Soil science basics

A healthy and productive vegetable garden starts at ground level.
Because soil is a living system, it needs as much care and attention as the plants that grow in it. A good understanding of your soil will help you decide how best to care for it.

What is soil?

Soil is a mixture of solids, spaces, and living organisms.

About 97% of the solid part of soil is mineral, mainly made of rock that has been broken down into tiny particles. The type of rock (also known as parent material) has a big influence on the type of soil that develops. For example, sandstone weathers into sandy soil while shale produces a more clayey soil.

The remaining 3% or so of the solid part of soil is organic matter. Organic matter is a mix of dead plant and animal materials in various states of decomposition plus living organisms and plant parts that reside in the soil.

Depending on texture, 30-60% of soil is space. The spaces range in size from tiny micropores to relatively large macropores. Under ideal conditions, all the tiniest spaces are filled with water while the rest are filled with air.

The living part of the soil is what keeps it productive. Billions of microorganisms decompose dead plant and animal material, releasing nutrients and organic matter. Animals and living plants do their part by adding organic matter and mixing and loosening the soil.

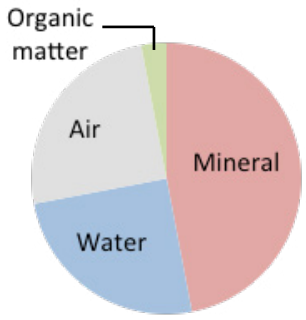


Figure 1. The mixture of parts in a typical soil. © *Desiree Jans, Dalhousie.*

Soil texture

The mineral part of soil is a mix of rocks, gravel and soil particles (pieces 2mm or less in diameter). Depending on their size, soil particles can be classified from largest to smallest, as sand, silt, or clay. The relative percentages of sand, silt, and clay determine the texture of your soil.

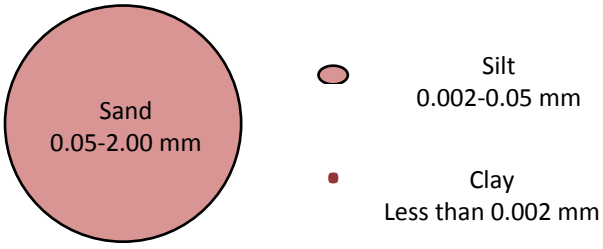


Figure 2. The relative sizes of sand, silt, and clay particles in soil. © *Desiree Jans, Dalhousie.*

Soils with lots of sand aren't very good at holding water or nutrients. Clayey soils can have drainage problems and plant roots may have trouble growing through these tight packed sticky soils. Of course, most soils are a mix of particle sizes. The ideal gardening soil is a loam; 40% sand, 40% silt, and 20% clay. Knowing the texture of your soil will help predict how it will respond to cultivation and what plants will grow well.

Learning to evaluate your soil's texture will help you manage it for both productivity and longevity.
© R. Campbell, Dalhousie.

Soil structure

Soil structure refers to the way in which soil particles are grouped together. The ideal soil for vegetable gardens is made up of small, loose granules or aggregates. It allows good movement of air and water; plant roots and soil organisms move easily through the spaces between granules.

Both biological and chemical forces are at work making soil granules. Sticky secretions of soil bacteria and hair-like threads of soil fungi bind soil particles together, as do the activities of earthworms. Calcium also helps pull soil particles together.

Soil pH

Soil pH is a measure of how acid or alkaline the soil is. The pH scale goes from 1 (most acidic) to 14 (most alkaline), with 7 being neutral.

Nutrients form different compounds depending on the soil pH. Some of the compounds are soluble in water; some are not. To be useful to plants, nutrients must be soluble. A pH between 6.5 and 7.0 keeps most of the soil nutrients in a soluble form. Most plants and soil organisms do well in this range.

As soil pH goes down (more acidic), phosphorus, calcium, and magnesium get tied up in insoluble compounds and become less available to plants. As pH goes up (more alkaline), iron and manganese become less available.

Soil nutrients

Plants need relatively large amounts of nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur (referred to as macronutrients). They need smaller amounts of iron, manganese, boron, molybdenum, copper, zinc, chlorine, and nickel (referred to as micronutrients). Ideally, the soil should supply all these essential nutrients.

Some nutrients become available as parent material breaks down but the most important source of nutrients is decomposing organic matter. Of course, you can also add specific nutrients to your soil in the form of organic and inorganic fertilizers. That's why it is so important to feed the soil with plenty of organic matter. It keeps the soil organisms happy and the essential nutrients flowing.

Soil testing

Check soil pH and fertility by having your soil analyzed at least once every three years. The best time to take soil samples is in the fall but whether spring or fall; make sure to take future samples at the same time of year so that you can compare results.

For a modest fee, soil samples can be analyzed by your Provincial Soils Lab. The lab will mail results to you with recommendations for correcting any deficiencies or other problems that may exist. Private companies also do soil testing; these give detailed reports and recommendations in many cases, but may be expensive. See the Activity below for instructions on how to collect a soil sample.

Soil organisms

Healthy soil is teaming with life. Soil organisms you can see with your bare eye are called macroorganisms; these include worms, beetles, and plant roots. Organisms that can only be seen with a microscope are called microorganisms; these include a huge number of different bacteria, fungi, and protozoa.

It's the soil life that allows soil to function as a base for growing plants. It ties together the soil physical and chemical properties. For example, fungi and bacteria get their energy by breaking down dead plant and animal matter. At the same time, they release nutrients in a form that plants can use. They also produce sticky substances that bind soil particles together to form granules. Soil macroorganisms further improve soil by breaking down larger residues and mixing the soil.

You can support a vigorous and well balanced population of soil organisms by adding plenty of organic matter (especially compost), making sure the soil is well aerated, and keeping it evenly moist.

Earthworms are soil macroorganisms. They help transform organic residues into humus and aerate the soil with their tunneling. © Desiree Jans, Dalhousie.

Activity 1

Follow these steps to take a soil sample from your garden

STEP 1: Obtain soil sample boxes and sample submission forms from your Provincial Soil Testing Lab.

STEP 2: Use a garden trowel to dig down 12 to 15 cm (5 to 6 inches) in 6 to 10 different areas of your garden.

STEP 3: Place samples from each area into a clean bucket. Remove plant debris. Mix the soil samples together.

STEP 4: From this mixture, take a 500 mL (2 cup) sample. This mixed sample will represent your garden soil.

STEP 5: Place the 500 mL (2 cup) sample into the box. If you do not have a soil box, a freezer bag that can hold the full sample of soil can be used.

STEP 6: When you receive your soil test results, have a look at the factsheet on 'Understanding the soil test report' available http://www.gov.ns.ca/agri/qe/factsheets/understand-soil.pdf or consult your local agricultural representative, professional garden or farm supply specialist about recommendations.

PROVINCIAL SOIL TESTING LABS

Nova Scotia Department of Agriculture, Quality Evaluation Division, Laboratory Services
176 College Road (Harlow Institute)
Truro, Nova Scotia B2N 2P3
gov.ns.ca/agri/qe/labserv/soilsamp.shtml

NB Dept. Of Agriculture, Fisheries and Aquaculture
Box 6000, Fredericton, NB, E3B 5H1
506-453-3495
www.gnb.ca/0179/01790003-E.ASP

P.E.I. Soil and Feed Testing Lab
P.O. Box 1600, Research Station
Charlottetown, PEI C1A 7N3
902-368-5631; www.gov.pe.ca/af/soilfeed

Newfoundland Soil Plant and Feed Laboratory
Department of Forest Resources and Agrifoods,
Provincial Agriculture Building
Box 8700, Brookfield Road, St. John's, NF, A1B 4J6
709-729-6638
www.nr.gov.nl.ca/nr/agrifoods/land_resources/soils/soilpflab.pdf

Activity 2

Use these two tests to figure out your soil's texture.

THE FEEL TEST:
Scoop up a bit of soil and moisten it with water. Make a ball about the size of a grape between your palms then try to make a rope. If your rope holds together, you likely have more than 15% clay; the longer and thinner the rope, the more clay is in your soil. Now put a little soil in your palm and add enough water to make a puddle. If it feels gritty, your soil is sandy. If it feels smooth or slippery, your soil is silty.

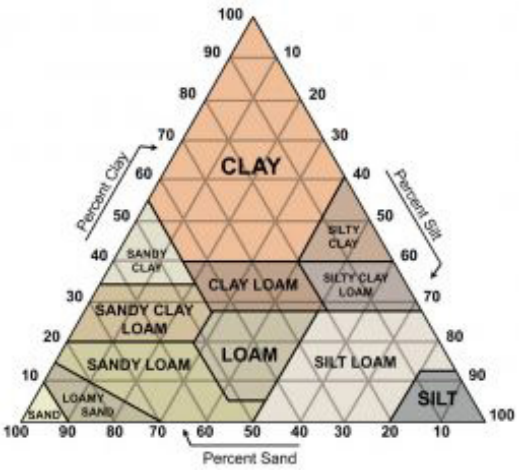
THE JAR TEST:
This test is more accurate but requires some time.
You will need:

- 1 cup of air dried soil collected from different parts of your garden
- A clean, fairly narrow glass jar with lid
- Distilled water
- Masking tape or pen to mark on the jar, and a ruler
- 1 tsp of non-sudsing dishwasher detergent OR 1 tsp of baking soda (To figure out which one to use, mix a tsp of vinegar with a tsp of soil. If it fizzes, your soil is high in lime; use baking soda).

Crush the soil with a hammer (it should be quite fine). Pick out rocks, sticks, and leaves. Place the soil in the jar, add the detergent, fill the jar two-thirds full of water, and close the lid tightly. Shake the jar vigorously for one to two minutes, then set it down in a spot where it will be undisturbed for 3-4 days.

One minute after you set the jar down, the sand particles will settle out. Mark the soil level with masking tape or pen – this is level A. Wait 2 hours for the silt to settle, then mark the new soil level – this is level B. Let the jar rest for 3-4 days, until the clay settles, then mark the new soil level - level C. Measure the height of each layer from the bottom of the jar. Use this 'textural triangle'
to figure out the textural class of your soil.

EQUATIONS
Percent sand = (A/C) x 100
Percent silt = [(B-A)/C] x 100
Percent clay = [(C-B)/C x 100



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