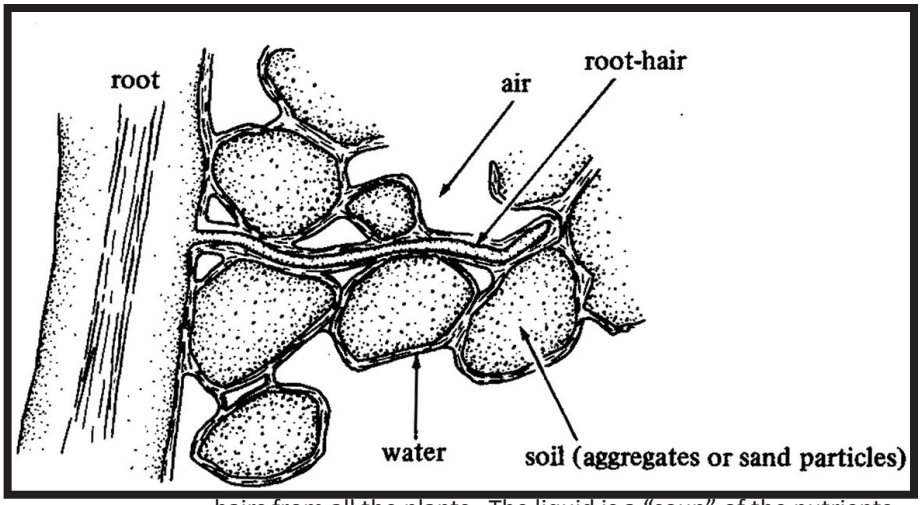
Understanding your Garden Soil

Frank Almquist - Hudson Adirondack Daylily Society

Master Gardener
Cornell Cooperative Extension – Ulster County



Introduction

The interaction between geology and climate over the millennia has created the soils we use today. Running water, freezing and thawing cycles, and heating and cooling cause rock to disintegrate into smaller and smaller pieces. Soil microbes, algae, fungi, chemical interactions and organic matter add into this mixture. Humus, the near end breakdown of organic matter is an important component that ultimately makes what we call "top soil". Soils are complex biochemical systems in which plants grow. All soils have structural and biological properties that distinguish them from the materials from which they were originated. Most important, soil is a dynamic ecological environment that provides plants with support, water, nutrients and air. All these ingredients are needed for plant growth. In addition, soil supports a large microorganism population that recycles organic matter.

Typical garden soil is a mixture of minerals, decaying organic materials, water, air and many living organisms, from bacteria to larger creatures such as earthworms and beetles. We will discuss what garden soil is, how it supports a plant (both mechanically and with nutrients). We will also cover fertilizers, how to understand the numbers on a bag label, and how the individual nutrients aid your plants.

Constituents

Soil is made up of three constituents, sand, silt, and clay. Sand, the type found on a beach, silt from those wooded places un-dug for years, and clay - that hard grey to yellow material that doesn't seem to break down. Sand is made up of fine particles of stone, primarily silicon dioxide. These particles range in size from the thickness of a piece of paper (0.1 mm) to the thickness of two dimes (2 mm). Clay is found as microscopic particles of aluminum and magnesium based compounds in the structure of microscopic flat plates. Clay is typically 1000 times smaller than the smallest sand particle. Silt fills the space between the clay particles and the smaller sand particles. All plant nutrients come from organic constituent portions of the soil. Biological decomposition of plant material form silt that provides the necessary ingredients for plant growth. Bacterial action on organic material, in conjunction with water and air provides the plants with a solution rich in minerals.

How do these three soil components work together? Imagine you shrink small enough to fit in among these particles. The clay particles would be the size of Lego blocks. The sand will now be the size of a garden tractor. Have you noticed we can still breathe? Air is present in a well-mixed soil provided it is not compacted or saturated. You will see a thin layer of liquid attached to the surface of the particles and what look like large ropes lying against that liquid. These "ropes" are the root hairs from all the plants. The liquid is a "soup" of the nutrients that every plant must have to grow and flourish. The nutrients in the solution are absorbed though the root hair cell wall and into the interior where they are passed on to other parts of the plant. These nutrients are used to build stems, leaves, and reproductive parts, the fruit.

Soil Makeup

Now that we know about the three main parts of soil, we should know how much of each is needed for good plant growth. We know that all clay is not a good growing medium. We cannot even get our hands into that material. All sand is no good either, water will run through it and plants will dry out rapidly. Organic material is required to amend the soil, hold moisture, and provide the home for microorganisms that put soil minerals into forms plants can use. The organic material (humus, loam, silt) is the gap filler between the sand and clay particles. It is this material that makes your soil friable or easy to work. Good soil texture should be such that when it is firmly squeezed in your hand then released, it relaxes into a soft ball. All sand will immediately fall apart and clay will seldom come apart.

Shown on the opposite page is a *soil triangle* that graphs the percentage of each of the three constituents, clay on the left side, silt on the right and sand across the bottom. The clay percentage increases from 0 to 100% from the lower left to the apex. The silt percentage follows the right side from 0% at the apex to 100% at the lower right. The sand percentage increases from 0% at the right to 100% at the left. On the triangle is an oval that helps locate the components of a good garden soil. The mix should include sand, silt and some clay which all help in the nutritive and physical support of plants.

Check your soil

How do you know what your soil is like? Go to each of your garden beds and do this sampling independently or you can mix the soil all together. Dig down four to six inches, the depth of the plant roots and remove a few spoonfuls of soil. Mix the soil thoroughly, removing coarse material. Put the soil mix into a tall jar, like an olive jar, about 2/3^{rds} full, add a few drops of a dishwashing liquid then fill the jar almost full with water. Shake vigorously, and let stand for a few days. The soil will settle out with the sand on the bottom, silt in the middle and clay on the top.

To determine your soil consistency, calculate the percentage of each component and mark the value on the appropriate arm of the soil triangle. Draw a line from the percent of sand number parallel with the right side of the triangle to the other side. Next, draw a second line for the silt number parallel with the left

side of the triangle. Now, draw a line parallel to the bottom of the triangle from the point for percent of clay. The intersection of the three lines indicates your type of soil.

Now that the composition of your soil has been determined, you can add the appropriate amendments to move into the area of better soil consistency. In most cases, more organic material must be added. Typically, one to two inches of compost tilled into the soil will provide a source for the microbes and other bacteria the soil needs to turn the minerals in sand and clay into usable plant nutrients.

Soil Nutrients

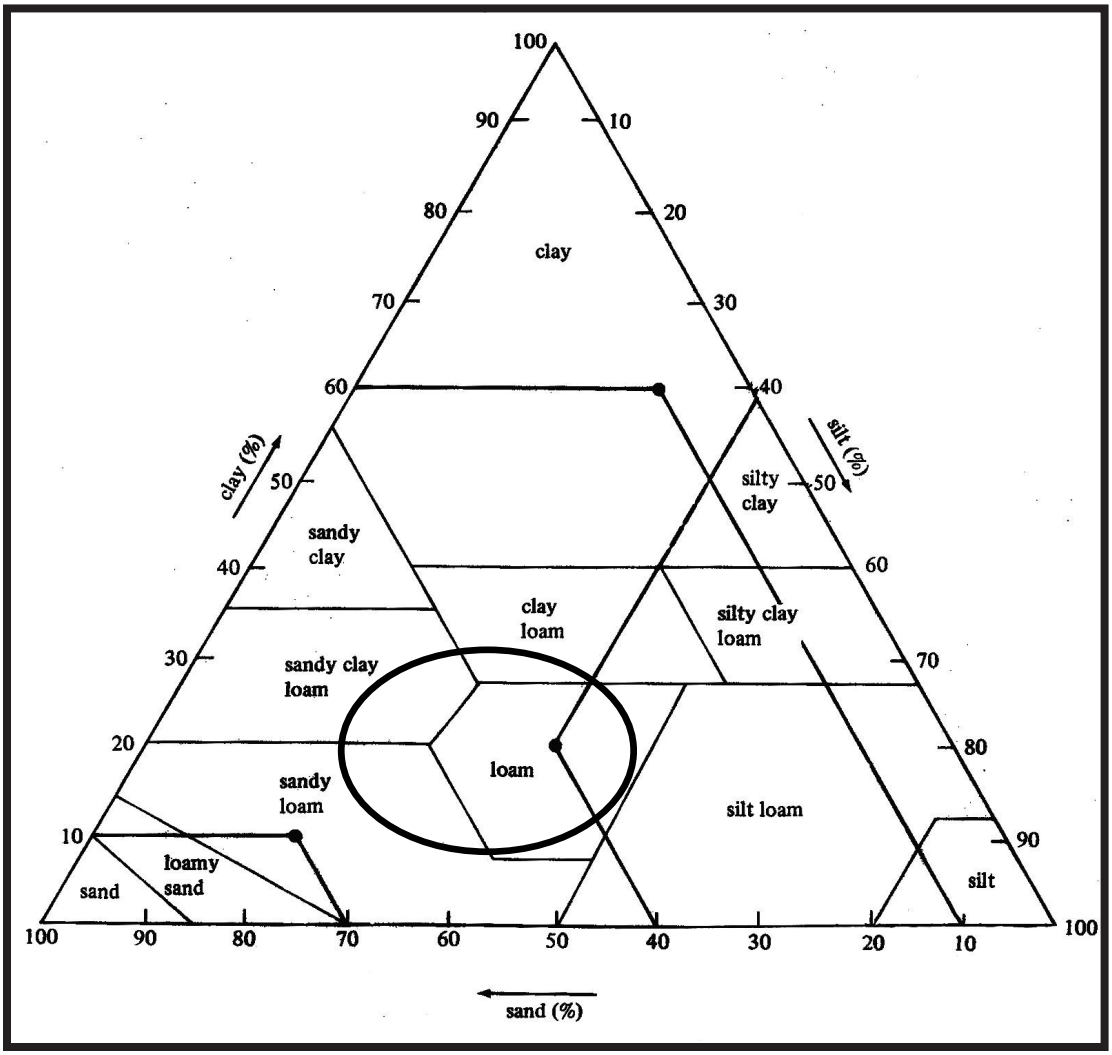
Compost is a soil amendment. It is **NOT** a primary source for the three basic elements plants need, Nitrogen, Phosphorus, and Potassium (N-P-K). If one were to test compost for these elements, the results would read well under 1 - 1 - 1. These three are natural materials that must be added to the soil through the use of fertilizers. Inorganic or organic fertilizers do the same thing to improve soil nutrition. Organics have much slower release of the three ingredients than does an inorganic fertilizer. However, most necessary, trace elements found in organic fertilizers are not found in the inorganic materials.

The most-commonly applied nutrients are nitrogen (N), phosphorus (P), and potassium (K). Plant response to all three elements is quite strong, and it became customary to apply the three together. As a result, all three are still applied even though there are many situations, especially in gardens and landscapes, where plants may not respond to one or more of these nutrients. Nitrogen always evokes a growth response while potassium and phosphorus are slow to affect the plant. Phosphorus stays in the soil, therefore, additional applications may be of little or no value. Phosphorus is released from the soil to the plants by breakdown of phosphates depending on soil pH. Spring thaw and excessive rain may cause the some nutrients to leach out of the soil so use of a complete fertilizer is still recommended.

Other plant-essential nutrients called macronutrients that are used in smaller quantities are calcium (Ca), magnesium (Mg), and sulfur (S). However, fertilization with these nutrients is not usually necessary because the Ca and Mg contents of soil are generally sufficient for most plant species. Also, large quantities of Ca and Mg are supplied when acidic soil is limed with dolomite. Sulfur is usually present in sufficient quantities from the slow decomposition of soil organic matter, an important reason for composting grass clippings and leaves.

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. The micronutrients are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), cobalt (Co), nickel (Ni), and chlorine (Cl). If one of your plant species has a micronutrient deficiency, apply the recommended rate of the deficient nutrient. Recycling organic matter such as grass clippings and tree leaves is an excellent means of providing micronutrients (as well as macronutrients) to growing plants.

Without performing a soil test for the three main components, the best advice is the spring use of a simple well balanced fertilizer, 5-5-5 or 10-10-10. These numbers indicate the percent of Nitrogen, Phosphorus and Potassium by weight in the bag of fertilizer. If you have a fifty pound bag of 10-10-10, there would be five pounds each of available nitrogen, phosphorus, and potassium. Keep in mind that many of the liquid organic fertilizers such as fish emulsion or seaweed blends are high in micronutrients but also high in nitrogen, which stimulates strong foliar growth.



Plant Nutrition

Eighteen elements are considered essential for plant growth. Carbon, hydrogen, and oxygen are primarily supplied by air and water. Plant roots absorb the remaining elements from the soil. These elements are divided into three groups based on their relative abundance in plants: Primary Nutrients, Secondary Nutrients (or Macro Nutrients), and

Micronutrients. Although the Primary Nutrients are needed in the greatest quantities, a deficiency of any nutrient can limit plant growth. Even though some soils may already contain all nutrients, they may not be in a form available for plant growth. The best way to ensure that all of the nutrients are available in the soil is through regular applications of plant foods. The table below provides more information on each nutrient, its deficiency symptoms, and possible plant foods to cure the deficiency.

Primary Nutrients	**Function**	**Deficiency Symptoms**	***Solutions**
Nitrogen	Vigorous growth & dark green color	Light green leaves; stunted growth	Dried Blood, Garden Manure, Cottonseed Meal, Ammonium Sulfate, Urea
Phosphorus	Root development & flowering	Smaller yields of seeds & fruit; purplish leaves, stems & branches;	Rock Phosphate, Bone Meal, Single Superphosphate, Triple Superphosphate
Potassium	Overall hardiness & disease resistance	Reduced yields; Spotted or curled leaves; Weak root system	Sulfate of Potash, Sulfate of Potash Magnesia, Muriate of Potash, Greensand

Secondary Nutrients	**Function**	**Deficiency Symptoms**	***Solutions**
Calcium	Plant vigor; Aids in uptake of nutrients	Deformed terminal leaves; Poor root growth	Garden Lime, Garden Gypsum
Magnesium	Essential part of chlorophyll	Yellowing of older leaves	Garden Lime, Sulfate of Potash Magnesia
Sulfur	Dark green color; Seed production	Yellow leaves; Stunted, spindly plants	Garden Sulfur, Sulfate of Potash, Gypsum

Micronutrients	**Function**	**Deficiency Symptoms**	***Solutions**
Boron	Increases flowering & fruit development	Terminal buds die; Less flowers & fruit develop	Garden Manure, Bone Meal
Chlorine	Helps control water loss & moisture stress	Plants wilt; yellow leaves	Muriate of Potash, Garden Manure, Greensand
Cobalt	Improves growth & transpiration	Reduced growth and yellowing of foliage	Greensand, Kelp, Cottonseed Meal
Copper	Helps produce chlorophyll	Yellow, wilted leaves; Lack of flowering	Garden Manure, Greensand
Iron	Promotes dark green leaves	Yellow leaves	Greensand, Garden Manure, Cottonseed Meal
Manganese	Helps produce chlorophyll	Intervenous chlorosis in younger leaves	Garden Manure, Greensand
Molybdenum	Essential in some enzyme systems	Pale green, rolled or cupped leaves	Greensand, Lime (makes it more available)
Sodium	Aids water regulation & photosynthesis	Plants wilt	Kelp, Garden Manure, Bone Meal, Greensand
Zinc	Enzyme & growth hormone production	Yellow leaves, Rosetted (clustered) leaves	Garden Manure, Greensand, Cottonseed Meal

Daylilies

Daylilies will grow acceptably without fertilizer, however, addition of nutrients is highly recommended for optimum growth and flowering. The plants prefer moderate nitrogen and higher rates of potassium. As mentioned earlier, phosphorus is always in the soil. Proper pH (6.0-6.5) and soil moisture are necessary to make P available to the plants. Slow-release or organic fertilizers are best for late spring and summer use. Spring fertilization is done by using a general purpose fertilizer (10-10-10) before the ground thaws. Broadcast the material around the plant crowns while the soil can still be walked on. This feeding provides nutrients as soon as the ground thaws and the plant wakes up. Most of us have seen Brian Culver's leek size plants at auctions. Early fertilization is his "secret", as well as loose, silt rich soil. As soon as spring growth is around 4-6 inches, apply a slow-release or an organic fertilizer, then again in midsummer. Never fertilize after mid-August. Late fertilizer applications encourage new foliar growth that will weaken the plant. Water after applying fertilizer or time your applications before a rain.

Mix a generous hand-full of most any organic fertilizer (Espoma is one brand) into the soil when planting a new daylily. If the ground is cold, the material will be there when the soil organisms become active, usually a soil temperature above 50-55F. Topdressing with more organic fertilizer just before blooming will provide the plant with more nutrients to get it through this energy hungry period.

References:

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2) **Soil Fertility and Fertilizers**, Tildale, Samuel L., Nelson, Werner L., Beaton, James D., Havlin, John L., Prentice Hall, Inc. 1993

3) **Websites**

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