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Improving Garden Soils with Organic Matter

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This publication will help you understand the importance of soil organic matter levels to good plant performance. It also contains suggestions for suitable soil amendments. Any soil, no matter how compacted, can be improved by the addition of organic matter. The result will be a better environment for almost any kind of plant.

What gardening problems are caused by poor soil quality?

Many problems with home vegetable gardens, fruit trees, shrubs, and flower gardens are caused not by pests, diseases, or a lack of nutrients, but by poor soil physical conditions. Symptoms of poor soil quality include the following.

- The soil is dried and cracked in summer.
- Digging holes in the soil is difficult, whether it is wet or dry.
- Rhododendrons, hydrangeas, and other shrubs wilt in hot weather, even with added water.
- Leaves on shrubs turn yellow and have brown, dead sections on them, particularly on the south side of the plant.
- Tomatoes and peppers get blossom-end rot, even if fertilized with calcium.
- Water tends to pool on the soil surface and to drain slowly, or it runs off the surface.

What makes a productive soil?

A productive soil provides physical support, water, air, and nutrients to plants and soil-dwelling organisms (see "What is soil?" page 2). Like humans, roots and soil organisms breathe and require sufficient air and water to live. As a result, a good soil is not "solid"; rather, between 40 and 60 percent of the soil volume is pores. The pores may be filled with water or air, making both available to plants (see illustration on page 3).

The largest pores control aeration and movement of water through the soil and are largely the result of earthworm burrowing or root growth. The smaller pores store water. In a good soil, individual soil particles are aggregated into larger units, and the pore arrangement remains stable over time.

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What is soil?

Soil layers. Note that most of the organic matter is found in the top layers of soil.

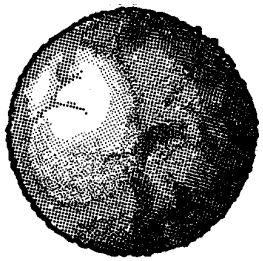
Soil includes mineral and organic components, water, and air. All of these are essential to plant growth. Soil formation is the result of physical, chemical, and biological processes. The process of soil formation begins when wind, rain, and fluctuating temperatures break rock down into smaller and smaller fragments. The rock fragments that compose most soils, in order of decreasing particle size, are sand, silt, and clay.

Soil texture refers to the coarseness of the soil, which depends on the combinations of these three types of particles. Soils high in sand tend to be fast-draining and subject to drought, while soils high in clay can store a lot of water but are "heavy" and not as permeable to air and water. Loam soils feel as if they have a balance of sand, silt, and clay.

The soil is also host to a large number of living organisms. Without soil organisms, very little soil formation would take place. Some of these organisms, such as bacteria, fungi, and certain insects and mites, are microscopic. Others, such as ants and earthworms, are larger.

Soil formation results in layers of soil, much like the layers of a cake. The topsoil is where most of the organic matter is and where most biological activity occurs. The subsoil layers tend to be lighter in color and finer textured than topsoil. Subsoil tends to be low in organic matter and is usually less suitable for plant growth.

Silt



Sand

Clay

Soil particle sizes. The larger sand particles allow water to drain quickly through soil. Clay particles tend to pack more closely together, causing water to drain more slowly.

Benefits of adding organic matter to soil

One of the most important reasons for adding organic matter is to improve the ability of the soil to accept and store water (see "Soil structure and compaction" at right). Amending your soil may mean that you can reduce the amount of water a newly planted garden requires. This effect can be enhanced by the use of an organic mulch on the soil surface, which will reduce evaporation as compared to bare soil.

Adding organic matter also increases the activity and number of soil organisms. Over time, a well-amended soil will supply more of the nutrients your plants require, which will reduce fertilizer requirements.

Although you might not expect it, adding organic matter to soil also helps to protect water quality and the environment. Soils amended with organic matter are a better sponge for water. More water goes into the soil, and less water runs off the surface. Because surface runoff is reduced, pesticides and fertilizers are retained in the soil instead of washing into nearby rivers and lakes.

Checking soil organic matter in your garden

Here are some simple ways to assess organic matter content of your soil.

- Use your eyes. Soils with adequate organic matter content are dark in color, both because they have more humus, which is dark, and because they hold more water.
- Look for puddling and standing water. Soils rich in organic matter content and with good tilth allow water to percolate below the surface.
- Use your fingers. Look for aggregated soils. If you rub the soil between your fingers, the soil will seem to contain "crumbs" made up of mineral and organic particles. The crumbs

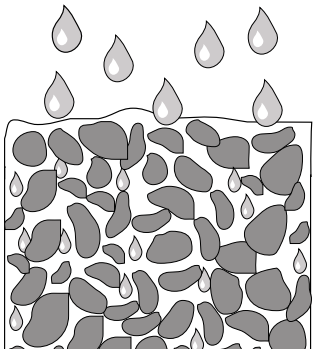
Soil structure and compaction

Soil structure is another name for the units of soil that you see when you dig into a soil. You might remember throwing dirt clods at your siblings! The most desirable structure for a topsoil is a granular structure (small "pebbles" or "crumbs" of soil). Soils with a stable granular structure are easy to dig, accept water readily, and make a good seedbed. This kind of ideal soil condition is often referred to as "good tilth."

Good soil structure is analogous to a sponge. Like a sponge, pore spaces in a good soil are stable. In contrast, soil with poor structure is like a bowl of popcorn, where the pore spaces are easily crushed.

A productive soil is a dynamic community made up of many species of fungi, bacteria, insects, and mites. This community depends on organic matter as a food and fuel source. Together with earthworms and plants, these organisms provide the "glue" that holds soil together and gives it structure.

Soil structure is delicate and is damaged by actions that compact the soil. Compaction by machinery or foot traffic is a common problem. Compacted soils hinder penetration of air and water and growth of roots. Compacted soils are a poor environment not only for plants, but also for earthworms and other soil organisms. Tilling the soil, particularly when it is wet, damages soil structure and increases the rate of soil organic matter loss through decomposition.



Soil with good structure has stable pore spaces that allow water penetration, root growth, earthworm movement, and air storage.

are examples of aggregation and are the result of sticky substances released by soil bacteria after feeding on organic matter. Aggregation generates soil structure.

- Use your nose. Soils with adequate organic matter content have the rich smell of earth. Soils that have poor air circulation, a result of reduced organic matter content, may smell sour.

Fresh versus composted materials

Both fresh and composted organic materials are useful for amending soils. Fresh organic material is rapidly decomposed by microorganisms in a compost pile or in the soil. The microorganisms use the organic material as a food source and release carbon dioxide to the atmosphere. As decomposition proceeds, the remaining organic compounds are more resistant to decomposition. (They have less "food" value to microorganisms.)

Decomposition is usually very rapid for the first 30 days after application of fresh leaves, fruits, or other vegetative material to soil (Figure 1). When decomposition of fresh organic materials takes place in soil, the sticky exudates produced by soil organisms help glue soil particles together, improving soil structure. The volume of material will be reduced rapidly as decomposition takes place.

Soil microorganisms require nitrogen for their growth, so the process of degrading fresh organic matter in the soil sometimes causes a nitrogen deficiency for plants. If you use fresh plant material, allow it to decompose in the soil for several weeks before planting into it. Also keep in mind that very woody materials, such as sawdust or sawdust-bedded manures, may cause nitrogen deficiency in soils for a long time, even after composting.

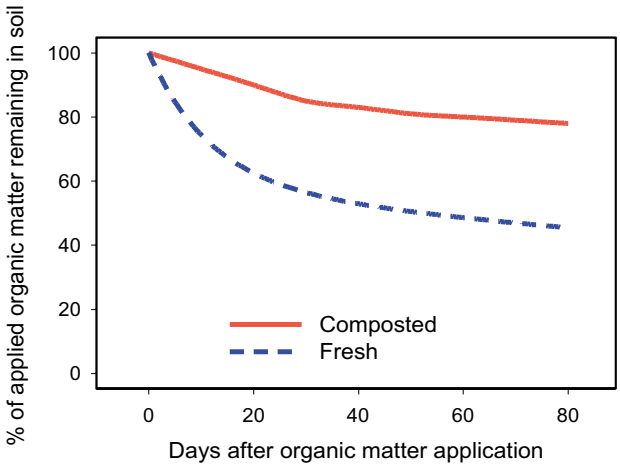


Figure 1.—Fresh organic materials decompose more rapidly than composted organic materials. About half of fresh organic matter is lost from the soil as carbon dioxide gas during the first 60 days after soil incorporation. Composted materials increase soil organic matter for a longer time. About half of the composted organic matter is lost in the first 1 to 2 years after application.

When organic materials are composted before use, the rapid decomposition phase takes place in the compost pile instead of in the soil. Organic matter supplied by compost lasts longer in soil than fresh organic matter because much of the decomposition has already occurred. However, composted organic matter is a poorer food source for soil organisms compared to fresh organic matter, so less of the sticky exudates that build soil structure are produced in the soil after compost application. On the other hand, composted materials have fewer weed seeds and are less likely to carry plant disease organisms. Composted manures are preferred over fresh manures when contamination of food crops with human pathogens such as *E. coli* is a concern.

In a garden situation, fresh or composted materials may be used. If you are establishing a raised-bed garden, compost is preferred because it will lose volume less rapidly and because it has less potential to compete with plants for nitrogen.

Common organic amendments

Because organic amendments are bulky, heavy, and expensive to transport, look for suitable amendments close to home. You can make your own compost (see "For more information," page 15) or use fresh organic materials from your yard. Local private or municipal composting operations offer a variety of compost products and usually provide delivery. Also consider the types of farming, ranching, or other agricultural operations in your area, and what types of residuals they might produce that would be available at little or no cost. You might be able to arrange for bulk deliveries of these materials with a landscape supply or trucking company. If you need only half a load, consider splitting a load with a neighbor.

Locally available amendments may include:

- Yard trimmings compost
- Leaves from deciduous trees
- Crop residues
- Manures and manure composts
- Separated dairy manure solids

The following sections describe the characteristics of these common amendments and give some suggestions for getting the best value from each amendment.

Yard trimmings compost

Sometimes sold as "garden compost," yard trimmings compost is the most widely available material suitable for high-rate incorporation into soil. Private composting companies usually produce it. Grass clippings, leaves, brush, tree and shrub prunings, or other plant materials are composted for 3 to 9 months in large piles, then screened to remove large sticks (greater than 0.75 inch). Piles typically reach temperatures above 130°F, killing most weed seeds. Woody materials dominate most yard trimmings composts. They usually have a carbon:nitrogen (C:N) ratio of less than 20:1, a pH of 6 to 7, and relatively low levels of ammonium-N and soluble salts (3 to 6 mmhos/cm). (See "Interpreting laboratory analyses for fresh organic material or compost," page 7.)

Yard trimmings compost usually increases nitrogen fertilization requirements for the first 2 months after application. Later on, it has little or no effect on nitrogen requirements.

Composted yard trimmings decompose slowly in soil. About half of the organic matter added usually remains in the soil after two growing seasons. Apply yard trimmings compost at a rate of 1 to 2 inches.

You can make yard trimmings compost in a backyard compost pile (see "For more information"). To make compost from woody trimmings, you usually need to grind these materials prior to composting.

Be selective in the materials you include in a home compost pile. It is quite common for weed seeds, vegetable seeds, and plant disease organisms to survive the home composting process.

It usually takes about 12 months to make high-quality yard trimmings compost in a backyard pile with minimal maintenance. Because yard trimmings compost from a backyard pile is not screened, it usually is coarser than purchased compost and is best used as a mulch in perennial shrub beds (see "Trees and shrubs," page 11).

Leaves from deciduous trees

Leaves are perhaps the best and most readily available organic matter source for vegetable gardens or other areas that get some annual tillage. Some cities will deliver leaves collected from streets to your property at little or no charge.

Leaf mulch, or leaf mold (partially decomposed leaves), has a near-neutral pH (6 to 7.5). The C:N ratio typically is about 50:1 in fresh leaves, decreasing to below 20:1 when fully composted. Most kinds of leaves are a good source of potassium (K); a 2-inch application supplies about 0.3 to 3 lb potash (K_20) per 1,000 square feet.

Because leaves decompose rapidly, they are not as useful as yard trimmings compost for one-time applications to landscape beds to increase organic matter.

Mulching an annual vegetable or flower garden with 1 to 2 inches of leaves in the fall adds organic matter, protects soil from raindrop impact, and smothers winter annual weeds. In the spring, the remaining leaf debris may be dug or rototilled into the soil. If you plant a fall cover crop, reduce leaf application or omit it altogether so that you don't smother the cover crop.

To compost leaves, pile them in the fall, then turn the pile several times in March and April. Leaf mulch from a home compost pile is excellent for summer mulching around rhododendrons, blueberries, and other shrubs that are sensitive to summer drought, or in vegetable and flower gardens. Apply 1 to 2 inches after soil has warmed (June).

Partially composted leaves also can be used to improve soil in annual planting beds.

Crop residues

Fresh or composted crop residues may be available from nearby farms, tree-trimming companies, or your own kitchen. Uncomposted crop residues may contain weed seeds, while properly composted residues are weed-free.

Woody materials such as hazelnut shells or ground tree prunings can be used as a mulch around trees or shrubs. Crop residues from annual crops (fruit, leaves, straw) decompose more rapidly in soil than do woody materials. Fruit and vegetable residues contain mostly water and readily degradable organic matter. They can be incorporated into a backyard compost pile or buried immediately in soil. As a general rule, the juicier and leafier the crop residue, the less valuable it is for long-term soil organic matter enhancement.

Peppermint hay, consisting of leaves and stems that have been heated to remove peppermint oil, is one of the most commonly available residues from Willamette Valley farms. Freshly cooked peppermint hay, offered for sale in August, has roughly the same levels of nitrogen and potassium as manure and fresh grass clippings. It also is high in soluble salts. Over half of the organic matter in fresh hay decomposes in the fall after application.

Composted peppermint hay, which is offered for sale in the spring, is more suitable for landscape use than freshly cooked hay and has greater long-term value as a soil amendment. After composting, peppermint hay is dominated by fibrous stems that make a good mulch or soil amendment. Peppermint can be composted with other low-nutrient materials (e.g., straw or woody materials) to make an excellent soil amendment.

Manures and manure composts

Many manures and manure composts have high soluble nitrogen, ammonia, or salt content, or high pH (above 8). Thus, their suitability for use in landscapes is limited.

Composting transforms soluble nitrogen in manure to slow-release organic forms, decreases ammonia to levels that do not injure plants, and sometimes reduces pH (to 7 to 7.5).

However, composting concentrates salts. Chicken manure and feedlot (steer) manure composts typically contain very high salt levels. Mushroom compost, a mixture of manure plus cottonseed or soybean meal and other inorganic amendments, is also high in salts.

In general, it is best to avoid manure and manure composts for high-rate applications to planting beds. Use manures in small amounts to replace nitrogen–phosphorus–potassium fertilizers. Ask for a compost analysis and check for soluble salts and ammonium-nitrogen when evaluating composted manure products. See "Interpreting laboratory analyses for fresh organic material or compost," page 7, for more information.

continues on page 8

Interpreting laboratory analyses for fresh organic material or compost

Laboratory analyses describe and quantify product quality. Many commercial compost suppliers regularly test their product and provide product information if you ask for it.

Moisture content (% "as-is" amendment weight). Tells how much water and organic matter are present. A material that has 40 percent moisture has 60 percent dry matter. *Best:* 40 to 60 percent moisture content. Less organic matter is present at high moisture content (greater than 60 percent), and the material usually is very dense and heavy. Low-moisture materials (less than 40 percent) sometimes are dusty.

Percent organic matter (% dry weight). Percentage of a dry amendment that is organic matter. *Best:* 40 to 60 percent. Low values (less than 30 percent) usually indicate that organic matter has been mixed with sand or soil. High values (greater than 60 percent) indicate fresh, uncomposted material.

pH. Indicates acidity or alkalinity of the soil. Lower values indicate greater acidity. *Best:* 6 to 7. Values below 5 or greater than 8 may injure plants. Some plants (blueberries, rhododendrons) prefer an acidic pH, near 5.

C:N (ratio of carbon to nitrogen). *Best:* Stable soil organic matter has a C:N ratio of 12:1 to 15:1. Ratios less than 10:1 are typical of uncomposted manure, which will decompose rapidly in soil and release plant-available nitrogen. Ratios greater than 25:1 are typical of uncomposted woody plant materials or crop residues such as wheat straw. Incorporation of high C:N materials (greater than 25:1) usually reduces the supply of plant-available nitrogen in the soil for several months.

Ammonium-nitrogen (NH_4-N; dry weight basis). Ammonium-nitrogen is available for immediate use by plants. *Best:* less than 500 ppm.

Ammonium-N concentrations above 1,000 ppm (0.1 percent) typically are present in manures that have been incompletely composted. Materials with high ammonium concentrations are not ideal for high-rate incorporation into soil because they supply too much water-soluble N (see "plant-available nitrogen"). High ammonium-N levels can cause plant injury when the organic material is added to planting holes or is not thoroughly mixed with soil. Ammonium-N usually is converted to nitrate-N within a few weeks after application. You usually can avoid problems with ammonia toxicity to roots by allowing a month between organic matter application and planting.

Electrical conductivity (EC). A measure of the soluble salt content of the material. Salt content is measured by the electrical conductivity (mmhos/cm) of the material. *Best:* 0 to 4 mmhos/cm. *Poor:* above 8 mmhos/cm. High salt content means high conductivity, which may injure plants. Avoid using materials with high EC in planting holes because salts may damage roots.

Nitrate-nitrogen (NO_3-N; dry weight basis). Nitrate-nitrogen is immediately available to plants. *Best:* 200 to 500 ppm. Materials with high nitrate concentrations supply too much water-soluble N (plant-available N) when applied at typical rates (1 to 2 inches of compost). Materials with very low nitrate concentrations (less than 50 ppm) and high C:N ratio (above 25:1) likely are incompletely composted and will increase N fertilizer requirements for several months after application.

Plant-available, water-soluble, or inorganic nitrogen. This is the sum of ammonium-N plus nitrate-N (dry weight basis). One inch of a compost with 1,000 ppm N (ammonium + nitrate-N) supplies about 1 lb of water-soluble nitrogen per 1,000 square feet.

Excess water-soluble N can leach through soil and contaminate groundwater. Limit application rates of materials having ammonium + nitrate-N concentrations above 1,000 ppm.

Separated dairy manure solids

One manure by-product that is acceptable for high-rate application to most planting beds is called separated dairy manure solids. Separated solids are available from dairies west of the Cascades in fresh and composted forms. Separated dairy manure solids (composted or uncomposted) are much lower in salt, ammonia, and soluble nitrogen than raw dairy manure. They have a pH of 7 to 8 and soluble salt levels similar to yard trimmings compost (3 to 6 mmhos/cm). The C:N ratio of fresh solids is approximately 30:1, declining to 15:1 after composting.

Fresh separated solids usually are less expensive, but lower in quality than composted separated solids. Fresh solids may contain weed seeds. Fresh dairy solids increase nitrogen fertilizer requirements for 4 to 8 weeks following application, then act as a slow-release source of plant-available N. About half of the organic content of fresh separated dairy solids is lost via decomposition during the first months following soil incorporation.

Composted separated solids are a better value for long-term soil organic matter enhancement because they decompose more slowly in soil. Composted solids are essentially weed-free. Composted solids provide slow-release nitrogen for plant growth starting several weeks after application.

Organic amendment quality

When applying high rates (1 to 2 inches) of an organic amendment, look for organic amendments that will promote stable soil conditions and balanced plant nutrient levels. Organic amendments like these are:

- Well-mixed and easy to spread—Quality organic amendments have a consistent texture and moisture content, are free of large sticks, and can be handled easily with a shovel or fork.
- Do not injure plants when applied at high rates or change usual fertilization practices—Quality organic amendments have a pleasing, earthy smell. They do not smell like ammonia (excessive nitrogen will burn seedlings and tender root growth) or rotten eggs (anaerobic decomposition results in organic acids, which may prove toxic to some plants). Excessively woody materials will rob plants of soil nitrogen as they decompose.
- Decompose slowly—Quality organic amendments decompose slowly when applied to soil because considerable decomposition has already occurred during storage or composting. Rapidly decomposing materials may tie up soil nitrogen temporarily, may create organic acids in the soil as oxygen levels are reduced, and will undergo a reduction in volume as decomposition proceeds.

Amendment quality also includes particle size, nutrient and organic matter content, pH, and carbon-to-nitrogen ratio. Quality amendments have low concentrations of contaminants, including salts, weed seed, pesticides, or other foreign substances.

Many commercial compost suppliers regularly test their product and provide product quality information if you ask for it. “Interpreting laboratory analyses for fresh organic material or compost” (page 7) discusses some of the criteria for assessing the quality of organic materials and will help you interpret product information.

Estimating amendment volume needed for a project

You can easily estimate how much amendment you need to cover a known area to a desired depth. Choose the depth of application (in inches), and measure the area to be amended (in square feet). Table 1 estimates the volume of amendment (in cubic yards) you will need.

Table 1. Estimating the volume of organic amendment needed.

Depth of amendment desired (inches)	Area of garden (square feet)*			
	200	500	1,000	2,000
	Organic material to add (cubic yards)			
1	0.6	1.5	3.1	6.2
2	1.2	3.1	6.2	12.3
3	1.9	4.6	9.3	18.5
4	2.5	6.2	12.3	24.7

*To estimate square footage of a garden, multiply the length by the width (in feet).

For smaller gardens, a yard of material is too much, so a 5-gallon bucket makes a handy measuring device. For example, suppose your garden is 10 feet by 10 feet (100 square feet), and you want to incorporate a 1-inch layer of compost. One inch is 1/12 of a foot, so you would need 1/12 times 100 square feet (100 x 1/12), or 8 cubic feet of compost. One and one-half 5-gallon buckets equals approximately 1 cubic foot, so you would need 12 buckets of compost (8 x 1.5). Keep in mind that there are 27 cubic feet in 1 cubic yard of compost.

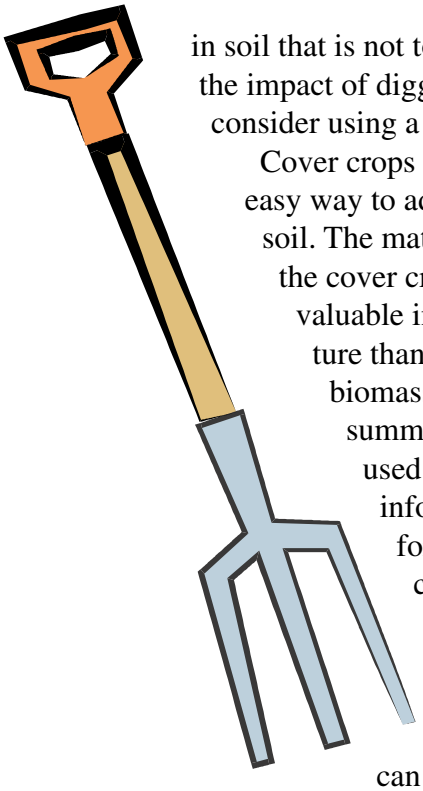
Incorporating organic matter into soil

There are several ways to mix organic matter into garden soil. The most common methods involve digging or rototilling (Figure 2). Rototillers are effective, but hand-operated machines usually are capable of working only the top 4 to 6 inches of soil. Tractor-mounted rototillers may enable you to mix up to 8 inches deep. For incorporating amendments over a relatively large area, rototillers are probably the best option.

Excessive rototilling, however, has very detrimental effects on soil structure, particularly if done when the soil is wet. Rototilling can compact soil just below the tillage depth, reduce the volume of pore spaces in soil for air and water, and kill earthworms.

Digging amendments into the soil is laborious, but will enable you to incorporate as deeply as you choose to dig, up to 12 inches. It also avoids many of the problems associated with rototillers. An ordinary spade works well

Figure 2.—Rototilling is one way to incorporate organic matter into soil. Hand digging can be just as effective, however, and is less likely to damage soil structure.



in soil that is not too wet. To minimize the impact of digging on soil structure, consider using a spading fork.

Cover crops provide a relatively easy way to add organic matter to soil. The mat of roots formed by the cover crop often is more valuable in building soil structure than the above-ground biomass. Both winter and summer cover crops can be used. (See "For more information," page 15, for details on cover crops suited to your garden.) You can dig in the cover crop before planting your garden. Or, you can remove the above-ground plant material and compost it.

Another option is to apply a layer of organic amendment on the soil surface and simply plant into it. This method has the advantage of not requiring any disturbance of the soil structure. Also, the amendment will serve as a mulch and help preserve soil moisture and suppress weeds. It will take longer for the amendment to improve the organic matter content of the soil by this method, however.

Using organic matter for landscape installation and maintenance

Lawn establishment

Amending soil with compost prior to establishing turf can help get a new lawn off to a good start by providing a better environment for root growth. Healthy lawns with deep root systems require less water during summer and are more resistant to weed invasion.

After establishment, a vigorous lawn produces its own organic matter. Grass roots are one of nature's best soil structure builders, partly because they provide food for soil organisms. Living roots provide a rich food source for organisms. Grass roots live for a year or less; new roots grow each year to replace those that die. The dead roots are continuously sloughed from the plant and add to soil organic matter. One of the keys to getting this natural organic matter factory working in your lawn is to provide good soil quality for turf establishment.

Use only composted organic materials for soil amendment prior to grass establishment. Use compost that has been screened (particles less than 0.5 inch). Sticks and other coarse organic materials make it difficult to establish a firm seedbed prior to seeding or sodding. Screened yard trimmings compost is widely available and usually is suitable. Do not use fresh organic materials, because they are too difficult to mix evenly with soil and can cause low spots in the lawn as they decompose rapidly.

Apply 0.5 to 1 inch of compost and incorporate it into 6 inches of soil with a rototiller. Higher compost application rates can cause an uneven, bumpy lawn as the result of intense earthworm activity and loss of volume as compost decomposes. Use less compost if the material is high in plant-available nitrogen (ammonium-N + nitrate-N; see "Interpreting laboratory analyses for fresh organic material or compost," page 7). Use less compost if you do not till the soil to a 6-inch depth.

Lawns require adequate pH and nutrient levels for rapid establishment. By testing your soil and compost, you can provide the right amount of phosphorus, potassium, and lime for the new lawn (see "For more information," page 14). It's best to incorporate these fertilizer materials into the soil at the same time you incorporate compost.

Nitrogen fertilizer can be added before or after you mix compost with the soil. Compost analyses may be helpful in adjusting nitrogen fertilizer application rates.

Vegetable and flower gardens

Vegetable gardens tend to contain many annual or biennial plants. Because some, or all, of the soil can be disturbed annually, these soils can be amended on a routine basis.

Some vegetable crops, such as rhubarb, are perennials, and many herbs are small shrubs. The deeper roots of these plants and of annual root crops such as carrots do better in soils amended to a depth of 10 to 12 inches.

Ornamental gardens that contain mostly herbaceous perennial or woody plants must be amended prior to planting. Many perennial plants are dug from time to time for division, providing an opportunity to add further amendments every few years.

Trees and shrubs

Shrubs and trees are more permanent, so soil must be well prepared at the time of planting. It's best to amend soil to a depth of 12 inches in these gardens. Mulching in these situations will increase the effectiveness of the soil amendment, and over time some of the mulch will become incorporated into the soil.

Tree and shrub root systems are not a mirror image of the top of the tree; instead, they resemble pancakes. Roots are found mostly in the top 2 feet of soil, and can spread to two to three times the diameter of the canopy, or more. Thus, it generally is better to amend the largest possible area around these kinds of plants.

Figure 3.—When planting a tree or shrub, dig the hole only as deep as the root ball, but several times wider. It's best not to amend the planting hole with organic matter.

Amending only a planting hole and not amending surrounding soil is not the best way to use organic amendments in tree and shrub plantings. If soil is compacted and has poor structure, and only the planting hole is heavily amended with organic matter, the planting hole functions like a large pot. The tree roots grow rapidly through the permeable, amended soil, but have difficulty penetrating the hard surrounding soil. This limits growth and increases the risk of tree blow-downs. Another problem is that water readily enters the amended planting hole, but drains more slowly into the surrounding compacted soil, which may create problems with waterlogging and cause root damage.

When planting trees and shrubs, dig the planting hole no deeper than the root ball of the plant, but several times wider than the diameter of the root ball (Figure 3). At a minimum, loosen the top 12 inches of soil around the planting hole to increase permeability and aeration. If the soil quality is particularly poor, you might consider adding a maximum of 25 percent organic amendment (by volume) to the loosened soil. Always use a soil amendment that is low in soluble salts, such as yard trimmings compost or composted leaves. Avoid materials that typically have a high soluble salt content, such as animal manures or mushroom compost.

Small shrubs have smaller root systems and are not a risk to blow over, so they can be planted in raised beds amended with organic matter. Raised beds provide better drainage than flat plantings, and it often is easier to mix organic matter with loose soil in a newly formed raised bed. If you add soil or a compost-soil mix to construct a raised bed, loosen the existing soil with a shovel or fork before adding the new soil to form the raised bed.

Construct raised beds several inches above the existing grade to provide sufficient rooting volume. The width of the raised bed should reflect the size of the plant at maturity. The larger the plant, the wider the root system is likely to be. Thus, the bed probably should be at least twice the diameter of the shrub's expected width at maturity.

Mulching the soil surface with 2 to 4 inches of coarse compost, wood chips, bark, or similar materials is a way to add organic matter to existing shrub beds and under trees. Mulch can suppress weeds, conserve soil moisture, and moderate soil temperatures, all of which improve plant growth even if soils are not amended before planting. If you amended a shrub bed prior to planting, mulching the bed afterward will help maximize the benefit of the soil amendment. Mulching to conserve soil moisture is particularly useful for raised beds, since water tends to evaporate more readily from beds than from flat soil.

Over time, earthworms and other soil organisms incorporate some of the mulch into the soil, providing a natural soil amendment process similar to what happens under a forest.

Questions and answers

Topsoil was removed or buried during the construction of my home. Is adding more topsoil better than amending with organic matter?

After topsoil is removed or buried, you are left with subsoil, a poor medium for plant growth. Subsoil typically is low in organic matter and impervious to water, air, and plant roots. This problem is often addressed by spreading topsoil over the compacted subsoil layer. Before you use this approach, consider several potential problems:

- The quality of the added topsoil may not be significantly better than the existing soil. Unlike compost, there are no standards for topsoil quality, so before accepting delivery of topsoil, inspect it and try to assess organic matter content and other quality issues such as the presence of weeds or weed seed.
- Even if the topsoil quality is good, the layer of soil will be thin and may not allow for extensive root growth, as roots will tend not to grow into the compacted soil below. One result can be reduced growth, but more importantly shallow root systems increase the likelihood of blow-down in high winds, especially in the case of trees.
- The subsoil layer beneath may impede drainage, causing problems with growth and root diseases.

In most cases, the best alternative is to amend the existing soil with organic matter, then bring in topsoil for areas of the landscape where added soil will have the most benefit (e.g., a raised-bed garden).

Will gypsum improve soil structure?

Gypsum is sometimes recommended for improving soil structure for soils west of the Cascades. Gypsum is calcium sulfate, and it is claimed to break up and loosen clay soils. In fact, soil response to gypsum is variable. There is no consensus among soil scientists that gypsum will improve soil structure in heavy clay soils.

Is there anything organic matter won't do for soil quality?

A single addition of organic matter to soil will not necessarily have long-term effects on soil quality. Over time, the organic matter content of the soil will decline because of decomposition. To maintain the organic matter content of the soil, further organic matter incorporation, mulching, or establishment of a perennial grass sod will be required.

Addition of organic matter will not eliminate the need for watering flower beds and vegetable gardens during dry summer weather. You probably will find that gardens amended with organic matter require less frequent irrigation,

but, in most areas, summer water still is required for best growth and appearance of most plants.

Although in many cases incorporation of organic matter into soils improves drainage, there are some drainage problems that organic matter cannot improve. In low-lying areas where water tends to pond on the surface, the soil will become saturated if there is no lower-lying area to which the water can drain. In saturated soils, additional organic matter may undergo anaerobic decomposition, and plant-toxic organic acids may result.

Will adding organic matter to soil eliminate or reduce soil-borne plant disease?

Amending soils with organic matter generally improves plant health by encouraging root system development, improving drainage, and allowing gas exchange within the soil. Organic matter addition also usually increases the quantity and diversity of soil microorganisms and increases the level of competition among them, which generally is beneficial to the soil ecosystem.

On the other hand, fresh organic matter may contribute to plant disease by providing a food source for disease-causing soil microorganisms. Uncomposted materials also might contain plant and human pathogens. Gardeners may inadvertently introduce plant diseases with fresh organic materials. Allow fresh organic materials to decompose in the soil for a month before planting.

Suppression of plant disease by soil organisms is a complex biological process that is difficult to predict. If you have experienced problems with common soil-borne diseases such as Phytophthora root rot, Verticillium wilt, or damping off, you should not expect to solve these problems by adding organic matter.

Will adding sand promote drainage in clay soil?

Occasionally, a homeowner tries to change the basic nature of a clay soil by adding sand. Clays are well-ordered mineral structures that form extremely fine, flat particles. These particles are layered something like a messy deck of cards. The spaces between clay particles are extremely small, which is why water and air move between them so slowly.

The diameter of the finest sand is more than a thousand times larger than the diameter of the largest clay particle. Sand worked into clay soils provides a surface onto which clay particles can adhere. The result is a concrete-like mixture that can be more difficult to manage than the original clay soil. No amount of added sand will change a clay loam into a sandy loam.

Are herbicide residues a problem in composted materials?

In very rare cases, compost is contaminated with herbicides used in turf or agricultural weed management. These residues survive the composting process and result in injury to subsequent plantings. Another source of herbicide contamination in compost can be animal manure, as animals can pass some herbicides through their systems from contaminated feed.

The easiest and cheapest way to tell whether compost is contaminated with herbicides is to conduct a bioassay. This is a simple test that allows you to look for the effects of herbicides in compost. To conduct an herbicide bioassay, mix equal parts of potting soil and the suspect compost. Fill four pots with the potting soil–compost mix, and four pots with potting soil alone. Plant each pot with the plant you would like to grow. Place pots in adequate light, and water regularly. Compare the results from the two sets of pots. Extension Master Gardener volunteers can provide more information on the diagnosis of plant injury from herbicides.

Will adding organic matter correct problems with soil acidity?

Some plants, including many vegetable crops, are sensitive to soil acidity (low pH). Soils west of the Cascades are naturally acidic. Plants sensitive to soil acidity may exhibit poor growth even when the soil has excellent physical condition (good tilth).

Adding organic materials to soil generally increases soil pH slightly (reduces acidity). However, it is not as effective as lime at raising the pH of very acid soils. The best way to determine appropriate lime application rates is to have a soil test performed by a reputable soil testing laboratory. If you are considering tillage to incorporate organic matter, it makes sense to add lime (if needed) at the same time, because lime needs to be mixed with soil to be effective.

What is the difference between a mulch and a soil amendment?

A mulch is a protective layer of material that is spread over the soil surface. Unlike a soil amendment, mulches are not dug or rototilled into the soil. Mulches are commonly used in home and commercial landscapes to reduce water evaporation from the soil, suppress weeds, protect soil from compaction, and provide nutrients to the soil. Generally speaking, mulches improve the soil environment and growing conditions for most plants, regardless of whether the underlying soil is amended.

Mulching materials are as varied as the reasons for using them. They include manufactured products, such as woven polyethylene sheets, and organic materials, such as compost, leaf mold, manure, barkdust, and nutshells.

Organic materials that make good mulches in perennial plantings usually have larger particle size than organic materials used for amending soil. Woody materials make excellent mulches because they have lots of pore space to trap water and prevent it from running off, and they are not conducive to weed growth. When woody materials are used as a mulch, their decomposition does not cause nitrogen deficiency in plants.

Some materials that are used as soil amendments, such as leaf mold, compost, and certain crop residues, also can be used as effective mulches.

For more information

OSU Extension Service publications

Cover Crops for Home Gardens, FS 304 (revised 1994).
Fertilizing Home Lawns, EC 1278 (1989).
Gardening with Composts, Mulches, and Row Covers, EC 1247 (1986).
A List of Analytical Labs Serving Oregon, EM 8677 (revised 2002).
Practical Lawn Establishment and Renovation, EC 1550 (2002).
Soil Sampling for Home Gardens and Small Acreages, EC 628 (revised 2002).
Soil Test Interpretation Guide, EC 1478 (1996).
Using Cover Crops in Oregon, EM 8704 (1998).
Water-efficient Landscape Plants, EC 1546 (2001).
Willamette Valley Soil Quality Card, EM 8711 (1998).
Willamette Valley Soil Quality Card Guide, EM 8710 (1998).

Many OSU Extension Service publications, as well as additional gardening information, may be viewed or downloaded from the Web (**http://eesc.oregonstate.edu**).

Copies of many of our publications and videos also are available from OSU Extension and Experiment Station Communications. For prices and ordering information, visit our online catalog (http://eesc.oregonstate.edu) or contact us by fax (541-737-0817), e-mail (puborders@oregonstate.edu), or phone (541-737-2513).

WSU Cooperative Extension publications

Backyard Composting, WAEB 1784.
Soil Management for Small Farms, EB 1895.

Visit the WSU Cooperative Extension publications Web site (**http://pubs.wsu.edu**).

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