***10-Minute University*™**
The Clackamas County Master Gardener Association in collaboration with and in support of the OSU Extension Master Gardener™ Program

Gardening in Clay Soil

Introduction

Soil comes from decomposed rocks and organic matter. Healthy soil, by volume, should be 45% rock minerals, 5% organic matter, 50% pore space for water and air. Among the many important functions of soil are:

- Home for living organisms such as bacteria, fungi, nematodes, protozoa, and earthworms;
- Anchor for plant roots;
- Nutrient reservoir to support plant growth; and
- Repository and purifier of water.

Sand, silt, and clay are the mineral particles of soil. Sand particles are visible to the eye and feel gritty while silt particles are smaller (similar to a particle of white flour) and feel smooth. Both are shaped like miniature rocks. Clay particles are invisible to the naked eye and are typically flat. Most soils are a mixture of sand, silt and clay. Loam has a mixture of roughly equal portions of all three particles.

Soil texture reflects the proportion of sand, silt, and clay; good soil structure relies on living organisms (bacteria and fungi) and humus (decomposed organic matter) to glue particles together into peds which are the building blocks of soil.

Properties of Clay Soil Compared to Other Types

	Loam	Sandy Loam	Silt Loam	Clay and Clay Loam
Water-Holding Capacity	Moderate	Low - Moderate	High	High
Fertility	Moderate	Low	Moderate	High
Permeability	Moderate	High	Low-Moderate	Low
Feel	--	Gritty	Smooth, pliable when wet but not sticky	Hard when dry, sticky when wet; Can be molded into ribbons

What Does Soil Science Tell Us?

Fertility

- Clay soils are rich in plant nutrients. Clay particles carry negative charges which hold positively charged particles such as calcium, potassium, magnesium, iron and other plant nutrients.

Permeability

- Wet soil and fine-textured soil (those heavy with clay or silt) compact easily. Compacted soils have flattened peds which impede movement of water and roots. Compacted clay soil is difficult to restore.
- Healthy soils have lots of space between peds (macropores) to support movement of water, gases, and roots. More macropores lead to better drainage.

Water-Holding Capacity

- Small pores or micropores (the space within a ped) give the soil its water-holding capacity.

Disturbing the Soil

- Digging and tilling break up peds, but introduces air into the macropores. Excessive tilling reduces the functionality of fungal hyphae, kills beneficial nematodes, and usually results in compacted soils.

Soil Life

- Soil is teeming with life -- many of which are beneficial to plants. Soils containing higher levels of organic matter tend to have more microorganisms. Soil microorganisms are most active between 70°F and 100°F while earthworms are most active at about 50°F.

- Plant roots secrete a substance called exudate which contains sugar, vitamins, oxygen and other compounds. Exudate attracts microorganisms to the vicinity of plant roots. Studies show exudate compositions vary by plant species and shape the fungal community around each plant.

Beneficial Microbes

- Rhizobia bacteria capture nitrogen in air for plant use.
- Beneficial nematodes are highly sensitive to disturbance and many are killed by tillage, often perturbing the entire soil food web in a disturbed soil.
- Many kinds of fungi form beneficial associations (called mycorrhizae) with plant roots. Fungal hyphae work like long root hairs to get water and soil nutrients for the plant. Mycorrhizae also improve soil structure by aggregating soil particles into peds.

How to Manage Clay Soil

Test Your Soil

- Before adding amendments, test your soil. Fertilize only if soil test shows deficiency or plants don't grow well. Remember that clay is rich in nutrients. In the Willamette Valley, most trees, shrubs, and perennials don't need added fertilizers.

Keep Living Roots Growing

- Living plants harvest sun's energy and support a community of soil microorganisms through their root exudates. Studies show that exudates shape the makeup of soil microbes. Growing a diverse variety of plants maximizes diversity in soil life which helps build healthy soil.

Minimize Disturbance

- Anything that disturbs the soil (walking on it, digging, tilling) can break up or compact peds and reduce pore space which is important to permeability and water-holding capacity.

Keep it Covered

- Mulch to moderate soil temperature, minimize evaporation, and reduce weed growth. Organic mulch breaks down and adds organic matter to soil -- coarser materials allow air flow while denser substances, such as cardboard, impede gas exchange. Arborist wood chips (4-6") is a good mulch – it allows air flow and slowly breaks down to add organic matter to soil.

Feed Soil Microbes

- Organic matter (OM) is at the bottom of the soil food web; adding OM feeds soil microbes. Choose a form that has been properly composted and does not contain undesirable attributes such as high salt or heavy metal. OM such as composted leaves and yard waste may be mixed in or a thin layer 1/2 to 1" may be laid on top to create an environment that favors microbial activity.

Make a Planting Bed for This Season

- If you need a new bed for an annual vegetable crop, mix composted OM into the entire bed. This should give you immediate benefits of workable soil and greater fertility. However, such benefits are short-term in nature because OM will break down quickly, unused nutrients are likely lost, and the soil will settle.

A Change from the Past

- The mantra of "Just Add Organic Matter!" as the solution to improving clay has been modified. In the past, we recommended an initial addition of 2-4" of OM with subsequent, lesser quantities. This has changed. Recent studies of urban gardens where OM has been added over years show unhealthy levels of phosphate and OM. High phosphate level inhibits plant uptake of iron and development of beneficial mycorrhizae, and contributes to pollution of rivers. If buying OM from commercial sources, Oregon Department of Agriculture analyzes OM for nutrient content. Check to ensure you buy OM low in phosphorus if you have been adding OM to your soil for a long time.

Learn More about Soil

Publications

Oregon State University Extension publications https://catalog.extension.oregonstate.edu/

- A Guide to Collecting Soil Samples, EC628
- Soil Health Principles, EC1647
- Analytical Laboratories Serving Oregon, EM8677
- Applying Lime to Raise Soil pH for Crop Production, EM9057

Washington State University Extension publications https://pubs.extension.wsu.edu/extension-publications

- Cover Crops for Home Gardeners West of the Cascades, FS111E
- A Home Gardener's Guide to Soils and Fertilizers, EM063E
- A Gardener's Primer to Mycorrhizae, FS269E

Soil Myth Busting for Extension Educators: Reviewing the Literature on Soil Structure and Functionality https://www.nacaa.com/journal/index.php?jid=1024&fbclid=IwAR1vZ1tBQOXBJHjLTSSkmkIxiMpsIkfJ81TOUcCrXgzwBptLufJBzDsTUNc

Videos

Mulches: The Good, The Bad, and the Really Really Ugly, a 10-Minute University™ video https://www.youtube.com/watch?v=NXL9n2KNm1E&feature=youtu.be

Home Soil Sampling, Washington State University https://www.youtube.com/watch?time_continue=305&v=0tRQUPDRiDU

Soil Health Demonstration https://video.search.yahoo.com/yhs/search;_ylt=AwrVk.PbmkheP2YANRoPxQt.;_ylu=X3oDMTByNWU4cGh1BGNvbG8DZ3ExBHBvcwMxBHZ0aWQDBHNlYwNzYw--?p=ray+archuleta%27s+soil+health+demo+2014+custom&fr=yhs-symantec-ext_onb&hspart=symantec&hsimp=yhs-ext_onb#id=1&vid=9dc2f4b19ef0a17fdbf63b79d0262fea&action=view

Soil Carbon Cowboys https://www.youtube.com/watch?v=ZGvVli0OTrQ

From Dirt to Soil https://video.search.yahoo.com/yhs/search;_ylt=AwrVk.mVYEhe9HEAagsPxQt.;_ylu=X3oDMTByNWU4cGh1BGNvbG8DZ3ExBHBvcwMxBHZ0aWQDBHNlYwNzYw--?p=gabe+brown+cover+crops&fr=yhs-symantec-ext_onb&hspart=symantec&hsimp=yhs-ext_onb#id=7&vid=bcbc67625385789d9244a52f91a2843d&action=view

Websites

Web Soil Survey www.websoilsurvey.sc.egov/

10-Minute University™ Handouts and Videos, www.cmastergardeners.org/10-minute-university