

## DEPARTMENT OF THE INTERIOR

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## HOW TO MAKE THE GARDEN SOIL MORE PRODUCTIVE

To grow well a plant requires a deep, mellow, moist soil, supplied with the right amount of air, heat, and available plant food. An important step, then, in the successful growing of vegetables is to prepare the soil in such a way that it will be congenial to the best root growth. The soil for truck crops is a rich sandy loam—a soil containing varying proportions of clay, sand, and organic matter. A good vegetable soil can be made in most back yards by intelligent management.

*How can a clay soil be made mellow?*—Examination of a dry clay soil shows that the particles of clay are very fine, like wheat flour, with smooth rounded edges. Such particles fit closely together and produce a compact soil, which prevents roots penetrating easily or the rain entering before it evaporates. To make a clay soil mellow, something must be done to make the pore spaces larger. Thorough tillage of the soil, the application of organic matter and lime, and drainage, will all help to do this. Occasionally the addition of sand or fine coal cinders is needed.

(1) *By tillage.*—The soil should be made mellow to a depth of 12 inches by deep plowing and by thorough harrowing with a disk harrow. To do the best work the soil should be both plowed and harrowed the same day. If the lot is too small to plow, equally as good work can be done by spading the soil thoroughly, using a spading fork and crushing each spadeful of soil before another is lifted, then leveling the top soil with a garden rake.

Of all the garden soils, clay is the most easily injured by tilling when it is not in the right condition as to moisture. If worked too wet, the particles all slide together into a compact mass. On the other hand, if worked too dry, the clods are hard to break. When clay soil is in the right condition to work, it will crumble apart if squeezed in the hand. If it sticks together, it is too wet. Clay soil should never be worked when it is wet, not even with a hoe. This is an important lesson for all gardeners.

In a deep, mellow soil, the plants grow more quickly, since larger root systems can be developed and more food and moisture taken in. A deep, mellow soil affords a larger reservoir to hold rain needed during the droughts that come in the growing season. Such a soil is warmer and contains air needed for the growing roots and for the bacteria that cause decay of organic matter or gather nitrogen from the soil air.

(2) *By organic matter.*—Organic matter is decaying vegetable or animal matter. It may be added to the soil in the form of barnyard manure, in compost made of autumn leaves, plants, and garden refuse, or in turning under crops, like rye or crimson clover, that have been grown for this purpose. If the barnyard manure is well rotted, it may be harrowed in after the soil is plowed. If it is fresh and coarse, it is better to plow or spade it under. Fresh manure introduces weed seeds in the soil; for this reason it is not the most desirable form to use. To prevent crops of rye or crimson clover consuming moisture needed by the vegetables, they should be plowed under and harrowed in before they mature. If plowed under while green, they will also decay more quickly and the movement of soil moisture will not be retarded. Since organic matter decays rapidly, additional amounts should be supplied each year.

A large amount of organic matter is essential in soils in which vegetables are to be grown. It improves the texture of a soil, making a clay soil more mellow and a sandy soil more compact. It makes a soil warmer for winter vegetables. Because of its texture, it enables the soil to hold and retain more moisture. It is also the storehouse for nitrogen plant food, the most expensive plant food to buy.

(3) *By lime.*—The chief use of lime is to improve the texture of a clay soil. Lime helps to liberate plant food and occasionally acts as a direct plant food. It neutralizes harmful acids. It hastens the decay of organic matter and increases the work of nitrogen-gathering bacteria. As a rule, the best form of lime to use is finely ground limestone. This can be applied at any time at the rate of 2 tons to the acre. It should be applied after plowing or spading, rather than before, so that it will not be buried too deeply.

Plants vary in their need of lime. The yield of lettuce, beets, cantaloupes, onions, and clovers is increased by the use of lime; while watermelons seem to be somewhat acid-loving in their habits and therefore lime retards their growth. Irish potatoes do better in a soil that is slightly acid, since the fungus that causes scabby potatoes can not thrive in an acid soil. Lime should, therefore, not be applied to the section of the garden where Irish potatoes are to be planted.

Experiments have shown that, to get the best results, most garden soils need a liberal dressing of finely ground limestone.

(4) *By drainage.*—Drainage makes a clay soil more productive by removing the surplus soil water and by helping to correct acidity. It deepens the root zones and enables the plant to obtain more moisture during a dry spell. It hastens decay of organic matter by making the soil warmer and by providing a supply of oxygen.

Not all soils require drainage. The need for it is indicated by the following conditions: Moss growing on the surface, plants looking yellow or dwarfed, deep cracks during a dry season, and water standing more than 24 hours after a rain.

A soil may be drained by laying the land out in beds, by constructing ditches, or by making a system of underground tile drains. In many sections the land is thrown up in level beds 5 feet wide, to insure sufficient drainage for winter vegetables.

*How can a sandy soil be made compact?*—Examination of sandy soils shows that too many of the particles are large, with sharp edges, and as a result the soil is so open that it can not retain the rain or hold the plant food within the reach of the roots. To make a sandy soil compact, then, something must be added to fill up the pore spaces. This can be partially done by applying barnyard manure, by turning under green crops, and by adding clay or loam.

*How can a soil be made to contain sufficient moisture for plant growth?*—On a clay soil the rain runs *off*; this can be prevented by making the soil mellow. On a sandy soil the rain runs *through*; this can be prevented by having the soil well supplied with organic matter. When the top soil is compact, moisture is lost by evaporation. In early spring every day's delay in preparing the soil means loss by evaporation of large quantities of soil moisture. During the summer there is a loss of soil moisture by evaporation; this can largely be prevented by making the top soil so loose and porous that the soil water can not reach the surface. This loose top soil is called a mulch. It should be from 2 inches to 2½ inches deep, and can be made by a hoe or a cultivator. A mulch to be effective should be frequently renewed; that is, the soil should be hoed, or cultivated, as soon as possible after every rain, and at least once or twice a week during a drought. A safe rule is never to allow a crust to form on the surface of the soil, for the crust indicates that the soil moisture is coming to the surface, evaporating, and leaving the plant food on the top to cement the soil particles together. Every gardener should learn the value of a dust mulch, for it will increase the yield of a crop at least twofold. In many localities it would be far better to hoe a crop than to water it artificially. This means *hoe, hoe, hoe, or cultivate, cultivate, cultivate*. The upper 2½ inches of soil should be kept loose and dust-like. Cultivation should be shallow; otherwise the upper roots may be cut in tilling. In general, level cultivation is the best, for less surface is exposed to evaporation. The same prin-

ciples apply to the hilling of corn and beans. A plant needs about 500 pounds of water to produce 1 pound of dry matter, and 4,000 tons of water are required to produce an acre of cabbage. Vegetables will not suffer during a drought if the soil is first prepared so that the rain can enter and be retained, if surface evaporation is prevented by having the top soil loose, and if the garden is kept free of weeds which use up soil moisture, plant food, occupy space, shade the vegetables, and prevent a free circulation of air.

*How can a soil be made warm for winter and early spring vegetables?*—All wet soils are cold, for heat is removed in the evaporation of water. The first thing to do to make a soil warm, therefore, is to drain it. Drained soil allows the entrance of warm spring rains and warm air—both important sources of heat to the soil. Organic matter makes a soil warm through the process of decay and also through its ability to absorb more of the sun's rays. The soil for winter vegetables should be well drained and well supplied with organic matter.

*How can a soil be made to contain sufficient air?*—Damage is the controlling factor in the air property of a soil, for the air in the soil is between the soil particles, and a wet soil lacks air because the spaces between the particles are filled with water.

*How can a soil be made to contain sufficient plant food?*—Over 90 per cent of the foods used by plants come from the air. These are water, carbon dioxide, nitrogen, and oxygen. The remaining plant foods are supplied by the soil. Those that may be deficient and need to be supplied are nitrogen, phosphorus, and potassium.

Nitrogen plant food is especially desirable for vegetable production, for it induces leafiness and rapid growth. This is important, for vegetables that grow rapidly are more tender than those that grow slowly. As previously indicated, organic matter is the storehouse of nitrogen in the soil. The nitrogen in organic matter is slowly made available by the work of soil bacteria. A more readily available form of nitrogen is found in commercial fertilizers, such as nitrate of soda, sulphate of ammonia, dried blood, tankage, fish scraps, and cottonseed meal. Of these, nitrate of soda is immediately available and ought not to be applied until the crop is well up, and then not in one heavy application but in three or four applications at different times. It is the common form of commercial fertilizer used by professional gardeners, but cottonseed meal is recommended for gardens cultivated by children. Nitrogen in the form of commercial fertilizers should not be used until after the soil has first been well supplied with barnyard manure, decaying legume crops, or other forms of organic matter.

Legume crops, such as crimson clover, cowpeas, soy beans, beans, and peas, do not need nitrogen in the form of commercial fertilizers,

for they can obtain nitrogen from the soil air by means of nitrogen-gathering bacteria that live in the nodules in the smaller branches of the legume roots. This ability to secure nitrogen from the soil air make the legume crops desirable for green manuring.

Phosphorus plant food induces fruitfulness and can be profitably used for all vegetables. Organic matter helps to make phosphorus in the soil available, and legume roots bring some phosphorus up from the subsoil, but it is often necessary to supply phosphorus through commercial fertilizers, such as ground rock; ground bone, dissolved rock, or dissolved bone. These are obtained from the bones of animals, either ancient or recent forms. There are extensive deposits of phosphate rock in the Carolinas, Florida, Tennessee, and some of the Western States. The phosphorus in dissolved rock and bone, commonly known as acid phosphate, is more easily made available and should be used for the growing of vegetables. Care should be taken not to add acid phosphate and lime to the soil at the same time, for lime unites with the phosphorus and makes it less available.

Potash is an essential plant food for all starch and sugar producing vegetables, such as potatoes, sugar beets, and corn. Garden peas and beans respond to potash food. The best form of potash for vegetables is wood ashes that have been stored in a dry place until used. Muriate of potash is the commercial form most often used for vegetables, except for white potatoes; for these, sulphate of potash is used. The European war has, for the present, cut off the supply of potash to this country.

It is often more convenient to purchase a complete fertilizer instead of separate amounts of the commercial fertilizers that supply nitrogen, phosphorus, and potassium. A complete fertilizer contains all three of these plant foods. There are many of such fertilizers on the market. Cottonseed meal, acid phosphate, and wood ashes make an excellent complete fertilizer; but the wood ashes should be applied separately. Cottonseed meal should be applied at the rate of 2 to 10 pounds per 100 feet of drill, acid phosphate at the rate of 5 to 8 pounds per 100 feet of drill, while wood ashes should be spread over the soil just so it can be seen. A complete fertilizer can be used at the rate of 5 to 10 pounds per 100 feet of drill. Under ordinary conditions commercial fertilizers should be applied and thoroughly mixed in the soil just previous to the planting of the crop. Some gardeners, in order to obtain maximum yield, make one or two subsequent applications at intervals of three or four weeks.

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