K·STATE Research and Extension
Master Gardener
Johnson County

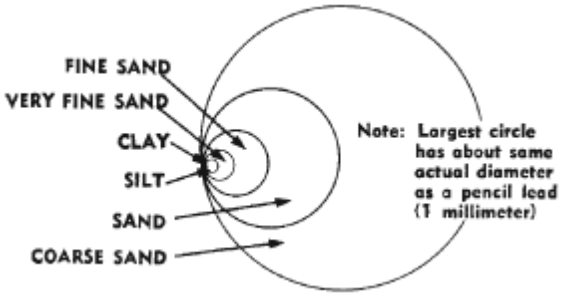
Soil … More Than Just Dirt

Good soil is the foundation of successful gardening because it helps develop strong roots and a healthy plant. Learning to manage soil is an important and often overlooked aspect of gardening.

Soil provides physical support for roots, which anchor plants to the ground. It acts as a reservoir for nutrients, water and oxygen.

Soil is composed of …

- **Sand, silt and clay particles** of various sizes.
- **Minerals and nutrients** such as nitrogen, phosphorous, potassium, iron and sulfur.
- **Air**, which provides oxygen to the roots and to microorganisms.
- **Water**, which carries moisture and nutrients to plant roots.



- **Humus**, which is partially decomposed vegetative and animal products.
- **Fungi and bacteria**, which help break down dead organic matter.
- **Insects, earthworms and small mammals that burrow** into the soil, thereby aerating, loosening and separating the soil particles.

Gardening is considered both an art and a science. Choosing plants and designing their placement is the art. Learning what plants need and how to provide the correct soil environment is the science. Hard work is involved in creating a "good" soil, but the reward is a more beautiful and productive garden. As the old adage states, "Grow the roots and the plant will follow."

Characteristics of "Good" Soil

pH factor

The soil's level of acidity or alkalinity is measured by the pH factor. It is important because of the effect pH has on soil minerals and microorganisms. Soil minerals are more available to plants if the pH is close to neutral or 7. The action of soil microorganisms is more vigorous when soil pH is between 6 and 7. Some plants also require a specific soil pH.

Water retention and drainage

An ideal soil retains enough water to keep plant roots moist and allows for the absorption of nutrients. There should be sufficient drainage so that the spaces between soil particles are able to hold enough air and oxygen for the roots. If the soil drains too quickly, plants may not have a chance to absorb enough water to adequately sustain their growth, no matter how often you water. If the soil retains too much water, the roots may suffocate and rot, leading to plant death.

A simple test can determine if you have a drainage problem. Dig a hole 6 inches wide and 1 foot deep. Fill the hole with water and let it drain. When the water has drained completely, fill the hole with water again and this time keep track of how long it takes for the water to drain from the hole.

If the water drains completely within three hours or less, your soil drains too rapidly, probably due to high sand content. Usually this is not a problem in the Kansas City area. If water is still standing in the hole after eight hours, your soil is draining too slowly. This type of drainage problem is often due to excessive clay in the soil. If the water drains within four to six hours, congratulations! You don't have a drainage problem.

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Fertility

Plants grow better in soils that are fertile or rich in nutrients. Nitrogen, phosphorus and potassium are the major nutrients that plants need from the soil. They also require sufficient levels of calcium, magnesium and other micronutrients. Soils lacking in nutrients do not support healthy plant growth. Because nitrogen is highly soluble in water, it leaches out of the soil quickly and a deficiency can develop. An excess of nutrients can also be a problem. Excess nutrients can come from naturally occurring soil minerals, irrigation water, fertilizers, lack of rain or poor drainage.

Soil texture

The proportions of sand, silt and clay determine soil texture. Ideal soil, or loam, consists of 40% sand, 40% silt and 20% clay.

To literally get a feel for the texture of your soil, perform a squeeze test. Dig about 5 inches below the surface of your lawn or garden and collect a handful of soil. Roll the soil in your hand until it's about the size of a golf ball. Squeeze the ball tightly in your hand and release.

- If it fails to hold together at all, the soil is sandy.
- If the soil crumbles into loose clumps and is not sticky, it has a well-balanced texture.
- If it is sticky and holds its shape, it has a fair amount of clay.
- If you can squeeze it between your thumb and forefinger into a ribbon or roll it into a snake, it has more clay than you want.

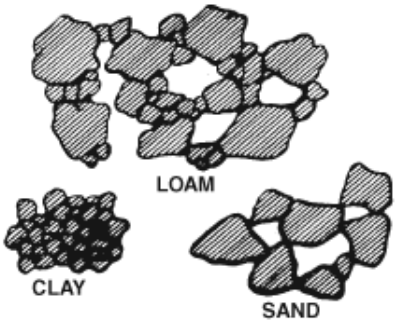
Soil structure

Soil structure is the way the soil particles fit together to create pore spaces. The size of pore spaces plays a key role in plant growth. In fine-textured clay soils a lack of large pore spaces restricts water and air infiltration. In sandy soils, the lack of small pore space limits the soil's ability to hold water and nutrients.

The structure of the soil will also determine how the soil compacts. Soils with higher levels of organic matter generally have better structure and are more resistant to compaction than soils with lower organic matter levels.

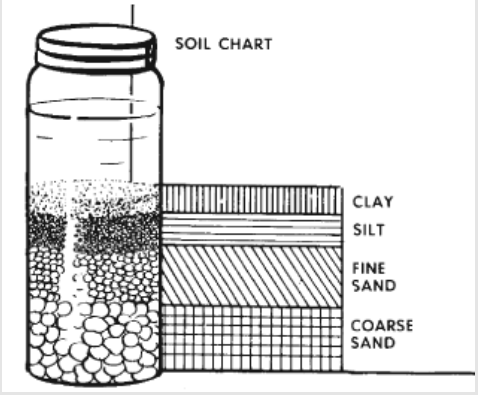
Soil compaction is a big problem in our area. Some signs of soil compaction include:

- Roots appearing enlarged, stubby, twisted or thin and flattened.
- Roots growing horizontally and close to the surface.
- Standing water.
- Excessive water erosion.



Determining How Much Sand, Silt and Clay is Present in Your Soil

1. **Dig down about 6 inches and remove several trowels full of soil.**
2. **Remove any rocks, trash, roots, etc. Crush larger lumps and clods.**
3. **Fill a tall, slender jar one-fourth to one-half full with the soil.**
4. **Add water until the jar is about three-fourths full.**
5. **Add 1 teaspoon of powdered, non-foaming dishwasher detergent.**
6. **Put on a tight fitting lid and shake hard for 10 to 15 minutes until**



7. **Set the jar down where it will not be disturbed for at least two to three days and allow the soil to settle. Normally this takes one to three days, but with some soils it may take weeks.**
8. **After one minute, mark on the jar the depth of the sand that settles to the bottom.**
9. **After two hours, mark on the jar the depth of the next layer, which is silt. When the water clears, mark on the jar the top level. This layer will be composed of clay particles. Most of the particulate organic material will float to the top and should not be used in the calculations.**
9. **Measure the thickness of the sand, silt and clay layers and calculate the percentage of each by comparing the thickness of the different component levels with the total thickness of the solids.**

Characteristics of Local Soils

In most urban areas, soils tend to have less organic matter, high pH, frequent drainage problems, less soil microbial activity, construction waste materials and high clay content. This is a fairly accurate description of the soil in most of the yards in our area. Clay soils hold nutrients and water but, because of the small particle size and reduced aeration, water retention and compaction are problems.

As Colorado State University's D. Whiting says, "*Soil compaction is the primary factor limiting plant growth in urban soils."*

How to Make "Good" Soil

In our area, the prescription for reducing compaction and achieving larger pore spaces in our heavy clay soil is to add organic matter. Organic matter, often called humus, consists of plant and animal remains in various stages of decay. Types of organic matter include sphagnum peat moss, compost and manure. Grass clippings and shredded leaves also can be used but are best applied when decomposed.

Adding organic amendments offers many benefits. Soil aeration, water filtration and nutrient-holding capacity will be improved. Organic matter contains plant nutrients and is an important energy source for bacteria, fungi and earthworms.

How often should I add organic matter? Organic matter is not an addition that is made just once. It is generally recommended to add 2 to 4 inches of organic matter every year. Because it is always decomposing and being used by the plants, organic matter must always be replenished.

How exactly do I add it? When preparing or renovating an existing garden, till or loosen the soil to a depth of at least 6 to 8 inches first. Then spread 2 to 4 inches of organic matter over the area before re-tilling or spading it into the soil. This process works well for vegetable or annual gardens. Perennial gardens can be amended as plants are replaced or divided.

As the organic content of the soil increases, the soil will become easier to till, develop a crumbly structure and drain quicker while still holding enough moisture for uptake of nutrients by the plant roots. In areas with established plantings of trees and shrubs, top-dress with a layer of composted organic material on an annual basis.

When should I add organic matter? The best time to add organic matter is in the fall. Fall is usually a dry time of the year and the soil is not too wet or too dry. Even if wet soil is tilled or spaded in the fall and clods form, the freezing and thawing that takes place during the winter will break them down. Winter's rain, freeze/thaw cycle and snow will also allow the use of fresh grass clippings and shredded leaves. Normally a maximum of 6 inches of shredded leaves or other vegetation can be spread over the garden and allowed to compost naturally into the soil over the winter. If possible, spade or till these amendments into the soil at least 6 or more inches. A small amount of a granular fertilizer may help speed decomposition.

What about springtime? Spring applications of organic material can be made if the material added is already well composted. Adding dry or not fully composted materials during the growing season can tie up nitrogen in the soil and cause nitrogen deficiency in plants. Therefore, it is recommended that only a very thin layer of dried grass clippings, crumpled dead leaves and shredded straw or hay be applied as a light mulch in the spring.

I put down mulch. Is that enough? *Mulching the soil is not the same thing as amending the soil.* Mulch is left on the soil surface. Its purpose is to reduce evaporation and runoff, control soil temperature and inhibit weed growth. Mulches may be incorporated into the soil as an amendment after they have decomposed to the point that they no longer serve their purpose.
ay be applied in the spring.

Should I add sand? *Sand is **not** the solution for correcting compacted and slow draining soils.* In order for sand to be effective in breaking up clay soils, enough sand must be added so that sand grains come in contact with each other. This will create pore spaces large enough to hold air and water. If the sand grains do not touch, the clay particles fill all the spaces leaving no pore space. This is the same principle used to make concrete. In our clay soils, it would take approximately 80% sand to improve aeration. This is impractical. The only exception to this would be the use of a custom-mixed soil of equal parts garden soil, sand and organic matter in a raised bed.

Cautions

Don't overtill! Overtilling or cultivating at the wrong time can destroy the structure of garden soil. Rotary tillers can pulverize soil to such a degree that it loses the porous quality needed for water and air circulation. Pulverized soils are also easily compacted when wet. Rotary tillers can create hardpan below their blades, which leads to drainage problems.

Turning over the soil with a spading fork is actually the best method. New beds need to be tilled deeply — at least 12 inches and sometimes more. Rotary tillers cannot go down that far.

Before tilling, either by hand or with a rotary tiller, the soil should be dry enough to shatter easily. If the soil is too wet, it will form compacted clumps rather than be broken up. When using a tiller, try to use as few passes as possible. Vary the depth by hand spading a little deeper in some areas. This will create a transition zone between the well-tilled top layer and the more compacted lower layer. This is particularly beneficial for plant material that has deep penetrating roots.

Don't add lime or sulfur without first doing a soil test. Many garden references recommend adding lime or sulfur to change the soil's pH. Never apply these or any other pH altering compounds unless a soil test has been done. Without a soil test, the results may be destructive rather than constructive.

Gypsum doesn't improve clay soils. Another popular misconception is that gypsum (calcium sulfate) will improve clay soils by making them more friable or crumbly and increasing water filtration. Research has shown that gypsum does not affect these qualities unless the soil contains high levels of salt.

Skip the fireplace ashes. Some gardeners want to use fireplace ashes in their gardens. Though wood ashes do contain significant amounts of potash (a form of potassium), they contain little phosphate and no nitrogen. Most soils in our area are naturally high in potassium and more is not needed.

Also, wood ashes raise the pH making the soil more alkaline. Local soils naturally have a high pH. Consequently, wood ashes provide little benefit and in fact, may cause harm. Ashes could be added to the compost pile. Compost is normally acidic and the pH of the ashes would be neutralized.

Remember: Adding any chemicals or fertilizer components *without a soil test* can cause more harm than good.

Soil innoculants

Studies on gardens and landscapes find that mycorrhizal amendments are generally ineffective and unnecessary. Given the widespread presence of fungal spores already in the landscape, plants quickly become colonized by native mycorrhizal species. This may be because native mycorrhizal species are better adapted to site conditions and outcompete packaged inoculants. Avoid using bactericides and fungicides as these kill beneficial bacteria that can assist in mycorrhizal activity.

Testing Your Soil

A soil test is the best way to determine the nutrient level of your soil. A basic soil test determines the pH level of the soil and the availability of the plant nutrients nitrogen, phosphorous and potassium. You can also request a test to determine the level of organic matter present.

Details on taking a soil sample and submission procedures are available at the Johnson County K-State Research and Extension office (see the bottom of these pages for the address). You will receive a written analysis and specific recommendations for improving your soil.

A soil test is a valuable tool in establishing a base line on soil fertility. However, a soil test will not identify the most common garden problems related to over-watering, under-watering, poor soil drainage, soil compaction, diseases, insects, weed competition, too much shade, poor plant selection, environmental factors, toxic substances, or just neglect.

Works Cited

Linda Chalker-Scott , A Gardners Primer to Micorrhazae: Understanding how they work and how to protect them.

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