A Garden's FOUNDATION

Healthy plants start with healthy soil. The author outlines the first step in creating great soil from the bottom up (part one in a three-part series).

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SOIL IS THE FOUNDATION upon which a garden is built. Healthy soil is an immensely complex living system, teeming with billions of microscopic creatures and larger life forms, such as earthworms. As they live, eat, and die, these creatures produce substances that benefit our plants. If we create a balanced soil environment in which these forms of life can thrive and multiply, our reward is one of those wonderfully fertile gardens where every plant is visibly bursting with energy.

We can achieve this by balancing the basic chemistry of the soil, and improving its texture. The principles of soil chemistry are easy to grasp if you're willing to delve into a little science. Two factors, more than any others, influence soil health: The first is the soil's pH (a measure of acidity or alkalinity), and the second is cation exchange capacity, or CEC. Blindly adding soil supplements without having a pretty good idea of these measurements can do more harm than good. Both pH and CEC can be manipulated.

Another important factor to understand is soil texture. Soil is made up of mineral elements—sand, silt, and clay—and organic matter. Knowing what you have influences how you manage your soil. When the soil has a perfect balance of minerals it is called loam, and its composition is 40 percent sand, 40 percent silt, and 20 percent clay. Organic matter should be 5 to 10 percent of the total volume.

Grains of sand may seem tiny to you, but in the soil sand stands out like boulders. Sandy soil drains fast, but does not hold nutrients well. Silt particles are a lot smaller, and clay particles are minuscule by comparison. Silt and clay soils may not drain easily, but they do hold nutrients. Organic matter, from compost or green manures, is one soil component that you cannot have too much of. It encourages soil life, stores water and nutrients, and improves tilth.

You can find out what kind of soil you have by either of two easy methods. Take a large glass jar and halfway fill it with a slice of your soil from the top eight inches. Fill the rest of the jar with water and cap it; shake well. Let it settle for a couple of days without moving the jar. The biggest particles—sand—will quickly settle to the bottom. Layers of silt and clay will be visible above that. On top will be organic matter, the rotted debris of plants. The finest clay particles may remain in suspension.

The Jar Test

Fill a jar halfway with a slice of your soil. Add water to fill the jar. Shake well and leave for a couple of days. The sand will sit on the bottom, silt and clay above, and organic matter on the top.

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The other method is to take a handful of soil and moisten it. Squeeze it tightly in your hand. If the soil ball crumbles no matter how much you moisten it, you've got sand. If it hangs together, take a pinch of it and try rolling it into a little sausage shape. The longer you can make the sausage before it breaks, the more silt and clay you have in your soil. Finally, add enough water to make a soupy mixture in the palm of your hand. Roll some of this between finger and thumb. A gritty texture means sand, while degrees of greasiness indicate greater or lesser amounts of silt and clay. When dry, silt feels slippery and powdery, like talcum powder, while clay feels harsh, almost abrasive. By repeating this procedure in several areas you will develop a sense of soil texture. It is an acquired skill.

Soil pH is perhaps the most important factor in soil life, and one you must control. I am amazed at how many supposedly serious gardeners haven't a clue about their soil pH. If you don't know your soil's pH, you are gardening in the dark. Buy a test kit, or if you like gadgets, get a pH meter that will give an instant reading when you stick it in the ground.

What you want for most plants is a soil pH between 5.5 and 6.5. This is on the "sweet," or acid, side of neutral, which is 7.0 on a scale that runs from 0 to 14. When you achieve this, most soil life will thrive, and your plants will have access to any soil nutrients that are present. If the soil is too acid or too alkaline, plant nutrients get "locked up" and become

Soil ball

Squeeze a moist handful of soil. If it breaks apart easily, you've got sand. If it stays together, your soil has more silt or clay.

Clay & Silt

Roll the soil into a sausage shape. The longer the sausage gets before breaking, the higher percentage of silt and clay you have.

Texture

A gritty texture indicates sand, while a smooth texture indicates silt and clay.

Cover Crops

Cover crops, called green manures, are a good way to add organic matter to soil. Seed them by broadcasting (scattering), then covering lightly with soil. Allow them to mature before chopping them down—a string trimmer works well—and tilling them into the soil. Some favorite annual cover crops:

Hairy vetch (*Vicia villosa*): A pretty plant with an odd name. A member of the pea family, it puts down deep roots that add nitrogen to the soil.

Sweet clovers (*Melilotus alba* and *M. officinalis*): Another legume, the long taproots make insoluble minerals available to the plants that follow them.

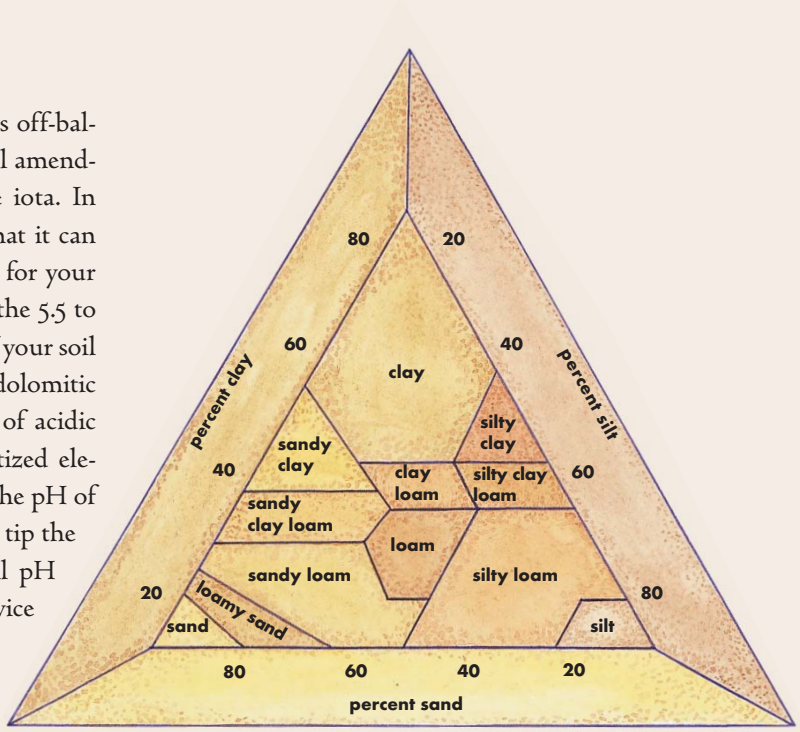
Mustard (*Brassica* spp.): Great for opening up heavy or compacted soils.

Buckwheat (*Fagopyrum esculentum*): A good hot-weather cover crop that, if seeded densely, can even choke out quackgrass and nutgrass. It accumulates phosphorus that it releases when tilled under. Attracts beneficial insects, including honeybees.

Annual rye (*Lolium multiflorum*): Germinates and grows fast in cool weather. Its vigorous root system helps soil tilth. The seed can be mixed with a legume.

Oats (*Avena sativa*): Grows fast when planted at any time of year. Will not regrow in spring.

unavailable, and soil life suffers. If the pH is off-balance, you can add immense quantities of soil amendments without benefitting your plants one iota. In fact, you may upset the balance so much that it can take years to correct. If you do nothing else for your soil, check the pH and correct it to achieve the 5.5 to 6.5 range, following the recommendations of your soil test. As a general guide 2 to 8 pounds of dolomitic limestone per 100 square feet raise the pH of acidic soil, while one pound of granular or pelletized elemental sulfur per 100 square feet will lower the pH of alkaline soil. Err on the low side so as not to tip the balance too far in the other direction. Soil pH changes slowly, so testing should be done twice a year, spring and fall.



Soil Texture Triangle

The percentages of sand, silt, and clay are plotted on this triangle to help the gardener determine what type of soil they have. —Adapted from *Knott's Handbook for Vegetable Growers* (John Wiley & Sons, 1980)

Cation exchange capacity can get horribly technical, but the essential fact is that cations (pronounced "CAT-eye-ons") are soil particles that carry a positive charge and hold on to three essential nutrients. Other particles, called anions ("AN-eye-ons"), have a negative charge and influence the availability of a different group of nutrients. Think of CEC as your soil's bank account. Plants and water make withdrawals, and it is up to you, the gardener, to make deposits to restore fertility.

The major cation nutrients are calcium, magnesium, and potassium. Cation micronutrients are iron, copper, zinc, and manganese. Clay and humus particles hold these nutrients and make them available to plants. Anion nutrients include nitrogen, phosphorus, sulfur, and two micronutrients, boron and molybdenum. Soil with a deficiency or imbalance of cations and anions will not grow healthy plants.

It is the interaction of cations and anions that makes a balanced diet available to your plants. To improve CEC, make sure your soil has the right pH, that there is ample organic matter, and that there is enough calcium. Calcium is an essential plant nutrient in its own right as it is vital for nitrogen uptake and the creation of plant protein. Horticultural gypsum is a good source of calcium.

Soils with a high CEC tend to be those that contain some clay and a high percentage (again 5 to 10 percent) of organic matter. Mature compost and green manures are the best sources of organic matter. Sandy soils with little organic matter are likely to have a low CEC. Clay and humus hold cation nutrients and—most important—make them available to plants. Therefore, plants do better in soils that have a high CEC.

Fall is the best time to start thinking about improving your soil. First, take soil samples from your garden and test your soil. This is your baseline, the "before" picture. Then start amending your soil according to the results of the soil test, and next year you will see better growth in your garden than ever before.

Soil Testing

There are many places to get your soil tested. The most accurate way is to have a professional do the test for you. Look in your local yellow pages under soil testing. Alternatively you can purchase a kit from reputable mail-order source such as Johnny's Selected Seeds (184 Foss Hill Road, Albion, ME 04910; www.johnnyseeds.com); Peaceful Valley Farm Supply (P.ox Box 2209, Grass Valley, CA 95945; www.groworganic.com); A.M. Leonard (241 Fox Drive, Piqua, OH 45356; www.amleo.com).