



# Soil Preparation

*Alex X. Niemiera, Extension Horticulturist, Virginia Tech*

*Reviewed by John Freeborn, Assistant Master Gardener Coordinator, Horticulture, Virginia Tech*

The ideal soil for a vegetable garden is deep, friable, and well-drained with a high organic matter content. Proper soil preparation provides the basis for good seed germination and the subsequent growth of garden crops. Careful use of various soil amendments can improve garden soil and provide the best possible starting ground for your crops.

## Soil preparation

Check soil pH and fertility by having your soil analyzed at least once every three years. Your local Extension agent will have directions for properly collecting a soil sample. Your soil samples can be sent to the Virginia Tech Soils Laboratory or a commercial lab. Soil testing kits are also available. Soil pH measures the degree of acidity or alkalinity of the soil. Vegetables vary to some extent in their requirements, but most garden crops will do well with a soil pH of 6.2 to 6.8. This is a little below neutral, or slightly acid (sour). If soil pH is too high or low, poor crop growth will result, largely due to the effects pH has on the availability of nutrients to plants. A soil test report will include the relative level of phosphorus, potassium, and micronutrients in the soil. The report also will give you recommendations for the amount of lime and fertilizer to add so that your soil pH and nutrient levels are suitable for vegetables.

If you are using a turf area for your vegetable garden, remove the sod with a spade and use it to patch your lawn or put it in a compost pile to decay. If you have a large area, you can rent a sod cutter or kill the turf with an appropriate herbicide. Plow, spade, or rotary till the soil. Work only when soil moisture conditions are right. To test, pick up a handful of soil and squeeze it. If it stays in a ball, it is too wet. If it crumbles freely, it should be about right. Excessively dry soil is powdery and clumpy and may be difficult to work. Take samples at the surface and at a 2- to 3-inch depth in several locations in the garden plot. If

soil sticks to a shovel, or if when spading, the turned surface is shiny and smooth, it is still too wet. Working excessively wet soil can destroy the soil structure (the various size clumps of soil particles), which may take years to rebuild. Plowing with a tractor when the soil is wet is especially damaging, causing the formation of a compaction layer that will inhibit root growth. Soils with adequate humus levels generally allow more leeway because of their improved structural qualities.

Just prior to planting, break up large clods of soil and rake the bed level. Small-seeded vegetables germinate best in smooth, fine-surfaced soil. Do not pulverize the seedbed soil. This destroys the structure and promotes crusting and erosion problems.

## Tilling the soil

The type of equipment you use to prepare your garden will depend on its size and your physical ability, time, and budget. Options include hand digging with a spade or shovel, tilling with a power rotary tiller, and using a small garden tractor or a full-sized farm tractor. While garden plowing is still a common practice, turning the soil completely over has been found to be detrimental. It can cause soil compaction, upset the balances of microorganisms, and cause layers of coarse organic material to be buried below the zone where insects and microbes break it down. In addition, gardeners in other-than-rural areas have trouble finding a farmer who will come to plow and disk the garden for a reasonable price, if at all. Rotary tilling (rototilling) is sufficient for most home gardens, as long as the plant debris accumulation is not out of hand. Rotary tilling mixes the upper layers of soil rather than completely turning the soil over, and the effects are generally desirable. One possible harmful effect of rototilling is the formation of a compaction layer just beyond the reach of the tines. Using deep-rooted cover crops or double digging can do much to prevent or alleviate this problem when it exists. Small gardens can be designed using raised



beds, which may be worked entirely by hand if the area is small enough. In recent years, there has been an increase in research on the design of no-till systems in commercial vegetable production. These systems hold promise for application in the home garden also.

Gardeners often wonder whether to plow/till in the spring or fall. Working the soil in the fall has several advantages over the traditional, spring plowing. Fall soil preparation allows for earlier spring planting, since the basic soil preparation is already done when spring arrives. Turning under large amounts of organic matter is likely to result in better decomposition when done in the fall, when temperatures are higher than in the early spring, and there is more time for the process to take place. Insects, disease organisms, and perennial weeds may be reduced by killing or inactivating them through burial or exposure to harsh winter weather. The physical condition of heavy clay soils may be improved by the alternate freezing and thawing, which breaks up tightly aggregated particles. Also, snow is trapped between the hills of roughly plowed soil, so more moisture is retained than on flat, bare ground. Incorporation of limestone or relatively insoluble fertilizers in the fall gives these amendments more time to react with the soil and influence spring plant growth.

Fall plowing alone is not recommended for hillside or steep garden plots, because it leaves the soil exposed all winter and subjects it to erosion when the spring rains come. If a winter cover crop is grown to improve

soil and prevent erosion, the ground will have to be tilled in the fall to prepare the soil for seed and again in spring to turn under the green manure (cover crop; to be discussed). Spring plowing is better for sandy soils and those where shallow tilling is practiced. Generally, most gardens must be disked or rotary tilled in the spring to smooth the soil for planting.

## Soil Amendments

### Amendments to change pH and nutrient levels

Lime and sulfur are common amendments to change soil pH. The correct soil pH is essential for optimum plant growth. Dolomitic limestone (calcium carbonate and magnesium carbonate) adds calcium and magnesium and increases the pH. Agricultural (elemental) sulfur is used to acidify alkaline soil. The amount to add depends on the current and the desired pHs, which is one good reason to have garden soil checked periodically. Gypsum (calcium sulfate) adds calcium and sulfur but does not affect the soil pH nor does it enhance the structure of Eastern U.S. clay soils as it does certain Western soils.

You can use wood ashes as a soil amendment. They contain potash (potassium), phosphate, boron, and other elements. Wood ashes also raise the soil pH; but you must use twice as much ash as limestone for the same effect. Ashes should not come into contact with germinating seedlings or plant roots as they may cause root burn. Spread in a thin layer over the winter, and incorporate it into the soil; check the pH yearly if you use wood ashes. Never use coal ashes or large amounts of wood ash (no more than 20 pounds per 1,000 square feet), as toxicity problems may occur.

Your garden may need other amendments added specifically to improve its soil nutrient levels. Greensand and granite meal are sources of potassium. Granite meal is finely ground granite rock that releases its potassium slowly. Greensand (sandy rock or sediment containing a high percentage of the mineral glauconite) is relatively low in potassium and trace nutrients. Neither should be considered a sole nutrient source. Both materials may be hard to find in some areas. Other nutritional amendments you can purchase for garden use include cottonseed meal, kelp meal, bone meal, leather meal, and worm castings, as well as an array of synthetic (inorganic) fertilizers. The organic amendments are particularly useful where a trace-element deficiency exists, while synthetic fertilizers are generally more available,

less expensive, and have quicker results. The need for any of the previously mentioned amendments will be determined by your soil-test results.

## Amendments to improve soil qualities

In special cases, coarse sand or perlite is sometimes added to clays to attempt to improve soil texture (the ratio of sand:silt:clay). However, these inert materials can be expensive and extremely large quantities are needed to do any good. If too little is added, sand can cause clay to react much like concrete. In most cases, the amount of sand needed to improve soil structure makes it an impractical task.

Organic matter is a great improver for both clay and sandy soils. Compost, manures, leaf mold, sawdust, and organic amendments improve soil structure and thereby increase its water-holding capacity, aeration, and water infiltration. These materials are decomposed in the soil by soil organisms and their byproducts release plant nutrients and provide sites for nutrient retention. Various factors, such as moisture, temperature, and nitrogen availability, determine the rate of decomposition through their effects on these organisms. Adequate water must be present, and warm temperatures will increase the rate at which the microbes work. The proper balance of carbon and nitrogen in the material is needed to ensure adequate nutrient availability both to growing plants and decomposing organisms. Adding nitrogen may be necessary if large amounts of undecomposed leaves, straw, sawdust, or other high-carbon substances are used. Nitrogen is used by the decayers to make proteins for their own bodies, and if it is not present in sufficient amounts, the microbes have no qualms about stealing the plants' share. Generally, fresh green wastes, such as grass clippings, are higher in nitrogen than is dry material.

Using compost is one way to get around the decomposition problem. A gardener usually makes compost from plant and/or animal wastes. Correct composting is an art that can result in a valuable nutrient and humus source for any garden. The basis of the process is based on the microbial decomposition of mixed, raw, organic materials to a dark, fluffy product resembling rich soil, which is then spread and worked into the garden soil.

Animal manures are commonly used as a garden soil amendment. The value of manure in terms of the nutrients it contains varies. Fresh horse, sheep, rabbit,

and poultry manures are quite high in nitrogen and may even burn plants if applied directly to a growing garden. They are best applied in the fall and tilled under. Manure usually has fewer total nutrients than synthetic fertilizers in terms of nitrogen (N), phosphorus (P), and potassium (K), but it is a valuable soil builder. Unfortunately, manures may be a source of weed seeds; if this is a problem, composting in a hot pile may help.

Another source of inexpensive soil improvement that you should not underestimate is the cover crop. Green manures, or cover crops, such as annual rye, ryegrass, and oats, are planted in the garden in the fall for incorporation in the spring. For best results, sow seed a month before the first killing frost. In a fall garden, plant cover crops between the rows and in any cleared areas. Cover cropping provides additional organic matter, holds nutrients that might have been lost over the winter, and helps reduce erosion and loss of topsoil. Legume cover crops can increase the amount of nitrogen in the soil and reduce fertilizer needs. You can allow a deep-rooted cover crop to grow for a season in problem soil to help break up hardpan and greatly improve tilth (soil workability). Incorporate green manures at least two weeks before planting vegetables; they should not be allowed to go to seed before incorporation.

The regular addition of manure, compost, cover crops, and other organic materials can raise the soil nutrient levels and improve physical characteristics to a point at which the need for adding synthetic (inorganic) fertilizers is greatly reduced. This comes about not only through the intrinsic fertilizing value of the amendment, but also through the increased action of microorganisms on the soil and humus. Humic acid (and other acids) helps to release previously locked-up nutrients naturally present in the soil, and the extra surface area provided by humus serves as a reserve, holding nutrient elements until they are needed by plants. This highly desirable soil quality does not come about with a single or even several additions of organic material, but rather requires a serious, long-term, soil-building program. Remember, your soil is alive and constantly changing. By keeping it fertile and rich, you may be able to diminish many gardening problems. Soil is the base for plant growth, and you should pay much attention to getting and keeping it in the best condition.

*This publication was originally authored by Diane Relf, Extension horticulturist (retired), and Alan McDaniel, associate professor emeritus, Department of Horticulture, Virginia Tech.*