

## SOIL MANAGEMENT

### Introduction

Good gardening begins with good soil. The successful gardener needs a basic understanding of soil since soil conditions strongly influence how plants grow. Healthy soil is a complex substance full of beneficial bacteria, fungi and animals. These organisms help break down rock, plant, and animal matter and release their nutrients in forms that plants can use.

### Soil Texture

Three different soil particles determine a soil's texture. Sand particles are the largest, clay the smallest, and silt is in between. Medium-textured soils (loam, sandy loam, and silt loam) have a good mixture of sand, silt, and clay that is ideal for growing most plants. It is more difficult to grow plants in soils that contain an excessive amount of either clay, sand, or silt.

The easiest way to evaluate your soil's texture is to lightly squeeze a handful of moist soil. If the clump crumbles apart, the soil is sandy. If it forms a sticky ball, it is clay. If the soil ends up as a spongy ball, you have loam. Click this link <http://www.csgn.org/curriculum-digging.php> to go to the California School Garden Network for curriculum activities to evaluate the texture.

### Soil Structure

The combination of individual sand, silt, and clay particles into larger clumps called aggregates creates soil structure. Good garden soil is crumbly. Nutrients and water are held within the aggregates. The spaces between aggregates allow water and air to move easily through the soil and provide enough space for plant roots to grow.

Plants grow best when good soil structure is maintained. Do not walk on, work in, or drive machinery over wet soil. It is also important to refrain from excessive tilling. Any of these actions can damage soil structure, compacting the pores, which decreases the movement of air and water through the soil.

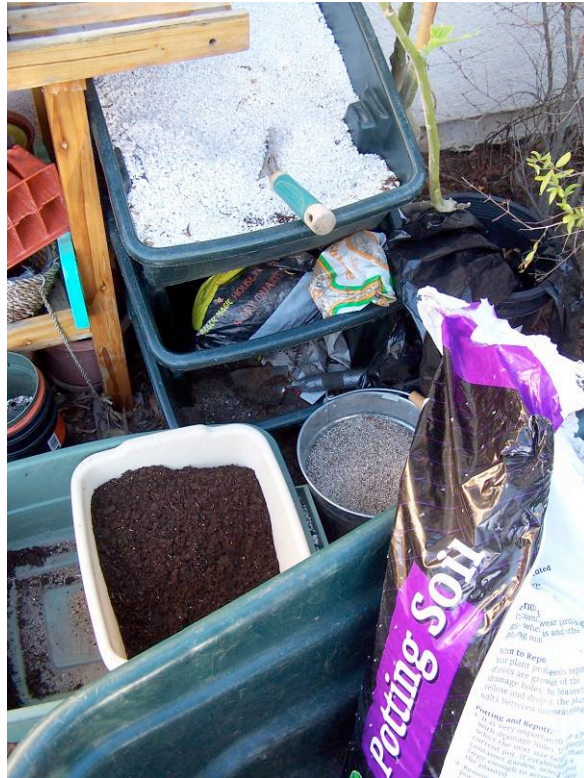
### Amendments

Amendments are materials which change the physical or chemical properties of the soil and indirectly improve plant growth. Reasons to change the properties of the soil with organic matter or chemical amendments include:

- Make soil surface more water permeable, especially silty soils
- Enlarge pore spaces so water and air move more freely, important in clay soils
- Prevent soil cracking; distribution of roots, water, and air are more uniform

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- Make soil easier to work, important for managing annual plants
- Allow roots to grow easily and quickly from container soil into heavier native soil



A variety of amendments

Soil organic matter consists of all the dead plant and animal matter in various stages of decay. A soil rich with organic matter supports a thriving population of beneficial organisms from microscopic bacteria and fungi to larger life forms like earthworms. Organic matter acts like a slow release fertilizer and also improves soil structure. Soil microorganisms feed on organic matter and release nitrogen and other nutrients it contains in a form that roots can absorb.

Compost is an excellent organic amendment. Good compost, either homemade or store bought, is the most beneficial all-purpose amendment for soil. [Click here to go to the Composting topic for more information on how to compost and composting methods.](#)

In addition to compost, there are other amendments that may be helpful. [Click here to go to the Amendments table for information on specific amendments and their benefits.](#)

Amendments should be free of weed seeds, toxic materials, and disease organisms. Wood ashes should not be used on soils in the San Diego area. Ashes are very alkaline and have a high salt content.



Working the amendments into the soil

The top six to eight inches of garden soil should be amended with composted organic matter. If you spread two inches of compost on top of a previously cultivated soil and incorporate it to a depth of six inches, the soil will be amended 25 percent by volume.

Organic matter continually breaks down and decomposes, so you must periodically add new material. Good gardeners incorporate organic matter into their soil before each planting season.

### **Macronutrients and Micronutrients**

Fertile garden soil is essential to obtain the best growth and productivity from vegetables and flowers. Plants need different amounts of seventeen essential elements to grow. Soils are rarely fertile enough to supply adequate quantities of all the elements needed for best plant growth. Most soils do not contain enough Nitrogen for optimum plant growth. Vegetables and other shallow rooted plants also usually grow better with additional Phosphorus and sometimes Potassium. These three elements, and any other elements that a soil may lack, can be supplied with an appropriate fertilizer and compost. Fertilizers may be either organic or inorganic (often called chemical) materials. Compost and similar organic amendments are a source of plant nutrients, but usually do not provide enough Nitrogen for optimum plant growth.

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Plants require seventeen essential elements for growth. If any one of these elements is missing, a plant will not grow, even if all the other elements are present in their required amounts. The elements which plants require in relatively large amounts are called macronutrients. The primary macronutrients are Nitrogen (N), Phosphorus (P), and Potassium (K). Nitrogen promotes green leaves and foliage growth. Phosphorous stimulates healthy root growth and helps with the formation of flowers, seeds, and fruit. Potassium is required for proper development of flowers and fruit, ensuring good size, color, and quantity. Commercial fertilizers show the percentage of these three nutrients on the label. A 16 – 20 – 0 fertilizer contains: 16% Nitrogen, 20% Phosphorus, and no Potassium.

The secondary macronutrients are Calcium (Ca), Magnesium (Mg), and Sulfur(S). [Click here to go to the detailed Macronutrient table for information on symptoms of deficiency and symptoms of excess.](#)

Essential elements which plants need in relatively small amounts are called Micronutrients. The Micronutrients are Boron, Chlorine, Copper, Iron, Manganese, Molybdenum, Zinc, and Nickel. Composting organic matter such as grass clippings and tree leaves is an excellent way to provide micronutrients. [Click here to go to the detailed table for information on symptoms of deficiency and symptoms of excess.](#)

### **Fertilizers**

Vegetables and flowers usually grow better if fertilizer containing Nitrogen, Phosphorus and Potassium is mixed into the soil prior to planting. Organic fertilizers are derived from plant, animal, and mineral sources. They are not made with synthetic materials. Organic fertilizers feed microorganisms in the soil, which break down the organic matter and release nutrients in a form that plant roots can absorb. The advantage of using organic fertilizers is that they contain more than one nutrient. These nutrients are released slowly, in smaller quantities, making them available to the plant for a longer period of time. They are less likely to burn plants or be lost from the soil. Another advantage is that organic fertilizers may also act as soil amendments.

Inorganic, chemical, or synthetic fertilizers are often referred to as commercial fertilizers. These fertilizers are usually water-soluble and produce a sudden flush of mineral salts that are taken up rapidly by plants. They act quickly and can produce good yields, but they do not “feed earthworms and other humus-making creatures”.

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Prior to planting apply fertilizer uniformly over the soil, then till it in to a depth of about six inches. Manure that is not mixed into the soil after it has been applied will lose some of its nitrogen content as ammonia gas. Phosphorous and potassium have very little mobility in the soil; they must be worked into the soil where plant roots can reach them.

During the growing season, most plants will periodically need additional applications of nitrogen fertilizer. A fertilizer containing nitrogen should be applied on direct-seeded crops when the plants have four to six true leaves. Fertilizer containing nitrogen should be applied to transplants about four or five weeks after planting.

Additional applications of nitrogen fertilizer should be made at intervals of about four to six weeks depending upon the crop. In sandy soils, which require frequent irrigation, small amounts of fertilizer will be required at more frequent intervals. [Click here for more information on Post Planting Fertilizing.](#)

### **Soil pH - Acidity or Alkalinity**

Soil acidity or alkalinity is expressed as a pH number ranging from 1.0 (extremely acid) to 14.0 (extremely alkaline). A pH of 7.0 is neutral, neither acid nor alkaline. Most plants grow best in slightly acidic to neutral soil (a pH between 6.0 and 7.0). San Diego soils that are cultivated tend to be alkaline because our irrigation water is alkaline. Soil pH affects the chemical form of some nutrients like phosphorus and iron. When the pH is too high or low, plants may suffer a nutrient deficiency even in a nutrient rich soil. When the pH is too high or low, some nutrients convert to a form that cannot be absorbed by plants. This can cause a nutrient deficiency in plants - even in nutrient rich soil.

### **Soil Testing**

Soil testing can provide information on your soil's texture, pH, salinity and the level of essential plant nutrients and fertility. This information may be very useful if you are starting a new garden in an area where plants have not been grown before.

Soil testing may also help you find out why plants are not growing well in an existing garden. A soil test is not always necessary, however, and it will not tell you if poor plant growth is caused by pests or diseases, improper irrigation or poor cultural practices, such as planting at the wrong time of year.

One of the most useful soil tests is the measurement of soil pH. The test will tell you if your soil is too alkaline or acidic and if corrective measures are needed. A lab can measure soil pH for you or you can do it yourself. A simple pH meter and test kit are available at local nurseries or from mail order companies.

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Commercial soil testing services are available through some nurseries and garden centers. You can also find analytical laboratories listed in the phone directory. Soil testing is not performed by the County or State Agriculture Department, or the University of California.

You will only get good information from a soil test if you collect a good sample. To collect soil for testing, dig a small hole 6-8 inches deep with a trough and collect a thin slice of soil from one side of the hole. Put the soil in a bucket and collect more samples from several locations in the garden. Mix the samples together to produce a representative sample from your garden. If you use a commercial testing lab, ask if they will provide a report to help you interpret the results of your soil test. Also ask if they provide recommendations on how to correct soil problems.

### SOIL AMENDMENTS TABLE

<b>Amendment</b>	<b>Benefits / Cautions</b>
Wood sawdust, shavings, or ground bark	Nitrogen should always be added with these amendments. Add ammonium sulfate, blood meal, or cottonseed meal to provide extra nitrogen. Do not use chemically treated wood or sawdust in the garden.
Manure	Good for high bacteria count. Bad because of high salt content. Can also have an abundance of weed seed unless composted. Ammonia gas from fresh manure can damage plants. Use only when well aged or composted.
Peat moss	When added to a moderately alkaline soil will pull pH down toward acidic. Loosens and aerates soil. Will last up to five years in soil. High water holding capacity.
Sand	Not a practical amendment for clay soil. Would need to add large volume of sand to clay which is expensive and difficult to mix. Adding a small amount to clay will only increase density and may create concrete.
Soil Sulfur	Makes soil more acidic. Process occurs slowly and takes up to a year. Mix small amounts into soil. Heavy application can damage plants. Bacteria change Sulfur into acid
Gypsum (Calcium Sulfate)	Used to reclaim soils that contain excess sodium. Does not change soil PH. Mix into soil and water thoroughly several times.
Vermiculite	Light weight, fluffy, clay product. Used in potting soil. Holds several times its weight in water and allows room for roots to grow.
Perlite	Light weight “puffed” sand product. Provides aeration and drainage.

### PLANT MACRONUTRIENTS

Nutrient / Application	Function	Symptoms of Deficiency	Symptoms of Excess
<p><b>Nitrogen (N)</b> San Diego soils contain little and it depletes rapidly. Mix into soil before planting or apply to surface and water in. Replenish regularly. Nitrate form is very mobile in soil.</p>	<p>Important for many growth and development processes. A constituent of proteins, enzymes, and chlorophyll (needed for photosynthesis).</p>	<p>Slow growth, stunting, and yellow-green color; more pronounced in older tissue; tips and margins turn brown; premature death</p>	<p>Excessive vegetative growth, dark green color, excessive transpiration, reduced yield; delayed maturity; few fruits.</p>
<p><b>Phosphorus (P)</b> Does not move far in soil. Remains near source of application. Mix into soil before planting. Apply around the root zone of established plants</p>	<p>Stimulates early growth and root formation; promotes seed, fruit, and flower formation.</p>	<p>Slow growth, stunting, and purplish color on foliage or dark green color; dying leaf tips; delayed maturity; poor fruit or seed development</p>	<p>Excess can interfere with micronutrient absorption; may mimic Zinc (Zn) deficiency. <a href="#">Click here to go to description of Zn deficiency.</a></p>
<p><b>Potassium (K)</b> Does not move far in soil. Remains near source of application. Apply around the root zone of established plants. Adequate in most San Diego soils.</p>	<p>Proper growth of fruits and flowers, ensuring good size, color and quantity.</p>	<p>Slow growth; leaf tip and marginal burn (starts on more mature leaves); weak stalks; small fruit and shriveled seeds.</p>	<p>Light green foliage; tendency for Calcium and Magnesium symptoms to appear.</p>
<p><b>Calcium (Ca)</b></p>	<p>Essential part of cell wall structure, must be present for formation of new cells. Adequate in most San Diego soils.</p>	<p>Reduced terminal growth of shoots (buds) and roots, resulting in plant death.</p>	<p>Interferes with micronutrient availability.</p>
<p><b>Magnesium (Mg)</b></p>	<p>Essential for photosynthesis</p>	<p>Leaves curl upward along margins; marginal yellowing with green “Christmas tree” pattern along mid-ribs of leaves.</p>	<p>Interferes with Calcium uptake</p>
<p><b>Sulfur (S)</b></p>	<p>Responsible for characteristic odors of plants such as garlic and onion</p>	<p>Reduced growth, delayed maturity. Light green to yellowish foliage on leaves; small spindly plants.</p>	<p>Not known.</p>

**PLANT MICRONUTRIENTS**

<b>Nutrient</b>	<b>Function</b>	<b>Symptoms of Deficiency</b>	<b>Symptoms of Excess</b>
<b>Iron (Fe)</b>	Required for formation of chlorophyll in plant cells.	Yellow-green color, but veins remain green; twig dieback; reduced growth, and death in severe cases.	Mimics phosphorus, manganese deficiency
<b>Manganese (Mn)</b>	Assists iron in chlorophyll formation and serves as activator for enzymes in growth process.	Yellow-green color of young leaves, but no sharp distinction between veins and interveinal areas as with iron.	Mimics iron deficiency; loss of foliage color, bronzing of leaf margins, necrotic areas.
<b>Zinc (Zn)</b>	Important plant growth regulator; essential in root and plant growth. Micronutrient most often deficient in San Diego crops.	Yellow-green color, but veins remain green; decrease in stem length; rosetting of terminal leaves; reduced fruit bud formation; twig dieback after first year	Not known.
<b>Boron</b>	Regulates metabolism of carbohydrates in plants. Critical for new growth in plants and assists in flower pollination, fertilization, fruit set.	Death of terminal growth; thickened, curled, wilted leaves; Reduced flowering.	Rare except in inland deserts with high boron contaminated water.
<b>Copper (Cu)</b>	Activator of enzymes in plants.	Stunted growth; dieback of terminal shoots in trees; death of leaf tips.	Reduced growth



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<b>Nutrient</b>	<b>Function</b>	<b>Symptoms of Deficiency</b>	<b>Symptoms of Excess</b>
<b>Chlorine (Cl)</b>	Required for photosynthesis and root growth.	Very rare; wilting followed by yellow-green color; leaf bronzing.	Poor growth; marginal leaf necrosis.
<b>Molybdenum (Mo)</b>	Required by plants for the utilization of nitrogen. Plants cannot transform nitrate nitrogen into amino acids without molybdenum.	Stunting; reduced yield; lack of vigor; marginal scorching; cupping, rolling of leaves.	Not known.
<b>Nickel (Ni)</b>	Needed to complete the life cycle of the plant and viable seed.	Leaf tip necrosis	Induces iron and zinc deficiency. Interveinal yellowing of foliage.