Soils and Gardening in the North

Manitoba Agriculture, Food and Rural Initiatives

Soil Overview

Soils form the uppermost layer of the Earth's surface and productive soil is one of our most valuable resources. Man's first interest in the soil came from its ability to produce plants for food and fibre. Most of our food and much of our shelter and clothing comes from materials produced by the soil.

Soils vary significantly in their properties. They may be deep in some places, shallow in others; black or gray in color, sandy or clay-like in texture. But all soils have some things in common. All soil is a mixture of organic and mineral material plus water and air. It is the proportion of these factors that makes all the different kinds of soil.

Soil Components

Soil is made up of two main parts: a solid part and the pore space. The solid part is made up of organic matter and a mineral or inorganic portion. The pore space between soil particles, is occupied by air and water and is just as important as the solid part. The proportion of these four components affect soil properties and how the soil can be used.

- **The Pore Space—Air and Water**

The pore space contains air and water. They are essential for plant growth and soil microorganism activity. The pore space also allows for an exchange of gases between the soil and the atmosphere.

The amount of pore space, or porosity, is determined by the arrangement of solid particles in the soil. Sandy soils have a low total porosity, fewer, large pores. Clay soils have a higher total porosity because they are made up mostly of very small pores.

Air and water move easier through soils with large pores but these soils also cannot hold much water. Water in such large pore spaces is not held tightly and is pulled down through the soil by gravity. Clay soils have small pores that slow air and water movement, but contribute to a higher water holding capacity. For this reason, clay soils are more likely to become waterlogged than sandy or loamy soils because they have very small pores that allow water to move through it more slowly. Clay soils tend to be inadequate for satisfactory root development and microbial activity.

- **The Solid Part—Organic Matter**

The organic portion of soils is formed by the accumulation of the residues of plants, animals, insects and microorganisms. Over time, these materials decompose and become part of the soil. These materials improve the soil's structure and ability to hold water. The organic content of soils ranges from one to 12 percent, in mineral soils, all the way up to 98 percent in peat soils. Climate and native vegetation determines the amount of organic matter in the soils.

- **The Solid Part—Mineral Matter**

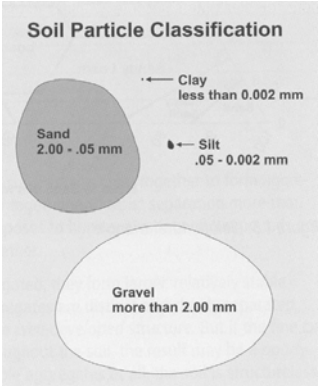
Mineral content comes from the weathering and breaking down of the rocks and minerals at the Earth's surface. Mineral ingredients in soils vary in type, size and proportion. This proportion of silt, sand and clay-sized particles determines soil texture.

Soil Properties

- **Texture**

The mineral particles in soil are commonly grouped according to size into sand, silt and clay. Sand particles are visible to the naked eye but clay-size particles are invisible even under a microscope. See picture below. Silt particles fall between these two in size. Soil texture is determined by the proportion of sand, silt, and clay particles making up the soil mix. Texture refers to the way a soil feels and the way it handles when wet or when it is dry.

A soil that has a large proportion of clay size particles is clayey in texture. A soil containing nearly equal proportions of sand, silt, and clay size particles is called a loam. A soil that contains a large proportion of sand size particles has a sandy texture. The presence of coarser particles, larger than coarse sand, is considered gravelly, cobbly or stony.



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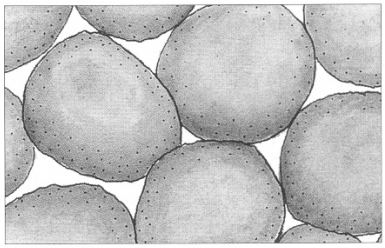
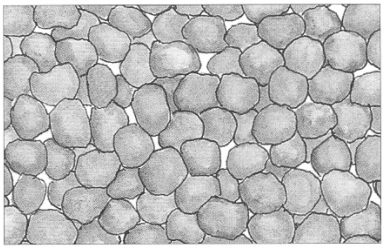
Soil texture strongly influences the soil's ability to hold moisture, its general level of fertility, and ease of tillage. Water moves easily through coarse-textured (sandy) soils, so little moisture is retained and these soils dry out more quickly than clayey soils. Sandy soils also do not retain plant nutrients as well as finer textured soils and are lower in natural fertility. Sandy soils often have a loose or single grained structure which is very prone to wind erosion.

Fine-textured clayey soils have a high proportion of tiny clay particles and very small pore spaces which hold moisture tightly. Also, clayey soils are usually more fertile because they are able to retain plant nutrients. The clay particles also cause fine-textured soils to swell when they are wet and crack as they shrink with drying.



BIGGER PARTICLES of sandy soils have more air spaces between them. When water is applied, it drains through freely.



FINE PARTICLES of clay soils pack together closely, excluding air and making penetration of water slow and difficult.

Medium-textured (loamy) soils have properties that fall between the extremes of coarse and fine-textured soils. They are generally fertile, able to retain enough moisture for plant use and are relatively easy to till. For these reasons, loamy (medium-textured) soils are the best soils for gardens.

If you're interested in determining what kind of soil you have in your garden spot, try the method on the last page.

Maintaining Soil Quality

- **Too Much Clay**

The north has a lot of clay soil. While clay tends to be much higher in nutrients than sandy soil, it is one of the most difficult soils for a gardeners. It tends to be dense and sticky when wet, becomes very slippery when soaked and packs like pavement when dry. This is because clay particles are extremely small and clump together.

When clay soils are worked when in wet or "plastic" condition, the pore space in the soil will be reduced. This will make the soil virtually resistant to air and water. When this soil dries, it becomes hard and dense leaving no room for air, water or root movement. Tilling dry clay soils turns up clods which are difficult to work down into a good seedbed.

Tillage on clay soils must be carefully timed so that the moisture content is slightly below that needed to produce a plastic, slightly sticky consistency— not too wet, not too dry.

Clay soils can be improved by adding organic matter. This will be an ongoing process, not one that can be solved in one season, but the benefits will pay off in the long run. Generous additions of compost, leaf mold, peat moss (muskeg from the bush), composted materials or other organic matter will gradually bulk up the texture of clay soils, making them more suitable for gardening. They can be worked in to the clay soils and over time will improve the texture.

- **Soil Temperature**

When we think of the effects of temperature on plant growth, we usually think only of the environment above the soil surface. Although that is very important, 50 percent or more of the plant is in the soil, so soil temperature is an important part of the plant's total environment.

Seed germination—when the plant starts to grow- is one of the most important processes affected by soil temperature. In general, soil temperatures in spring are not ideal for germination. This means germination and early garden growth is depends almost entirely on soil temperature.

Peas can tolerate very low soil temperatures, germinating when temperatures rise just above freezing (1to 3° C). Other vegetables, such as potatoes, require temperatures of 5 to 7° C. Beans and corn are unable to germinate unless the temperature rises above 10° C. Note that these are minimum temperatures for germination. Another 5 to10 degrees is needed for ideal growth. Soil temperature can be determined by placing a thermometer in the soil with the bulb at the same depth as the seeds will be placed.

- **Soil Fertility**

Of the 16 elements needed for plant growth, three—carbon, hydrogen, and oxygen—come from the air and water. Of the remaining 13, nitrogen, phosphorus, and potassium are needed in the largest amounts.

Northern clay and sandy soils are naturally low in these nutrients. Household compost, waste fish (watch out for animals wanting to dig in your garden) and well rotted animal manures are inexpensive ways that gardeners can add nutrients to the soil for plant use.

When looking to use commercial fertilizers, the main ingredients of all-purpose fertilizers are nitrogen, phosphorus and potassium. These all-purpose fertilizers help maintain nutrient levels for most plants in average soil. They are available in solid form (as powders or granules) and in liquid form. Liquids have the advantage of being easily applied and quickly absorbed, though they are generally more expensive. They do not remain in the soil as long as solid fertilizers, so they must be applied more often and in smaller doses.

When buying a commercial fertilizer, you will find at least three numbers on the label (10-6-4, for example). This is the NPK rating. The first number always represents the percentage of nitrogen (N); the second stands for the percentage of phosphorus (P); and the third, the percentage of potassium (K) in the form of potash. If one of these nutrients is missing, a zero indicates its absence.
Commercial fertilizer, either granular or liquid are another way to add nutrients to the soil— 1/3 pound of a water soluble fertilizer such as 16-20-0 or 11-48-0 is a general recommendation.

- **The pH Level—Acid or Alkaline**

Acidity and alkalinity are measured on the pH scale, which runs from 0 (pure acid) to 14 (pure lye). Neutral is 7.

Slightly acid soil—about pH 6.5 is best for most plants. Most garden soils, including peat soils, are slightly acid and tend to become more so as fertilizers and humus are worked in and various chemicals are leached out.

To increase the alkalinity of the soil, use finely ground limestone. To increase the acidity of the soil, sulfur can be used. Both are usually available from garden supply centres. The amount needed depends on the soil texture. When changing the pH, there is always the danger of overdoing it so make changes in small steps.

- **Not Enough Soil**

Some communities have very sandy soil or very little soil at all to work with. The best way to garden in these communities is to build a frame (like a sandbox) and then fill it with a mixture of good soil from another area of the community, compost, etc. The frame keeps the soil together and keeps it from settling out in to other areas of the yard and “disappearing”.

Compost is a way of converting organic materials in to soil that can be added to the garden. Compost is a mixture of kitchen scraps, such as coffee grounds, tea bags, egg shells and orange peel, mixed with dried leaves, potato tops from the garden and a little garden soil. Avoid cooked food scraps and anything containing grease, as well as diseased plants, the roots of perennial weeds, and seeds of annual weeds. This is all piled in a bin and allowed to rot over the summer to form a loose soil like peat or muskeg.

The advantage to compost is that it contains nutrients for plants. Nutrients give plants the energy to grow faster, bigger and produce more for harvest.

- **Loose Soil**

A firm seedbed is normally required for good germination. The seed must absorb water from the soil to germinate and this is encouraged by the seed’s close contact of the soil. Sometimes peat or organic soils are too “fluffy” or loose for this to occur. A well packed seedbed also reduces the loss of moisture from tilled soils. Packing soil in a garden can be done by walking along the garden row and making sure to step on the seed row.

- **Water—Too Much or Not Enough**

Nutrients are useless to plants until they have been dissolved in water. They are equally useless to ordinary land plants if they are in waterlogged soil so it is important that plants have the right amount of water.

Too much moisture may be a result of poor drainage which may simply be the result of a compacted soil. This problem is fairly easily solved by digging deep in to the subsoil and then working in porous material to lighten the subsoil. If this doesn’t work, it may mean the

water table is too high and you will have to choose between growing only shallow-rooted plants, raising the garden, lowering the water table through drainage or relocating the garden site.

A garden with too little water is easier to solve. A quick way to determine if water is needed, pick up a handful of soil and squeeze it into a ball. If it holds its shape, it's probably moist enough. If it crumbles easily, more water may be needed.

When watering, soak the soil to at least a foot deep. Mere surface sprinkling encourages shallow roots, which are vulnerable to scorching in the hot sun.

How often you should water your garden depends on the condition of your soil, the weather, the kinds of plants you are growing and their location. Vegetables, on average, need twice as much water as flowers. Newly planted trees and shrubs need frequent watering in dry weather. Plants sheltered by walls or hedges may need watering even after a rain, but they are not likely to dry out as fast as plants in the open. Plants high on a slope will dry out faster than those at the bottom. Plants growing in light, sandy soil need watering more often than those growing in heavier soil.

The garden needs about one inch of water a week. If there's not enough rain, you'll need to water with a hose or watering can. To measure how much you've watered, set out an open container in your garden, marked off in half inches. Aim for your garden to get 1 to 1.5 inches of water a week. Schedule your watering for the mornings or early afternoon, so that leaves can dry off before nightfall. Wet leaves are more susceptible to fungus diseases. Overcast days are better than sunny days, because the water will evaporate less quickly.

Working the Soil

A good seedbed should be warm, moist, and firm under the seed and provide good seed-soil contact. Soil should be worked to a depth of eight to 10 inches.

No matter how large or small your garden is, certain tools are needed to ensure a good seedbed and tillage throughout the season.

It is important to have a sharp spade to open the soil, a garden fork to break it up, a shovel for digging and a level-head rake to crumble the surface. Then, you will need a trowel for small-scale digging, a good garden hoe and perhaps a Dutch hoe to keep weeds down. Unless you want to haul water to your garden spot, a long garden hose, equipped with an adjustable nozzle will provide water during the summer.

What is your soil type?

Drip water onto about a tablespoon of fine soil held in your hand. Squeeze and roll the soil until it just starts to stick to your hand. The extent to which it can then be shaped (see drawing below) gives you a rough idea of its texture class.

Method and drawings after Ilaco (1985)

(A) Sand - remains loose and single-grained, can be heaped, but not formed.

(B) Sand loam - can be shaped into a ball that easily falls apart — with more silt, it can be rolled into a short thick cylinder, called a ***silt loam C) .***

(D) Loam - about equal sand, silt and clay, can be rolled into a thick thread about 15 cm long, that breaks when bent.

(E) Clay loam - soil can be rolled as above but can also be bent carefully to a U shape without breaking.

(F) Light clay - soil feels smooth, can be bent into a circle with some cracks.

(G) Clay - handles like plasticine, can be bent into a circle without cracks.