the lid on tightly, then shake hard for about 2 minutes
5. Put the jar in a place where it won't be disturbed
6. The different soils will separate themselves by settling according to size. After 1 minute: mark the jar where the sand has settled
7. After 2 hours, mark the depth of the silt
8. Once water is clear, mark the level of the clay (this may take up to several days)

Measure and divide each layer by the overall height to determine the percentage of each type within your soil's total composition. These percentages will indicate your soil type.

Soils high in sand drain quickly, while clay tends to retain water. Soils that drain too quickly often leach nutrients vital for plant growth, while soils that retain water excessively can become water-logged, inhibiting the plants' uptake of nutrients.

The best way to achieve a healthy balance in your soil is by amending it. For sand, use peat moss, top soil, and compost to provide organic content and moisture retention. For clay and other types that don't drain as well, amend with compost or peat moss to increase organic content and improve drainage. A note about peat: ***don't*** add sand, lime, or gypsum to clay, as it forms a structure similar to concrete.

Testing soil for acidity and nutrient content

Most plants grow best in soils with a pH of 5-6.5. In Colorado, a lot of our soil tends toward the alkaline side, between 7.0 and 7.8 or above. There are inexpensive tests you can use at home. A test that we carry in our garden supply department has been done by the CSU Master Gardeners, and gives you not only a detailed analysis, but also suggestions for how to improve your soil.

The only recommended solutions for acidic soil here in Colorado are adding organic matter, organic mulches, and light, frequent irrigation. Addition of sulfur is ***not*** recommended.

Improving your soil

- **No-till cultivation-**Avoid unnecessary roto-tilling, as it destroys mycorrhizae (beneficial fungi) and soil structure. Instead, use a broadfork, only digging where you plant. Mulch for weed control. Try straw, grass clippings, and shredded bark
- **Avoid compaction-**Stay off your garden beds as much as possible. Use no-till cultivation; utilize wise designing and plant in a way that mimics nature (spirals, concentric circles, diamonds, and

keyholes) *instead of* straight blocks, rectangles, and rows. If you must plant in rows, try to be sure that you can reach across and around your beds without putting a lot of weight on the soil and compacting it. Beds should be no wider than 32-36" (arm length), nor longer than 10'

- **Mulch-**Avoid fabric and plastic as they starve soil of air flow/oxygen. Plastic fabrics block light, nutrients, water, and oxygen. Stick with organic material. For an inexpensive alternative, try newspaper or cardboard covered with straw, grass clippings, leaves, or bark.

Encouraging biological organisms

Earthworms, along with a host of other organisms, decompose organic matter in soil. As earthworms digest, the form taken by the nutrients they consume is one that is more readily available for absorption by nearby plants. These "castings", or nutrients digested by earthworms, carry significantly more nutrients usable by plants than the surrounding soil.

In addition to nutrients, the burrows of earthworms create passages for air, water, and roots. In so doing, they also increase moisture retention of soils. Encourage earthworms by providing a food source in the form of organic material: mulching grass clippings, putting down layers of organic mulch in beds, amending soil with compost, and turning under green manure (explanation to follow). You can also transplant worm colonies from established areas to new ones. Avoid chemical fertilizers, herbicides, and, of course, pesticides.

Beneficial Fungi (Mycorrhizae)

Mycorrhizal fungi are fungi that have a symbiotic relationship with the root systems of living plants, from garden vegetables to trees in old growth forests. These networks of mycorrhizal filaments envelop a seedling's root structure and support the plant's own ability to utilize water and nutrients in soil, encouraging healthy, vigorous growth. They also enhance plants' ability to tolerate environmental stress (drought, dry winter weather, etc.), and reduce transplant shock. Plants with these beneficial fungi require less fertilizer, and may have fewer soil-borne diseases.

Fertilizers

Another benefit of knowing your soil type, pH, and nutrient content is that it will allow you to choose the fertilizers that will be most beneficial to your garden. Fertilizers have an N-P-K rating (Nitrogen, Phosphorous, Potassium) that will supplement your own soil's composition. Nitrogen is good for green leaves, Phosphorous for roots and flowers, and Potassium for overall health and vigor. If a fourth number is listed, it will be the percentage of "S", or Sulfur. Organic fertilizers are very beneficial; look for kelp, manure, and bone meal (high in Nitrogen and Phosphorous).

Compost

Compost is a very effective way of adding organic material to your garden, and is also helpful in reducing kitchen waste. It also attracts earthworms and other beneficial organisms and provides

nutrients to vegetables while improving soil. When composting, try to balance "green" (wet, high Nitrogen) with "brown" (dry, high carbon, like dead leaves).

"Green" compost items: coffee grounds, chopped leaves and grass clippings, eggshells, fruit waste, grains, manure, seaweed, vegetable scraps, weeds, etc.

"Brown" compost: corncobs, cornstalks, hay, nutshells, paper (avoid colored paper), sawdust, straw, etc.

Items you should **NOT** compost:

- Meat scraps, or trash containing a lot of fat
- Colored paper
- Diseased plants
- Pet droppings
- Plants sprayed with synthetic chemicals (pesticides, herbicides, etc.)

Once you cannot distinguish any of the raw materials in your compost, you'll know it's ready for use.

Manure

Composted manure will be lower in Nitrogen than raw manure, but will have higher levels of Phosphorous and Potassium. When adding amendments to soil, keep in mind that they decompose at different rates; grass clippings and manure are the quickest, breaking down in a few weeks. Composts can take up to six months, and wood chips, bark, and peat can take years to break down.

The fresher the manure, the more Nitrogen it has. Use caution if manure is from horses or cows, as these animals don't digest seeds in their food nearly as well as other grazers like goats, rabbits, alpacas, and sheep. If you can access them, these are better manures to use.

Cover Crop or "Green Manure"

Green manure is a crop grown and then mixed in with soil to increase the content of organic matter. Crops that can fall in this category include: buckwheat, clover, soybeans, and winter rye. Some of the advantages of green manure are increasing organic content and nutrients for plants, and also preventing erosion; ground that is covered rarely erodes.

Resources and Recommended Reading

CSU Master Gardener Manual and Extension Handouts
How to Build Your Garden Soil Naturally, by Todd Heft
Edible Forest Gardens, by Dave Jacke
The Permaculture Handbook, by Peter Bane